CQ VHF Ham Radio Above 50 MHz

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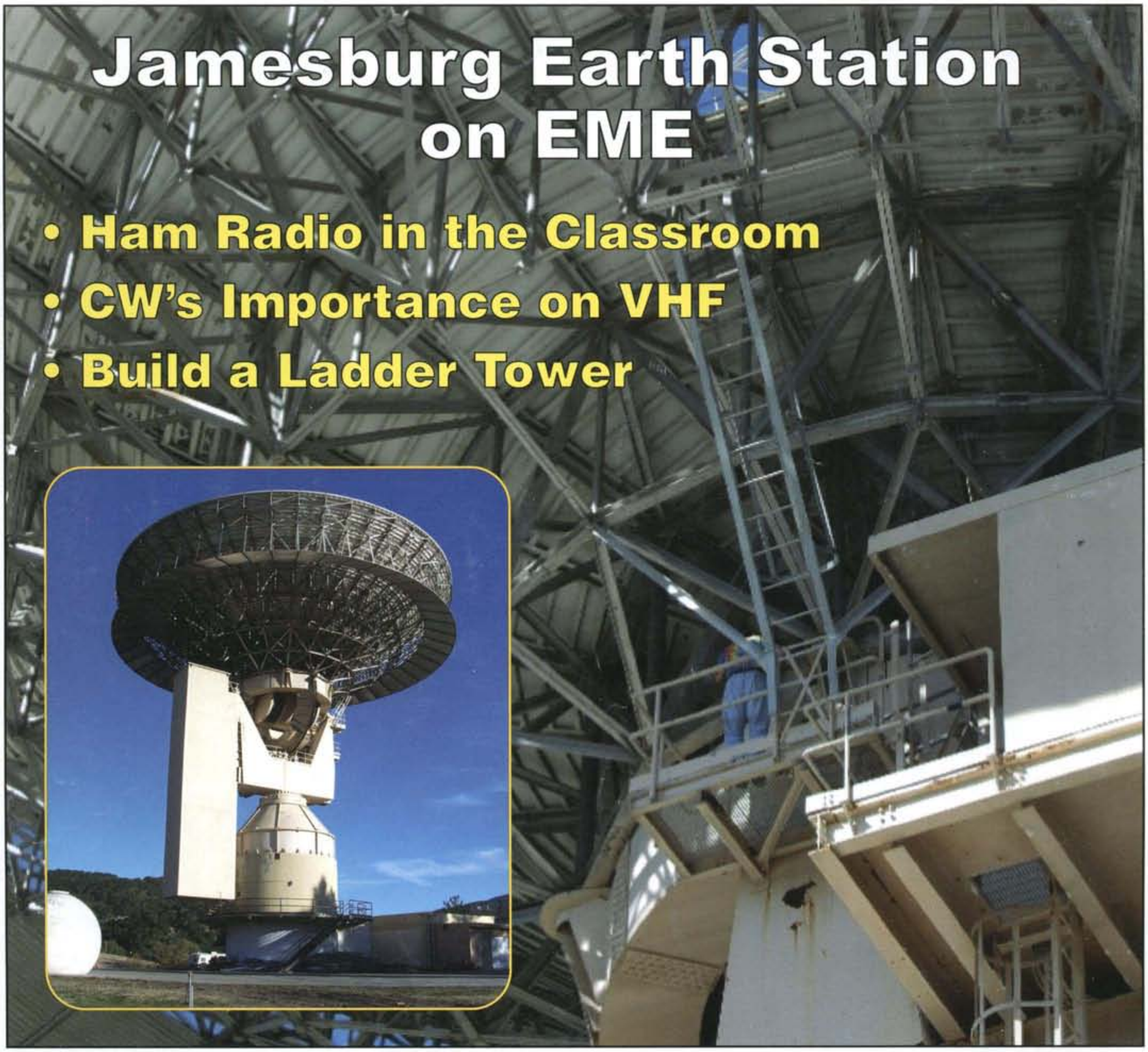

Jamesburg Earth Station on EME

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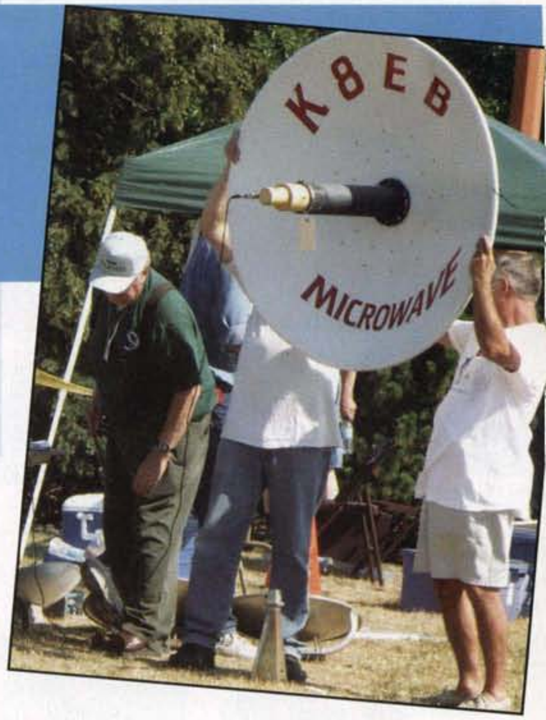

Spring 2007
Vol. 10 No. 1

FEATURES

COLUMNS

DEPARTMENTS

On The Cover: The Jamesburg Earth Station in California, with its 30-meter dish, is finding new uses, including EME. For details see the article by Pat Barthelow, AA6EG, on p. 6. (Cover photo by Stephen Gocala, KB8VAO; inset photo by Gerald Moseley)

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Dire Warnings of Work-Force Shortages

"By next year, an estimated one-in-four U.S. aerospace workers will be eligible to retire; nearly one-in-three civilian scientific and technical workers in the Defense Dept. have already reached that milestone. And the full impact of the graying work force hasn't hit yet. In 2011, an 18-year-long wave of baby boomers will start collecting Social Security and Medicare benefits."

This dire warning, written by Joseph C. Anselmo for the February 4, 2007 issue of *Aviation Week and Space Technology* is only part of his comments on the gloomy picture of the condition of today's aerospace and defense industries. Regarding the Social Security and Medicare benefits, some of the baby boomers who retire early will begin to collect Social Security benefits as early as next year!

In addition to the aerospace and defense industries, our air-traffic-control system is expected to see mandatory retirement of 15,000 air-traffic controllers in the next ten years. This means that the FAA will have to begin recruiting and training new controllers almost immediately. Additionally, it will have to recruit and train a considerably smaller but still significant number of electronic technicians who maintain the radar and radio equipment used by these controllers for managing this country's air-traffic system.

What can we do about this crisis? The good news in our hobby is the unprecedented spurt in growth of as a result of the elimination of the Morse code requirement for ham radio licensing. According to Dick Renaud, W8KDR, of the "ARRL Club News": "Volunteer Exam sessions around the country, many of them club sponsored events, are churning out many new and enthusiastic hams. This is evident on the airwaves. The influx of good operators looking to learn the ropes of DXing, contesting, traffic handling, and just plain old rag chewing is remarkable."

Will this growth be sustained? The pessimists claim that it will not. Citing other incentive licensing events as short-lived spurts in the growth of our ranks, they claim that "this too shall pass." As a pragmatist, I think that it very well may pass if we do not capitalize on the growth. One very important way of doing this is by good mentoring, or as we call it, "Elmering." With this steady influx of new hams comes an immediate and strong need for them to be properly trained and mentored. Without it, they will not learn the needed good operating techniques and will become discouraged and leave the hobby, almost as fast as they entered it.

Going back to the growing industry shortages, we also need to work on recruiting and training amateur radio operators who show an interest in the technical side of our hobby. We can do this in a number of ways. For example, if you are considering retiring from your present job, you might think about using your new-found leisure time wisely by volunteering in the science or math department in your nearby middle school or high school. Better yet, if you have a bachelor's degree, you might consider becoming a school teacher. Every state in the country has some form of alternative certification for persons with a bachelor's degree. Check with your state's education department to learn about its requirements and how easy it might be for you to start a second career as a school teacher. You can also apply for a job as an adjunct instructor or professor in the electronics department of your nearby community or junior college or vocational school.

Speaking of alternative certification Jeff Sharrock, AF4CM, is just such an example. A former Marine, Jeff went through the military's Troops to Teachers program to become a history teacher at Wagoner, Oklahoma High School. During his tenure there he started an amateur radio club that capitalizes on the proud history of the Native American military code talkers, calling his club the Wagoner Windtalkers. You can read his story beginning on page 36.

Another way to find opportunities to volunteer is via your state's space grant consortium. You can locate your state's space grant consortium at <http://calspace.ucsd.edu/spacegrant/webmap/sg_homepages.html>. On this website you will find a map of the U.S. Simply click on your state and you will be taken to its website. Once there, you will need to navigate around to learn about what amateur radio related activities might be taking place in your state. A clue is to look for a mention of CubeSats or balloon satellites on the website or via one of the links on the website.

Speaking of space grant consortia, beginning on page 14 in this issue is an article written by Kevin Carr, KE7KVT, that speaks to his experience with the Oregon Space Grant Consortium. Kevin is a newly licensed amateur radio operator who first got interested in radio communications as a youth. Now, at age 42, as a professor at George Fox University in Oregon he is teaching teachers of K–12 schools how to build amateur radio based payloads for balloon satellites as well as how to launch these balloons.

Sharrock's and Carr's articles are only two of the more than half of the feature articles in this issue that have education as a common theme. Hopefully, you will find something that will inspire you as you read through these articles. It is my plan to regularly publish education-related articles. If you have an education-related story to tell, please submit it to me (e-mail: <n6cl@sbcglobal.net>).

As I think of stories, I am reminded of the book *The Star Thrower*. In it, author Loren Eiseley writes of his experience of seeing a man throwing starfish back into the sea. In the course of his conversation with the man, he discerns that the man is trying to make a small difference in his world by saving one starfish at a time. One of the things that we are trying to do via this magazine is create an opportunity to bring in one new amateur radio operator at a time. We do this by way of publishing your story or giving publicity to your activity. While we are a small magazine with a limited readership, like the starfish thrower, we intend to make a difference, thanks mainly to you and your contributions. Until the next issue…

73 de Joe, N6CL

Jamesburg Earth Station on EME

Nearly 40 years ago the Jamesburg Earth Station was built for the purpose of providing reliable satellite communications, as well as support for the U.S. mission to the Moon. While some of the station seems to have outlived its usefulness, AA6EG has envisioned new uses for the old dish.

By Pat Barthelow,* AA6EG

A few years back, I came across a story in the *Carmel Pine Cone,* the local newspaper of the quaint, small, expensive town of Carmel, on the Monterey Peninsula, on the central California coast. The article featured a photograph of the old AT&T/Jamesburg/COMSAT Earth station and a story about it, with the complete 160-acre parcel, being put up for sale by AT&T. AT&T now does with fiber optics what it used to do with the big, worldwide Earth station network, so it decided to sell some of its Earth stations. In fact, most original Earth stations have become dormant, and in some cases been dismantled, in recent decades. The 30-meter dishes are no longer necessary for solid satellite communications, although they might be put to use for other deeper space communications pursuits. There are a number of large dishes waiting for hams or others to apply the TLC and money to bring them back to useful life.

I thought, what a wonderful opportunity for someone to purchase the Jamesburg station, but I also thought that most likely the 30-meter dish would then be demolished. Here was an opportunity to approach the new owner to see if, after purchase and before disposition of the dish, perhaps some ham radio opera-

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The Jamesburg Earth Station in Cachagua Valley, California shown nestled in among the rolling hills of the 160-acre property. (Photo by Gerald Moseley)

This is a nice view of the adjacent countryside with its surrounding hills. (Photo by KK6MK)

Full view of the 10-story Jamesburg Earth Station Dish. (Photo by Gerald Moseley)

The underside of the Jamesburg Earth Station Dish in Cachagua Valley, California (about 20 miles southeast of Monterey), a 10-story tall, 97-foot diameter dish. This view shows the ladder to the access hatch and top surface of the dish. The operations room is to the right. (Photo by KB8VAO)

Partially elevated dish. (Photo by N9JIM)

tors could work on the dish, bringing it back to life for moonbounce communications.

Using public information sources, I learned that the entire 160-acre AT&T parcel was purchased for $1.75 million and by whom. I contacted the new owner and his representatives. The owner is a Silicon Valley businessman who appeared to want the property for a "country home" and had no particular interest in the dish. In fact, at the time he thought of it as more of a liability than an asset in his property development plans.

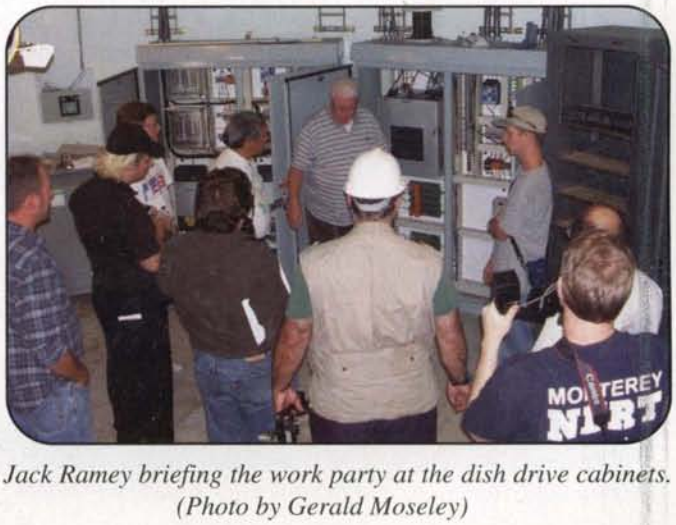
A Plan

I contacted a long-time ham friend, Dave Smith, W6TE, an avid and well-equipped moon-bounce operator, and told him the news. We immediately thought about how to make an offer to the owner to allow us to commission the dish for EME (Earth-Moon-Earth) operations. For a while it seemed that the owner was not interested, except maybe for the publicity that would be generated by our EME activity.

At about the same time I was working on a terrestrial microwave community-service project with Cal State, Monterey Bay, and was active in WETEC 2005, a conference at the university covering various student and faculty wireless-technology projects with professional and student papers submitted. I arranged for a tour of Jamesburg during the conference. Susan Irwin, CEO of Irwin Communications, and well known in the satellite communications industry, among others, came out, and we immediately brainstormed at the site to find a future for the dish. After careful deliberations by some of the best people in the satcom business, it was determined that there were probably few to no viable business models for use of the dish in the industry.

Sue, Dave, and I lamented that the price of the 160-acre total package, or even the 60 acres that comprise the 5-acre dish compound, was out of our financial reach. Dave and I, along with some other hams, were allowed another visit to the site and were even encouraged to clear out and cherry pick some of the remain-

Planning meeting with the master, Jack Ramey. Left to right: Chris Knight, K6PIC; Gerald Mosley; Brian Klofas, KF6ZEO; Brian Yee, W6BY; Jack Ramey; Jim Moss, N9JIM; Pat Barthelow, AA6EG; John Castorina, WB6AZP; and Thor Rasmussen, N6FNP. (Photo by AA6EG)



Jack Ramey briefing the work party at the dish drive cabinets. (Photo by Gerald Moseley)

Bryan Klofas, KF6ZEO, and Brian Yee, W6BY, using heat to loosen the stow pin. (Photo by WB6DCE)

Stow pin puller jig. (Photo by WB6DCE)

ing RF gear. We ended up bringing home oscilloscopes, spectrum analyzers, signal generators, rubidium frequency standards . . . you know, the usual hamfest stuff.

We then saw that the owner had listed the dish for sale on eBay and became resigned to the fact that it was not likely to be accessible for moon-bounce use. However, the eBay offer had no takers. This turn of events created new hope—and a new sense of urgency!

Team Building

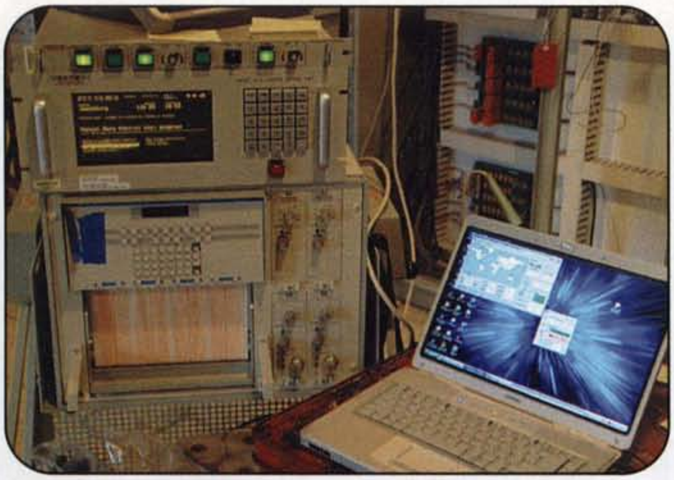
Dave and I put out the word, and together we quickly began to build a team to go to Jamesburg to get an EME station on the air before the dish perhaps was sold, or the 20,000-square-foot concrete "bunker" was turned into a residence for the owner, in which case access to the dish would be gone.

Initially we received a few positive responses, with a lot of new hams asking, "What is moonbounce?" For me, this question confirmed the fact that mainstream ham radio is a much less technical hobby than it used to be. Much of the feedback from the ham community, and particularly the professional satcom community, was interesting—something like, "Yeah, right. You bunch of hams got access to a 100-foot dish for use on EME? Give us a call when/if it's real and quit breathing that solder smoke." The strongest response to our inquiry came from guys within the 50-MHz and up group in south Silicon Valley.

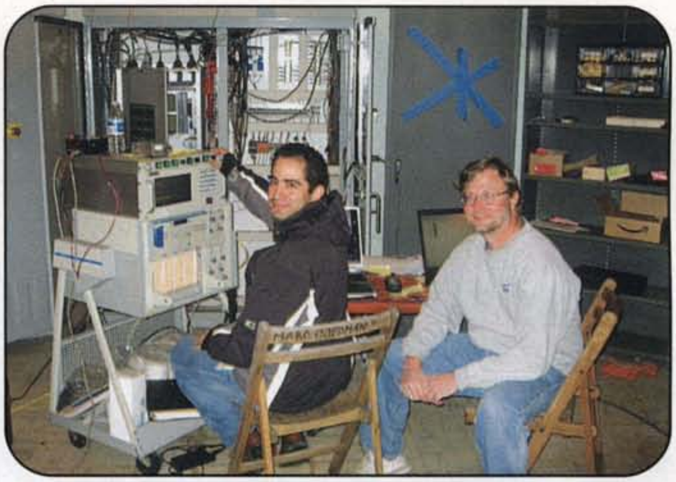
In the fall of 2006 I arranged to have the team visit the site and see what needed to be done to make the dish workable for moonbounce. However, at about this same time Dave, W6TE, had to remove his EME and HF contest super station from the roof of California State University Fresno, because new faculty members wanted the rooftop for other projects. As a result, he was burdened with that huge job and therefore could not lead in the initial stages of the Jamesburg recommissioning.

The Jamesburg owners were quite impatient to move forward. Therefore, new key players emerged, many coming out to the site

Jim Moss, N9JIM, on the dish about to install the feed. (Photo by W6BY)



The Vertex 7210 tracking computer, with ham control computer. (Photo by KK6MK)



Rico Maldonado and Jim Moss, N9JIM, at the tracking computer. (Photo by KK6MK)

in November 2006. They came from as far north as Sacramento to as far south as Santa Paula, and included people from university astronomy departments and CubeSat programs, including the father of the CubeSat program, Dr. Bob Twiggs, KE6QMD. Our work party had a good time inspecting the dish and drive system. We also received valuable help from Jack Ramey, a retired COMSAT employee who had spent 30 years at Jamesburg and had intimate knowledge of the Jamesburg Earth station.

Jim Moss, N9JIM/6; Brian Yee, W6BY; and Bryan Klofas, KF6ZEO, a student involved in CubeSats at Cal Poly, came out, along with a lot of other local hams. With this team we did a walk-through orientation of the Jamesburg station, read the comprehensive manuals for dish operations, and then grabbed our flashlights, DVMs, and soldering irons, doing checks and repairs of the various interlocks and wiring that controlled the dish.

Huge Machine

With tons and tons of moving steel and some parts that were unknown or irreplaceable, it was scary to contemplate commanding the dish to move for the first time in three years, hoping there were no defects that could do damage to the dish, or to us! For almost its entire lifetime the dish had been pointing close to the International Date Line at the equator at an Intelsat geosynchronous satellite, passing phone and television traffic among the United States, Asia, and Australia/Micronesia. Now we were getting ready to put it through major elevation maneuvers to point it at, and ultimately track, a very nonsynchronous satellite, the Moon.

It was in attempting to make these elevation maneuvers that we discovered we had a major problem. A huge motor-driven pin that locks the dish in a safe "birdbath" position when not in use or in the event of extreme winds was solidly stuck in the locked position and would not move despite our efforts. Over several weeks we tried a number of ideas without success. Then Brian, W6BY, carefully machined a fixture attached to a long lever that he and Bryan, KF6ZEO, used with heat to crack (twist) the 5-inch diameter, 15-inch stainless-steel pin free of its jammed position. Once cracked free, the 85-pound pin drew the first blood of the project, falling free, impacting on fingers of some of the crew, and causing painful, though relatively minor injuries. Once this pin was out, however, vertical motion of the dish was possible, and the crew then spent more time finding and fixing hardware and firmware problems.

Computer Drive

Fortunately, we had good documentation for the system, and we continued to slog through the systematic correction of cut/broken cables, connectors, and sensors, working toward getting the Vertex-RSI 7210 control computer to command and control the dish movement. We planned to command the Vertex tracking computer through a serial port with a PC equipped with some of the popular EME tracking software programs, including Jean-Jacques Maintoux, F1EHN's package. Additionally, I worked with Robin Lucas, G8APZ, who wrote some custom software using Visual Basic for Brian Coleman, G4NNS's 3.7-meter dish in England, and who offered and developed some custom software for the Jamesburg application. I plan to give it a go, once things settle down at Jamesburg.

Jim Moss, N9JIM/6, and the crew, being familiar with the F1EHN program, used it to command/drive the Vertex-RSI 7210. Jim brought in a few more friends and ham/software experts and was the leader of that group. They interfaced moon-tracking software between the laptop PCs and the 7210. They were able to drive the dish to track the Moon, something the original computer and this dish were never before tasked to do, having only had to keep locked on to a geosynchronous satellite during its entire 40 years of service. In doing so, they cleared further faults, and we are now close to having fully computer-controlled motion for the dish.

In the interim, we have been successful in using two different Vertex manual controllers to drive the dish to current moon coordinates and to set rates of change of azimuth and elevation to match the Moon's movement. An initial offset was figured out, which allowed for our hand-placed feedhorn alignment to be slightly different from the main dish alignment that is delivered to the computer by the .001-degree resolution optical position encoders. Once that offset was determined and put into firmware, it was then relatively easy to "manually" track the Moon, easily matching and tracking the moving target coordinates to within 0.1 degree.

We are still debugging a persistent firmware/hardware problem that prevents us having from a fully automatic tracking con-

The Vertex 7210 screen. (Photo by KK6MK)

Brian Yee, W6BY, going through the hatch to the topside of the dish. (Photo by KK6MK)

trol system. We believe the problem is related to a reload of firmware parameters that was required when the backup battery was replaced. GD Satcomm in Longview, Texas recently has supplied us with the original custom parameter set, which we will install during our next visit to the site. Hopefully, that will clear up the problem.

Dish control and tracking computers have been upgraded through the years; the last upgrade was done in 1997. The dish is driven on each axis by two variable-frequency-drive, 20-horsepower motors, with one of each pair applying a small amount of opposite torque to the drive-gear train, eliminating backlash. The motors transmit power through massive gear boxes to the drive gears, rings, and pinions that one has to see to believe.

The Feed

The dish's original feed is a corrugated circular horn 10 feet long with a 23-inch opening. It is still installed and sitting on the feed pedestal 7 feet above the vertex. For 1296-MHz EME we placed a VE9ALQ-N9JIM/6 horn feed inside the original horn, matching the phase center of the dish.

The Technical Side of the Dish

On the technical side, the solid-surface dish was built in 1968 by Philco-Ford. It is a 30-meter Intelsat-A model for COMSAT use and was targeted for completion to carry live and worldwide the Moon landing by Neil Armstrong. Cassegrain fed, it had uplinks in the 6-GHz band and downlinks in the 3-GHz band. The dish's solid surface, soon to be precisely mapped using a laser theodolite, is estimated to have an RMS accuracy of ±2 mm, which should make it easily usable to 10 GHz. Specifications show a dish gain of 63 dBi at 6.8 GHz. We have been getting approximately 48 dBi gain in our first attempts on EME on 1296 MHz with first cut, less-than-optimum feeds.

Other dishes of the same size and design still exist in Puerto Rico, Washington, Virginia, and Georgia. The dish's support turret and yoke are impressive. Optical encoders on each axis monitor position with resolution to .001 degree. Most awesome is the backing structure for the dish surface itself, which is made of extremely lightweight material and complex joint intersections with welds that are works of art. How anyone can design and build such a large, movable structure and keep surface accuracies to 2 mm is beyond my comprehension.

EME Operations

We created an operating position that is currently located about 60 feet up from ground level in the room near and behind the dish's vertex, with easy access to feed antennas. Jim, N9JIM/6, Brian, W6BY, and the rest of the crew set up the EME radios at the operator's position and conduct the dish control work from the control room on the ground floor of the pedestal. This eventually will be refined to have tracking and operations at the same location.

The current radio station line-up consists of a Yaesu FT-817 radio; a custom-built AD6IW .6-dB NF preamp; a custom-built AD6IW 100-watt amplifier; and coax to the VE1ALQ-design waveguide-N9JIM horn, placed collinearly and literally in the mouth of the existing COMSAT feed horn. With time, we will improve the RF feed path with better feed horns and with more closely mounted preamps. Additional band operations are anticipated, perhaps up to 10 GHz or higher.

During the first weekend operators worked the 1296-MHz "pileups" both on CW and phone. At times it sounded a lot

The author sending CQs during EME operations at the Jamesburg station. (Photo by KK6MK)

Jim Moss, W9JIM/6 and Goran, AD6IW, with an early version of the feed. (Photo by KK6MK)

like 20-meter HF pileups. I feel a little embarrassed, as I have been a ham for 40 years, a weak-signal CW and contest guy on HF, with *no* EME experience as an operator prior to Jamesburg. I haven't "paid my dues" in the trenches with more ordinary EME stations. Sometimes the QSOs were so plentiful that there were mock fights for the microphone and key! W6BY and N9JIM were telling AA6EG that his EME operator chair reservation time had expired!

Dish Surface Mapping

During the course of the dish restoration, I met Mike Brenner, a specialist in big dish metrology. I learned how he developed a dish surface mapping system built around a surveyor's total station theodolite which is mounted in the dish to determine the X, Y, and Z coordinates of the corners of each dish panel to an accuracy of less than 1 mm. Mike is quite busy doing this service for many of the world's great dishes, most recently at MIT's Haystack Radio Observatory.

Mike was very intrigued by the fact that a rather unlikely but determined team of amateur radio operators would take on a volunteer project to restore the dish for moonbounce. At the same time, he wanted to take a vacation on the central coast of California, visiting the Monterey Aquarium and Point Lobos, south of Carmel. Therefore, he offered to help us and do the four-day job of surface mapping *for free*! I gladly accepted, and now we are looking forward to seeing how accurate the surface really is after nearly 40 years of use.

Mike knows the family of Philco-Ford 30-meter dishes and thinks this one should be accurate to within about 2 mm RMS error. Mike has to "hang out" rather precariously on the dish for four days. For Mike to accomplish his task we have to design and build supports for him and his theodolite. Included in this article is a picture of Mike doing the same job at another big dish.

Operational Safety

From the beginning we realized the importance of operational safety, as well as the requirements of diligence to safety procedures. I queried other dish operations as to safety issues and even looked at a safety sheet for ops at the Australian Narrabri facility. A written safety manual is on the list of things to do. All dish (and people around the dish) movement operations are coordinated by hand-held radios, so prior to the dish being commanded to move, we know the location of all persons on or near the dish and can be assured that they are safely out of harm's way. Recently we installed wireless cameras so that the dish operators can see critical areas before moving the dish.

The Future of Jamesburg

I have been working on long-term solutions to keeping the dish operational and accessible to hams for EME and other scientific pursuits. The land owner is focused on return on his land investment. I am focusing on the uniqueness of the site, namely the 30-meter, fully steerable dish, the 20,000-square-foot operations building, and God's country acreage.

Jamesburg is located about an hour's drive from the Monterey Peninsula, a fascinating location in its own right, where a lot of education, recreation, and science activities go on and where conferences are held. Jamesburg is just *made* for creating a science outreach/education/research center, and/or a space camp for young people.

In my journey on this tack, the friends and contacts I have made along the way are priceless. I also have become familiar with similar EME or radio dish projects that provided valuable insights and problem solutions for us. I found that around the world there are quite a few dormant, large dishes of various sizes being scrutinized for use by local hams and other communities. The new applications for them are many and varied. Radio astronomy is a natural, as is deep-space communication.

A particularly active ham group in The Netherlands, known as CAMRAS, is getting a large dish up and running. There is also the Big Dish Project in Japan, 8N1EME, with a 32-meter steerable dish that made its first EME contacts the same weekend of the Jamesburg operation. We and that group also QSOed one another that weekend.

CubeSat Program/ Applications

"Jamesburg can play a very useful role in ham CubeSat programs," says Professor Bob Twiggs, KE6QMD, of Stanford University. Dr. Twiggs sees Jamesburg, if it survives, playing an important role in future ambitious CubeSat programs, including CubeSats in Moon orbit and possibly even headed to Mars. Bryan, KF6ZEO, sees it as a possible ground-control station for Cal Poly's ambitious CubeSat program.

Internet Remote Control

If Jamesburg finds a stable, long-term future, it will be a natural for remote control via the Internet. It has some of the broadband connectivity, now dormant, that is necessary to accomplish this. While operated by AT&T/COMSAT, it used a fiber-optic cable (that still exists) run to the telecom system from its remote location, providing at the time 600-megabit bandwidth. The dish sits in a bowl, surrounded by hills at all azimuths. The location was selected to shield it from terrestrial radio noise. This could be a great project, perhaps a Master's thesis in design/implementation. However, first we need to find a procurement solution for the facility. We need a QSO with an "angel" or the "man in the moon" to talk about saving Jamesburg.

We made *Aviation Week*!

A recent story about our project in *Aviation Week and Space Technology* is bringing a good response. For more information, please see page 31 of the March 19–26, 2007 issue of this publication.

Website Development

Early in the development of this project John Castorina, ex-WB6AZP, a college chum of mine who worked at COMSAT Jamesburg for several years and for COMSAT Washington, DC for decades, offered a lot of helpful advice and assistance, flying up to Monterey from his Santa Paula business location and then driving an hour to Jamesburg. John has created a great website with a picture gallery, project descriptions, and updates. In addition, Dr. Bob Lash of our team created an e-mail reflector for us. Visit: <http://www.jamesburgdish.org> for pictures and the latest news.

Through the Back Door

A Teacher's Journey into Amateur Radio

Each of us has a story of how we became an amateur radio operator. Here KE7KVT tells his story, as well as how he is inspiring others to become hams and even to make career choices related to our hobby, all by way of his teaching profession.

By Kevin Carr,* KE7KVT

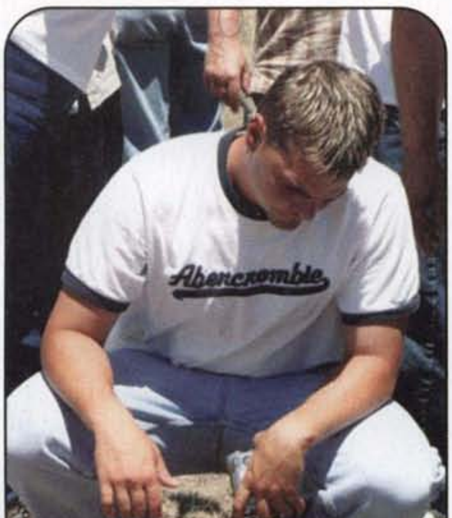
I just received my first ham radio license, Technician Class, a few months ago at age 42. What took me so long?

I have been fascinated by radio since I was a school-age kid, spending nights hiding under the covers with a clock radio and ear plug scanning up and down the AM band, where, mysteriously, stations began appearing from all over the U.S. and Mexico as it got dark each night. Like Einstein and his compass,[1] I was hooked.

I then moved from under the covers to my grandfather's kitchen countertop Realistic set, with which I could hear strange languages and even stranger sounds on the bands labeled "SW1" and "SW2." WWV particularly fascinated me as I begin to decode the regular pattern of clicks and tones and the occasional solar-storm report. In high school I got a Panasonic radio with crystal marker tuning. With the solar maximum of the late 1970s to early 1980s, a hundred feet or so of wire strung outside through Colorado ponderosa pine enabled me to log

**470 Inglewood Lane, Woodburn, OR 97071*

Recovery of EOSS launch in Colorado. Note the long string of balloon SATs. (Photo courtesy of KØLOB)



The moment of truth for a new balloon SATer. (Photo courtesy of KØLOB)

The land owner who allowed us to recover our equipment from the middle of his large ranch in eastern Colorado. (Photo courtesy of KØLOB)

A proud balloon SAT team. (Photo courtesy of KØLOB)

more than 50 countries, all the while losing many hours of sleep.

My high school band teacher supplied me with a code key and oscillator with which to practice Morse code. Even so, my encounter with radio stopped short of a ham license. That said, there is no doubt that the hours spent staring at program schedules, reading DX magazines, studying diagrams of propagation paths, and listening to stations fade in and out with the daily solar cycles helped form the foundation for my current vocation as a physics teacher and science educator.

Balloon Satellites: The Journey Continues

Why did I finally get my ham license now, 25 years later? My path through the back door into ham radio started two years ago. The school where I teach physics, George Fox University, is an affiliate member of the NASA Oregon Space Grant Consortium (OSGC), an organization of Oregon research institutions, science museums, and colleges that is involved with work associated with NASA's aerospace mission. Through OSGC I first heard about "balloon satellites," or balloon SATs for short. Balloon SATs are small instrument packages that are carried as payload by helium balloons to altitudes in excess of 100,000 feet—the "edge of space"! Think of a balloon SAT as a poor-man's space satellite; they don't quite reach space, but at $300 or so they are quite a bit cheaper! At 100,000 feet—just beyond the tropopause at the lower edge of the stratosphere—atmospheric pressure is less than 1% of sea level, a better vacuum than can easily be produced in a lab. Temperatures there hover at –70° C and instruments are exposed to high levels of cosmic and UV radiation. Balloon SATs therefore serve

The launch team of EOSS-093 at the recovery site. (Photo courtesy of KØLOB)

The LaunchPSU team overlooking Prineville Reservoir and the rough search terrain. (Photo courtesy of KE7KVT)

as an excellent educational design platform, introducing students to the fundamental challenges faced by NASA and other space agencies in designing operational instrumentation for use in space.

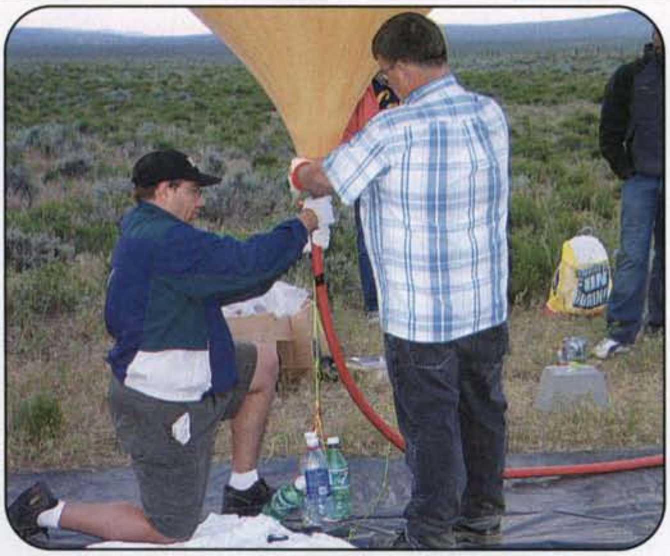
Balloon SATs are also a great project for middle school and high school age kids, provided they have knowledgeable mentoring from their teachers in not only balloon SAT design and construction, but in launching and recovering the balloons that will take their payloads to the edge of space. A group from GFU and the University of Oregon decided to include balloon SATs as part of a teacher development project called North Coast Teachers Touching the Sky (NCTTS). NCTTS trains grade K–12 teachers in astronomy and earth systems science. Therefore, the balloon SAT project seemed like a natural capstone for our year-long program. However, we had a lot to learn about ballooning!

As science instructors and working scientists, we knew nothing about the details of either building balloon SATs or the process of launching and recovering high-altitude helium balloons. Through OSGC, during the summer of 2005 a team from Oregon attended a workshop hosted by Chris Kohler of the University of Colorado. Chris led us through building a balloon SAT and launching it on July 30, 2005, with the help of the Colorado Edge of Space Science (EOSS) organization (http://www.eoss.org). The focus of our work was designing and building a SAT—a 555 timing circuit with a modified Canon Elph camera, a HOBO data logger, and a power-resistor-based heating circuit to keep the batteries working at –70° C, all packaged inside an insulated 6-inch cube. We also were exposed to the balloon launch and recovery process, which includes an automatic position reporting system (APRS) radio tracking system and software. This was the first time that I realized I was headed back into radio!

We launched our balloon SATs from Deer Trail, Colorado at dawn on a hot summer day as part of the EOSS 96/97 launch. With temperatures forecast at 105° F, we were geared up for a long, hot adventure following and tracking our balloon SATs. The launch was handled by the expert blue-hatted EOSS crew, who flawlessly filled the balloons, attached our payloads, and most important, controlled the APRS systems. I had never seen so many pickup trucks mounted with sundry antennas and dishes. As our balloon SATs soared skyward, our attention turned to our tracking units. The tracking units consisted of mobile 2-meter transceivers and TNC and GPS units, all connected to laptops via the serial port. The chase was on and the real fun was about to begin!

Using APRSpoint software on a PC attached to a TNC and the 2-meter transceiver, we tracked our balloon, labeled on the map by its onboard radio operator's callsign. We were able to see latitude,

North Coast Teachers Touching the Sky (NCTTS) preparing for launch of their balloon SATs in the Oregon high desert. (Photo courtesy of KE7KVT)



Filling the balloon with helium. The bottles are ballast used to determine the proper upward lift during filling. (Photo courtesy of KE7KVT)

View from 100,000 feet over central Oregon, taken on June 27, 2007. (Photo courtesy of KE7KVT)

longitude, and altitude data in real time, tracing a path on the "MapQuest"-type map. At the same time we could hear the modem-like sounds of the packets being received by the 2-meter transceiver. I felt like I was back in front of grandpa's Realistic, getting hooked on radio all over again! We tracked our balloon to the middle of a giant sagebrush-covered ranch where we were met by its long-time owner, who escorted us through a couple of miles of hot, dry hiking to the landing site. What a feeling to get back our payloads from the edge of space!

Bringing the Balloon SAT Project Home

In the summer of 2006 we led our first group of K–12 teachers from Tillamook, Oregon in building balloon SATs. With the help of Mark Weislogel, KE7HVE's LaunchPSU club (PSU stands for Portland State University, specifically the Engineering Department), we launched our SATs from Milikan, Oregon, which is in the high desert 30 miles east of Bend. Our team of K–12 teachers participated in filling and launching the balloons and waited anxiously as they ascended into the early-morning inversion layer, which made it a chilly morning. However, this time as we lost visual contact with the 6-foot diameter yellow helium balloon it was obvious from the expression on Mark's face that something was wrong. I could hear the packets received by Mark's Kenwood 2-meter rig on the ubiquitous 144.390-MHz frequency, but the position on the APRSpoint map was not moving! We quickly determined that something had gone wrong and that all the packets received contained the same encoded data, simply giving the last "good" position of the balloon's command module, that of the launch pad in our rough camp among the sagebrush.

Launch PSU command module. (Photo courtesy of KE7KVT)

The LaunchPSU crew went into trouble-shooting mode, working through radio and GPS systems, rebooting laptops, even checking via cell phones with friends who were attempting to track the balloon on the internet via a local digipeater. The results were the same. The command module was sending digital packets with no updated information. The balloon was now out of sight, and all we had to go on was the weather report of local winds, indicating a probably flight path to the northeast. This balloon SAT and command module appeared hopelessly lost.

Then we heard a new sound, a clear and strong beep, beep, beep. One of the LaunchPSU crew was holding a directional antenna and scanning in the direction we had last had visual contact with the balloon. LaunchPSU had added a new

Recovery site among sagebrush cattle land. (Photo courtesy of KE7KVT)

My Story of Kevin Carr, KE7KVT's Ill-Fated Launch

By Mark Weislogel, KE7HVE

This LaunchPSU (the sixth) was a bone crusher for me. Fortunately, however, it ended well. The launch was conducted in collaborated with Kevin Carr, KE7KVT, associate professor of education at George Fox University, who was heading a week-long seminar in Bend, Oregon for a fun group of Tillamook School teachers. The aim of the GFU program is to equip teachers with more knowledge about science and new ways of looking at teaching. The balloon launch was to demonstrate one project idea by lifting four of the teacher's experiments to >90,000 feet and have them return with data and images.

Everything for this launch went perfectly—well almost perfectly. We had perfect preparation, a perfect plan, and a perfect group! Unfortunately, it appears that the GPS must have become unplugged from the radio transmitter while we were doing things just before the launch. Everything worked perfectly just before we connected all the lines for the final countdown. With this sense of assurance (which later proved to be false), we released the balloon and readily received transmissions from the payload. However, we continuously received the same (the initial) GPS coordinates.

Gradually it dawned on me that we had a major tracking problem. My heart sank as I had to explain to Kevin and the teachers that for all I knew we had just sent our balloon and their payloads to Siberia.

The group was very kind and understanding about the whole thing and we went on a chase anyway. Even so, it was overcast and we certainly weren't expecting to see anything—and we didn't. Fortunately, however, we had a dog tracking beacon that we had duct taped to the payload almost as an afterthought. Amazingly, we were able to track the descent of the payloads to the horizon straight north of our position and straight south of the Prineville Reservoir. It is important to note that the dog tracker is good for a distance of up to 7 miles. We later realized that it was detecting a signal over 30 miles away!

We knew it was tracking the correct signal when both the (faulty) GPS signal and dog tracker signal ceased at the same time. Therefore, we were hopeful that we might still find the package using the dog tracker. With this confidence we spent some time looking for it. Our team as well as our balloon's journey are shown in photo 1.

We drove through beautiful country that had great vistas for scanning the land with the antenna, but no luck. It turned out that we were too far south. I felt terrible all day, and we said goodbye to Kevin and the teachers that afternoon and returned home. That hurt.

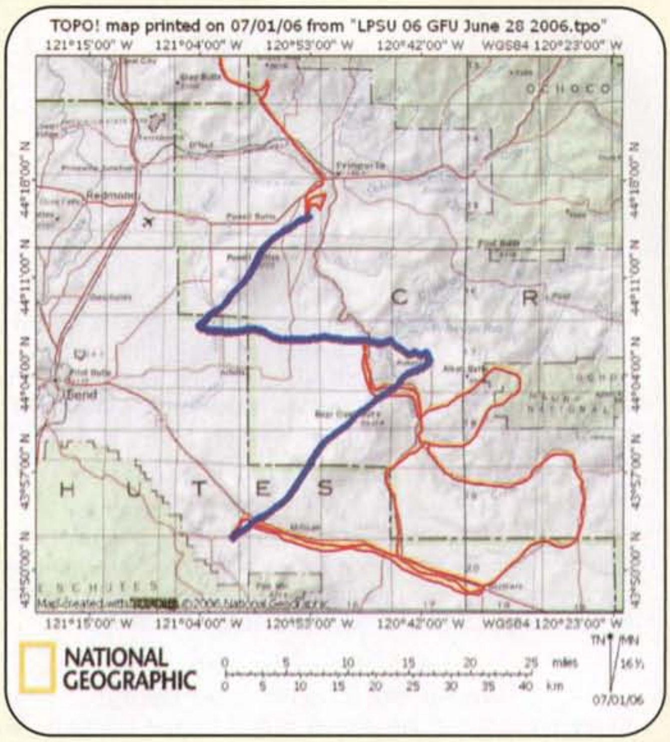


Figure 1. Ground GPS "tracks" of balloon flight (blue) and chase vehicle(s) (red—lower track is day 1, upper track is day 2). Approximately 27 miles at 15 degrees NNE from launch point. (Map courtesy of National Geographic*)*

The next day LaunchPSU team members Yongkang, Donovan, Matthias, and I returned to the region. We figured that the payload was in a 225-square-mile zone. We were kind of hopeful, but not very much so.

element to their command module for this flight, a small transmitter normally used to track tagged animals such as elk though the rough and open terrain of eastern Oregon. We had planned to use the tracker to help locate the payload once we lost line-of-sight contact with the APRS transmitter, which normally happens as the balloon descends through the last few hundred feet during recovery. Now, however, this steady beeping, designed to last up to 14 days before battery power fails, was our only contact with the balloon!

The LaunchPSU crew took out their Delorme topo maps and began plotting a heading based on the gain readings from the directional antenna. We narrowed down the search to a northeasterly direction, over the rugged canyon and tablelands of the rugged and beautiful Ochoco Mountains. This was not a good thing. Once the balloon landed, in approximately two hours, it could easily be deep in a clefted canyon, while the line-of-sight signal could be lost, weak, and/or reflecting off multiple canyon walls and hillsides.

After persevering for several hours and traveling more than 200 miles on dirt desert roads, we quit for the day, feeling pretty demoralized. The K–12 crew headed back to the north coast, without their SATs, photos from the edge of space, and logged data for which they had worked so hard.

Lucky for us, the LaunchPSU crew was not ready to give up. Shortly after returning the next day via a three-hour drive from Portland, they found a strong signal from the animal tracker and picked up the command module and our payloads near Prineville, only 20 or so miles from our launch site. The recovery site was so close, yet so far. As it happened, we were looking on the opposite side of the Ochoco mountain range. *(Editor's note: please see the accompanying sidebar written by Mark Weislogel, KE7HVE, for his perspective on this launch.)*

LaunchGFU

This year a group of GFU engineering students and two college faculty members are working to create our own high-altitude balloon launch and recovery capability. One of the first steps was for me to get a ham radio license in order to operate the command module APRS system! In February 2007 I took and passed the Technician Class exam under the auspices of the Portland Amateur Radio Club (PARC, <http://www.w7lt.org>) and was assigned the callsign

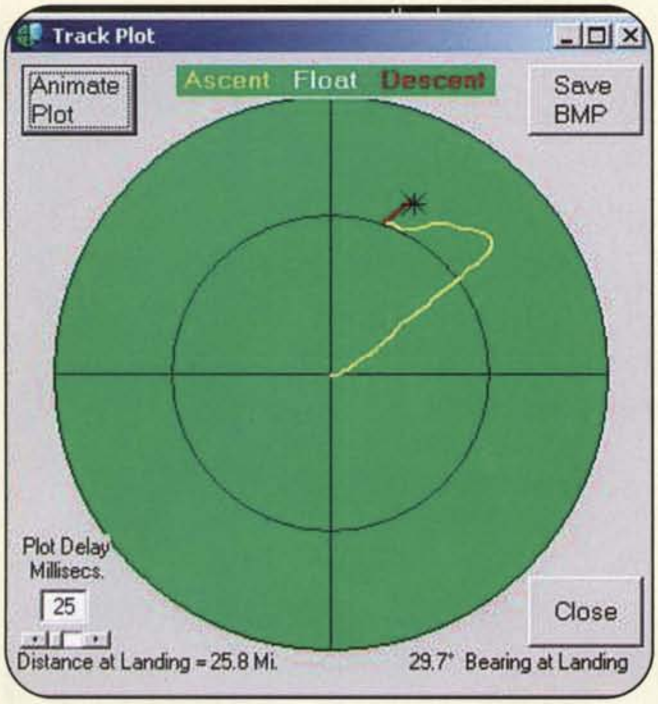


Figure 2. Prediction of ground GPS track using meteorological data at altitude. Approximately 26 miles at 29.7 degrees NNE from launch point. Not a dad prediction compared to figure 1.

We stopped north of Prineville, where Donovan got out the dog tracker antenna and immediately picked up a signal! We drove another 15 miles across the valley in that direction and again picked up the same signal; this time it was much stronger. We eventually walked right up to the payload. It simply was lying on the desert floor, as you can see in the pictures in Kevin's article. I was elated!

After recovering the payload, we put everything in the car and headed for GFU, catching Kevin before the end of the day in order to give him the teachers' experiments. We also gave him copies of our pictures, which were stunning.

Thank you, dog tracker. You will fly again!

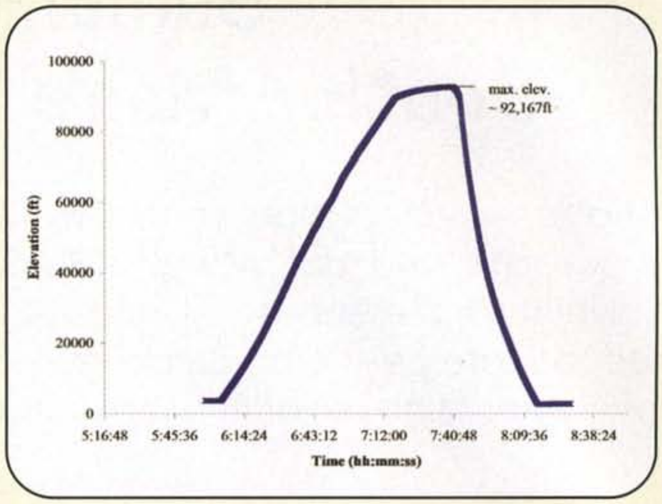


Figure 3. Approximate elevation data computed from onboard temperature and pressure data.

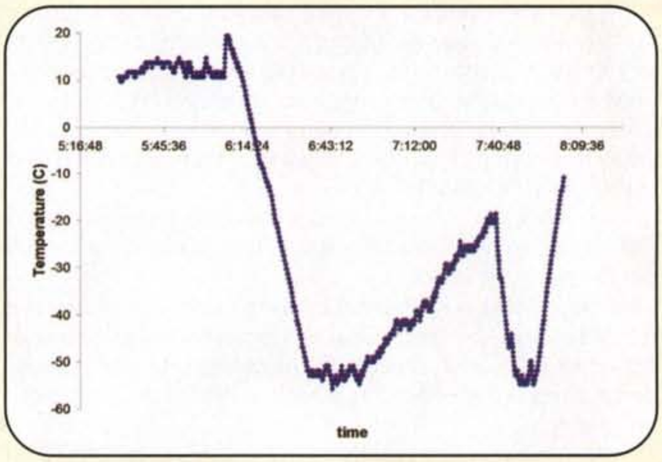


Figure 4. Atmospheric temperature vs. time during flight.

KE7KVT. After becoming licensed, I proudly announced my new "amateur radio club" membership to my college physics class, which cheered and was amused that even professors had to take and pass exams!

We began by making some purchases. For the command module we opted for a Kenwood TH-D7AG, Garmin Legend GPS, and a 7.1-megapixel digital camera, along with a basic HOBO data logger and heating unit. The engineers are responsible for design, fabrication, and testing of the command-module electronics and environmental systems. We will be following the now-standard practice of including a backup directional beacon, as this really saved our bacon last year! We are using a Kenwood Mobile TM-D700A and APRSpoint as our tracking system.

Our goal this spring is to carry out a command-module-only launch and recovery. If all goes well, in June 2007 we will launch a set of balloon SAT packages built by K–12 North Coast Teachers Touching The Sky. The long-term goals of LaunchGFU are to (1) give local K–12 teachers and schools the capability of taking their students to the "edge of space," and (2) to provide a platform for scientific research done by our engineering students. One research project that is under discussion is a measurement of cosmic radiation as a function of altitude.

All of this education and experimentation would not be possible without the infrastructure and expertise of amateur radio operators! The existence of packet radio as a technology and the availability of amateur radio bands on which a dedicated person can work creates amazing opportunities for K–12 students and teachers, college students, and yes, even college professors to do "real science" without the need for multi-million-dollar budgets and equipment is simply amazing! Thanks to all of you amateur radio operators who paved the way for APRS. Keep up the great work!

Note

1. When Albert Einstein was four or five years old, he was given a magnetic compass. He was so fascinated with the needle's consistent northward swing that seemed to be guided by an invisible force that he was convinced there had to be "something behind things, something deeply hidden." His quest to find that "something" hooked him into a lifetime pursuit of science.

SumbandilaSat
South Africa's Latest Satellite

It has been about eight years since South Africa made its entry into the space age, and that by way of SunSat 1, an education project of the University of Stellenbosch. If all goes well, in June South Africa will have its second satellite in orbit, SumbandilaSat, this one also being a university-level education project—with a surprisingly youthful connection.

By Hans van de Groenendaal,* ZS6AKV
President, South Africa AMSAT

Soon South Africa will have another voice in the sky when its second satellite, named Sumbandila, is launched in June 2007. The naming of the satellite is an interesting story in itself. A competition was held among high school students. Entries in various languages were received, but ultimately the Venda language version was chosen, *Sumbandila.* It means showing or pointing the way. Freely translated into English, it is "Pathfinder."

Sumbandila is a very appropriate name for a satellite that is paving the way for a number of satellites planned for launch over the next few years.

SumbandilaSat is sponsored by the Department of Science and Technology and was built at SunSpace in cooperation with the University of Stellenbosch. The amateur payload offers similar activities to that of SunSat, but implemented in a new, innovative way.

South Africa's entry into the space age began in 1999 with the launch of SunSat 1, a modest satellite built by students and lecturers at the University of Stellenbosch. The satellite carried various experiments and an amateur radio transponder that delighted radio enthusiasts worldwide. From this modest beginning grew SunSpace (Pty) Ltd., today a successful company involved in the space communications field.

SumbandilaSat Payloads

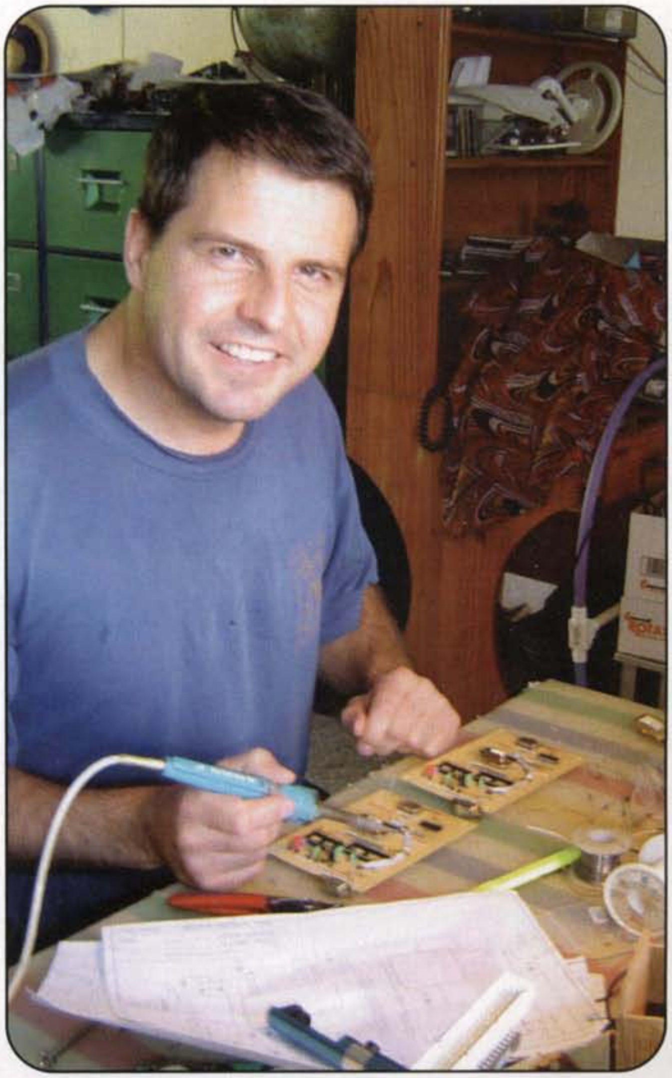
The main payload is a multi-spectral imager with a 6.5-meter Ground Sampling Distance (GSD) with six spectral bands and will be supported by an on-board storage of 6 gigabytes, expandable to 24 gigabytes. In addition, there are several experimental payloads, including:

• SA AMSAT: A 2m/70cm amateur radio transponder and digitalker.

• Stellenbosch University: A Software Defined Radio (SDR) experiment and an architectural radiation experiment for commercial off-the-shelf devices (ARECOTS).

• Nelson Mandela Metropolitan University: A forced vibrating string experiment.

**e-mail: <zs6akv@amsat.org>*
<www.amsatsa.org.za>



Hannes Coetzee, ZS6BPZ, working on the prototype controller. He built two prototype controllers, one for the University of Stellenbosch and one for SA AMSAT to do software testing in Pretoria. This allowed work to be carried out in parallel.

• University of KwaZulu, Natal: A very-low-frequency (VLF) radio experiment.

The amateur radio payload is operating in conjunction with the University of Stellenbosch Software Defined Receiver project sharing the V/U transponder.

SA AMSAT has designed and built a control system to facilitate the following operations:

• V/U voice transponder with an uplink in the 2-meter band and a downlink in the 70-cm band.
• A parrot repeater (voice digipeater).
• A voice beacon.

The control unit commands the various functions of the transponder and handles the parrot and beacon messaging. On receipt of a tone from the VU/CU VHF receiver, the CTCSS tone will be decoded, and depending on the tone received, the unit will command the VU transponder operation or the parrot repeater. In the transponder mode the satellite will act like a cross-band FM repeater and allow two-way communications with other stations on the ground.

If the tone received indicates parrot operation, the interface unit will record 20 seconds of audio on its VHF uplink receiver and replay the recorded audio on the UHF downlink.

Should, for a predetermined period, there be no tones received, the controller will initiate a voice beacon, transmitting a prerecorded message at regular intervals. This facility offers many opportunities for educational projects.

The initial beacon message was loaded while SumbandilaSat was still in the clean room at SunSpace. It was recorded by 15-year-old Anton Coetzee, a scholar at the Kimberley Technical High School. He won a competition for the most appropriate beacon message. The message is: "This is ZSOSUM in space. I am the voice of the South African youth. We are knocking on the door of opportunity, marking our place in the orbit of space research and communication. Hear us! Listen to us!"

The technical team comprised of Andrew Roos, ZS6AAA, and Hannes Coetzee, ZS6BZP, faced a real challenge—to complete two prototypes of the controller in time for evaluation and integration in the main unit by the end of July last year. Sumbandila is expected to be followed by two or more satellite projects, and with more time available, a more sophisticated amateur payload is envisioned.

The South African Minister of Science and Technology, Mosbudi Mangena (left), and Hans van de Groenendaal, ZS6AKV, President of SA AMSAT in front of SumbandilaSat in the SunSpace clean room.

The mission of the project is the development and growth of people and institutions, providing satellite data for applications addressing the needs of society and understanding the modalities of a small satellite program in order to inform the space policy process in South Africa. There are several additional benefits that will accrue from the project, including: technology demonstration of new-generation satellite avionics for future satellites, international and regional benefit through imaging and data provision, and a platform for international interaction through joint missions and multiple satellites.

An Unusual Launch

SumbandilaSat will be launched on a Shtil (meaning "calm weather") launch vehicle from a submarine. The Shtil is a three-stage launch vehicle that uses liquid propellant. It is the first launch vehicle to successfully launch a payload into orbit from a submarine, although launch from land-based structures is also possible. TubeSat was successfully launched on a Shtil. The launcher has a remarkable track record, with 51 successful launches and only one failure.

The launch is scheduled for the June 2007 time frame and will place SumbandileSat into a 500-km circular orbit with local pass time around 10 AM and 10 PM CAT (Central African Time = UTC plus 2 hours).

Educational Challenge

Like SunSat, the SumbandilaSat presents several educational opportunities at various levels from students at the lower level in schools to post graduate students at universities.

A steady stream of 18 undergraduate students, 19 Master Degree students, and three PhD students, plus a post-doctorate position are fully funded. In addition, between five and eight internships have been created for the building of a satellite knowledge base and applications in industry.

Andrews Roos was responsible for the design of the controller and the writing and debugging of the software.

Another outcome of SumbandilaSat and the satellites planned for the future is that they offer scientists at other institutions the opportunity to develop scientific experiments which will be included in the program. The next satellite in the series offers 2 kg of payload capacity. It is expected that SA AMSAT will have further opportunities for amateur radio payloads in the satellites planned.

Another important component is the expansion of the SUNSTEP program. SUNSTEP is a joint venture by sponsors and the University of Stellenbosch to reach out to students and increase their science, electronics, and technology knowledge. During the past nine years, 164,850 studentss and 5,039 teachers have been touched. Studentss generally love the fun, dynamic, "hands- and minds-on" approach, and as a result many have realized that the ability to study engineering is, in fact, within their reach.

Once in orbit, Sumbandila Sat will provide increased opportunities for the SUNSTEP programme and expansion to all provinces of South Africa. The amateur radio payload will be used extensively in youth programs with the objective of bringing youth into amateur radio.

Why an Entry-Level Satellite?

Amateur radio is at a crossroad. It is confronted with an aging population coupled with a relatively slow intake of new, younger enthusiastic hams. The South African Radio League has embarked on a program to attract young people into amateur radio, and an easy-to-use satellite will go a long way toward firing their imaginations. In the words of the late Bill Orr, W6SAI, about the launch of OSCAR 1: *"the spirit of adventure lies buried in every man's soul. Strike the spark and ignite the soul and the impossible is accomplished."*

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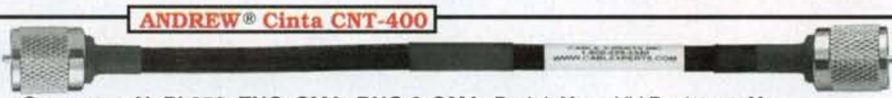

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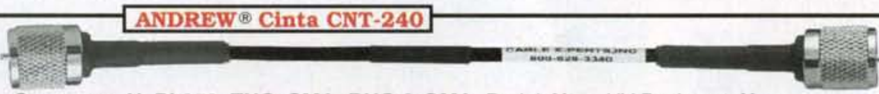

RG8X SIZE SHOWN

Connector: **N, PL259, TNC, SMA, BNC & QMA,** Burial: **Yes**, UV Resistant: **Yes**.
Shields: **2** (100% bonded foil +90% TC Braid) **VP 84%,** Attenuation 3.0dB @ 150 MHz at 100ft.
Usage 1 MHz and Higher.

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Bringing Space Into Your Classroom

Here is a "how-to" article on getting radio space communications into the classroom, written by one who knows how to jump the hurdles. The following is reprinted from the January/February 2007 issue of the *AMSAT Journal,* courtesy of AMSAT-NA and the author.

By Mark Spencer,* WA8SME

Space-borne technology affects many things in our daily lives, from telephone and television communications, to national security, to scientific research, to weather forecasting, to protection and husbandry of the environment and natural resources, to providing the location of your car when you have a flat tire and need help. It is important for our students to study space and space-borne technology so that they can use this technology more effectively to enrich their lives. Also, if you are looking for something that cuts across curricular lines, something that connects multiple content areas from geography and geology, from physics and environmental studies, from the science of radio to the science of space, bringing space into your student's learning experience, this just might be for you.

I suspect that you think that bringing space into the classroom has to be expensive and requires advanced and sophisticated equipment, but you are wrong. My purpose in this article is to illustrate a four-step approach that will allow you to bring space into your students' learning experience incrementally, at a level of rigor that is appropriate for your students and at a cost that is affordable.

The four incremental building blocks that you can use to bring space into the classroom include:

1. A computer and satellite orbit prediction software.

2. A receiver to receive signals sent by satellites.

3. Display software that will display imagery sent by certain satellites.

*ARRL Education and Technology program Coordinator, 774 Eastside Rd., Coleville, CA 96107

e-mail: <mspencer@arrl.org>

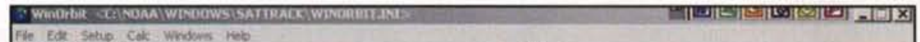


Figure 1. The typical display of orbital predication software. This is a free-ware software package showing the orbit and position of a satellite.

4. A dedicated satellite receiver and antenna for a quality satellite ground station.

Step 1

This step begins with obtaining a computer and installing satellite orbit prediction software so that satellite positions and tracking are displayed in the classroom. The computer could be the latest and newest high-powered computer, yet many older models that have been retired will do just fine. Satellite position prediction is fundamental to using space-borne technology and provides many learning experiences for students. Predicting satellite locations used to be done with tedious mathematic calculations, but for years computers have been used to do the chore. Some of the more capable prediction software packages can be purchased for modest cost, but many free computer programs for various computer platforms are available from web resources.[1]

When you have the computer with the satellite prediction software loaded, just following these steps to get started:

1. Update the computer's internal clock to the correct time. Although not absolutely necessary, the correct time is required for accurate position predictions.[2]

2. Update the Keplerian elements. The Keplerian elements are the mathematical parameters used by the formulas in the

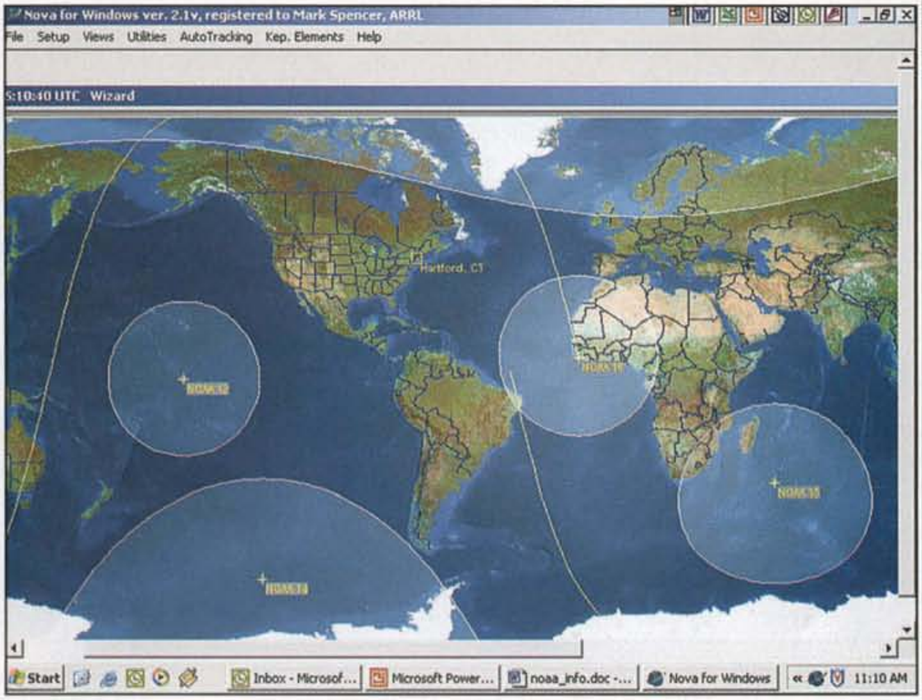


Figure 2. The display of satellite positions and orbits using a program called NOVA (approximately $50).

predication software to calculate the satellite position. Up-to-date Keplerian elements are available from the web.[3]

3. Select the satellites you would like to track. The International Space Station (ISS) and Hubble space telescope are interesting to students, but also there are low-orbiting NOAA weather satellites, ham radio satellites, global positioning satellites, and others that will interest students. You might have the students select a satellite, "their" satellite, and have them research and write a report on their satellite. You might consider choosing satel-

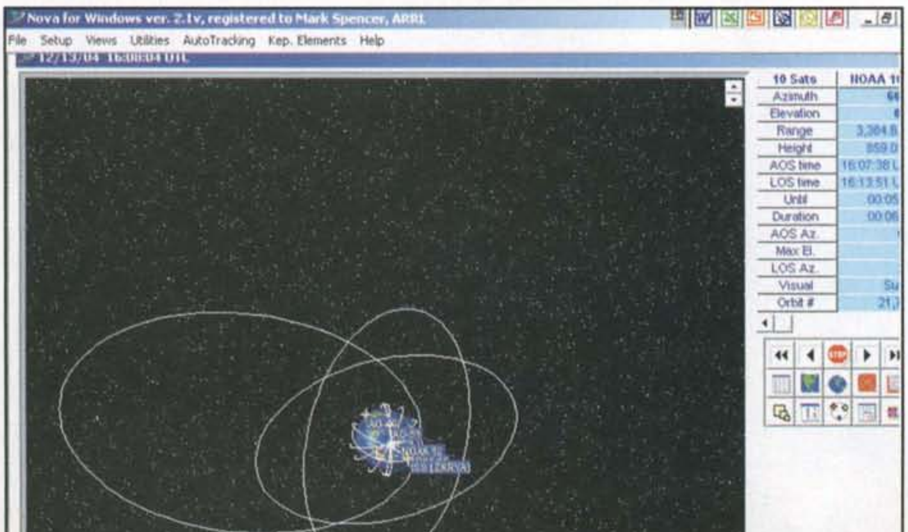


Figure 3. Three-dimensional view of orbits using NOVA software. This gives the student a different, and more realistic, perspective of satellite orbits.

• Geography	• Kinds of orbits
• Geopolitical boundaries	• Argument of perigee
• Periodicity	• Argument of apogee
• Map projections	• Descending/ascending nodes
• Line of sight	• Elevation
• Acquisition of signal	• Inclination
• Loss of signal	• Increment
• Location of satellite	• etc., etc., etc. …
• Satellite track	

Table I. Instructional concepts for Step 1.

• Frequency and amplitude modulation	• Signal acquisition
• Amplitude versus gray scale	• Signal strength
• Video synchronization	• Signal fading
• Digital encoding	• Signal polarization
• Timing pulses	• Path loss
• Doppler shift	• etc., etc., etc. …

Table II. Instructional concepts for Step 2.

• Geography	• Resolution
• Geology	• Gray scale
• Geo-political boundaries	• Calibration curves and data
• Remote sensing	• Latitude/longitude
• Weather phenomena	• Bandwidth and data throughput
• Infra-red spectrum	• Map projections
• Visual spectrum	• etc., etc., etc. …

Table III. Instructional concepts for Step 3.

lites in different kinds of orbits so that the students can learn why various orbits are used to accomplish different tasks or satellite missions.

Once the system is set up, just let it run. It does not require on-line access. The software and computer operate stand-alone and the computer continuously calculates the selected satellite positions and updates the computer display. Figure 1 is an example of the type of display that you can expect from free satellite prediction software. The software that I recommend is called NOVA, but it costs around $50. The graphic display is more detailed and there are other valuable tracking features. Figure 2 is an example of the type of display using NOVA.

Many students have the impression that satellites orbit the Earth in a wavy or sine-wave motion, because this is how satellite orbits typically are displayed. However, the satellites actually orbit in an elliptical orbit (almost circular) and the Earth turns underneath the satellite as it orbits. On a flat map display, this results in the apparent sine-wave track. One feature I like about the NOVA software is that you can select a view of the Earth from space that gives a more 3-D view of satellite orbits (see figure 3). In this view the students can see a more realistic orbital track, and the fast-forward button advances the satellites in quick time to better illustrate the orbital track.

There are a number of learning topics that can be addressed by this first step to bring space into your classroom (see Table I).

Step 2

Many of the satellites send out signals on frequencies that can be received on a standard police-scanner receiver. In particular, the NOAA low-orbiting satellites send out very strong and distinctive signals on 137.50, 137.62, and 137.10 MHz. In this step, simply place a police scanner that is tuned to the appropriate frequencies next to the computer. An outside receiving antenna helps, but it is not necessary for this step. When the NOAA weather satellite comes within range of your classroom, the students will hear the bing-bing-bing of the satellite come up out of the receiver background noise, and as the satellite goes beyond the horizon, the bing-bing-bing will stop. The satellite sends a weather picture using the varying audio tone that sounds like bing-bing-bing.

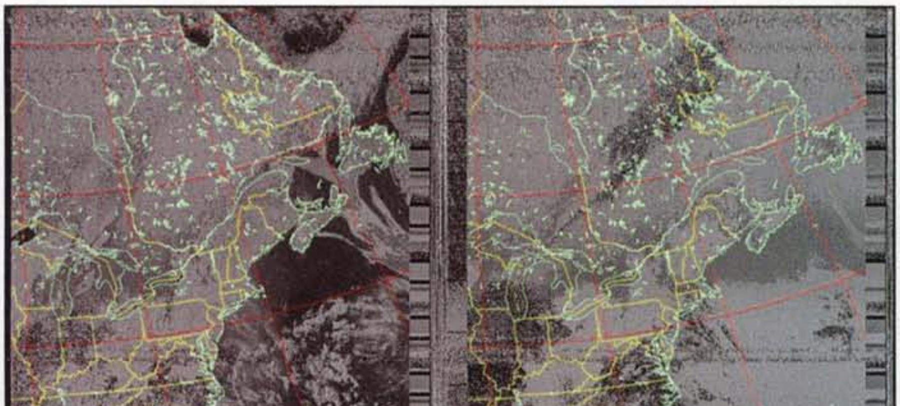


Figure 4. The imagery received using a police-scanner receiver. The visual and infra-red images are displayed side-by-side. Noise, static, and degraded signals prevent clear images, but the images are usable for instructional purposes.

With satellite signals as a backdrop, the students now can learn about satellite hardware and sensors, how they are powered, what information they collect, how that information is sent down to Earth, where these satellites are looking and why, and more. Table II illustrates just a small sample of the instructional concepts that can be covered when listening to signals from space.

Step 3

This is where bringing space into your classroom really starts to get exciting. In this step you add some display software that will take the bing-bing-bing and turn it into pictures of Earth that are transmitted by the satellites in space. Sure, there are lots of weather images available from the web, but there is nothing more exciting, nor satisfying, than receiving the pictures directly from the satellites as they pass overhead! Also, the imaging software is free!

Figure 5. Example of a dedicated satellite receiver.

Figure 6. A simple, but effective, satellite receiving antenna can be made from materials purchased from your local home-improvement store. The antenna is unobtrusive, lightweight, and easily installed on a rooftop.

To display satellite imagery you will need a computer with more capability than required in step 1, but the computer needed is becoming the standard nowadays and you may already have the computer in your classroom. Download a program called WXTOIMG (which stands for weather to imagery) from the website.[4] You can purchase an upgrade for the WXTOIMG software if you desire, but the free version provides ample capabilities for your students. Once the software is installed and set up (with your location and updated Keplerian data), connect the receiver audio to the computer sound card. Now when the satellite is within range, the bing-bing-bing will be translated into a weather picture, line by line. Figure 4 shows an example of a weather image received this way.

For various reasons which could be discussed with your students and are excellent learning opportunities, the police scanner is not optimized to receive signals transmitted from space and the resulting imagery is degraded. However, the imagery is very useful to show the students what actually is being collected by the satellite and transmitted. An image using the visual spectrum is sent side-by-side with the an image using the infra-red spectrum. WXTOIMG adds the map display which provides excellent reference points for the imagery. Your location would be displayed with an "X."

Now with this imagery in your students' hands, they can explore the environmental sciences along with the physical sciences and physics of space-borne technology. Table III lists just a few of the instructional concepts that can be added in this step.

Step 4

Because of the science of radio signals that originate in space from transmitters moving at high speeds, the signal characteristics require receiving equipment designed for the purpose. Although you can hear the satellite signals with a simple police scanner, Doppler shift and signal bandwidth requirements degrade the quality of the signal received with a police scanner (understanding both of these concepts is a good learning opportunity for students). With a little investment in a receiver designed to receive satellite signals, there is dramatic improvement in the quality of the signals received, and the real power of the WXTOIMG software and satellite pictures comes into focus. A satellite receiv-

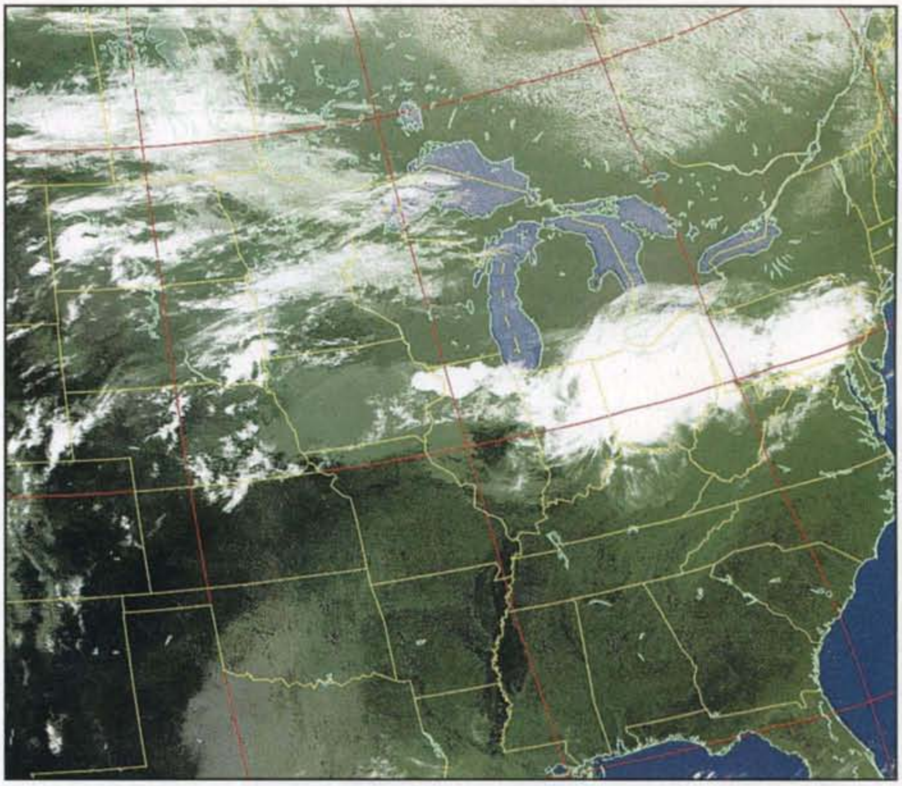


Figure 7. The imagery produced with a satellite receiver is a big improvement over the police scanner. The WXTOIMG software produces a multi-spectral display and colorizes the imagery for better interpretation. Here the oceans are blue, vegetation green, and various cloud levels shades of gray through white. Note the cloud mass over Ohio.

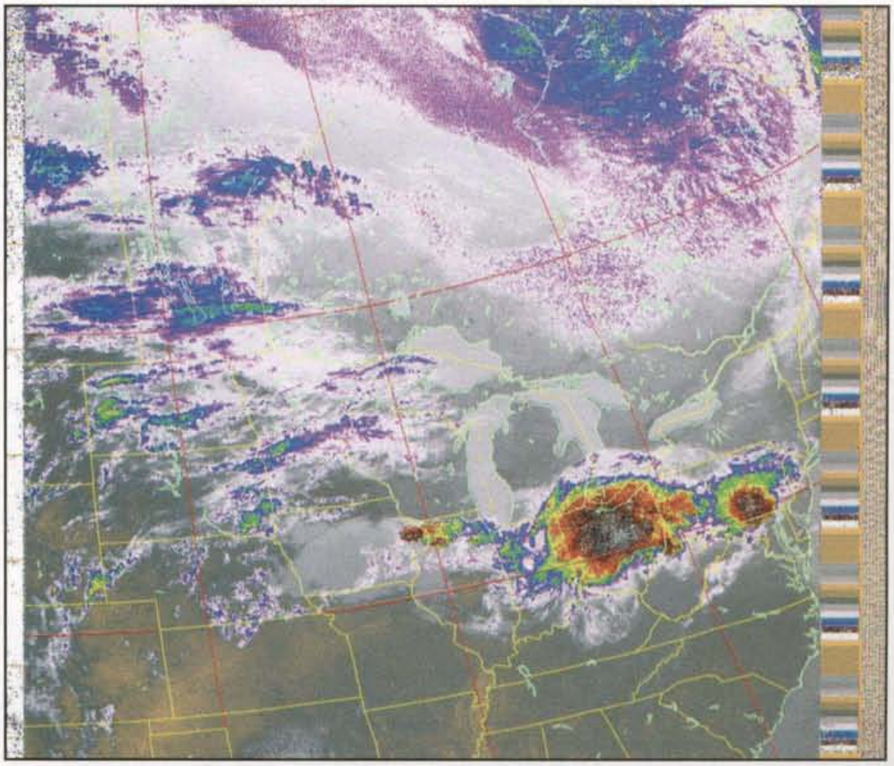


Figure 8. The same image with areas of precipitation enhanced. Note that those clouds over Ohio are actually some very intense thunderstorms.

Amateur Radio in Schools

How do I approach a school to interest it in offering amateur radio as part of its curriculum?

Many ham radio operators recognize the benefits of having amateur radio as an enrichment program in schools. They are aware of the relationship between the knowledge gained by participating in the hobby and the content of science, math, geography, language, and social studies subjects taught in schools. They have also observed how the use of amateur radio can improve a young person's verbal and social skills.

If the benefits of such a fun hobby are so evident, so important, why is there an apparent lack of interest in amateur radio among our youth and our schools? If amateur radio provides hands-on activities that allow students to apply what they learn in the classroom, connects the school and students to others around the world and in the local community, brings space exploration into the classroom, and allows students to participate in community service in a meaningful way, then schools should be beating down the doors to integrate amateur radio into their programs.

Why don't schools seem to be interested? Today, schools are asked to take on more and more of society's responsibilities. Not only are they responsible for providing a safe, stimulating educational environment, but they also provide many community and social services as well. Schools are under the microscope to meet state and national educational standards and to increase standardized test scores. Add to that staff issues, union issues, budget issues, local election issues, privacy issues, school-community based management issues, and the list goes on. Perhaps you can understand the tremendous load schools deal with daily. If you haven't visited your local school lately—during the school day, not just during athletic or other special events—you should. It will open your eyes.

We may perceive schools as not interested, but in fact, they are *very* interested in new ideas to help students learn. Unfortunately, learning enhancements, such as amateur radio, that do not neatly fit into the mold dictated by state and national standards are difficult for a school to embrace. Embracing amateur radio in the schools involves some risk, and risk is uncomfortable.

How do some schools do it? There are some that have very successful, robust amateur radio programs. How did they manage to start them? It is not usually a decision that was initiated at a top administration level. Virtually all schools using amateur radio for instruction began their programs with a teacher deciding to share his/her hobby with the students. Some magnet schools and academies have made an administrative decision to use amateur radio as a focus, but they are the exceptions rather than the rule. School boards, superintendents, and principals can dictate using amateur radio in the classroom, but the problem then becomes finding someone qualified to teach it enthusiastically.

What's The Solution?

1. Find a Teacher

To succeed in convincing a school to implement an amateur radio program, I would recommend finding either a teacher at the school with an amateur radio license, or someone who is innovative and willing to eventually become licensed. Have this interested person pursue it from within the system, with your support from the community.

Schools that do not have a teacher with an amateur radio license can offer amateur radio as an *enrichment program.* This requires a licensed volunteer from the community coming into the school several times per week to teach the class. A teacher within the school usually sponsors the program and supervises the volunteer. Some schools have regular enrichment periods several times per week. Other schools have specific teachers who offer enrichment programs through their classes.

Another possibility is to have an amateur radio operator volunteer to offer an *after school program.*

Yet another possibility is to concentrate on shortwave listening (SWL), for which no license is required.

2. Show Them

How do we inform the educational community *how* amateur radio can help young people learn? Don't tell them; show them. Show them a classroom where students are actively studying scientific concepts through amateur radio. Show them an active contest station. Show them how to construct a dipole antenna, emphasizing the math and physics involved.

If you are going to give a demonstration, make sure that you are prepared. I would suggest a demonstration of the basics of amateur radio, not the most complex operation requiring the most sophisticated equipment you have in the shack. We sometimes forget that even the simplest form of communication via amateur radio is impressive. My recommendation is a little 2-meter HT action and a little CW. Don't depend on a fishing expedition with exceptional band conditions. Plant some "sure" contacts, those who will be listening in case that rare DX is not on the air during your demonstration time. Show them something that is realistic and practical in a school setting.

3. Student Demonstration

A good way to get the attention of educational officials or teachers is to have students do a demonstration. A small group of sixth or seventh graders demonstrating an HF QSO or satellite contact can have a profound effect on educators. Allowing students to demonstrate the depth of their knowledge through several layers of questions will leave a lasting impression.

4. Speak "Education"

Educators, like all professionals, have a jargon to facilitate communication among themselves. While you should not attempt to come across as a professional educator (unless you are one), you should attempt to articulate the value of amateur radio in the classroom with a vocabulary that the professional educators can understand. Try to convey that amateur radio will improve student learning and achievement because:

- Amateur radio provides integration of technology, math, science, geography, writing, reading, and speaking through hands-on application of these concepts either individually or in a group.
- Amateur radio encourages investigation and experimentation as a basis for understanding technical subjects.
- Amateur radio encourages communications via a variety of methods: voice, various digital techniques, Morse code, and even ATV. In addition there is communicating by using satellites and bouncing signals off the moon.
- Amateur radio encourages public service through its links with state and federal disaster-preparedness agencies.
- Amateur radio holds few roadblocks for people with disabilities. Many people who are physically challenged or visually impaired are able to participate in communicating with simple adaptive devices.
- Amateur radio offers a platform for life-long learning through an active hobby that encourages competition in contesting, spreading international goodwill through friendships developed over years of communicating, and advancement in technology by experimentation

So what do you do now? Give me a call at 530-495-9150 (Pacific time zone), or e-mail at <wa8sme@arrl.org> and let's talk. I may be able to give you some help. Why re-invent the wheel when all you need is a simple alignment of what others have done?

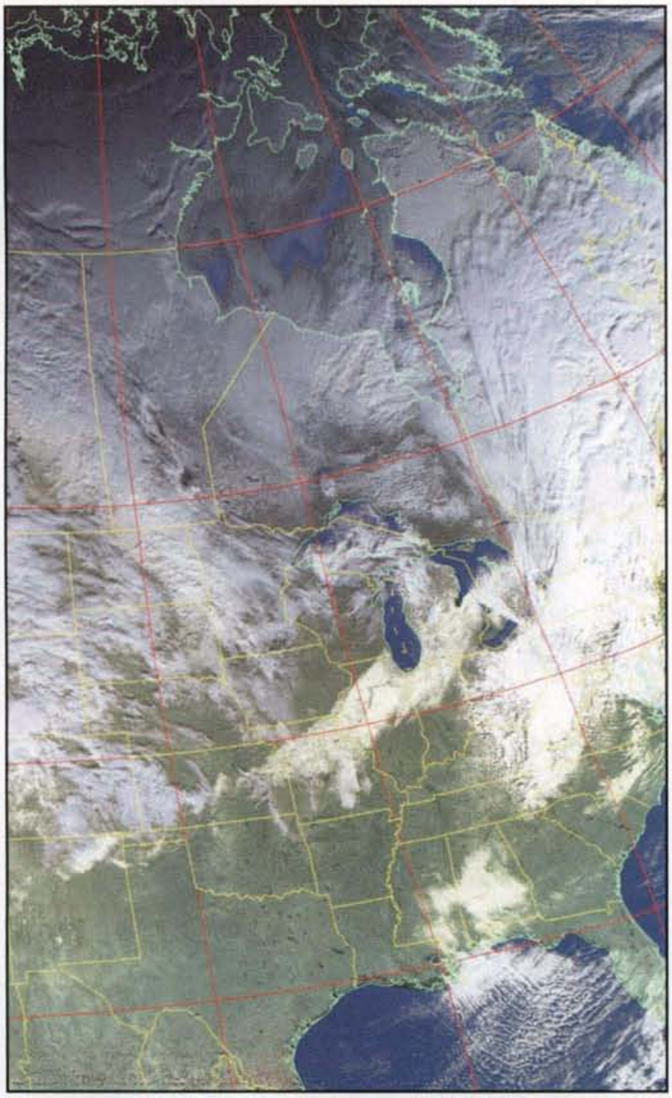


Figure 9. This imagery on Thanksgiving shows a band of snow cover over Illinois and Indiana from a passing cold front. Placing the mouse cursor over the snow-covered area showed the surface temperature to be near zero degrees Centigrade; cloud cover is typically well below zero degrees Centigrade.

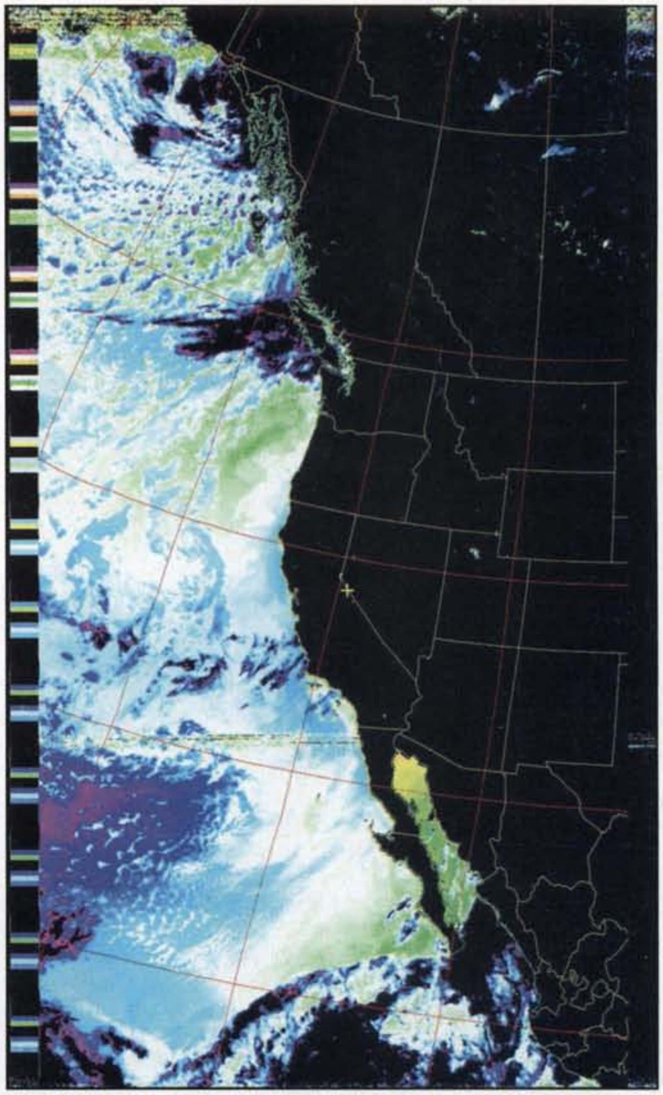


Figure 10. A West Coast image with sea-surface temperature enhancements. Notice the warm water in the Gulf of Baja (indicated by yellow). Students can plot sea currents by using the temperature measurements under the mouse cursor.

er isn't as expensive as you might think. The typical receiver (an example is depicted in figure 5) costs approximately $250. An outside antenna designed to receive signals from space also helps improve signal quality. I built a very good antenna from parts available from the local hardware store (shown in figure 6).[5] A local ham radio operator could be a valuable resource to help with antenna construction and station setup.

With quality signals, the imagery displayed by WXTOIMG is top notch. There now is a ton of information at the students' fingertips (or mouse pointer) to be explored. There are readouts of latitude, longitude, and temperature at the location

Available Resources

There are some very good resources available to help you bring space into your classroom.

An excellent on-line (and free) curriculum resource:
<http://octopus.gma.org/surfing/space.html>

There are very good on-line courses that can be used in your classroom:
<http://rammb.cira.colostate.edu/visit/topic_sat.html>
<http://cimss.ssec.wisc.edu/satmet/CourseInfo/about.html>

There are free resources available to help with basic electronics, wireless technology, and the science of radio:
<http://www.arrl.org/FandES/tbp/>
<http://www.arrl.org/FandES/tbp/Curriculum-Materials.html>

You are also invited to contact the author and request a CD-ROM packed with resources that will stimulate ideas to bring space into your classroom. The author can be contacted by mail: Mark Spencer, WA8SME, ARRL Education and Technology Program Coordinator, 774 Eastside Rd., Coleville, CA 96107; by e-mail at <mspencer@arrl.org>; by phone (Pacific Time Zone) 530-495-9150.

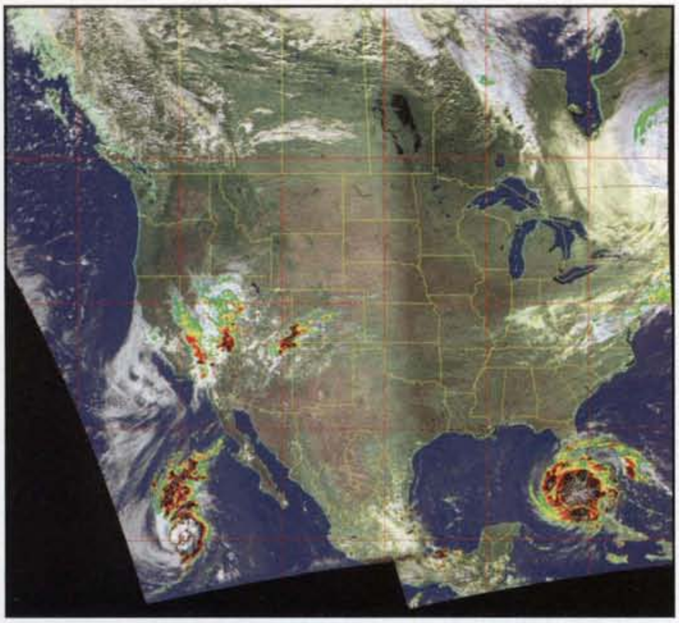


Figure 11. This a composite image produced by combining an image received on the East Coast with one received on the West Coast. Notice that there are two hurricanes at the same time. The shading difference is caused by different receiver settings.

beneath the mouse pointer. The imagery can be enhanced to emphasize different phenomena such as sea-surface temperature, precipitation, vegetation, visual or infrared spectrum, etc. In addition, the imagery can be displayed with different map projections, or sequential images can be combined to create a composite mosaic of images covering a greater geographic area. The potential for study and learning with this tool is without limit. The accompanying figures 7 through 13 illustrate some of the potential learning opportunities available to you if you bring space into your classroom. Let your students' imagination dictate what they can do with the images they get from space through their satellite station.

Notes

1. DOS Satellite Tracking Programs: <http://www.amsat.org/amsat/ftpsoft.html#pc-trk>. Windows Satellite Tracking Program: <http://www.amsat.org/amsat/ftpsoft.html#win-trk>.
2. Update computer clock to correct time: <http://www.boulder.nist.gov/timefreq/service/its.htm>.
3. Update software with current Keplerian data: <http://www.space-track.org/perl/login.pl>.
4. Download display software from: <http://www.wxtoimg.com/>.
5. Ralph E. Taggart, *Weather Satellite Handbook, 5th Edition,* American Radio Relay League, Newington, CT, ISBN: 0-87259-448-3, pgs. 2-9 through 2-11.

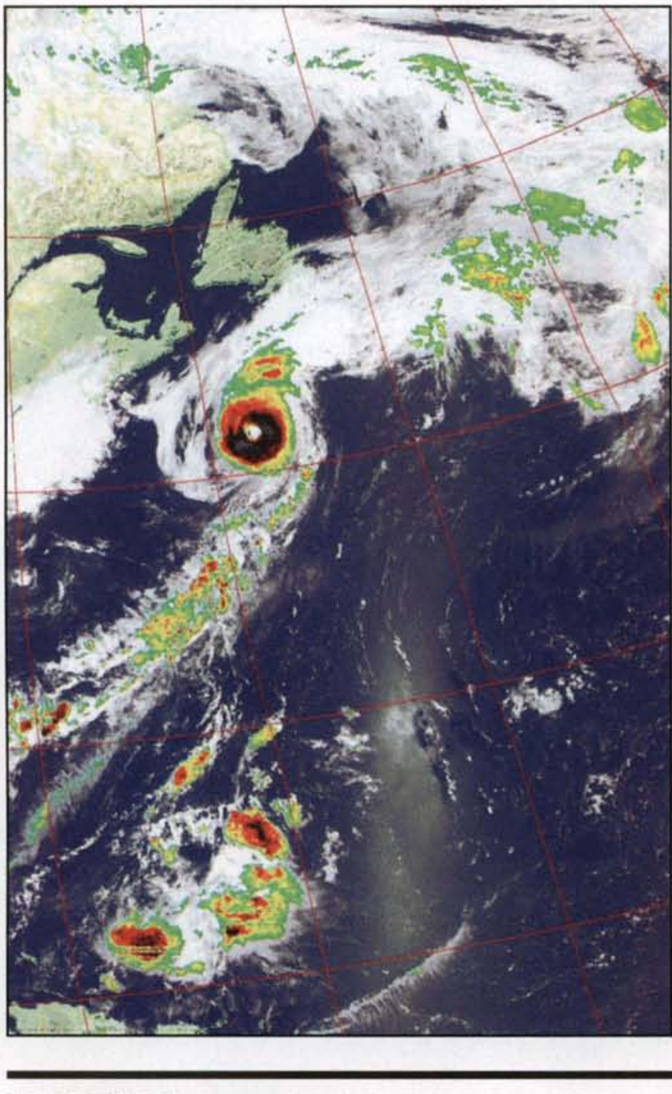
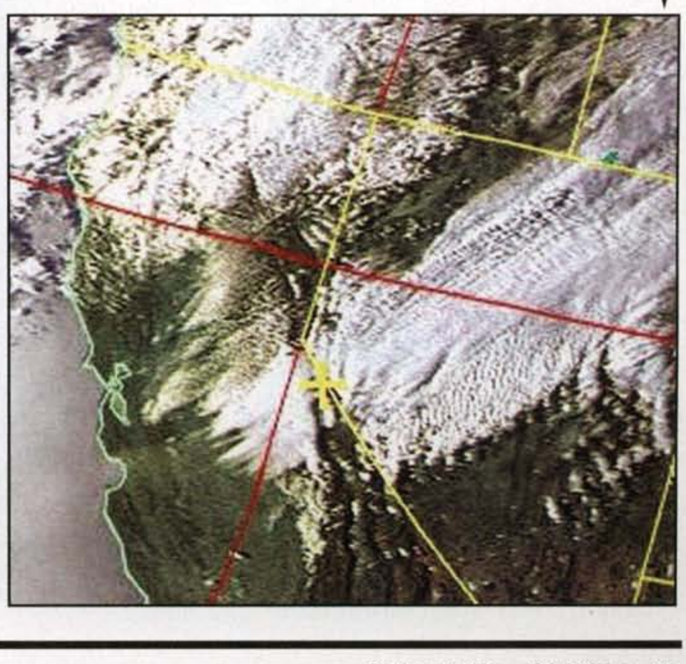


Figure 12. This is an image of a hurricane off the coast of Nova Scotia. Although over cold Atlantic waters, the hurricane is still intense as indicated by the prominent eye. Also note the vertical, bright area in the middle of the image. This is sun glint off the ocean surface, one way to explore angle of incidence and ← angle of reflection using the sun and the Earth's surface!

Figure 13. This enlarged image shows a more local weather phenomenon, a rain/snow shadow caused by the Sierra Mountains. Precipitation is wrung out of the clouds as they are lifted over the Sierra from the west, leaving little or no moisture to fall on the eastern slopes. Desert terrain is the result. ↓



Wagoner Windtalkers

Amateur Radio in the Classroom with a Historical Twist

The following is excerpted from the January and April 2007 "VHF Plus" columns in *CQ* magazine. It is an example of an in-classroom program in Oklahoma that, although is in its infancy, has already garnered recognition from non-amateur radio media for its innovative approach to using amateur radio in the classroom.

By Jeff Sharrock,* AF4CM

When I was in the U.S. Marines, I came to appreciate the importance of portable and reliable low-power communications. The transceivers that reconnaissance teams carry are essential to accomplishing missions. It is their means of reporting information (the eyes and ears of their units); of calling in for assistance, such as medivacs or emergency extracts; and it is the means they use to call supporting arms such as air strikes and artillery.

As a reconnaissance officer, I was particularly impressed with the science involved in high-frequency communications, as it always seemed to be harder to maintain than the UHF and VHF links. Despite our use of VHF, UHF, and SHF radios, it was my desire to master HF that took me into the realm of amateur radio, and once exposed to that as a hobby, I was hooked.

Photo 1. Student members of the Wagoner Windtalkers High School ARC, WI5ND. (Photos courtesy of the author)

I got my first amateur radio license while I was stationed on the Army base at Ft. Knox, Kentucky in 1996, and worked through the then six classes of licensing in a couple of months. When I retired from the Marines in June 2004, I transitioned to teaching through the military's Troops to Teachers program via the State of Oklahoma's alternative certification program. Shortly after starting my first year as a U.S. History teacher, we formed a school club and crafted a constitution that empowered the students to control all aspects of the club except issues involving safety and proper operating procedures (which I retain as the sponsor). I was very pleased to find out that we were the first licensed amateur radio high school club in the state and that the WI5ND callsign was available.

The club, the Wagoner Windtalkers, was named in honor of the American Indian Code Talkers, particularly from the Choctaw and Comanche nations, who hail from Oklahoma. When most people hear the name "Windtalkers," they only think of the Navajo, because they played such a vital role in the Pacific theatre with the Marines. What we want to bring to attention is the fact that the Choctaw were the first to employ their native language when wireless radio was introduced onto the battlefields in Europe during WW I. The Comanche played a significant role in the success of the Normandy D-Day landings and the subsequent liberation of Europe by reporting the progress of the landings on the beaches to Allied commanders across the English Channel and on all the way to the fall of Hitler's bunker.

In spring 2005, Mr. Charles Chibbity, the last living Comanche Code Talker, met with the students in our club and cap-

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Photo 2. Wagoner Windtalker student members pose with radios contributed to the club by Sam Plessinger, W8GRP.

tivated them with stories of his life and service in WW II. When he passed away the following July, the significance of their precious opportunity to meet the last living Code Talker from the Comanche nation was not lost on them.

Since its inception, the club has been oriented towards developing portable, low-power operating capability. First with HF, because of my own passion for it, we found ways to reach out and make QSOs with hams as far away as possible, with as little power as possible. In addition to demonstrating the capability of ham radio "when all else fails," the kids have steered towards contesting, using our modest base-station setup to develop operator skills by participating in School Club Roundups and other organized operator activities. Using homebrew wire antennas and an HF rig, and often a battery, solar panel, and charge controller, the kids have managed to work all 50 states (unconfirmed, as we lack a few QSL replies at the moment) and all the continents. In spring 2006, the club managed its greatest achievement, a second-place finish in the High School category for School Club Roundup, and without even participating all 24 hours. We were most pleased that while others apparently found conditions at the bottom of the sunspot cycle a bit tough, our QSOs doubled and our score tripled from the year before.

With the help of a couple of local donors who saw the club's activities featured in the *Tulsa World* daily newspaper and on OETA (Oklahoma Education Television Authority, the Oklahoma statewide public television network) and provided a used RadioShack 2-meter HTX-420 and a Kenwood TR-7500, we now have the means to develop our portability theme in the VHF realm. Eight of the 21 members currently in the club are actively working on getting at least a Technician license, and the VHF gear lowers the point by one license class, whereby I can let them function on their own without my direct control. In addition, the kids will soon have the means to make local CW QSOs and train operators for license upgrades using MCW over their FM VHF radios.

We are in the parts-collection mode now and will begin construction of MCW audio oscillators at our next weekly meeting. I also intend to use the VHF gear to teach them about other things I have not yet given them much exposure to, such as using repeater networks.

Speaking of VHF gear, I would also like to mention the generosity of Sam Plessinger, W8GRP. After seeing the initial write-up in the January 2007 "VHF Plus" column, by N6CL, in *CQ* magazine, Sam boxed up three of his 2-meter radios, complete with accessories, and shipped them to the school address.

One day early this past February I was making copies of my U.S. History lesson plan in the high school copy room when I noticed a box sitting there addressed to the Wagoner Windtalkers amateur radio club. Opening it, I discovered that a man whom I've never met, or even had a QSO with, had decided that he had the means to put more radio gear into the hands of my students and took action! I have included a picture of the radios Sam sent, which include an ICOM IC-25 A/E and Yaesu FT-2400H mobile transceivers and a Kenwood HT.

When I presented Sam's donation at the weekly club meeting, you would have thought it was Christmas. The club president, McKenzie Clothier (bottom row, second from left in photo 2) and some of her officers immediately set out to learn each radio's features and to make plans to use them to carry on a local net.

With School Club Roundup a recent experience for the club members, their excitement level had already been running high. However, the news of being mentioned in *CQ* magazine and the arrival of Sam's donation stirred them up even more.

My students want Mr. Sam Plessinger to know they are most grateful. As their sponsor, I feel that our exposure in *CQ* magazine plus Sam's generosity have given me some tremendous "backup" in my efforts to teach and inspire these kids, and I want N6CL, *CQ*, and Sam to know I really appreciate it. After watching the students' reactions to both the publicity and to Sam's gift, I can tell that their view of ham radio, and their place in it, has changed for the better. I think they feel a greater sense of fraternity with other hams than before; and with all the other ways young people have to communicate or be entertained these days, if there is a better way than Sam's example to get them to embrace ham radio and carry the torch forward, I just don't know what it could be.

Editor's Postscript

Jeff is a great example of a second career K-12 educator who has taken the initiative to bring amateur radio into the classroom. His efforts are beginning to pay off for the students. A recent Wagoner High School graduate and Wagoner Windtalkers ARC alum is Brett Greer, KE5EHN, who is in the U.S. Air Force working in electronics technology.

Elsewhere in this issue, Mark Spencer, WA8SME, the ARRL Education and Technology Program Coordinator, writes about how to get the classroom doors opened to amateur radio in his article "Bringing Space into Your Classroom" and his sidebar "Getting Ham Radio into Local Schools."

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

Opportunities for the New Ham and Imagination in Space Education

Since my last column, the amateur radio bands have been restructured and Morse code has been eliminated as a requirement for amateur radio licensing. None of these changes have directly affected the Amateur Radio Satellite Service, but the influx of new and upgraded licensees could and should affect our service. Educating these new folks and educating our school children calls for "Imagination in Education."

Amateur Radio Satellites for the New Ham

On December 15, 2006, restructuring of the amateur radio bands took effect. This restructuring did not directly affect any of the amateur radio satellite allocations, but it did widen the phone allocations on many of the HF bands and set the stage for the next step—*elimination of the Morse code requirement for amateur radio licensing.*

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This huge step came on February 23, 2007, and we are already seeing many new and upgraded licensees showing up on the bands—particularly HF. The Amateur Radio Satellite Service should receive its share of these new folks as well. Many of them have been out there waiting for years to get into amateur radio, but didn't want to bother or couldn't learn the code. Many are technically inclined and are naturals for operating via the satellites. Some, too, are apartment dwellers, naturals for the small and portable antennas that can be used to work the amateur satellites.

The Amateur Satellite Service is unique in its ability to provide local and long-distance communications with simple radios and small antennas, while providing challenges for the technically inclined by introducing new modes, new techniques, and new equipment combinations into our hobby. For example, we are introducing the exciting new Software Defined Transponder (SDX) into several new satellites—SuitSat 2, Phase III E, and Eagle. This SDX technology will increase the efficiency, reliability, and versatility of the satellites, while maintaining simple, proven user interfaces. To the old mode "B" users it will look just like AO-10 and AO-13, and the same ground stations will still be useful. We will also be introducing new

Kid's Connection simulated ARISS contact. The author and Kid's Connection Director Cindy Wooten work with the students to simulate or reenact an ARISS contact. The Kid's Connection is an after-school program operated by Hemphill Presbyterian Fellowship for Elementary School children from Daggett Elementary School in Fort Worth, Texas. A presentation about the International Space Station, the astronauts on board, and the school that made the real contact preceded the reenactment. A long Q&A session followed the reenactment, and the kids continued to express an interest in the subject several weeks after the reenactment.

text messaging and advanced digital techniques into the amateur satellite world with Project Eagle.

Let's take advantage of this new influx of amateur radio operators and steer them into the Amateur Radio Satellite facet of our hobby. We have space on the satellites now, and we could certainly use some "new blood."

Imagination in Space Education

Years ago I was challenged by a first-grade teacher, Dr. Debbie Coonrod, at Riverside Applied Learning Center in Fort Worth, Texas asked me to help her establish a contact for her students with the cosmonauts/astronauts on board the MIR Space Station during a Space Day at her school. Then, like now, it was impossible to guarantee such a contact with a short lead time and on a specific date/time.

Using imagination and all of the resources available, we were able to introduce the students to amateur radio satellites, filling up an entire Space Day with meaningful space-oriented activities and providing space projects for the next couple of years. An account of the original project was published in "The Proceedings of the 13th AMSAT-UK Colloquium '98," and again for the ARRL Education Workshop in 1999. An update of these ideas was presented at the 2007 AMSAT Space Symposium in San Francisco. A list of the ideas utilized follows:

1. Use large satellites—ISS, Hubble, etc.—for visual sightings. Schedule watch parties and explain what will happen with laser pointers, mirrors, and a globe.
2. Demonstrate satellite tracking software to illustrate orbital mechanics.
3. Do live communications demos through the "Easy Sats."
4. Copy and explain telemetry from amateur satellites.
5. Do live demonstrations with imaging from polar orbiting weather satellites.
6. Arrange for messages to be sent to the students via the digital satellites.
7. Arrange for classroom-to-classroom schedules via satellites, HF, EchoLink, IRLP, etc.
8. Submit an application for an Amateur Radio on the International Space Station (ARISS) contact, but don't hold your breath waiting for it to come along. Monitor the contacts with other schools via EchoLink, IRLP, and listening to downlink for other schools.
9. Stage an ARISS contact using recorded downlink for the answers and obtain the questions from ARISS press releases. The students can ask the questions as if they were their own and listen to the astronauts' answers. This can be done anytime that is convenient, and with proper explanation it can be almost as effective as a real-live contact.
10. Build simple equipment, such as antennas, to be used with the other demos.
11. Build and launch model rockets.
12. Use a "Parrot Repeater" to stimulate student interest in radio and to improve student speech.
13. Arrange talks with other space-oriented organizations and facilities that have amateur radio stations—e.g., Goddard Space Flight Center, Johnson Space Flight Center, Kansas Cosmosphere, other museums, etc.
14. Set up a full-time amateur radio station in the school with heavy emphasis on amateur satellite capabilities, but don't forget HF and other bands and modes.
15. Invite speakers into the classroom.
16. Build a wood and paper facsimile of the space station.
17. Don't pass up an opportunity to utilize the capabilities of all satellites to spark interest.

These are just a few of the things that can be done with radios, satellites, people, and *imagination*. Use yours to stimulate an interest in space, math, and science in your favorite school(s). The students surely will thank you, and who knows . . . one of the kids you help today may be the first person to set foot on Mars.

Summary

Amateur radio has a new opportunity to grow. Use this opportunity to increase the activity in the amateur radio satellite facet of our hobby. Tap the imagination of the existing hams and expand this growth to help educate our kids.

Also, don't forget to support the AMSATs of the world in their efforts to build and launch new and challenging satellites. If you read this in time, visit the AMSAT booth and forums at the Dayton Hamvention® in mid-May. If you can't make Dayton, see us at a hamfest near you this summer, and don't forget Field Day 2007 in June.

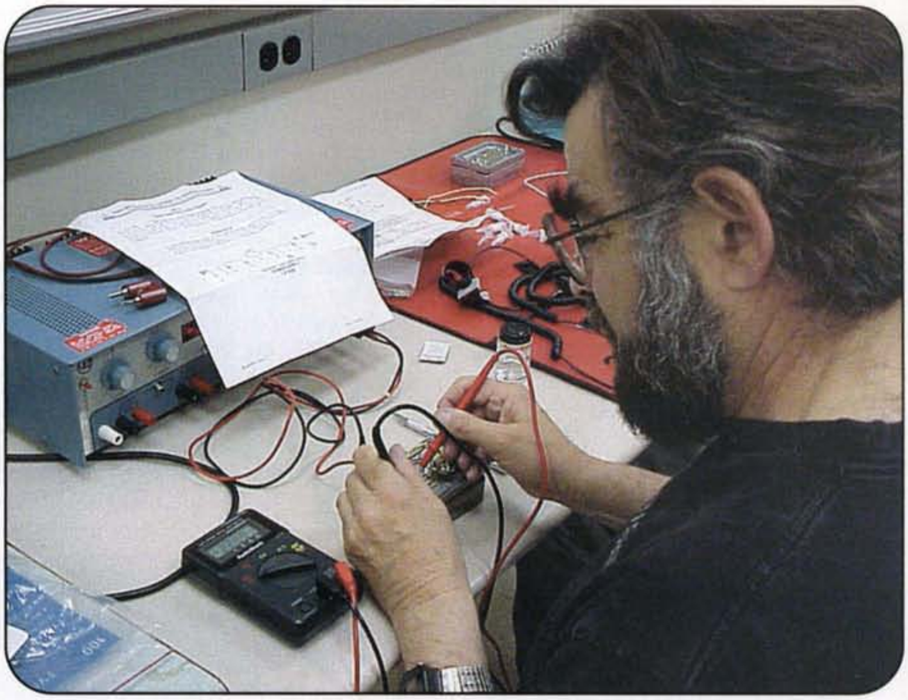
73, Keith, W5IU

By Dr. H. Paul Shuch,* N6TX

THE ORBITAL CLASSROOM

Furthering AMSAT's Mission Through Education

Education vs. Training



Mal Raff, WA2UNP, was already highly educated with a Ph.D. in astrophysics when at a recent conference Ed Cole, AL7EB (now KL7UB), trained him in the construction of microstrip low-noise preamplifiers. (N6TX photo)

Do you know the difference between *education* and *training*? Although the AMSAT mission includes both distinct components (see sidebar), because the two endeavors often overlap, they easily are mistaken for one another. The distinction is a subtle but important one.

As a gross oversimplification, you can consider education as the imparting of knowledge, while training involves the acquisition of skills. In the context of satellite communications, prior knowledge often is necessary before specific skills can be acquired. Conversely, prior specific skills often can enhance or accelerate the accumulation of knowledge. That is why AMSAT's educational and training departments must work so closely together.

In AMSAT, educational activities fall within my purview as Director of Education. I am tasked with developing curricula and materials to help the classroom teacher use our satellites as educational tools. Often this has nothing whatsoever to do with completing a QSO, and everything to do with the inner workings of the satellite or the outer workings of its orbit. If you think the only purpose of an HEO (high-Earth orbit) satellite is to facilitate making DXCC, you are missing its educational potential.

Training within AMSAT generally involves helping hams operate the rig, track the bird, and make contacts. It involves manipulative skills and thus requires hands-on practice with real equipment. AMSAT's training cadre is our growing network of volunteer Area Coordinators, organized through a structured Field Operations department, communicating largely through the Field Ops e-mail reflector. If you need a helping hand in making your station play properly, you can turn to Field Ops for swift and skillful training.

There is a great deal of overlap between these two distinct areas, however, so AMSAT's educational and training departments collaborate extensively. As Director of Education, I often find myself helping a teacher figure out the operation of a particular rig in order for him or her to complete a classroom contact. Also, there are many Area Coordinators who have had to educate local hams in Kepler's laws so they could properly plug them into their tracking software. Perhaps this is why the two distinct functions become blurred in the minds of many.

Satellites serve well as educational tools. They provide a concrete means for verifying scientific theory that to the student might otherwise seem abstract. By measuring acquisition of signal (AOS), loss of signal (LOS), and Doppler shift, for

The AMSAT Mission Statement

AMSAT is a non-profit volunteer organization that designs, builds, and operates experimental satellites and promotes space *education*. We work in partnership with government, industry, educational institutions, and fellow amateur radio societies. We encourage technical and scientific innovation, and promote the *training* and development of skilled satellite and ground-system designers and operators.

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"The ham station is a laboratory of sorts, and thus an excellent training ground. When you show someone how to tune the rig, aim the antennas, key the microphone, and make a satellite contact, you are training him or her in important manipulative skills."

example, we can give students real-world data to test their understanding of orbital mechanics. However, before such education can take place, one or more people in the classroom must be trained in the physical operation of the ham station. Otherwise, no practical data can be gathered to support the educational analysis.

Conversely, before the satellite ham can be trained in the tracking of the bird, a little formal education in coordinate systems (azimuth, elevation, right ascension, declination, latitude, longitude, and altitude) is probably in order. Without a solid educational background, operation reduces itself to "push this button, twist the knob, and hope for the best."

If education involves the acquisition of *facts,* training leads to a mastery of *tasks*. The factual emphasis in education is well suited to the classroom environment, so textbooks and the internet make excellent educational tools. The task-oriented nature of training, on the other hand, means that it most often occurs in the laboratory. The ham station is a laboratory of sorts, and thus an excellent training ground. When you show someone how to tune the rig, aim the antennas, key the microphone, and make a satellite contact, you are training him or her in important manipulative skills. When you help a visitor use these skills in calculating an orbit, evaluating Doppler shift, data-reducing a frame of telemetry, or predicting the next pass, you are engaged in education.

Still not convinced that the distinction between education and training is a significant one? Consider this: If you have school-age children they probably receive sex education in the health science classroom. That training, on the other hand, most likely takes place in an extracurricular manner.

73, Paul, N6TX

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Furry Hams and a New Rescue Beacon

Can someone tell me how ham radio hidden-transmitter hunting got to be called "foxhunting"? It's hard to imagine why hams gave the name of an inhumane pastime of the 18th and 19th century to an exciting and educational radiosport. Perhaps it's because we sometimes look just as silly as foxhounds when we scurry about trying to find hidden radio transmitters.

I prefer other names for competitions of radio direction finding (RDF), such as "T-hunting" for mobile events and "radio-orienteering" for hunts in the woods. However, this time I have the story of a radio foxhunt where the quarry was indeed a fox. In researching it, I was initiated into the world of anthropomorphics.

My old dictionary defines anthropomorphism as "the attributing of human shape or characteristics to objects and animals." A simple example would be a person who dresses up as the animal mascot of a sports team and performs for the fans, acting much more like a human than an animal.

Thousands of people on our continent have taken this to the next level. Calling themselves "furry fans," they make and wear their own animal costumes and develop distinct personalities that go with each one. Some of them are hams in more ways than one.

Here's Randy Fox, K9YAP, as his alter ego, Yappy Fox, ready to hide the transmitter. (Photo by Randy, K9YAP)

Hunting Florida's Red Fox

Amateur radio Newsline editor Bill Pasternak, WA6ITF, and furry fan Julie Fraedrich, KD8AYJ, tipped me off about a YouTube video[1] that shows a transmitter hunt at Anthrocon, an annual convention of furries in Pittsburgh, Pennsylvania. The hunt was organized by K9YAP of Kissimmee, Florida, whose name happens to be Randy Fox. (Really! Look it up.)

By day, Randy repairs audio/video equipment for Disney in Orlando, but at other times his colorful furry suit and his fox persona come out to play. "It started as a job," he told me. "I hired on as Chuck E. Cheese part time when I was in college

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Horses, Hounds, and Foxes

"The pursuit of the uneatable by the unspeakable!" That's how Oscar Wilde is said to have described foxhunting, which began in 17th century England. Back then, the preferred quarry were stags, boars, and hares. However, widespread tree cutting for fuel and shipbuilding had destroyed woodlands and decimated the deer population. After the king decreed in 1670 that hunting of the "endangered" stag could be done only by his personal invitation, the Duke of Buckingham started the sport of foxhunting.

In those days, foxes were considered to be vermin in the Midlands area north of London. They sometimes attacked little lambs, so sportsmen decided to chase them. "Chase" is the operative word here, as the gentry horsemen in a field of foxhunters left the actual hunting to a pack of about four dozen dogs. English Foxhounds were specially bred for speed and trained to hunt by a lower class servant called the Huntsman.

Traditionally, each year's foxhunting season began on the first Monday of November and continued through the end of the year. In the early morning of a hunt day, while these nocturnal animals were out foraging, servants stomped closed all the foxholes in the hunt area. Unable to find safety in their dens, the foxes sought cover in thickets.

A little before noon, after a gala lawn breakfast, all the gentry horsemen would gather at one end of a thicket. The Huntsman sent his hounds into the other end to flush out the foxes. "Tally ho!" was the cry as the first hapless fox appeared, where upon the hounds would run it down and eventually devour it for lunch.

What about the mounted sportsmen? In truth, all they did was chase after the hounds, galloping gleefully cross-country, trampling fields and splashing through rivers. If they could stop the ravenous hounds in time, each rider ended up with a fox head, paw, or tail for his mantel.

Foxhunting didn't really reduce the vermin population in England, because it became so popular that more foxes were imported just to have plenty of animals for the hunt. By the middle of the 18th century, it was the favorite activity of sportsmen. Gentry English emigrating to the New World sometimes sent their hounds ahead so that they could enjoy the sport here. George Washington was passionate about the sport, having been introduced to it when Lord Fairfax hired him as a teenager to survey portions of the five-million acres that Fairfax had inherited in northern Virginia.

After decades of controversy, a ban on all hunting with dogs in England and Wales went into effect two years ago. Nevertheless, the controversy continues.

As Electropaw, Brett Ring, K9RVN, searches for the fox at Anthrocon 2006, with help from Jacob Kinser, KB3LCB. (Photo by Christopher Bochna, N9RQW)

and I loved doing it. I did that for eight years part-ime, and then I decided that I wanted to do it for myself. Now I run an Internet puppet show and I do mascot gigs at conventions."

Randy continued, "In costume, I'm a very outgoing person, whereas out of costume I'm kind of shy and reclusive. When I started at the pizza place, it got me doing nutty things that I wouldn't have done outside the costume."

Randy and friends volunteer regularly for Give Kids the World,[2] a non-profit resort that provides lodging and visits to the attractions of the Orlando area for children with serious illnesses. "There is a village of duplexes where the kids stay," Randy explained. "We don our fur suits and go out there on a week night to entertain them."

Just as in ham radio, the furry world has builders and operators. "Some of us make our own suits," explained K9YAP. "You have to be a real artist to do it right, so mine are all purchased. Furry fandom has a lot of creative talent in it. Many people can design or make the suits, but the rest of us are art admirers who buy them and perform in them.

"Ham radio is beginning to pick up in this community of anthropomorphic arts. We're finding hams popping out of the woodwork. In my case, I went to buy parts for some radios I had and the guy asked, 'Why don't you get your Tech license?' When I got my ticket and talked to people about it, I found others. We've convinced some more to get their licenses."

K9YAP and other furry hams enjoy many aspects of ham radio, including chatting on voice and digital modes. The idea of transmitter hunting came to them at Further Confusion 2006, a convention in San Jose.

"People were saying that it would be neat to literally do a 'fox' hunt because we have a lot of fox mascots," Randy said. "It got the wheels turning. My roommate had a little 2-meter APRS transmitter kit that he had never put together. It can be made to do foxhunting tones by putting in a different chip.[3]

"I stuffed this kit together and put it in a protective case. Then I decided to do the first foxhunt at Anthrocon 2006. I didn't know how well it would take off or how many people would participate, so I advertised it. I took a couple of scanners along with me in case somebody wanted to hunt but didn't have any equipment.

"I did a forum on Friday. I explained that foxhunting is similar to tracking tagged animals. Then I talked about the equipment and techniques for searching. I was surprised because some people had walked into the room with all kinds of antennas, such as pre-made Yagis and homemade ones made out of measuring tape. They had other things such as field-strength meters. There were a couple of people who had never touched ham stuff before, but they had an interest in this foxhunt. I was glad I brought the scanners.

"I decided to do three hunts on three days in a row. On the first day, about a dozen people participated. I planted my transmitter in a room where there were booths for people selling things such as comic books. I gave it to one of the dealers in that room. The objective was for people to go up and ask if that vendor was the fox.

"This was a pretty good-size steel and concrete room, an expo hall. I got a big kick out of this hunt. Everybody with a beam antenna got to the right building pretty quickly. Then they began being fooled by reflections in that room. They all were pointing their beams at the walls and other incorrect places because the signal was bouncing all over.

"A new guy, with my scanner, started sniffing around and ended up being the first to get right next to the fox. He went to the table on the right of it and asked if it was there. Next he went to the table to the left if it and asked, and then he just went away frustrated. Somehow he never asked at the table in the middle, where it actually was.

"I think the hunt went on for 45 minutes. When they got close, the signal was too strong for most of them. Finally, a hunter with an attenuator box managed to triangulate down and he found the fox.

"On the second day, I put the transmitter on a person and told him to walk around. I instructed him that if somebody approached, not to hide it from them. If a person asks if he's the fox, he or she wins. On that day, they triangulated and found him fairly quickly.

"On the last day, I was the fox. This hunt was harder because a rule was that if the hider sees people coming toward him with radios, he can take off, mingling and disappearing into the crowd. I did that a couple of times, but they got me in about an hour."

Randy wasn't expecting anybody to do the hunt in costume, but one did. That was Electropaw, a green wolf who is prominent in the video. Inside the costume was Brett Ring, K9RVN, of Peoria, Illinois, a broadcast engineer who enjoys playing that wolf or a very bouncy dog named Champ.

"This was the first time I have foxhunted," Brett told me. "I'm really glad that Randy came up with the idea of building a fox and hiding it. The first time I tried, I couldn't find it. I homed in toward it with my Yagi, but when I got close, I discovered that the Yagi by itself was pretty useless."

Brett now knows about offset attenuators (more on them later), and I'll bet he does better at his next hunt. Meanwhile, K9YAP continues to bring foxhunting to furry fans. "I ran a hunt in Chicago at the Midwest Furfest last November," he said.

Computer rendering of a TracMe FRS emergency beacon, USA version. (Courtesy of TracMe Beacons Pty Ltd.)

"That one had a pretty good turnout. Then I ran one at Further Confusion in January of this year. I'll probably do another one again at Anthrocon in July. They are expecting it."

Another Rescue by Satellite

From the *Klamath Falls Herald and News* comes the story of another aviation rescue initiated by an Emergency Locator Transmitter (ELT) and the SARSAT system of satellites. A Piper Cherokee developed engine trouble while en route to an airport on the eastern slope of the Cascades on March 6th. It crashed into thick timber and deep snow in Lane County, seriously injuring the pilot and his passenger.

Two initial satellite fixes were hundreds of miles apart, but later readings were closer, and a passing civilian jet copied the transmissions. A National Guard helicopter with infrared sensor was able to locate the crash site that night and detect the men signaling with flashlights. A bag of blankets, food, water, and first-aid supplies was dropped to them and they were able to survive until rescuers reached them on snowshoes shortly after dawn.

It is estimated that 15,000 persons have been rescued in the last 20 years by the use of over 80,000 registered and 500,000 unregistered ELTs for aviators and Emergency Position Indicating Radio Beacons (EPIRBs) for boaters. Beginning in July 2003, the FCC authorized the sale and use of Personal Locator Beacons (PLBs) to individuals and rental companies for hiking and other terrestrial use. PLBs use the same transmitting frequencies and satellite detection system as ELTs and EPIRBs, but they have somewhat less stringent design and feature requirements, making affordable pocket-size units possible.

Opponents of PLB legalization in the USA feared they would become so popular that false alarms and inappropriate activations would clog the system, detracting from its primary maritime and aviation uses. They cited examples from Canada, including the New York man on a solo two-week canoe trip in the Northwest Territories who missed his connection with the bush plane that was to pick him up. Even though he had plenty of provisions to stay a while longer, he chose to set off his PLB, triggering a rescue with Hercules aircraft and helicopter flights that cost the Royal Canadian Mounted Police about $100,000.

In another case in Canada, a man and his son on a kayak trip set off their PLB because they were tired and "it was becoming hard to paddle." A Twin Otter came to pick them up and almost crashed while trying to make a landing at their camp site.

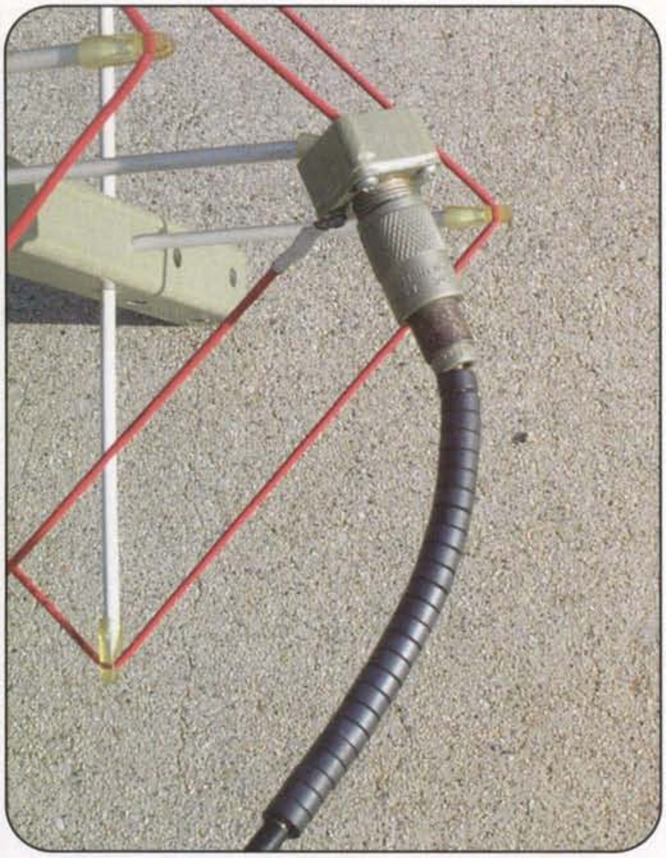
Proponents of legalization declared that inappropriate use by a few shouldn't be the sole reason to deprive everyone else of a useful rescue tool. They cited a pilot program that began in Alaska in 1995, allowing PLBs in the wilderness under a cooperative agreement with the National Oceanic & Atmospheric Administration (NOAA), US Air Force, Coast Guard and Alaska State Troopers. In one year, there were 54 rescues attributed to these PLBs, many of them snowmobilers stranded in sub-zero temperatures.

Now that satellite-trackable PLBs are legal in the U.S., they haven't become the problem that some feared. In fact, they seem to be a well-kept secret. I just inquired of the manager at my local sporting-goods emporium. He had never heard of them. Big-box electronics outlets seem to be ignoring them, too. Perhaps price is the deterrent to sales, because the cheapest PLB at Bass Pro Shops is over $500. Add $100 if you want a GPS sensor in your PLB to send your exact position.

Tracking the Lost and Injured on FRS

Two paraglider pilots in Australia have an idea for a more affordable rescue

Dave Reeves, AC6PP, learns UHF RDF techniques at a radio-orienteering event in Fullerton, California. Note that the antenna handle is well behind the reflector and that coax passes out to an attenuator mounted on the rear of the boom. (Photo by KØOV)



The feed-point connection of this UHF cubical quad forces the coax to loop outside the antenna. A balun of ferrite beads eliminated pattern distortion. The beads fit over the coax braid with the jacket removed. (Photo by KØOV)

device. Their TracMe beacons[4] are being rolled out "down under" and will soon become available in the U.S. and elsewhere in the world. The target market includes hikers, cross-country skiers, and hunters. Anticipated price is under $150 at sporting-goods stores.

TracMe beacons operate on license-free UHF bands. In Australia, they all are on UHF CB emergency channel 5 (476.525 MHz). Stateside units will be on Family Radio Service (FRS) channel 1 (462.5625 MHz). Power output is about 10 milliwatts, compared to 25 milliwatts minimum for 121.5-MHz PLBs and 100 milliwatts for aircraft ELTs. A quarter-wavelength stiff antenna wire pops out when the unit is opened for activation.

The TracMe call for help is a factory-recorded voice that is on for about three seconds and repeats four times per minute. There is enough lithium battery power in each beacon to keep it cycling for about a week, even after ten years of non-use. To keep users from carrying partially discharged beacons, they are programmed to be activated only one time. Once one is used and turned off, it will not operate again. "We have a policy that if you use it to get rescued, you will get a free replacement," says Neil Linsdell of Razlin Technologies, a New Hampshire company that will market TracMe in the USA.

The SARSATs will not pick up nor track these new beacons. It's not expected that there will be terrestrial monitoring sites for them, because the widespread use of FRS radios would make that impractical due to interference. Most FRS users activate the continuous or digital tone squelch feature to keep their receivers quiet; this will keep TracMe beacons from being heard by them.

TracMe says that lack of monitoring and satellite tracking will not be problematic because its beacons are to be used as rescue aids, not as alerting devices. Package instructions encourage users to always let others know where they intend to go and when to expect their return. If they are not back at the anticipated hour, rescuers would go to the target area by land or air and listen for the beacon.

Unlike standard PLBs, the TracMe beacons are unregistered and transmit no unique identification to let rescuers know who is the beacon owner or if they are hearing the right beacon.

How will the TracMe beacons be tracked? Do search/rescue agencies in your area have RDF gear that covers 462 MHz? TracMe isn't selling any now, but it plans to offer a tracking receiver in the future.

Could you help in the search for a TracMe beacon or a call for help on FRS in your area? Readers have written to me about the difficulty of performing RDF on this band. A RACES group in New Jersey held an exercise simulating a lost hiker with an FRS radio, attempting to track his signal. This test took place in a two-mile square park with bare trees and surrounding low hills. Participants reported that it was nearly impossible to get reliable bearings with the body-shield technique and with dual-antenna time-difference-of-arrival (TDOA) RDF sets. Yagis worked better, but effective attenuation was hard to achieve.

Signal reflections (multipath) will cause far more RDF problems on 462 MHz than on the 2-meter band. That's why I don't recommend dual-antenna TDOA techniques on UHF. The New Jersey experience confirms this. I think that the combination of a receiver with S-meter, a good directional antenna, and an attenuation system is the most promising method.

Ordinary FRS receivers are not suitable for RDF. By FCC rules, they have permanently mounted whip antennas with no provisions for attachment of coax. Many do not have signal-strength metering. A scanner or wide-range hand-held receiver would be more suitable.

This well-shielded offset attenuator was built by Mel Parrish, K6UV, who provided the photo.

A Yagi or cubical quad antenna of three to six elements is compact and suitable for on-foot FRS RDF. The directional antenna must be tuned for 462.5 MHz. Do not expect an unmodified antenna for the 70-cm ham band to have good directional characteristics on FRS. To use a 445-MHz Yagi, try trimming one-quarter inch from each element tip and checking the pattern. Trim a little more from a 432-MHz Yagi.

Hold your UHF RDF antenna behind the reflector to prevent pattern distortion caused by interaction with your hand. Experiment with coax routing while observing the directional pattern on a signal of known location. You will probably find that the coax should pass straight back along the boom instead of going off to the side.

One commercial UHF quad that I tested had a pronounced extra pattern lobe on one side, caused by feed-line pickup. I eliminated the lobe by adding ferrite beads as a choke balun. It took two dozen beads (4 1/2 inch balun) to attenuate outside shield RF currents to insignificant levels.

My balun, shown in an accompanying photo, is made from Amidon[5] FB-43-2401 beads. Number 43 ferrite mix has greatest attenuation at 2 meters but is only 10% less effective at 460 MHz. Number 64 would be slightly better for use above 400 MHz, but #64 beads of this size are not available. The balun does not require a jacket covering it to prevent shorts, because ferrites for VHF/UHF are non-conductive.

As you approach the signal source on foot, your signal-strength indicator (S-meter or RSSI indicator) will become "pinned," no matter where your beam is pointed. An ordinary resistive attenuator will be of little help, because the signal will eventually go around the attenuator, into the hand-held receiver, and pin the meter as you continue to get closer. As mentioned earlier, an offset attenuation system (sometimes called "active attenuation") can eliminate this problem.

An offset attenuator works by converting the strong on-frequency signal to a weaker and controllable off-frequency signal.[6] A typical offset is 4 MHz. With your attenuator powered up, tune your receiver 4 MHz higher or lower than the signal you're tracking. You will find the signal there also, at a level that can be adjusted over a range of up to 120 dB.

A properly built offset attenuator works very well on 2 meters, even in a plastic case. However, some builders report reduced effectiveness on UHF. I'm still experimenting, but it appears that a well-shielded case helps. Also try reducing the oscillator supply voltage from 5 to 3 volts and substituting a UHF mixer diode (such as NTE-112) in place of the garden-variety silicon diode. Keep all RF leads as short as possible within the unit.

In future "Homing In" columns, I will have more on the introduction of TracMe beacons into the Western Hemisphere. In the meantime, I want to hear of your experiences in tracking UHF signals on FRS and other bands.

I always appreciate receiving your stories and photos of mobile and on-foot transmitter hunts, including reports of the CQ World-Wide Foxhunting Weekend[7] activities. I also like to get your reports of RDF adventures in interference tracking and search/rescue. Please keep them coming! 73, Joe, KØOV

Notes

1. <http://www.youtube.com/watch?v=ZRpAXKB4OdI>

2. <http://www.gktw.org>

3. The Pocket Fox controller chip is sold by Byonics <www.byonics.com>. The Pocket Tracker transmitter hardware is no longer available. A new miniature 2-meter fox transmitter is being developed for Byonics. Watch for a "Homing In" review when it is released.

4. <http://www.tracme.com>

5. <http://www.amidoncorp.com/aai_ferritesshieldingbeads.htm>

6. Offset attenuators are described in "Homing In" in the Winter 2006 issue of *CQ VHF*. Construction plans are at <http://members.aol.com/joek0ov/offatten.html>.

7. This year's CQ World-Wide Foxhunting Weekend is May 12–13, but any date in the spring is just fine. Read "Take the Foxhunting Challenge" in *CQ* magazine, April 2007 issue, plus the announcement of the tenth annual Foxhunting Weekend and 2006 results in the May 2007 issue of *CQ*.

Register Now for USA's ARDF Championships

Every year, fans of on-foot transmitter hunting gather to see who is the best in the nation. Beginners and experts test their skills and learn from one another. This year's USA Championships Amateur Radio Direction Finding (ARDF) will take place September 14 through 16, 2007 at South Lake Tahoe, in the Sierra Mountains near the border between California and Nevada.

The Santa Barbara Amateur Radio Club and Los Angeles Orienteering Club are joining together to present the 2007 USA Championships. General chair of the organizing committee is Marvin Johnston, KE6HTS. As in recent odd-numbered years, our national championships are being combined with the ARDF championships for International Amateur Radio Union (IARU) Region 2, encompassing North and South America.

National ARDF Championships are for individuals only. No teaming or assistance on the course is permitted. Participants are divided into five age categories for males and four age categories for females in accordance with standard IARU rules. Medals for first, second, and third place will be awarded in each category.

The 2-meter and 80-meter ARDF courses will be open to all, beginner and expert alike. Event headquarters will be at Camp Concord in the El Dorado National Forest. An inexpensive package including two nights of lodging in the rustic cabins and five meals is being offered to event registrants. There are other lodging and dining options nearby.

Even if you have never before competed in an international-rules RDF event, and even if you don't have a ham radio license, you will be welcomed at the USA Championships. More information and registration forms can be found at <www.homingin.com>. There you will also find lots more about the international sport of ARDF.

Joe Moell KØOV
ARRL ARDF Coordinator

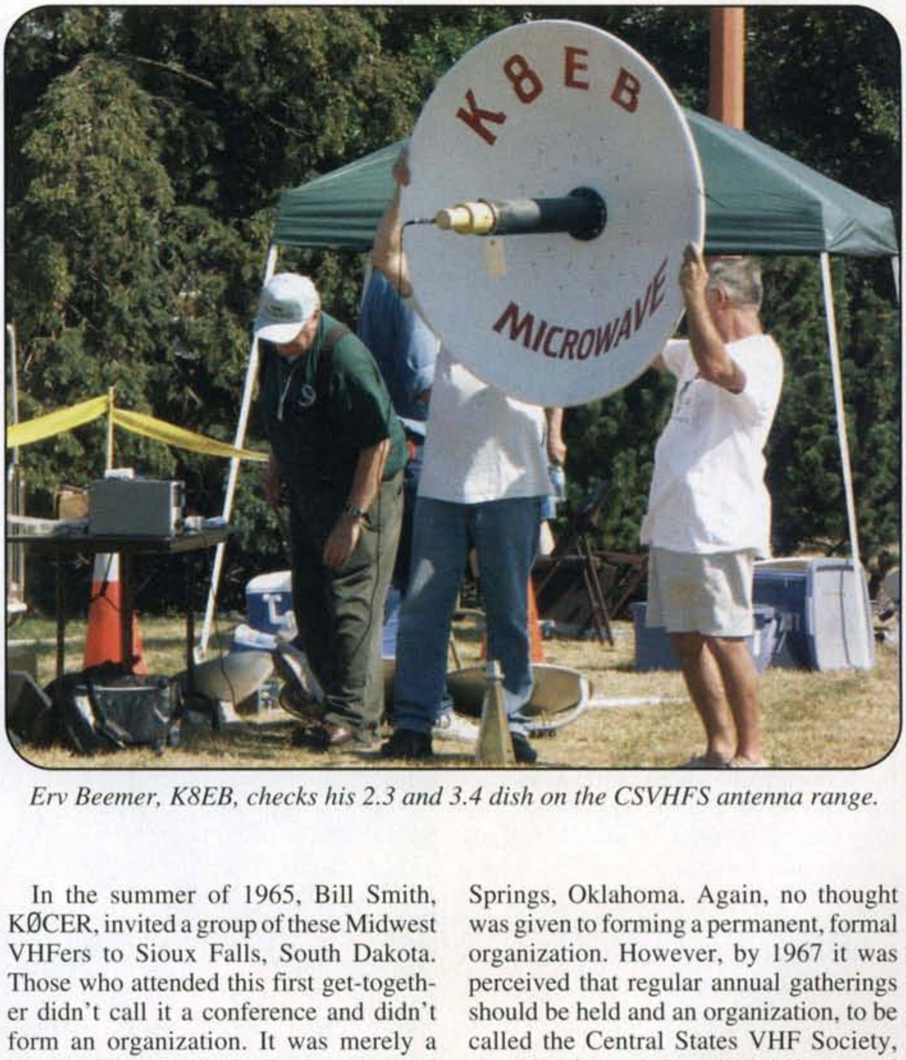
The Central States VHF Society
What It Can Do for You

Former Central States VHF Society president and AMSAT-NA president Bill Tynan, W3XO, tells the fascinating story of the history of the grandfather of regional VHF societies. He concludes his story with an invitation to this summer's annual conference.

By Bill Tynan,* W3XO

Are you active on 6 and 2 meters or the higher bands? Are you just beginning to think about venturing into these fascinating portions of the RF spectrum? In either case, the Central States VHF Society (CSVHFS) can be of great help to you. Its annual conferences provide a wealth of information for anyone involved in the VHF, UHF, or microwave frequencies.

CSVHFS is one of the oldest and most prestigious of the organizations dedicated to promoting activity on the bands above 50 MHz. Groups that have been around even longer include the Mount Airy VHF Society (otherwise known as the "Pack Rats") and the Rochester VHF Society in western New York. Other regional groups in the northeast, southeast, and West Coast hold VHF conferences. In addition, Microwave Update has become popular with those with a special interest in the upper reaches of the radio spectrum. All of these organizations and their meetings are worthy and deserve support, but this article will feature the Central States VHF Society and its upcoming 2007 conference.



Erv Beemer, K8EB, checks his 2.3 and 3.4 dish on the CSVHFS antenna range.

CSVHFS Through the Years

The Central States VHF Society began informally in the mid-1960s with a relatively small group of Midwest VHF hams who regularly got together on 75 meters to commiserate about their separation from the rest of the VHF fraternity on the east and west coasts of the U.S. and to discuss the greater distances they had to span to make QSOs and collect states.

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In the summer of 1965, Bill Smith, KØCER, invited a group of these Midwest VHFers to Sioux Falls, South Dakota. Those who attended this first get-together didn't call it a conference and didn't form an organization. It was merely a bunch of hams with similar interests and problems meeting to swap ideas and stories about operation on what was then considered the really high bands, 144 and 432 megacycles. They hadn't yet started calling them megahertz.

The following year, another informal gathering was held, this time in Sand Springs, Oklahoma. Again, no thought was given to forming a permanent, formal organization. However, by 1967 it was perceived that regular annual gatherings should be held and an organization, to be called the Central States VHF Society, should be formed. A general chairman and several committee chairmen were selected and a conference was called for August 19 and 20 at the Western Hills Lodge, Sequoyah State Park, near Wagoner, Oklahoma. Those dates were selected to follow the *Perseids* meteor shower so attendees could swap stories about what

Some of the 10-GHz gear displayed at the Twin Cities conference. There was also a line-up of interesting rover vehicles, some with absolutely monstrous arrays.

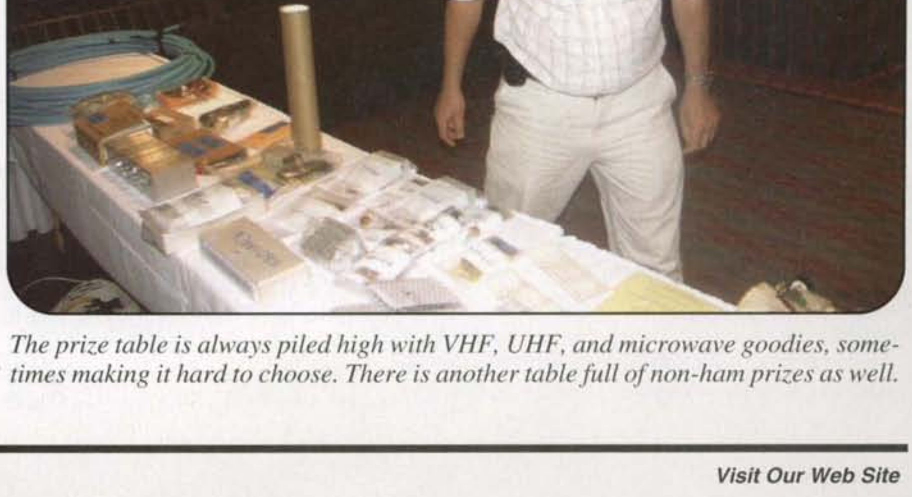
they worked and didn't work during this major meteor shower. Some 125 hams from 19 states and seven call areas descended on that beautiful location. Technical talks were supplemented by antenna tests, laying the groundwork for one of the most popular activities at succeeding CSVHFS conferences.

The 1968 conference, held at the Lake of the Ozarks, marked a milestone in the history of the Central States VHF Society in that it was decided to incorporate. This gathering saw some 100 hams from 35 states plus Canada and England, the CSVHFS conference already becoming internationally known as a prime venue to learn about equipment and operating techniques for the VHF and UHF bands. Participating in the program that year was Ed Tilton, W1HDQ, originator and long-time conductor of the *QST* VHF column and for many years that magazine's VHF Editor.

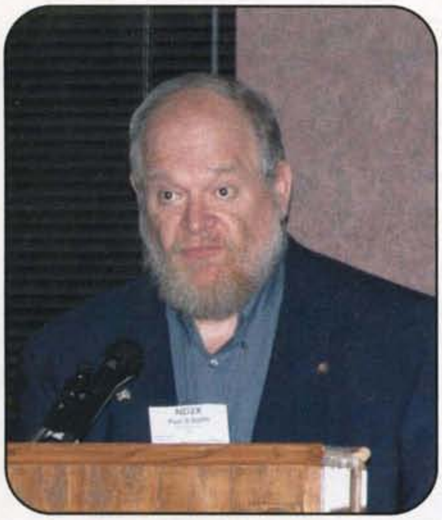
The 1970 conference again was held at the Western Hills Lodge near Wagoner. At the suggestion of KØCER, it was decided to institute an award honoring the memory of John Chambers, W6NLZ, for his many technical contributions to VHF and UHF, including the first terrestrial bridging of the Pacific between California and Hawaii on any VHF band other than 50 MHz. W6NLZ's contacts with Tommy Thompson, KH6UK, on 144, 220, and 432 MHz proved the existence of the Pacific duct. The Chambers Award, presented to one who has made a notable technical contribution applicable to the bands above 50 MHz, has been a mainstay of the CSVHF Society conferences since then. The 1971 conference saw presentation of the first Chambers Award to Mel Wilson, W2BOC, for his studies of sporadic-*E* propagation.

At the 1974 conference held in Boulder, Colorado, the members decided to affiliate with the ARRL and make the CSVHFS a Society Life Member of AMSAT. Mrs. John Chambers, W6NTC, was present at the Saturday evening banquet to present the Chambers Award to Dick Knadle, K2RIW, for his 70-cm amplifier design and development of stressed dishes.

The 1982 conference held in Baton Rouge, Louisiana was dedicated to the memory of Mel Wilson, W2BOC. With the passing of this distinguished



The prize table is always piled high with VHF, UHF, and microwave goodies, sometimes making it hard to choose. There is another table full of non-ham prizes as well.



At the 2006 Saturday evening banquet Paul Goble, ND2X, invited everyone to the 2007 San Antonio conference.

CSVHFS member and long-time secretary, a new award commemorating Mel was instituted. Lists of the recipients of the Chambers and Wilson Awards are presented on the Central State's website, <www.csvhfs.org>.

The Y2K conference marked a departure in the history of the Central States VHF Society. Not only was it the first CSVHFS gathering for the new millennium, it was the first society conference held outside the United States. The site was Winnipeg, Manitoba, Canada. Four years later, having broken the ice, the annual affair again moved north of the border, this time to Mississauga, Ontario.

Last July, the twin cities of Minneapolis and St. Paul served as the site for another CSVHF conference. A great team of active VHFers from the Northern Lights VHF Society made sure that it was a memorable gathering.

Need to Check Out Antennas and Preamps?

Both antenna-gain tests and noise-figure measurements have become key activities drawing VHFers to these conferences. In the early days, a 2-dB noise-figure could well win the competition. Nowadays preamps must measure considerably less than 1 dB to even be in the running, and that's not just on 2 meters. Phenomenally low noise figures are regularly turned in by preamps up to 10 GHz and beyond. Al Ward, W5LUA, has long been a prime procurer of the latest exotic noise-figure measuring gear. Through the years, the antenna range has been presided over by Marc Thorson, WBØTEM, and Kent Britain, WA5VJB, plus a number of able assistants. All who carry the load of providing and operating the antenna-range and noise-figure measuring equipment deserve the thanks of those who benefit from these tests. Ensuring that these popular activities come off successfully is a major contribution to each CSVHFS conference.

A Family Affair

The presence of many wives and children at that first 1967 CSVHFS conference made it apparent that future meetings must include programs and activities geared to families, as well as present high-quality technical programs. The family program has since become an important adjunct to all CSVHFS conferences. Many toddlers present at those early gatherings are now grown and well-known VHFers. Among them are active society members such as Charlie Calhoun Jr, K5TTT; Bryan Ward, N5QGH; and Ron Marosko, Jr., NN5DX.

Please Join Us!

If you are even somewhat interested in the bands above 50 MHz and have never been to a Central States VHF conference, you owe it to yourself to attend one. This year the beautiful, historic city of San Antonio, Texas is the site. Informative technical talks are planned as well as the antenna-range ad noise-figure tests, and perhaps some other technical measurements. There will be a display room for companies offering VHF and above equipment, as well as a Friday evening flea market. The CSVHFS flea markets have become famous for the amount of VHF, UHF, and microwave gear offered for sale. You'll find stuff you never come across at the average hamfest. In addition, there will be lots to keep the family members entertained while we hams learn about the latest in equipment and operation on the bands above 50 MHz..

For newcomers to VHF and above, or those merely considering operation on these fascinating bands, a special session is planned which will answer your questions about what our higher frequency bands have to offer and what you'll need to enjoy the same thrill the rest of us share on 6 and 2 meters and the shorter wavelengths. See you in San Antonio!

Mark your calendar for July 26 through 29 and bring the whole family to the Alamo City for a great time and lots of valuable info on all aspects of VHF and microwave operation. For further information, visit <www.csvhfs.org>, or write to Central States VHF Society, P.O. Box 380526, San Antonio, TX 78268.

New FCC Rules Help VHF-plus Activity

With the elimination of the Morse code as a requirement for licensing, WB6NOA has observed that with the influx of newly licensed hams has also come an increase in those interested in the VHF-plus bands. He challenges us to be good mentors for them.

By Gordon West,* WB6NOA

Recent FCC rules changes surprisingly have increased weak-signal activity on 6 meters and up. The following quote is typical of the old-timers' reaction: "On our W6OMF Sunday evening 2-meter SSB weak-signal net we had more new visitor check-ins than I have ever heard before," commented Bill Alber, WA6CAX, working with net control Larry Hogue, W6OMF.

"We thought we might lose Technician Class operators when they upgraded without a code test to General Class, so it was a nice surprise to see some fresh new signals on the VHF and UHF bands," added Alber.

Two FCC rulemakings have contributed to increased VHF/UHF weak-signal activity. In this article we can examine some reasons *why* they have done so.

In December 2006 the FCC adopted "Novice Refarming" to allow ham operators more voice spectrum in four currently authorized amateur HF bands. A handful of Novice operators and thousands of Technician Plus operators could take advantage of CW practice on expanded CW spectrum shared with General Class, Advanced Class, and Extra Class CW operators. These frequencies are: 10 meters, 28.0–28.5 MHz; 15 meters, 21.025–21.200 MHz; 40 meters, 7.025–7.125 MHz; and 80 meters, 3.525–3.600 MHz. Novice and Technician Plus operators would retain SSB HF privileges from 28.3–28.5 MHz.

This rulemaking gave Extra Class, Advanced Class, and General Class operators more voice elbow room on these bands, while at the same time giving Novice and Technician Plus operators more CW-only elbow room, too.

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Sam's Radio Hams have regular Elmering sessions for new amateur radio operators. (Photos courtesy of the author)

To the Novice and Tech Plus hams this was no big deal. The no-code Technician operator would continue to wait patiently for the anticipated elimination of the 5 words-per-minute code test, which is precisely what happened this past February.

On February 23, 2007 not only was the code test for General Class eliminated, but no-code Techs received an unanticipated bonus: "WT Docket 05-235 will call for a single Technician Class license regardless of whether the applicant has passed a Morse code examination or not. No-code Technician Class operators and those with a Technician Plus license will also have access to the Novice and Technician Plus frequencies on high frequency," commented Larry Pollock, NB5X, of the W5YI VEC (Volunteer Examiner Coordinator) program.

What's the big deal here for a no-code Technician Class operator with zero interest in operating Morse code on HF? Beginning February 23, 2007, no-code Technician Class (and higher) hams can now enjoy 200 kHz of SSB privileges on 10 meters!

Overheard from Will Anderson, AA6DD, was the following: "I was really surprised by the number of no-code operators who came up on the air when the rules went into effect at midnight, Washington, DC time, 9 PM Pacific time here in California." Will conducted a 10-meter "Welcome to HF" net within seconds of the new rulemaking, and all of us on frequency were amazed by the many no-code and code Tech operators coming on the air for the first time.

Giving no-code Technicians voice privileges on 10 meters creates more opportunities for them to experience short-skip sporadic-*E* propagation, especially during the summer months. Sporadic-*E* propagation does not depend on the 11-year solar cycle, and a constant taste of

Field Day is coming up soon. It is an excellent way to introduce newly licensed hams to many different aspects of our hobby.

10-meter openings will likely keep their enthusiasm up for continued VHF 6-meter activity, too.

Inactive Technician Class hams, burned out on 2 meters FM, may dust off an old HF rig and get excited about ham radio again, perhaps making a 1500-mile skywave contact between 28300 kHz and 28500 kHz. Who knows? The no-code Technicians might actually start "pounding some brass" on the expanded CW portions of 80, 40, 15, and 10 meters as well!

Currently, there are over 320,000 licensed Technician Class hams, and many of them are most eager to obtain new study materials to prepare for the multiple-choice written exam for General Class long-range all-mode privileges on the high-frequency bands. *CQ* magazine has been mailing a letter to every licensed Technician Class operator with the word that high-frequency privileges are just a single exam away with *no code test.* It is likely that this letter is big news to over 100,000 inactive Technician Class hams who got the license, got on FM a couple of times, and figured there was no easy way to ever get to any of the excitement of operating the high-frequency skywaves. Many of these 320,000 Technicians, active or not, will leap at the opportunity for a simple 35-question, multiple-choice exam to gain high-frequency privileges.

How does this help *us* increase activity on VHF and UHF? Thanks to manufacturers, the high-frequency rigs include 6-meter operation capability, and some offer 2-meter, 432-MHz, and 1.2-GHz band units—e.g., the Alinco DX-70 TH, ICOM 756 PRO III, ICOM 7800, ICOM 703+, ICOM 746 PRO, ICOM 706 MK IIG, ICOM 7000, ICOM 910H, Kenwood 570D, Kenwood 2000, Kenwood 480, Ten-Tec Omni VII, Yaesu DX 9000, Yaesu 2000, Yaesu 897D, Yaesu 857D, and Yaesu 817.

These new Technician-to-General Class operators will flock to the high-frequency airwaves, developing good HF operating skills. The excitement of skip will keep their interest up with their new HF transceivers, which may include 6 meters multimode, 2 meters multimode, and 70 cm multimode.

Many HF 40- and 75-meter nets also coordinate activities on 2 meters SSB and 432 MHz SSB. Since our new Generals, with their brand new HF/VHF/UHF rigs, have the capability for higher bands, their excitement for skip will allow us to encourage them to try 10-meter skywave operation, summertime 6-meter skywave operation, and occasional 2-meter short-lived skip with plenty of summertime and fall 2-meter SSB tropo.

These new no-code Generals will also experience the value of learning CW on *all* of the bands. This could allow us to develop local 6- and 2-meter CW practice nets, with the code instructor going to voice for CW copy instructions, and then swinging over to learn some new CW characters with voice announcements in between the dots and dashes.

For those of us who feel CW is an important skill for ham radio, it makes much more sense to offer 2-meter CW operating nets with SSB instruction, drawing much larger listening crowds than trying to do an MCW code session over a local 2-meter repeater.

Our greatest opportunity to encourage on-the-air ham radio activity is *right now* on our local nets. Our biggest selling job will be for those operators who are just coming on the air, anywhere on the dial, after years of no activity. Get them into a club; do demos of 50-, 144-, and 432-MHz activities; and let's show the quarter-million Technician Class hams that there is more to ham radio than just a dual-band handie-talkie hanging on the belt or a dual-band mobile rig under the dashboard. Let's talk skywaves and weak-signal work and get the thrill back, hearing new callsigns we've never worked before on the air. Our opportunity will never be greater than *right now*!

CW: An Important Mode on VHF

Just because Morse code has been eliminated from amateur radio testing does not mean that it is no longer a useful means of communications. Here *CQ VHF* Features Editor WB2AMU explains the important role that the code continues to play in many VHF-plus communications opportunities.

By Ken Neubeck,* WB2AMU

Here is the straight key that Ken, WB2AMU, uses when operating on 6 meters and the other VHF bands from his car during contests and also from his work location on Long Island, NY. It is used on a flat surface, such as the vehicle's seat or on top of the dashboard, whereas a bug might be a little more difficult to use. Hence, simple is better for portable operations! (Photo by WB2AMU)

The recent change made by the FCC to eliminate code testing as a requirement for getting a ham radio license in the U.S. has created a lot of questions with regard to whether CW will continue to be used on the amateur radio bands as much as it has been. Will the change in the requirement affect those of us who primarily operate in the VHF range? I submit that the use of Morse code will not change for those of us devoted to VHF. I feel that the major changes due to the dropping of CW from amateur radio testing are going to be felt more on the HF bands than in the VHF range.

The reason for this is straightforward. Technician Class hams who did not learn the code were pretty much situated in the VHF range from 6 meters and up, using both FM and SSB modes. Other licensees who use the VHF bands are there because of personal interest in the unique characteristics of these bands.

As emphasized in several sections of my book *Six Meters, A Guide to the Magic Band* (Worldradio Books, 2003), CW remains a very important mode for those who are devoted to the VHF bands, particularly in the weak-signal area. Specifically, CW remains a major mode for many active VHF operators in three areas: aurora propagation, VHF contesting, and chasing DX on 6 meters.

During times of high geomagnetic activity, contacts via propagation by means of aurora backscatter become possible on the lower VHF bands of 6 and sometimes 2 meters. Because of the tremendous amount of auroral distortion on the radio signals, CW is the most effective means of communication. While voice communication is possible during a strong aurora opening on 6 meters, it is not nearly as effective if the aurora is capable of reflecting 2-meter signals. Essentially, the great majority of aurora backscatter communications made on 2 meters is via CW. This is because the signal is made so wide via the distortion that the voice mode is completely unintelligible on the 2-meter band. Thus, CW will still be important in this area of propagation.

In VHF contesting CW is still a very important mode. This is true for contesters such as myself who operate QRP and need to attract the attention of stations that are far away and are not able to hear my 10-watt SSB signal. CW provides an appreciable dB gain over SSB with the width of the signal as well as the simplicity of the signal. From my VHF QRP contesting experience, I estimate that roughly 10 to 20 percent of my contacts with stations during the three ARRL VHF contests in which I have participated have been completed using CW. I find it both surprising and pleasant that many SSB stations on the VHF bands are able to decipher CW. Thus, being a VHFer does not mean that you are not capable of using CW!

During the major 6-meter sporadic-*E* opening that occurred during the June 2006 VHF contest, I found myself in a situation where I was hearing Lance, W7GJ, from Montana coming in on SSB to my portable station at my QTH on Long Island, New York. However, he had a pile-up of W1 and W2 signals, and the odds of my being able to work him with my 10-watt SSB signal seemed very poor. I knew from past contacts with Lance that he was a good CW operator, and I quickly called him on CW when he called QRZ on the frequency. After the second time that he went QRZ on frequency, Lance said, "Who is that station on CW?" I then came back with my call and he was able to work me despite the fact that there were kilo-

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watt stations calling him on SSB! Lance and I had a laugh about this contact when we met at the annual SMOGfest event in Rhode Island a few months later in 2006. Never underestimate the power of CW in breaking a pileup!

The same is true regarding the importance of making CW contacts with DX stations outside of the U.S. on 6 meters. A large part of the European VHF community is well-versed in CW, and during multiple-hop sporadic-*E* openings during the summer, as well as *F2* openings during the winter months of peak sunspot years for Europe and the U.S, the mode is very important. I can name at least 15 to 20 new countries that I worked where the QSO was made because CW was the mode of choice.

Some examples include the time I worked OX3LX during a double-hop *Es* opening in June 1994, when I was using only 10 watts to a dipole and he was able to hear my CW signal. Two of my longest range 6-meter contacts via *F2* were made during 2001 using CW, with CEØ/W7XU on Easter Island and with FR5DN on French Reunion. Both of those contacts were made using a portable setup and moderate power from the car. I remember working several new countries, including Faroe Island, where the station was in the very low end of the CW band on 6 meters, below the beacon frequencies. During the summer of 2006 I finally was able to work to Italy, where I contacted IKØFTA and IØJX using CW and a portable setup from my work location. The signals were at 449 levels and below, and CW was the most effective way to complete the contact.

The bottom line: For most 6-meter stations that are pursuing DXCC on the band, CW seems to be a necessity in order to make the goal reasonably obtainable in a certain amount of time. Yes, it is possible to reach the goal by working SSB only, but the task becomes much harder to accomplish over time.

Thus, if you ask me if CW will become less important on the VHF bands, my answer is that I doubt you will see much change over the next few years. Maybe over several decades this might change, but we will have to see. If hams continue to see the value of CW as a viable, important mode and realize how much fun it is, it will continue to be around, even if it is no longer a requirement for obtaining an amateur radio license.

By Bob Witte,* KØNR

FM

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

What is this Auxiliary Operation Stuff?

In October 2006 the FCC issued a Report and Order allowing auxiliary stations to operate on the 2-meter band. Previously, an auxiliary station could only operate on the 222-MHz band and higher frequencies. This prompts the questions: "What exactly is an auxiliary station?" and "What does this change mean to the Amateur Radio Service?"

FCC Rules, Opinions, and Disclaimer

First, I need to point out that I don't speak for the FCC and I am *not* an expert on radio regulations. When it comes to FCC rules and regulations, it is easy to get into the armchair lawyer mode and sound like you know how the FCC interprets the rules. My only credential in this area is that I have never been cited by the FCC for a violation of Part 97. Therefore, I must be doing something right—so far.

In the Report and Order the FCC said the following:

> As currently defined by the amateur service rules, an auxiliary station is an amateur station, other than a station in a message forwarding system, that is transmitting point-to-point communications within a system of cooperating amateur stations. Under the current Part 97 rules, an auxiliary station is restricted to transmitting only on the 1.25 m and shorter wavelength bands, with exceptions for certain frequency segments.

This definition seems simple enough and conjures up the notion of a "radio link" that connects different amateur radio stations. Note that you will sometimes hear the term *auxiliary operation,* but the FCC actually uses the term *auxiliary station* in its Part 97 definition.

The FCC also wrote:

> The underlying purpose of limiting auxiliary stations to these frequency bands has been to minimize the possibility of harmful interference to other amateur service stations and operations, particularly "weak signal" activity in the 2 m (144–148 MHz) band.

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I would add that, in general, the 2-meter band supports a wide variety of different types of amateur operation. The most common use is analog FM simplex and repeaters (FM, the utility mode), but don't forget other modes, including weak-signal CW/SSB, moonbounce (EME), OSCAR satellites, propagation beacons, meteor scatter, and AX.25 packet. This is quite a bit of amateur radio operating crammed into 4 MHz of frequency space. The concern of many people is that allowing auxiliary operation would increase the pressure on the 2-meter band, resulting in an unmanageable interference problem. The FCC wrote:

> In the NPRM *(Notice of Proposed Rulemaking—ed.)*, in response to a request from Kenwood Communications Corporation, the Commission sought comment on whether it should revise Section 97.201(b) of the Commission's Rules to allow auxiliary stations to transmit on the 2 m band above 144.5 MHz, except 145.8–146.0 MHz, in addition to the frequency segments previously authorized. In the NPRM, the Commission noted that there was no apparent basis to conclude that allowing auxiliary stations to transmit on the 2 m band would cause harmful interference to other stations' communications.

Clearly, the FCC concluded that the interference issues are manageable.

Kenwood Sky Command

The Kenwood Sky Command system II+ uses radio links on the 2- meter and 70-cm bands to provide remote control of an HF transceiver (such as the TS-2000). This system allows the HF transceiver to be controlled by a dual-band transceiver, including a handheld radio. Imagine walking around your neighborhood with an HT in your hand working a DX station on 20 meters (figure 1).

Kenwood used the two most popular VHF/UHF ham bands for the duplex link. The handheld radio transmits on 70 cm, sending control and voice information to the HF transceiver. The HF transceiver transmits back to the handheld on 2 meters. (I say handheld radio, but it can also be an appropriately equipped dual-

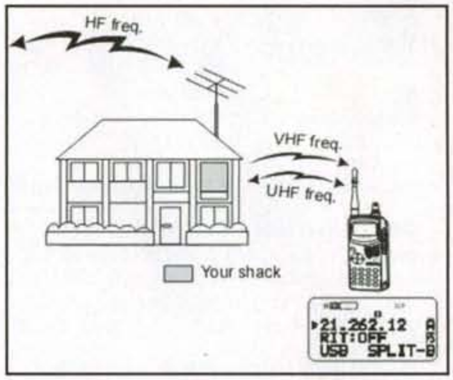

Figure 1. The Kenwood Sky Command system enables remote control of your HF transceiver via a VHF/UHF radio link. (Graphic courtesy of Kenwood USA)

band mobile rig.) Until the FCC approved auxiliary stations on 2 meters, the legality of the Sky Command system was in question. Why is that? FCC Rules Part 97.113 says: "(f) No amateur station, except an auxiliary, repeater or space station, may automatically retransmit the radio signals of other amateur stations."

Clearly, the HF transceiver in a Sky Command system is retransmitting the radio signals of other stations, so it has to be an auxiliary station, a repeater, or a space station. Repeater operation is limited to certain frequencies above 29.5 MHz, so retransmitting signals to/from the popular HF bands is not an allowed form of repeater operation. The system is probably not a space station, unless one of the International Space Station (ISS) crew managed to take a Sky Command rig into space. Thus, the Sky Command system must be operating as an auxiliary station. That is, the HF transceiver is a remotely controlled station, with the control point at the handheld transceiver. The 2-meter and 70-cm radio links are operated as auxiliary stations. Before the FCC said that an auxiliary station can operate on 2 meters, this was an issue.

Auxiliary Stations on 2 Meters?

The 2-meter band is somewhat of a paradox in terms of the level of use. In many parts of the U.S., all available repeater pairs have been coordinated. The other parts of the band are filled with simplex frequencies, weak-signal CW/SSB, and other modes, so the band is "full." With the band apparently full, it was comforting to keep auxiliary stations from contributing to the competition for spectrum. On the other hand, tune across the band listening for signals on a weekend afternoon and you'll find plenty of lightly used spectrum. Is the band full or is it under-utilized?

In the Report and Order, the FCC said:

> We agree with the commenters who support allowing the 2 m band to be used by auxiliary stations, because such use could result in the expansion of amateur service communication systems that incorporate voice over internet protocol operations or other sophisticated amateur radio communications systems, enhance communications capabilities for emergency communications supporting disaster relief efforts, or permit direct communication with HF radio networks using commonly available radios, such as 144/440 MHz handheld transceivers. Additionally, we agree with ARRL and others who contend that allowing auxiliary stations to transmit on the 2 m band would provide amateur stations with additional flexibility to utilize remote control facilities.
>
> We disagree with the concern of one commenter that transmissions by auxiliary stations should only be allowed on the UHF bands because these transmissions may "consume a frequency for hours on end." There is no rule limiting the length of time an amateur station may engage in communications on a particular frequency and amateur stations have the ability to switch among numerous channels when one channel is in use, thereby minimizing interference among stations. Likewise, we do not believe the fact that other frequency bands already are approved for auxiliary stations provides a sufficient reason alone to maintain the restriction prohibiting auxiliary stations from transmitting on the 2 m band. In this regard, we note that auxiliary stations were limited to bands above 220 MHz in order to minimize the possibility of harmful interference to other amateur service operations, particularly weak signal activity, an outcome some commenters believe may still occur. We note, however, that other commenters argue that additional interference, if any, from allowing auxiliary stations to transmit on the 2 m band would only be "slight" in areas of the country where large segments of the 2 m band are underutilized or where unused spectrum is available in the 2 m band to permit auxiliary station operation. We agree with these commenters and note that under our current rules, willful interference is prohibited. In addition, we believe that other safeguards such as voluntary frequency coordination and the requirement in the Commission's rules that stations use the minimum necessary power for the auxiliary link also minimize the possibility of harmful interference between auxiliary stations and other amateur stations. We also agree that in areas where segments of the 2 m band are underutilized or spectrum is otherwise available, interference is unlikely. We conclude, based on the above, that we no longer need to limit auxiliary stations to amateur service bands above 220 MHz. Accordingly, we amend Section 97.201(b), as proposed, to allow auxiliary stations to transmit on the 2 m band.

So there you have it: The FCC chose to allow auxiliary operation on 2 meters, betting that the increased flexibility given to the ham community would be worth the interference problems that might occur. Also, the FCC expressed confidence that the ham radio community would employ methods to prevent interference. Note that the FCC specifically calls out the *Voice over Internet Protocol (VoIP)* as a technique that will be aided by 2-meter auxiliary operation.

Other Rules for Auxiliary Stations

Let's take a look at the other rules concerning auxiliary stations (see sidebar FCC Part 97.201). Paragraph (a) just says that the station licensee and control operator must have a Technician or higher class license. Paragraph (b) defines the frequencies that an auxiliary station may use. It is important to note that the FCC did exclude auxiliary stations from the bottom 500 kHz of the 2-meter band and the OSCAR subband (145.80–146.0 MHz). Paragraph (c) specifically calls out the principle that frequency coordination has some weight in resolving interference (more on this later).

Paragraph (d) says that an auxiliary station can be automatically controlled. *Automatic Control* is defined in Part 97.3 as: "The use of devices and procedures for control of a station when it is transmitting so that compliance with the FCC Rules is achieved without the control operator being present at a control point."

Well, that is handy. It says that we don't have to have a control operator present at the control point. A common example of automatic control is your typical FM repeater. It has control circuitry that automatically keys the transmitter when a signal is heard on the receiver, operates a time-out timer in case the transmitter stays on too long, and automatically identifies the transmitter every ten minutes. A control operator does not have to be present during normal repeater operation. This rule allows us to use similar techniques to control an auxiliary station.

Paragraph (e) says that an auxiliary station can make one-way transmissions. Part 97 generally limits the use of one-way transmissions, mostly just being on guard for any attempt to use the Amateur Radio Service as a way to create a broadcast station. One-way transmission is allowed for auxiliary operation, to enable applications such as control of remote devices.

It is clear that the FCC has given us quite a bit of latitude in terms of regulations when it comes to employing auxiliary stations.

FCC Rules Part 97.201 Auxiliary Station

(a) Any amateur station licensed to a holder of a Technician, Technician Plus, General, Advanced or Amateur Extra Class operator license may be an auxiliary station. A holder of a Technician, Technician Plus, General, Advanced or Amateur Extra Class operator license may be the control operator of an auxiliary station, subject to the privileges of the class of operator license held.

(b) An auxiliary station may transmit only on the 2 m and shorter wavelength bands, except the 144.0–144.5 MHz, 145.8–146.0 MHz, 219–220 MHz, 222.00–222.15 MHz, 431–433 MHz, and 435–438 MHz segments.

(c) Where an auxiliary station causes harmful interference to another auxiliary station, the licensees are equally and fully responsible for resolving the interference unless one station's operation is recommended by a frequency coordinator and the other station's is not. In that case, the licensee of the non-coordinated auxiliary station has primary responsibility to resolve the interference.

(d) An auxiliary station may be automatically controlled.

(e) An auxiliary station may transmit one-way communications.

Internet-Connected Radios

One potential use of auxiliary stations is the growing area of Internet-connected ham radios. The typical application is connecting a VHF or UHF transceiver to another station or stations via the Internet, using VoIP. You probably will recognize some of these systems: EchoLink, IRLP, iLink, eQSO, and Wires-II. When these systems use a radio link, it is typically an auxiliary station. Steve Ford, WB8IMY, wrote an excellent article that summarizes and compares these systems (see references at the

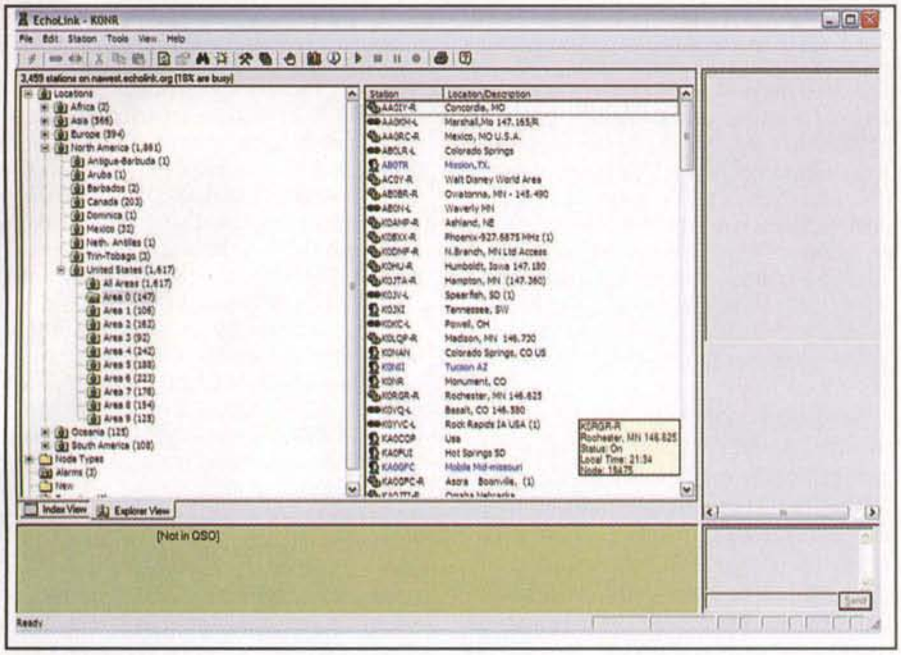

Figure 2. Computer display of the EchoLink software, a popular form of Voice over Internet Protocol (VoIP) ham radio.

end of this column). Also, take a look at the article by Gary Pearce, KN4AQ, on the Southeastern Repeater Association web site (see references). I won't go into that much detail in this column. Note that both of these articles were written before the rule change, so they assume auxiliary stations cannot operate on 2 meters.

After reviewing the FCC rules and the recent Report and Order, I conclude that VoIP nodes can be considered auxiliary stations. However, I checked the ARRL website (<www.arrl.org>, "Voice over the Internet Protocol and Amateur Radio FAQ") and discovered that its interpretation of the rules means that a VoIP simplex radio node is *not* an auxiliary station. Given the FCC's comments on how auxiliary operation will enable the use of VoIP on the 2-meter band, I am not sure how the ARRL reached this conclusion. (I sent an e-mail to the regulatory department at the ARRL, but had not received a reply at press time.) I don't want to get into the armchair lawyer debate, but I do want to note that a reputable organization such as the ARRL has reached a conclusion that is different from mine.

I also noticed that the Southeastern Repeater Association (SERA) concluded that VoIP simplex nodes are not auxiliary stations (see reference section). I contacted Gary Pearce, KN4AQ, who wrote the article that described the SERA position. We had a very useful exchange via e-mail that helped clarify the issue for me. The question seems to boil down to how broadly you define an *auxiliary station.* FCC Part 97.3 defines auxiliary stations as *point-to-point within a system of cooperating amateur stations.* A narrow interpretation of this is that auxiliary stations must be communicating from a specific location to another specific location (e.g., a repeater control link). A broader interpretation is that most amateur communication is point-to-point, so a simplex node that communicates broadly to multiple locations can be considered an auxiliary station. SERA used the narrow interpretation to conclude that VoIP simplex nodes are not auxiliary stations.

Crossband Repeater

Another potential type of auxiliary station is the crossband repeater. Most of the dual-band VHF/UHF FM transceivers *that include two independent receivers* include a crossband repeat feature. With regard to the FCC rules, one could probably consider this type of device to be a *repeater station.* I won't go into that interpretation in this article. Another view is that this is a remotely controlled station that is being controlled via a control link (i.e., an auxiliary station).

The typical use for crossband transceivers is to extend radio coverage into a weak spot or to act as a booster to a handheld radio. For example, I might leave the crossband repeater in my vehicle while I go inside a building with my handheld rig. The handheld only has to radiate enough to get to the crossband repeater, which retransmits the signal with full mobile power and mobile antenna. This is a useful way to augment your handheld radio.

Identification

One of the sticky issues with operating an auxiliary station is making sure that it is properly identified. Just like other amateur stations, an auxiliary station needs to transmit its assigned callsign at the end of each communication, and at least every ten minutes during a communication. This can be accomplished manually by having the control operator speak the callsign or it can be done automatically with a Morse code IDer or voice synthesizer.

Unfortunately, the typical crossband repeating transceiver does not have an identifier mechanism built into it. Most of these radios just repeat the signal from one band to another without any thought of identifying. OK, you say, I'll just make it a point to say my callsign when I transmit, so that will take care of the ID. Unfortunately, generally that will only work in one direction. The crossband transceiver transmitter that is talking back to you on your handheld radio will not be identified in this way. OK, so you get the station on the other end to handle

Figure 3. An example of a dual-band FM transceiver (Yaesu FT-8900) that is capable of being a crossband repeater.

that ID. At this point, the armchair lawyer debate starts with the need to clarify who is the control operator on what radio and how do you ensure that the ID is handled? Talk among yourselves.

A more robust way to handle this is to have a simple IDer built into the dual-band transceiver. Heck, they have just about every other feature imaginable included in these rigs, so why not a Morse code ID feature? As I write this column, I just received information that one of the major ham equipment manufacturers is about to introduce a dual-band transceiver that has this capability. (I am not going to spill the beans on the model number or manufacturer. I suspect we'll see this radio at the Dayton Hamvention®.) This model radio has a Morse code IDer built into it and an optional *voice recorder* that can be selected to perform the ID. The radio also lets you specify whether you want to crossband repeat in both directions (2 meters to 70 cm, 70 cm to 2 meters) or in just one direction (referred to as "locked band repeater"). I reviewed an early version of the manual, which indicates that this radio has the right feature set for a properly identified crossband repeater.

Going back to Kenwood's Sky Command system, the TS-2000 transceiver provides a Morse code identifier on the 2-meter transmitter, while the 70-cm control transmitter uses AX.25 packets that include the callsign of the transmitting station.

Implications for the Ham Community

If we step back from this specific issue of auxiliary stations, we see a general trend in the FCC's philosophy to reduce regulation and to enable new methods of ham radio communication. With changing technology, rules that let us experiment are a good thing. Otherwise, we have to wait for an FCC rule change to enable the use of new radio techniques. (Do you remember how long it took to make ASCII digital transmissions legal on the ham bands?) While this can be a bit unnerving, it represents an incredible opportunity for radio amateurs. The FCC has demonstrated that it will help the amateur radio service by supporting frequency coordination and the use of recognized band plans when dealing with interference complaints.

On the other hand, one can imagine that increased use of auxiliary operation, Sky Command, crossband repeaters, etc., could result in one big mess on the 2-meter band. What we don't need is a herd of ham transmitters out there IDing on random frequencies, interfering with one another and on-going amateur communications. The FCC clearly is counting on the self-regulating nature of the Amateur Radio Service to keep this from happening.

What do we do about this? A key action we need to take on a regional basis is to designate frequencies in the 2-meter band plan for the various forms of auxiliary stations. I don't propose that we do frequency coordination of these systems, but providing guidance on what frequencies to use would be very helpful. Since VHF/UHF band plans are done on a regional basis (see the "FM" column, *CQ VHF,* Fall 2006 issue), the local band-planning organizations need to take action. A good example is the Two-Meter Area Spectrum Management Association (southern California) band plan, which includes these frequency assignments:

- Internet Linking Frequencies (IRLP, Echolink, eQSO): 145.710, 145.725, 145.740, 145.755, 145.770, 145.785 MHz
- Crossband Repeater Frequency: 144.910 MHz

I suggest that other frequency-coordinating bodies provide similar guidance, addressing Internet linking, crossband repeaters, and Sky Command type radio links. The FCC is counting on the ham community to take confront this issue head on and establish practices that minimize interference.

That's the way I see it. I don't speak for the FCC, the ARRL, or *CQ VHF.* Let me know your thoughts on this important VHF topic.

73, Bob KØNR

Need Your Help

Creating The Complete List of FM VHF Operating Activities

How many times have you heard amateur radio operators say, "Two-meter FM is just too limiting; all you can do is chat with the local hams on simplex and local repeaters."? I don't see it this way. FM is the *Utility Mode,* which means it is the mode that gets the job done *and* it is useful for many different ham radio activities. The use of FM VHF is only limited by your imagination.

For the next issue of *CQ VHF,* we'll publish "The Complete List of FM VHF Operating Activities." I need your help with this, so please send me your ideas.

Here are the rules:

- To be on the list, the activity must be possible using a typical dual-band 2m/70cm FM transceiver (handheld, mobile, or base) and associated accessories (antenna, power supply, transmission lines, packet TNC, computer sound card, etc.).
- Existing ham radio infrastructure can also be used, such as repeaters, VoIP links, OSCAR satellites, Winlink, etc.
- The first person to submit an item that makes the list will be recognized in print in *CQ VHF.*
- Submit as many ideas as you like.
- Send your ideas to <bob@k0nr.com>, and be sure to include your name and callsign.

To get you thinking, here are a few sample items for the list:

- Chat with your buddies on simplex (OK, that's a freebie).
- Check into your local club FM VHF net.
- Participate in Skywarn severe-weather spotting.
- Provide communications for public-service events
- [insert your ideas here]

References

FCC Rules Part 97 on the ARRL website: <http://www.arrl.org/FandES/field/regulations/rules-regs.html>

The FCC Report and Order (FCC 06-149): <http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-149A1.pdf>

Kenwood USA (Sky Command System): <http://www.kenwoodusa.com>

"VoIP and Amateur Radio," Steve Ford, WB8IMY, *QST,* February 2003: <http://www.arrl.org/qst/2003/02/VoIP.pdf>

"SERA Looks at Internet Linking," Gary Pearce, KN4AQ, *SERA Repeater Journal,* February 2003: <http://www.sera.org/SERA%20on%20IRLP-Echolink.pdf>

"Voice over the Internet Protocol and Amateur Radio FAQ," ARRL website: <http://www.arrl.org/FandES/field/regulations/faq-voip.html>

Two-Meter Area Spectrum Management Association Band Plan: <http://www.tasma.org/bp0504.pdf>

By John Champa,* K8OCL

HSMM

Communicating Voice, Video, and Data with Amateur Radio

The Sociology of Regulations

When the ARRL Board of Directors, at the recommendation of its Chief Technical Officer, Paul Rinaldo, W4RI, established the High Speed Multimedia (HSMM) Working Group (WG) we were given a very broad mission statement. Since then some critics have rightfully commented that the assigned mission was too broad to be accomplished in any reasonable time frame given the limited resources available.

That is an after-thought, or "Monday morning quarterbacking." At the time, it all sounded challenging, but within reason. However, we were ignorant.

We proceeded to gather together the WG, drawing on the best volunteers we could find in the Amateur Radio Service. To accomplish the goal of designing a nationwide HSMM network, which we later dubbed "The Hinternet," we quickly realized that a change of regulations would be needed.

The current Amateur Spread Spectrum regulations, although drafted by hams with good intentions years ago, were totally unsuitable. For example, the Automatic Power Requirement (APR) was tough to achieve and had little meaning given the hidden node issue with IEEE 802.11 modulation.

Furthermore, why have the 100-watt power limit? We had enough trouble and expense just generating 1 watt on the 2.4-GHz shared band. Finally, our later work on lower frequencies depended on orthogonal freuency-division multiplexing (OFDM) modulation and wasn't really spread spectrum anyway, especially when some of the bandwidths got down to 100 kHz! It wasn't gaining any advantage by "spreading."

The toughest issue by far was dealing with the need for encryption for the purpose of network, not to obscure the meaning of the communications. Clearly, the current regulations were never intended for a post-9/11 high-speed data emergency communications environment. Chris Imlay, W3KD, was most helpful in working between the FCC and us on such complex issues.

When I read the comments of Bonnie Crystal, KQ6XA, regarding regulations and the digital-radio reflector, it brought everything into perspective, and I simply have to share her excellent observations with you. They are so classic that I like to call her comments "The Sociology of Regulations," but you judge for yourself:

Like laws, ham radio regulatory rules are not black and white. They are subject to interpretation, tradition, politics, and convincing arguments.

A gray area is the area of rules where an unclear or unsharp dividing line may apply to a specific instance, a trend, a group, or in this case … a communication signal.

Often, a new convincing argument may move a previously gray area situation into a more clear definition.

In the USA's ham radio rules, there are many gray areas. Generally speaking, gray areas are widely accepted in democratic societies and have a clear connection to the notion of tolerance, whereas in societies of totalitarianism, gray areas typically are not accepted on any level.

The notion is that there may be a gray area in a rule or regulation, as an area where no clear rule or precedent exists, or where the rule has not been applied in a long time, thus making it unclear if it is applicable at all.

Many people accept gray areas of life as a natural part of the human experience, whereas others may react with suspicion and a feeling of defect or incompleteness of any thought system (or paradigm) accepting gray areas.

It is not surprising that strong polarizing opinions exist regarding this subject or how it is applied to ham radio digital communications. Gray areas always are present in ham regulations and rules because:

1. Technology always moves faster than regulatory process.
2. Some rules are inherently self-contradictory.
3. Regulation rarely anticipates all things possible.
4. New inventions happen.
5. Users deploy technology that has not been previously in wide use.
6. "Spirit of the law" may tend to obscure or modify a rule.
7. New valid arguments may modify the way rules are interpreted.

One HSMM User's Perspective

By Rick Williams, KV9U

The WiMax setup here is just a very common ISP-installed RF link using Alvarion equipment. I use the term *WiMax* as a generic higher powered version of WiFi. Alvarion did not wait for the final IEEE specification and started marketing its products much earlier. I have seen these kinds of systems in other communities.

They do throttle back the throughput, since you are sharing the sector with anyone else on that connection. It can run over 1 Gbps, but Alvarion has it below 500 Mbps, I have heard. My understanding is that Alvarion has a hexagon array of antennas with each covering 60-degree beam-width to cover the full 360 degrees. The power level is a few watts and runs on 2.4 GHz. It cannot tolerate the slightest blockage from distant buildings or trees, so it is truly line of sight (LOS). The neighbor's barn just happens to be in line with a water tower located about 5 or 6 miles away, which has one of the access points, so there just is no usable signal at my location. Luckily, after cutting down some trees on the other side of the highway, I was able to open up a LOS link to a more distant tower about 7 or 8 miles away.

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e-mail: <k8ocl@arrl.net>

8. Enforcement may be different than actual commonly accepted meaning.

9. Valid loopholes may be found or become boldly evident.

10. Technology may be designed to effectively circumvent rules.

11. Technology may have an inherent higher value under "Spirit of the law" to preclude enforcement over a long time, thus rendering the rule null in the practical sense.

12. Civil disobedience or long-term use of a particular gray area method may effectively render it clearly within the rule through non-enforcement.

13. Pressure through widespread common use in surrounding jurisdictions may render the rule moot, ineffective, or non-enforced.

14. Humans wrote the rules, and humans are not infallible.

15. The value or strength of one rule may overtake or nullify another rule when applied to a situation.

16. Compelling arguments for one side may win over the other side.

There are other explanations for gray areas, and ham radio digital communications have many examples. In future columns we will attempt to cover some of these other gray areas.

73 de John, K8OCL

CQ's 6 Meter and Satellite WAZ Awards

(As of April 1, 2007)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26.28.29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	2,16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,2,3,6,7,12,18,19,22,23,25,28,30,31,32
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	KØSQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IKØPEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40.

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28, 29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23, 24,26,27,28,29, 33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13, 23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent *CQ* or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

**17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>*

Announcing:

The 2007 CQ World-Wide VHF Contest

Starts: 1800 UTC Saturday, July 21, 2007
Ends: 2100 UTC Sunday, July 22, 2007

I. Contest Period: 27 hours for all stations, all categories. Operate any portion of the contest period you wish. (*Note:* Exception for QRP Hilltopper.)

II. Objectives: The objectives of this contest are for amateurs around the world to contact as many amateurs as possible in the contest period, to promote VHF, to allow VHF operators the opportunity to experience the enhanced propagation available at this time of year, and for interested amateurs to collect VHF Maidenhead grid locators for awards credits.

III. Bands: All authorized amateur radio frequencies on 50 MHz (6 meters) and 144 MHz (2 meters) may be used as authorized by local law and license class.

IV. Class of Competition:

For all categories: Transmitters and receivers must be located within a 500 meter diameter circle or within the property limits of the station licensee's address, whichever is greater. All antennas used by the entrant must be physically connected by wires to the transmitters and receivers used by the entrant. Only the entrant's callsign may be used to aid the entrant's score.

For the four single-operator categories: A single-op receives no operating help either on or off the air.

1. Single Op—All Band. Only one signal allowed at any one time; the operator may change bands at any time.

2. Single Op—Single Band. Only one signal allowed at any one time.

3. Single-Op All-Band QRP. There are no location restrictions—home or portable—for stations running 10 watts output or less.

4. Hilltopper. This is a single-op QRP portable category for an all-band entry limited in time to a maximum of 6 continuous hours. Backpackers and portables who do not want to devote resources and time to the full contest period are encouraged to participate, especially to activate rare grids. Any power source is acceptable.

5. Rover. A Rover station is one which is manned by no more than two operators, travels to more than one grid location, and signs "Rover" or "/R" with no more than one callsign.

6. Multi-Op. A multi-op station is one with two or more operators and may operate 6 and 2 meters simultaneously with only one signal per band.

Stations in any category, except Rover and QRP Hilltopper, may operate from any single location, home or portable.

V. Exchange: Callsign and Maidenhead grid locator (4 digits, e.g., EM15). Signal reports are optional and should not be included in the log entry.

VI. Multipliers: The multiplier is the number of different grid locators worked per band. A "grid locator" is counted once per band. *Exception:* The rover who moves into a new grid locator may count the same grid locator more than once per band as long as the rover is himself or herself in a new grid locator location. Such change in location must be clearly indicated in the rover's log.

A. A rover station becomes a new QSO to the stations working him or her when that rover changes grid locator.

B. The grid locator is the Maidenhead grid locator to four digits (FM13).

VII. Scoring: One (1) point per QSO on 50 MHz and two (2) points per QSO on 144 MHz. Work stations once per band, regardless of mode. Multiply total QSO points times total number of grid locators (GL) worked.

Rovers: For each new grid locator visited, contacts and grid locators count as new. Final Rover score is the sum of contact points made from each grid locator times the sum of all grid locators worked from all grids visited.

Example 1. K1GX works stations as follows:

50 QSOs ($50 \times 1 = 50$) and 25 GL's (25 multipliers) on 50 MHz

35 QSOs ($35 \times 2 = 70$) and 8 GL's (8 multipliers) on 144 MHz

K1GX has 120 QSO points ($50 + 70 = 120$) $\times$ 33 multipliers ($25 + 8 = 33$) = 3,960 total points.

Example 2. W9FS/R works stations as follows:

From EN52: 50 QSOs ($50 \times 1 = 50$) and 25 GL's (25 multipliers) on 50 MHz

From EN52: 40 QSOs ($40 \times 2 = 80$) and 10 GL's (10 multipliers) on 144 MHz

From EN51: 60 QSOs ($60 \times 1 = 60$) and 30 GL's (30 multipliers) on 50 MHz

From EN51: 20 QSOs ($20 \times 2 = 40$) and 5 GL's (5 multipliers) on 144 MHz

W9FS/R has 230 QSO points ($50 + 80 + 60 + 40$) $\times$ 70 multipliers ($25 + 10 + 30 + 5$) = 16,100 total points

VIII. Awards: Certificates suitable for framing will be awarded to the top-scoring stations in each category in each country. Certificates may also be awarded to other top-scoring stations who show outstanding contest effort. Certificates will be awarded to top-scoring stations in each category in geographic areas where warranted.

Geographic areas include states (U.S.), provinces (Canada), and countries, and may also be extended to include other subdivisions as justified by competitive entries.

Unique, handsome plaques will be awarded to the highest scoring stations. For more information on plaque sponsorship, click on "Plaque Program" on the contest website at <http://www.cqww-vhf.com>.

IX. Miscellaneous: An operator may sign only one callsign during the contest. This means that an operator cannot generate QSOs by first signing his callsign, then signing his daughter's callsign, even though both callsigns are assigned to the same location.

A station located exactly on a dividing line of a grid locator must choose only one grid locator from which to operate for exchange purposes.

A different multiplier cannot be given out without moving the complete station at least 100 meters.

Making or soliciting QSOs on the national simplex frequency, 146.52 MHz, or your country's designated national simplex frequency, or immediately adjacent guard frequencies, is prohibited. Use of commonly recognized repeater frequencies is prohibited. Recognized FM simplex frequencies such as 146.49, .55, and .58, and local-option simplex channels may be used for contest purposes.

Aeronautical mobile contacts do not count.

Contestants should respect use of the DX window, 50.100–50.125 MHz, for intercontinental QSOs only.

UTC is the required logging time.

X. Log Submissions: Log entries must be submitted by September 1, 2007 to be eligible for awards. Submit your electronic log in the Cabrillo format created by all major logging programs. Send via e-mail attachment to <cqvhf@cqww-vhf.com>. Subject line: Callsign [used in the contest] only.

Entrants are reminded to be sure their log indicates their grid location. For USA/VE stations operating away from their home address, be sure to indicate the state or province location of operation.

It is strongly recommended that paper logs be entered on-line for automatic Cabrillo submission. Click on the "CQ WW VHF Web Form" link on the contest website at <http://www.cqww-vhf.com>. Computer-generated logs must be e-submitted. Callsigns of electronic logs received are posted and updated regularly on the website.

For those without web access, paper logs may be submitted to: CQ VHF Contest, 25 Newbridge Road, Hicksville, NY 11801 USA. Questions may be sent to <help@cqww-vhf.com>.

Remodeling an Old 6-volt Auto Battery "Booster" into a 12-volt Power Supply

One of the best ways to rekindle your interest and enthusiasm for amateur radio is to build a piece of equipment for your station. Here's a 4-amp "12-volt" power supply built from an old automotive 6-volt battery booster that's an easy, inexpensive weekend project. If you're concerned that the project appears "home-brewed," it can be placed out-of-sight behind your rig, yet provide excellent service.

By Tom Turner,* K8VBL/VP2VEL

Photo A. Drilling out the rivets to remove old components from a typical "battery booster." The new electrolytic cap with its home-brew mounting strap, meter, rectifier, and regulator in its heat sink are in the foreground. (Photos by Jack Chandler Studio, St. Joseph, Michigan)

Two-meter FM transceivers of older vintage are available at hamfests for bargain prices. Used with a simple home-brew J-pole antenna, an old crystal-controlled rig is useful for monitoring the local FM repeaters. However, the "12-volt" 4-amp power supplies for these rigs usually are not bargains, because they can be used with the newer rigs as well.

A handy and inexpensive 12-volt power supply can be built from an old 6-volt automotive battery booster. Available at garage sales and farm sales, an otherwise worthless, old battery booster provides a transformer, on/off switch, and cabinet. Additional major parts required are a high-capacitance "computer" electrolytic capacitor, obtainable at most ham/computer fests, and a bridge rectifier and three-terminal regulator that are inexpensive over-the-counter items at electronics stores. If you are unable to scrounge a suitable battery booster to remodel, a transformer may be purchased along with the other parts, and the power supply may be built up in a suitable enclosure, such as a school lunch box.

Birth of a Notion

While cleaning out the tractor shed, I came across two old 6-volt battery boosters that had been used in the 1950s and

**Apple Hill Farm, 8530 N. Branch Road, Watervliet, MI 49098*

Selenium Rectifiers

A typical 117-VAC "battery booster" built in the 1950s before the advent of silicon diodes generally will contain selenium rectifier diodes. They consist of sheet-metal squares about 3 inches by 3 inches onto which selenium has been evaporated. In large quantities selenium is toxic. When selenium rectifiers age, they develop a high forward voltage drop that can cause them to overheat and catch fire, releasing foul-smelling smoke that is similar in odor to burning garlic. Very old 110-VAC battery chargers have hot-cathode vacuum-tube rectifiers called Tungar Bulbs.

'60s to trickle-charge auto and tractor batteries. Their name-plate ratings are 7 volts, 6 amps DC output at 110 volts 60 Hz AC input. It occurred to me that they could be remodeled into regulated "12-volt" supplies that could power 2-meter, 20-watt FM rigs, which require about 4 amps in the transmit mode.

What Have We Here?

A typical battery booster consists of a 100-VA continuous-duty step-down transformer and a pair of old-time selenium rectifier diodes in a full-wave center-tapped circuit. An 8-amp circuit breaker in one DC lead offers overload protection, and a current indicator shows charging amps. Would the transformer secondary voltage be high enough to provide at least 14 volts regulated DC output?

To investigate, I blew most of the dust and chaff out of the booster's enclosure, disconnected the long-defunct selenium rectifiers, and connected an AC voltmeter across the transformer secondary. Cautiously I plugged the unit into 120 VAC. The indicated voltage was 18 VRMS. Eighteen volts RMS times 1.41 equals 25.5 volts peak. Subtracting 1.2 volts forward voltage drop through a pair of silicon rectifiers in a bridge circuit leaves 24.3 volts peak. This voltage could be filtered by a surplus high-capacitance 30/40-volt computer electrolytic capacitor with adequate safety margin. A 1.2–32-volt, 5-ampere regulator then could be set to provide regulated DC output voltage of 13.8 volts as required by most 20-watt 2-meter FM rigs. A rheostat in the regulator's voltage divider would provide any DC output from 1.2 to about 20 volts, so the power supply could also be used for experiments with 5- or 12-volt logic, or perhaps power a vintage 6-volt radio.

Of course, the remodeled battery booster will still provide its original function—trickle charging 6- or 12-volt batteries. This little goodie definitely has possibilities!

Remodeling the Old Booster

To remodel an old 6-volt battery booster into a modern, adjustable "12-volt" power supply, drill out the mounting rivets and remove all components from the chassis (photo A). Retain only the transformer, on/off switch, chassis, and enclosure. The component locations will probably have to be changed to accommodate the new filter cap and solid-state DC modules. Sand any rust spots off the sheet-metal parts and spray paint them to match the rig with which the power supply will be used—generally gray or flat black.

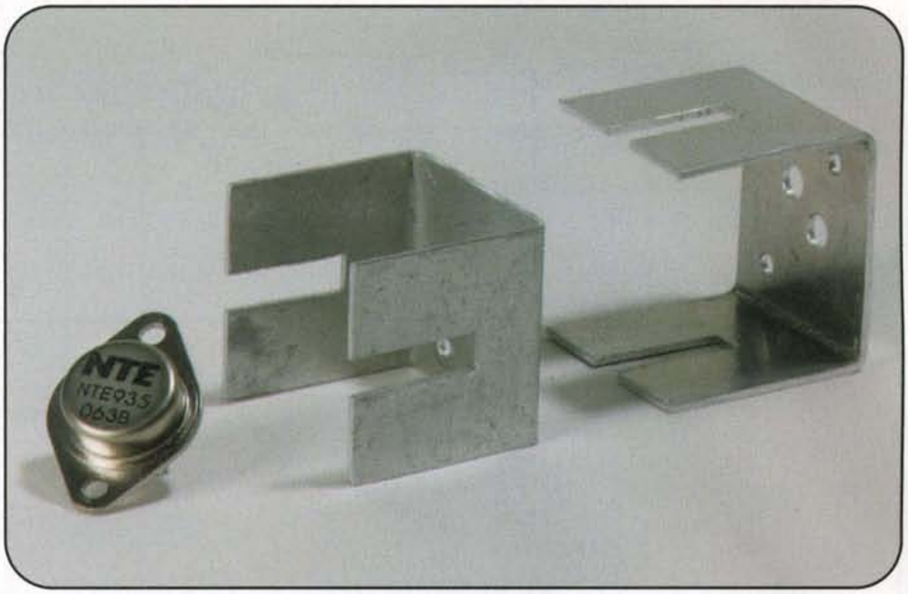

Photo B. NTE 933 regulator and its home-brew two-section heat sink ready for assembly.

Electrolytic Filter Capacitor

As a rule of thumb, the required filter capacitance is approximately 3000 µF for each amp to be drawn from a low-voltage power supply. The 100-VA transformer will put out about 6 amps, and the specified regulator module handles up to 5 amps. Most "20-watt" rigs draw about 4 amps in "transmit," so the capacitor should be at least 20,000 µF; more is better, up to a point. When the supply is switched ON, the large filter capacitance appears as an instantaneous dead short. Inrush current is limited by the transformer's secondary resistance, so 50,000 µF is about maximum to avoid overheating the transformer due to "I^2R" losses during a long charging period. A capacitor voltage rating of 30/40 volts peak will provide adequate margin on a 25-volt peak rectifier system.

Danger!

A 20,000-µF, 30-volt capacitor can store a tremendous amount of electrical energy. When such a cap is charged to 25 volts, short-circuiting its terminals will melt the metal and cause flash burns to your eyes, similar to the action of a buzz-box welder. Twenty-five volts pose little danger of electrical shock, however. That's why the old farm DC lighting plants operated at 32 volts; 32 volts is considered to be just below the danger threshold of electrical shock.

Mounting the Electrolytic Filter Capacitor

Surplus computer electrolytic caps usually are devoid of their mounting straps. Fashion a mounting strap from a large hose clamp made for automotive-radiator or farm-irrigation piping, and two hardware-store "L" brackets. Two short hose clamps may be connected "in series" in place of a single large clamp to hold the "L" brackets to the cap.

Mounting the Three-Terminal Regulator Module

A heat sink must be provided for the TO-3 cased regulator. One may be purchased, or fabricated with a pair of $1^1/2 \times 4^1/2$ inch strips of aluminum or copper. Heat-transfer capability is directly related to electrical conductivity, so copper is best but may be difficult to obtain. A good source for aluminum is the frame of an old storm door.

Make a template for drilling the heat sink by pressing the regulators' two pins through a small square of cardboard, and then mark on the cardboard the locations of the two mounting holes. Use the template to drill one strip of metal to pass 6-32 machine screws and $^1/4$-inch clearance holes for the regulator pins, and then use the drilled strip as a jig to drill the sec-

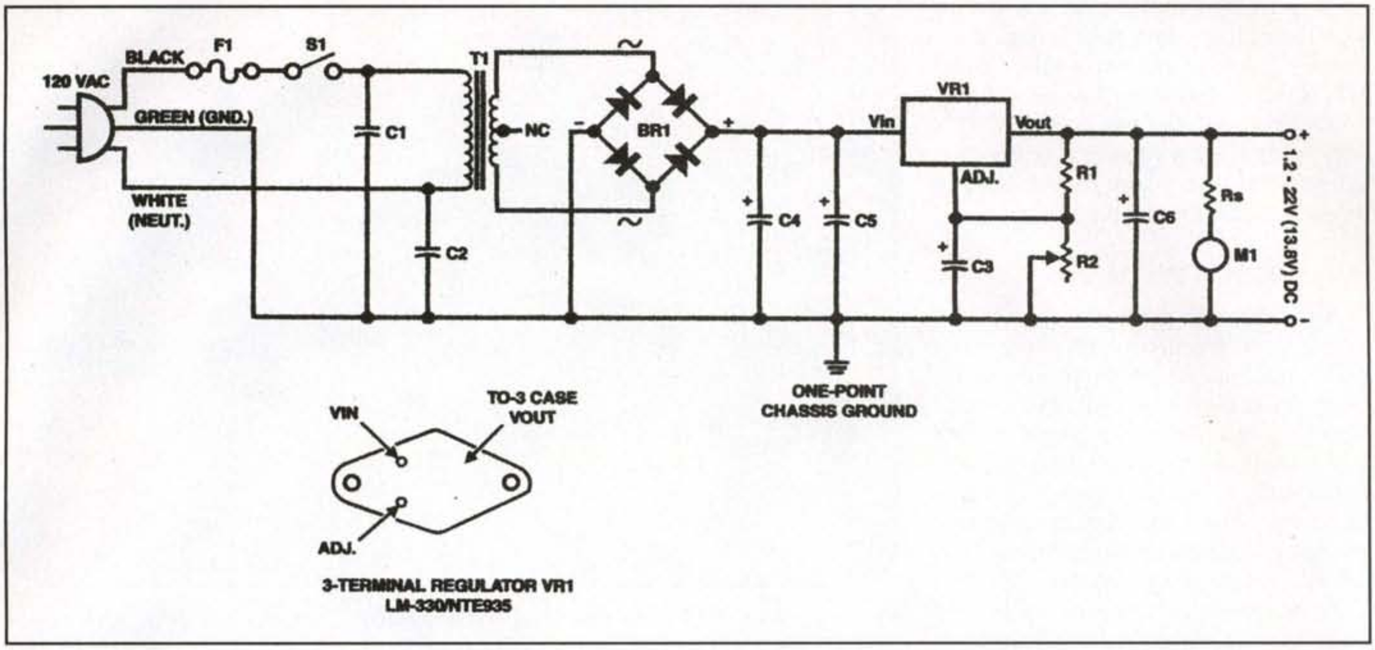

Figure 1. Schematic of the 4-amp variable-voltage power supply. (Drawing by Randy Kaeding, K8TMK, Heathkit Co., Benton Harbor, Michigan)

ond. Remove all burrs from the metal with a knife or file so that the regulator will make full contact with it. Bend two 1 1/2-inch "ears" on each strip to form the heat sink. Mount the regulator with 6-32 hardware (photo B). The regulator does not require a socket; leads may be soldered directly to its pins after it has been mounted on the heat sink. Use a hot soldering iron and solder quickly to avoid excessive heating.

The TO-3 case is the regulated DC output terminal and must be insulated from the chassis. Rather than the use of insulating washers between regulator and heat sink, mount the regulator directly to the heat sink for improved thermal transfer, and then mount the heat sink to the chassis on insulating blocks of plastic or wood.

Parts List

Parts Re-Used from Battery Booster

Tl—Power transformer, 100 VA, 120–18 volts. *Note:* A 100-VA transformer has a core cross-section of about one square inch within its coils.
S1—SPST 5-amp switch

New Parts

Fl—2-amp 120-volt slow-blow fuse and holder
C1, C2, C3—0.0047-µF 600-volt capacitors
C4—25,000-µF 30–40 volt surge electrolytic capacitor (computer surplus)
C5, C6—2.2-µF 50-volt tantalum electrolytic capacitors
Rl—300-ohm 1/2-watt resistor
R2—5K 1/2-watt linear potentiometer
M, R_s—Milliammeter, and multiplier resistor, or potentiometer (see text)
BR1—200-PIV, 25-amp bridge rectifier module: NTE5322, LM-330, or equivalent
VR1—Three-terminal, positive, adjustable voltage regulator, V_{in} = 3–35 volts, I_o=5 amps, TO-3 case: NTE935, LM-330, or equivalent

Note: None of the parts values are critical (with the exception of the multiplier resistor, R_s).

Rectifier Module

The husky bridge rectifier is rated at 25 amps so it won't require a special heat sink. It may simply be bolted to the chassis at a convenient location.

Circuit Protection Features

• The power supply enclosure is kept safely at AC ground potential by a surplus computer-type three-wire power cord with three-prong, U-ground plug.

• A 120-VAC fuse holder with a 2-amp slow-blow fuse, Fl, will protect the transformer in case the bridge rectifier, electrolytic cap, or regulator short-circuits.

• A pair of 0.005-µF 600-volt buffer capacitors (Cl, C2) down stream of the fuse offer low impedance to any voltage spikes that might arrive via the power line. It may seem redundant that two buffer caps are needed, since the neutral side of 120 VAC is grounded, and the 3-prong plug can be inserted only one way to assure ground continuity. However, the 3-foot long line-cord wires have considerable reactance at VHF, which could allow steeply rising voltage spikes to enter the power supply. Such spikes are effectively short-circuited by a pair of buffer caps in series across the transformer's primary. The "el-cheapo" open-frame transformer has no electrostatic shield that could otherwise protect the down-stream solid-state components.

• A "delayed current limit" feature of the NTE935 regulator module VR1, protects the entire power supply against over current, as might be caused by shorting the DC output terminals.

Mechanical Considerations

Adding a voltmeter to the power supply as described below will probably require a new hole in the cabinet, or enlargement of an existing hole that once held a current indicator. A carpenter's coping saw with a fine-tooth blade can be used for this work. Rubber or felt "stick-on" feet from a hardware or building-supply store can be added to the bottom of the cabinet. If all of the required components won't fit into the cabinet, the transformer may be mounted outside the cabinet, on its back panel. Insulate the transformer leads where they pass through the cabinet with short lengths of automotive rubber windshield-washer hose.

Wiring Considerations

The two 2-µF, 50-volt tantalum electrolytic caps (C5, C6) must be connected to the regulator module using the shortest possible leads, from its input to ground and from its output to ground, to stabilize its internal high-gain op-amp. Watch the polarity: the (+) lead of each cap must go to the regulator module. These tiny caps, about the size of a drop of buckwheat honey, have low reactance even into the VHF range and thus provide excellent bypassing.

All ground connections must be brought to a *single point* on the chassis as indicated in the schematic, figure 1. A single-point ground avoids "ground loops" that could introduce hum currents or interfere with regulator action, and is best done by securing several solder lugs by a single 6-32 bolt, at a point on the chassis cleaned of paint, that will allow the two tantalum caps to have short leads. Lengths of the other ground leads are not particularly critical. Secondary circuit leads that will carry up to 5 amps should be #20 wire or larger, or two parallel wires of smaller gauge may be used. A pair of universal binding posts will make convenient DC output terminals for experimenting, or a length of #18 zip cord fitted with a socket that will plug into your rig may be used, or both. The secondary winding of transformer Tl has a center tap. This is not used and is marked "NC" in figure 1. Insulate the center tap lead with tape or a wire nut. Many of these automotive battery boosters were made before three-wire grounded power cords were common. An old, brittle two-wire cord should be replaced with a computer-surplus three-wire cord. Color codes of the three wires are indicated in figure 1.

Metering

Battery boosters generally have some type of current indicator, which will be of little use in the unit's new role as a regulated, adjustable-voltage power supply. A 0–20 or 0–25 DC voltmeter (Ml) is a handy addition to the power supply and will serve as an additional "bleeder" to slowly discharge the filter cap after the 120-volt input power has been turned off. Most any DC milliammeter, available at hamfests or from RadioShack, can be converted to read DC volts as follows. If possible, choose a meter that has a scale of 0–20 or 0–25 ma so that when wired as a voltmeter the scale can be read directly in volts. To read volts, the milliammeter must have a multiplier resistor (R_S) in series that will pass the meter's full-scale current at the highest anticipated output voltage of the power supply. With the exception of the meter multiplier resistor, none of the parts values are critical.

The resistance of the multiplier resistor, R_S, is calculated by:

R_S = (desired full scale voltage/meter's full-scale current) – resistance of meter

As an example, suppose you find a 0–20 milliammeter, as I did. Measure the meter's resistance. See the "Caution" section below before you attempt to measure a meter's resistance. My meter has a resistance of 2 ohms. The meter is to read 0–20 volts when installed in the power supply. Although the supply is capable of slightly higher voltage than 20, the 0–20 scaling will provide good resolution of indication in the range of 14 volts, where the supply will be used.

Therefore, the correct multiplier resistor R_S = (20 volts/0.02 amps) – 2 ohms = 998 ohms. In this case the 2 ohms may be neglected since it is much less than the ±1% tolerance of the multiplier resistor. Thus, a standard 1K-ohm resistor will suffice. If you use a 0–200-ma meter, its resistance may be near 50 ohms, so it should not be neglected. If the multiplier resistor calculates to a non-standard value, a potentiometer connected as a rheostat, set by an ohmmeter to the correct value, will serve. If you choose not to include a voltmeter in your power supply, a pilot light such as a 120-volt neon type, should be added across the transformer primary to indicate that the unit is ON.

Caution!

When measuring the resistance of a milliammeter: Some VOMs, in the low ohms range, put out current that is sufficient to severely over-range a 0–20 milliammeter. For instance, my RadioShack model 22-221 analog VOM, in the RX1 range, puts 65 ma through a 1-ohm test resistor and 55 ma through a 4-ohm test resistor, so it would damage a 20-ma meter if an attempt were made to measure its resistance. Check the output current of your DMM or VOM before using it to measure the resistance of a milliammeter by measuring a test resistor (R) of 1 to 10 ohms, while measuring the voltage drop (E) across the resistor with a second VOM or DMM. Calculate the current by Ohm's law (I = E/R) to determine if your milliammeter would be over-ranged if you were to directly measure its resistance. If the calculated current is higher than the full-scale indication of your milliammeter, use the following indirect method to determine its resistance.

Set a 50K-ohm pot to its full resistance and connect it in series with a 1.5-volt flashlight cell and your milliammeter. Adjust the pot for a full-scale meter indication. Now connect a second pot (100 ohms or so) across the milliammeter and adjust it to bring the indication back to exactly 1/2 scale. Disconnect the second pot and measure its resistance, which will be the same resistance as that of the milliammeter.

Checking and Testing the Completed Power Supply

Double-check your wiring, especially the polarities of the bridge rectifier and electrolytic capacitor: The (+) of the rectifier must connect to the (+) of the capacitor. See that the connections to the pins and TO3 case of the regulator are correct and that the case is not shorted to the chassis.

Connect a DC voltmeter to the output leads and power-up the unit. When the voltage adjust pot R2 is turned end-to-end, output voltage should go smoothly from about 1.2 volts to 20 volts or so, depending on the secondary voltage of your particular transformer.

Due to various errors (measurement of meter resistance, resistor tolerance, and meter error), the voltage indicated on the installed meter may be in error by a volt or so. Perform a 1-point calibration of the meter by setting the power-supply output voltage to 14 volts using an accurate voltmeter (DMM). Then tweak the installed meter's zero adjust screw or the multiplier pot if used so that the installed meter also indicates 14 volts.

Set the output voltage to 13.8 volts, which is the voltage generally recommended by transceiver manufacturers.

Photo C. Variable-voltage power supply built from components of an old battery booster, powering a vintage Regency HR-212 two-meter FM rig. A CTCSS access tone encoder sits atop the rig.

Now connect a load, such as an automobile headlight or tail lamp, to the unit. The voltage indication should not change, proving that the regulator is working correctly.

Note: Manufacturers generally specify transceiver current draw and RF power output at an input voltage of 13.8 VDC. However, newer Chrysler vehicles have computer-controlled voltage of 12.6 ±0.1 volt. Ford and General Motors alternator regulators maintain a voltage of 13.6 to 13.7.

As a final check, I connected an unshielded 52-ohm dummy load consisting of thirteen 670-ohm, 2-watt resistors sandwiched between a pair of soup-can lids to my 2-meter rig and powered it with my new power supply. The power-supply side panels had not yet been installed. When I keyed the mic, the power-supply voltage dropped about one volt! Apparently, RF energy from the unshielded dummy load was entering the power-supply regulator, probably via the unit's DC output cord, which I inadvertently had made 20 inches long, a resonant 1/4 wave at 146 MHz. In any event, when the side panels were in place on the power supply. its voltage regulation stabilized. As a precaution against RFI, a 0.005-µF bypass capacitor (C3) was installed from the regulator "adjust" pin to the single ground point. NTE's spec sheet for its 935 regulator states that the "adjust" port may be bypassed. The port draws only about 50 microamperes, so is high impedance. Therefore, a 0.001–0.005-µF ceramic-type bypass cap should suffice to keep RF out of the port, without adding significant time constant to the regulator function.

Conclusion

My "battery booster" power supply has given good service for about two years powering an old Regency HR-212 two-meter FM rig hooked to a twin-lead J-pole antenna in my attic. I've installed a CTCSS access tone encoder in the rig (photo C). This setup enables me to access Michigan's wonderful W8HVG/R linked repeater system. Based in the Grand Rapids area, the link system covers the entire lower peninsula of Michigan with the exception of Detroit. Request an information brochure on the "Michigan Link" by sending an SASE to: Independent Repeater Association Inc., 562 92nd St. SE, Byron Center, MI 49315, or visit the IRA website at: <www.w8hvg.org>.

The Ladder Tower
A Simple Antenna Structure

Are you in a hurry to get on the VHF-plus ham bands and don't have the wherewithal to put up a conventional tower? Here W8FR offers a possible solution—an extension ladder.

By Fred Race,* W8FR

These days many hams are seeking ways to improve their reception and up their signal strength while being limited or modest in their antennas and antenna-related structures. An easy way to get some short-boom UHF/VHF antennas "up" is by constructing and using a ladder tower. Photo 1 illustrates an installation with three antennas at nearly 30 feet.

The ladder tower isn't a new idea by any means, as it is one of several wooden tower structures of early ham radio days, when even rotary-beam antennas were mounted on a wooden framework using stand-off insulators. When you don't want/need, or just can't invest in, a conventional structure (sections of Rohn 25G, etc.), look to your hardware store for an inexpensive aluminum extension ladder. A convenient length is 12 feet, with extension to 20 feet plus, depending on your load. The ladder used in photo 1 supports 225 pounds, is lightweight, and is of sturdy construction.

The method of attaching the ladder tower to the house is simple and somewhat unique. The overhang attachment uses two mounted 6-inch, heavy-barrel bolts that can be positioned to hold the ladder tower in place and locked on either side of the ladder. Simple 3/8-inch holes were drilled in each side of the ladder and the bolts slid through to hold it in place. Six 3-inch drywall screws hold each barrel bolt in place. Using U-bolts to attach the ladder tower to the base is very simple: Two 1 3/4-inch steel post pipes at 16 inches each were set in the ground, while one bag of quikcrete mixed to a slurry was poured and dried for three days. Photos 2 and 3 illustrate these attachment points for the ladder tower.

Let's start with the overhang and base preparation. The overhang is prepared with one 36-inch treated 2-by-4 to span three roof-rafter ends. Three-inch dry-wall screws are used to attach the 2-by-4 through the flashing, and it provides the mounting surface for the two upper ladder-tower barrel bolt mechanisms (right and left sides of the ladder to hold it to the house). A hole is dug down to around 12 inches in a rectangular shape extending about 4 inches beyond the ladder width, with a front/back depth of 6–8 inches to accommodate the base attachment scheme.

Positioning and "plumbing" the ladder is simple, but done in a prescribed manner. First, the ladder is set into the hole (hole dug/centered beneath the overhang attachment point) to enable driving the two pipes in on either side of the ladder to a depth of 8 inches, while holding the ladder plumb (photo 4). This is a two-man job, and three might even be better. Once one is driven in, shift to the other side while maintaining plumb and drive in the other base pipe. Work in construction stops at this point to allow the concrete to set (three days).

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e-mail: <w8fr@earthlink.net>

Photo 1. The ladder tower.

After the base concrete sets, reposition the ladder to plumb, and with it setting on the concrete, mark each side for U-bolt holes; one is sufficient. This is accomplished by placing the U-bolt over the pipe and against the ladder side at a point on the pipe. Draw around the threaded shanks on either side of the pipe. When you are ready to drill the holes, use a centerpunch to mark in the center of the drawing circles. All the holes in the ladder, including the rotor base pipe holes, are marked and drilled later.

Photo 4. Base-pipe attachment scheme.

Photo 2. View of the ladder with both barrel-bolt fixtures.

Photo 3. Close-up of the right-side barrel-bolt fixture in place.

Maintaining plumb and held against the overhang, center the barrel bolts on the 2-by-4 mounting surface and mark the point at which they are aligned and at the point on the ladder through which the bolt must pass. This completes the preliminary alignment and enables the drilling. All the holes are drilled into the stationary 12-foot ladder, not the extension, which slides and rests on the stationary section.

When finished drilling the marked holes for base and overhang attachment, mark and drill the four holes to accommodate the two U-bolts associated with the rotor pipe. This pipe is a $1^3/4$-inch gas pipe (very robust) and serves as the rotor mount. It must be aligned along one side of the ladder at the top of the extension section. Place the ladder on its side (using two sawhorses as the table) and center the pipe in the flange wells of the ladder side. Plumb the pipe to the ladder side by aligning through equal distance measurements from one flange or the

Photo 5. Final stand pipe and rotor configuration.

other, and hold the U-bolts over the pipe, which is also being held in place, and then mark the shank ends as in the ladder tower base U-bolt alignment procedure.

Use a center punch to determine the center of the markings and drill through the side, afix the U-bolts and pipe, and mount the rotor on the pipe (use standard rotor alignment procedures). Photo 5 illustrates the rotor in final placement.

The ladder tower is now ready for final installation against the overhang. It is an option to install the antenna(s) and mast to the rotor prior to attaching the ladder tower to the overhang. The most important part of the procedure is as follows:

1. Place the ladder tower (in the nearly *down* position) between the base stand pipes and against the overhang.

2. Align at the base and between the barrel bolts.

3. Install U-bolts at the base, close the barrel bolts, and tighten all fixtures.

4. Follow rotor alignment procedures (set to north, install antenna(s), mast).

5. Tie-wrap cabling to the ladder extention as desired and raise the extention.

The installation illustrated in photo 1 depicts three antennas:

1. A 3-ele 6-meter lightweight Yagi.

2. An 11-ele 432-MHz short-boom Yagi.

3. A 10-ele 144-MHz short-boom Yagi.

Other antennas might include:

1. A dual-band UHF/VHF Yagi in place of the two discrete 144/432-MHz Yagis, or mount it vertically below the other antennas, or by itself for FM use.

2. A vertical base antenna for 146/440 MHz atop the mast.

3. An offset mast attached to the *other ladder side top* to accommodate a non-rotatable short ground plane, or a Wi-Fi Yagi antenna.

In any use, this ladder tower should prove to be an inexpensive way to improve your VHF/UHF operating without creating what some may consider an "eyesore" or "too busy an installation" for the neighborhood. No guy wires; no incredible height-getter; just a modest, practical effort to expand operation. Isn't that what we all want . . . to operate?

(Editor's note: As with any antenna project, be aware of the environment, particularly overhead power lines. Contact with them can be deadly.)

CTCSS Modulation and the LC Phase Modulator

How can you improve the quality of CTCSS modulation while using LC phase modulation? Here WØINK explains the drawbacks and offers a couple of solutions for improving the quality of the modulation.

By Virgil Leenerts,* WØINK

CTCSS modulation of a LC phase modulator has been used successfully in FM communications systems and from a practical point of view works well. However, those who would like a higher quality voice modulation may notice that the LC phase modulator has some voice-quality degradation when the CTCSS tone is combined with the voice response. The reason for voice-quality degradation with higher distortion is that the modulation index for CTCSS tones is in the same range as the voice response (sloping 6 dB per octave) and results in distortion products in the modulator itself due to nonlinear (tan x) phase shift curve. Note that modulation input level to a PM modulator is directly proportional to the modulation index.

Figure 1, a plot of modulation index, shows the comparable levels of modulation index for voice response and CTCSS. The CTCSS frequency range shown is from 60 to 200 Hz. For example, the voice frequency of 500 Hz, and the CTCSS frequency of 100 Hz, results in a 2:1 ratio of modulation levels.

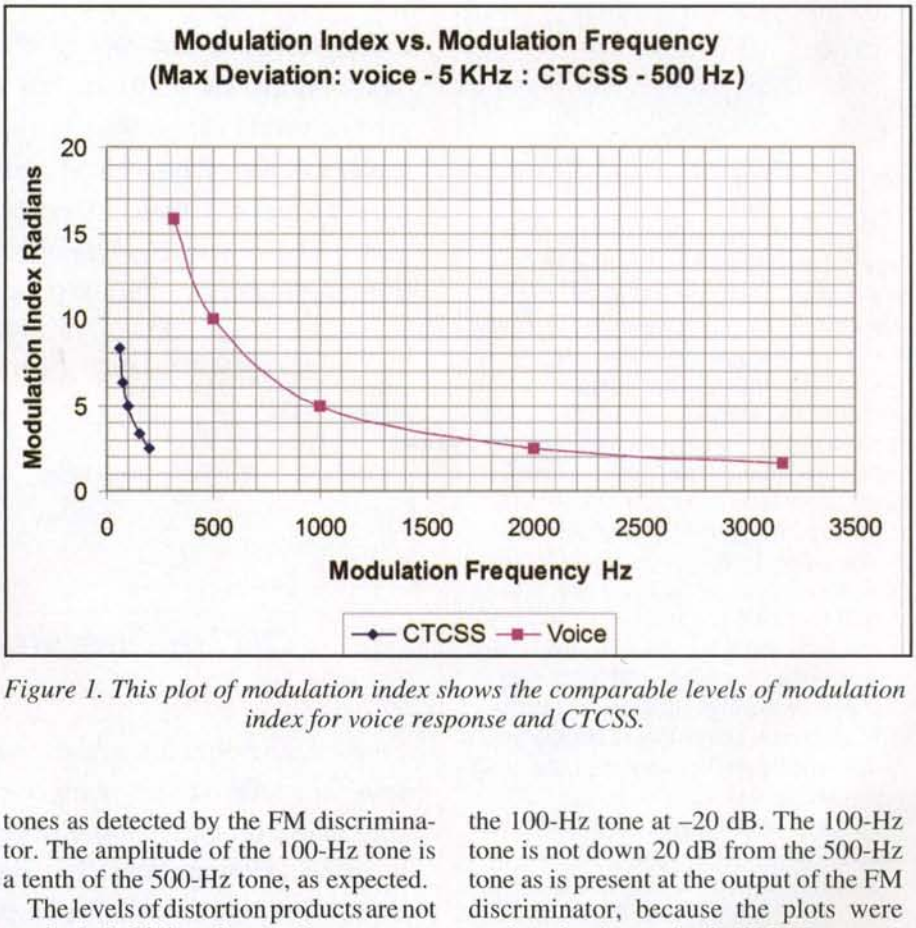

Figure 1. This plot of modulation index shows the comparable levels of modulation index for voice response and CTCSS.

Figure 2, a scope trace, is the time-domain view of the 500-Hz and 100-Hz tones as applied to the PM modulator. One may note that the deviation level of CTCSS is nominally a tenth of the voice deviation. So why this 2:1 ratio? It is because the modulation index is related to deviation divided by the modulation frequency.

The scope trace in figure 3 is the time-domain view of the 500-Hz and 100-Hz tones as detected by the FM discriminator. The amplitude of the 100-Hz tone is a tenth of the 500-Hz tone, as expected.

The levels of distortion products are not particularly high and normally are not an issue for the communication system. However, for higher quality applications they may be an issue.

Figures 4 and 5 show 10 dB per division, and the frequency sweep is from 0 to 2 kHz. The resolution bandwidth of the HP3580A spectrum analyzer was 10 Hz. The 500-Hz tone is at about –10 dB, with the 100-Hz tone at –20 dB. The 100-Hz tone is not down 20 dB from the 500-Hz tone as is present at the output of the FM discriminator, because the plots were made at the de-emphasis (200-Hz corner) output. As can be noted, the distortion products look like AM modulation of the 500-Hz tone and its distortion products at 100-Hz intervals and are generally 40 dB below the 500-Hz tone.

To eliminate the distortion, isolation of the voice and CTCSS tones is required. This is not possible with a single-stage

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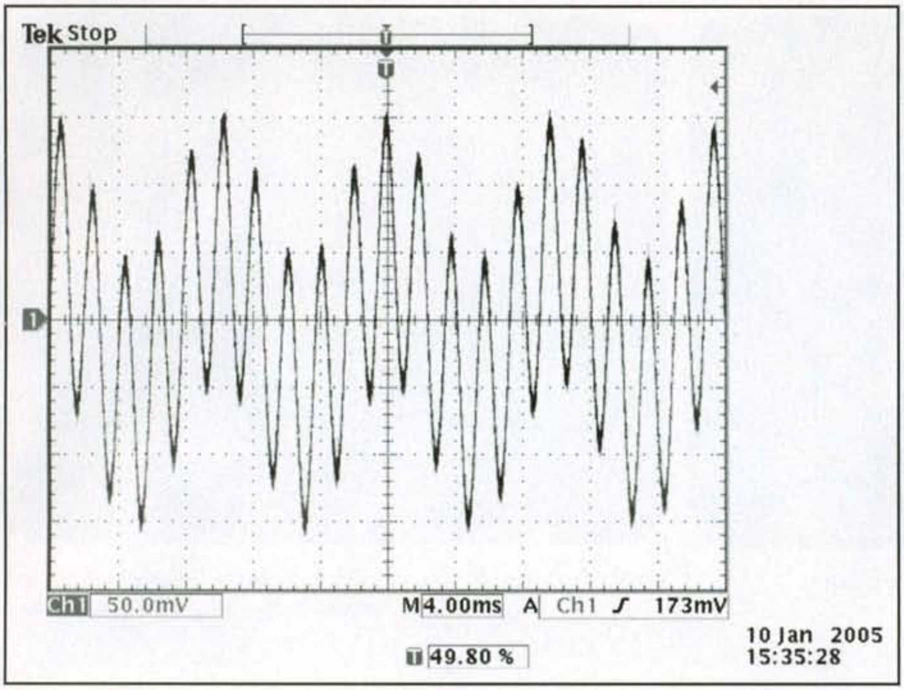


Figure 2. This scope trace is the time-domain view of the 500-Hz and 100-Hz tones as applied to the PM modulator.

LC phase modulator. Two possible solutions are another LC phase modulator stage for the CTCSS tones or FM modulate the oscillator with the CTCSS tones.

Of note is that CTCSS tones are an FM response with a required constant deviation over the CTCSS-tone frequency range. Thus, CTCSS is like a separate sub-tone channel with the voice response being the other channel. Thus, the best case is for the voice channel to be PM and the CTCSS channel to be FM. The isolation with an additional phase modulator stage will meet the isolation re-

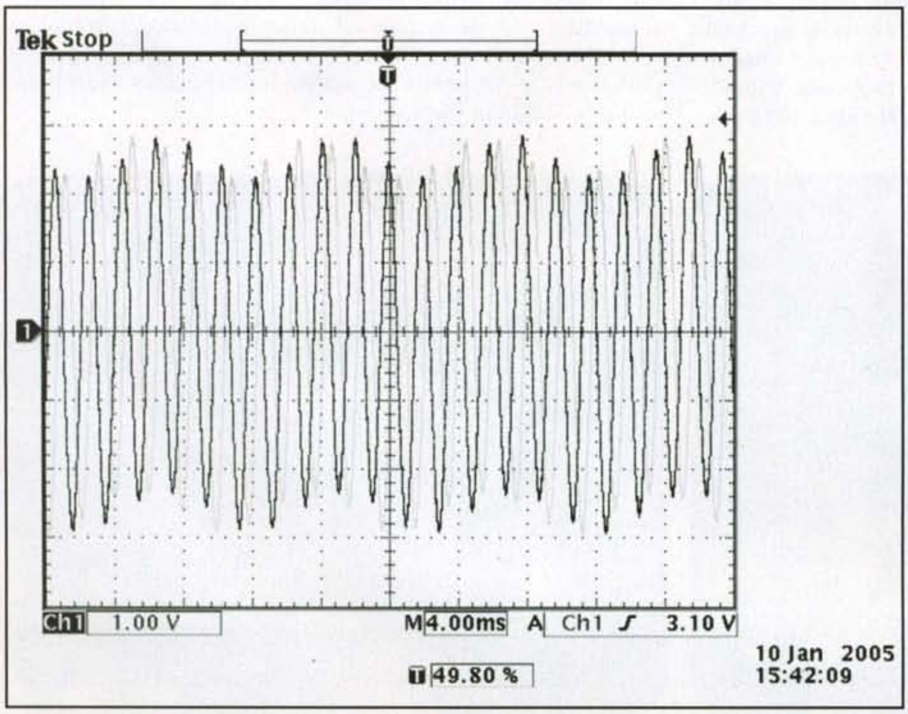


Figure 3. This scope trace is the time-domain view of the 500-Hz and 100-Hz tones as detected by the FM discriminator.

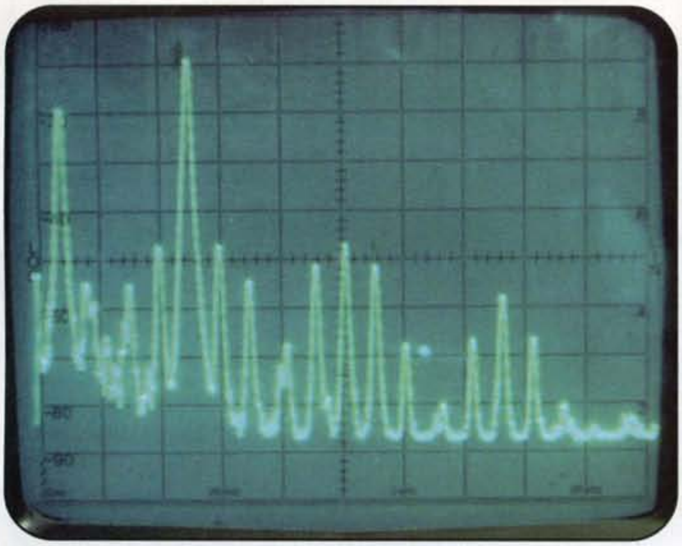


Figure 4. Plot of the GE 450-MHz exciter.

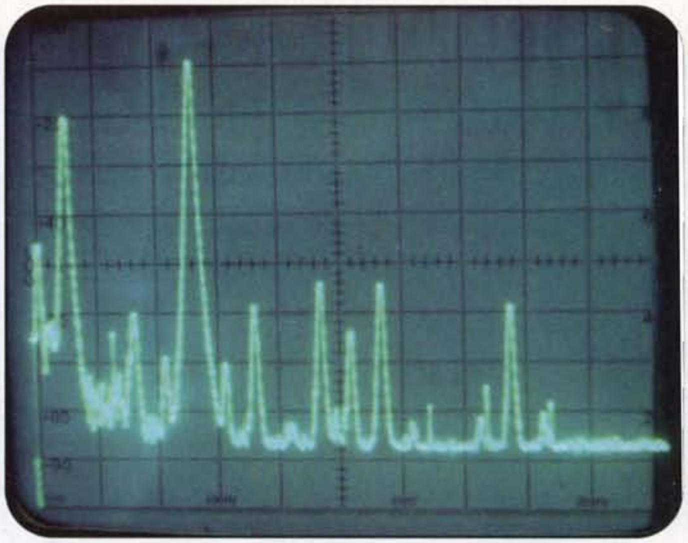


Figure 5. Plot of the GE 450-MHz exciter with external-design LC modulator.

quirement; however, it does not have constant frequency deviation over the CTCSS frequency range unless the amplitude is correspondingly changed to maintain constant deviation.

In the case of the GE 450-MHz exciter, the channel element (ICOM) has a temperature compensation circuit that shifts the frequency of the crystal for frequency stability as a function of temperature. The TC circuit is estimated to be able to pull the crystal about ±5 PPM. One PPM is about 12 Hz in this case.

Looking at the deviation requirement of ±500 Hz and dividing by 36, the oscillator needs to shift only ±14 Hz, which is well within the ability of the GE ICOM channel element (the element was a 2C version). Since the deviation is only about 1 PPM, it leaves room for the TC circuit to perform its function. A test was done by connecting a tone generator to the temperature compensation pin through a 1-μF film capacitor, with the result of no distortion products on the 500-Hz tone due to the 100-Hz tone. The modulation voltage level to TC pin was 60 mV at 100 Hz. A test was also done using two LC phase modulators in series with the same result.

Figures 6 and 7 show the elimination of the distortion products with the isolated modulation of the 100-Hz CTCSS tone from the 500-Hz voice tone.

In conclusion, the intent of this article is to show how additional distortion products come about when CTCSS and voice are applied to a single-stage LC phase modulator. Also, the 100-Hz CTCSS tone distortion products on the voice tone can be eliminated with an additional phase modulator stage or by FMing the oscillator. It is beyond the scope of this article to show specifics of how to accomplish the isolated modulation means in different PM exciters.

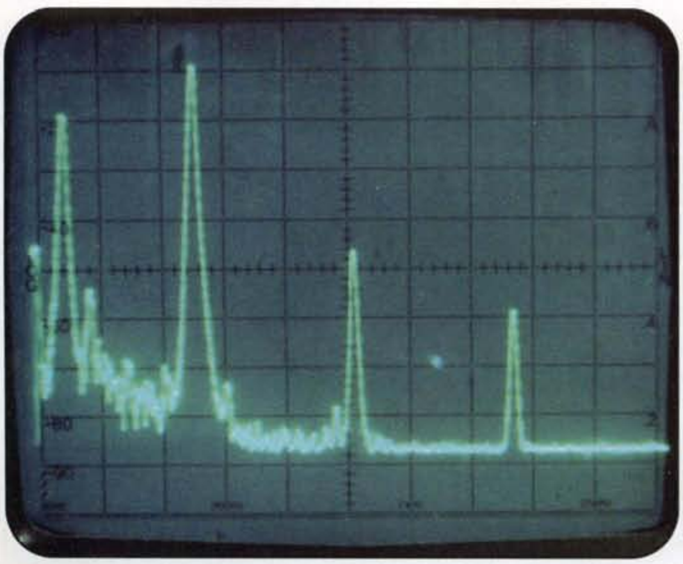


Figure 6. Plot of the GE 450-MHz exciter with FM modulation of the CTCSS tone.

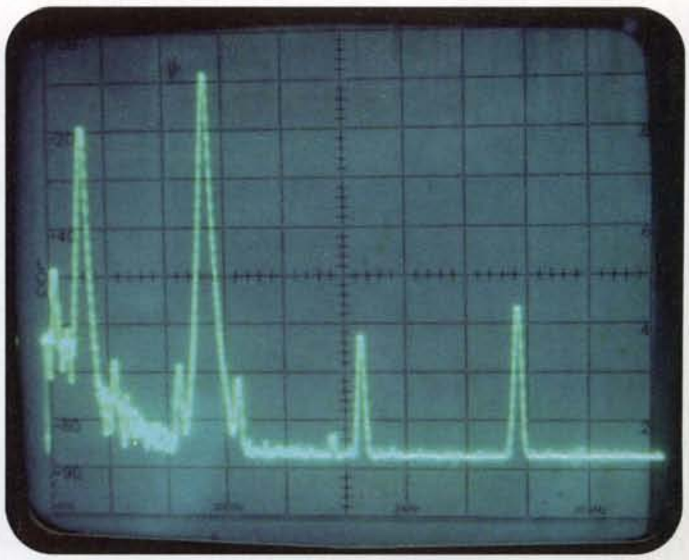


Figure 7. Plot of the GE 450-MHz exciter with second-stage PM modulation of the CTCSS tone.

QUARTERLY CALENDAR OF EVENTS

Current Contests

June—ARRL June VHF QSO Party: The dates for this contest are June 9–11. Complete rules are in the May issue of *QST*. Rules can also be found on the ARRL website (http://www.arrl.org). Many are making plans to activate rare grids. For the latest information on grid expeditions, check the VHF reflector (vhf@w6yx.stanford.edu) on the internet. This is by far the most popular VHF contest. For weeks in the run-up to the contest postings are made on the VHF reflector announcing Rover operations and grid expeditions. It is a contest that will create for you plenty of opportunities to introduce the hobby to your friends who are not presently working the VHF-plus bands or are not hams.

EADX 6 Meter Contest: The EADX 6 Meter Contest is from 1000 UTC June 9 to 1600 UTC June 10. Single operators must have a minimum resting period of 6 continuous hours. Exchange is RST plus full 6-digit grid locator. All contacts must be direct and terrestrial. No repeater or EME QSOs are allowed. Paper logs are to be sent to EADX6M Contest, PO Box 68, E-08960 Sant Just Desvern, Barcelona, Spain. Electronic logs in Cabrillo format only are to be e-mailed to <eadx6mcontest@gmail.com>. For full contest rules see the SMIRK Klub website (http://www.smirk.org). Click on the Contest link in order to go to the EA6DX 6 Meter Contest link.

SMIRK Contest: The SMIRK 2006 QSO Party, sponsored by the Six Meter International Radio Klub, will be held from 0000 UTC June 16 until 2400 UTC June 17. This is a 6-meter only contest. Exchange SMIRK number and grid square. Score 2 points per QSO with SMIRK members and 1 point per QSO with nonmembers. Multiply points times grid squares for final score. Awards are given for the top scorer in each ARRL section and country. Please note that the rules have been changed for this year's contest. In particular, the .150 rule has been eliminated. Additionally, the person to whom you send your logs has changed. Please send a legal-sized SASE for a copy of the log forms. Logs and log requests should be sent to: Dale Richardson, AA5XE, 214 Palo Verde Dr., Kerrville, TX 78028. Entries must be received by August 1. For more information see the club's URL at <http://www.smirk.org> and click on the SMIRK Contest link at the top of the page.

Field Day: The ARRL's classic, Field Day, will be held on June 23–24. Complete rules for this contest can also be found in *QST* and on the League's website: <http://www.arrl.org>. In years past, tremendous European openings have occurred on 6 meters. Also, as happened in 1998, huge sporadic-*E* openings can occur. Certainly, this is one of the best club-related events to involve new people in the hobby.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

May 2	Full Moon
May 5	*Eta Aquarids* Meteor Shower Peak
May 6	Very poor EME conditions
May 10	Last Quarter Moon
May 13	Good EME conditions
May 15	Moon Perigee
May 16	New Moon
May 20	Moderate EME conditions
May 23	First Quarter Moon
May 27	Moon Apogee; Poor EME conditions
June 1	Full Moon
June 3	Very poor EME conditions
June 8	Last Quarter Moon
June 10	Good EME conditions
June 12	Moon Perigee
June 15	New Moon
June 17	Moderate EME conditions
June 21	Summer Solstice
June 22	First Quarter Moon
June 24	Moon Apogee. Poor EME conditions
June 30	Full Moon
July 1	Very poor EME conditions
July 7	Last Quarter Moon
July 8	Good EME conditions
July 9	Moon Perigee
July 14	New Moon
July 15	Good EME conditions
July 22	First Quarter Moon and Moon Apogee; Poor EME conditions
July 28	*Southern Delta Aquarids* Meteor Shower Peak
July 29	Poor EME conditions
July 30	Full Moon
Aug. 3	Moon Perigee
Aug. 5	Last Quarter Moon; Moderate EME conditions
Aug. 12	New Moon and *Perseids* Meteor Shower Peak; Good EME conditions
Aug. 19	Moon Apogee; Poor EME conditions
Aug. 20	First Quarter Moon
Aug. 26	Moderate EME conditions
Aug. 28	Full Moon and Total; Lunar Eclipse visible throughout most of eastern Asia, Australia, the Pacific Ocean, and the Americas
Aug. 31	Moon Perigee

—EME conditions courtesy W5LUU.

July—Six Club Contest: The Six Club Contest runs throughout the month of July. All logs are due 30 days from the ending date of the contest and they go either by e-mail or snail mail to: Joey Fiero, W5TFW, 30155 Napoleon Circle, Denham Springs, LA 70726; e-mail: <w5tfw@cox.net>. For further information go to: <http://6mt.com/contest.htm>.

CQ WW VHF Contest: This year's CQ WW VHF Contest will be held from 1800 UTC July 21 to 2100 UTC July 22. Complete rules can be found on page 63 in this issue.

August—There are two important contests this month: The **ARRL UHF and Above Contest** is scheduled for August 4–5. Complete rules can be found in the July issue of *QST*. The first weekend of the *ARRL 10 GHz and above* cumulative contest is scheduled for August 18–19. The second weekend is September 15–16. Complete rules for this contest also can be found in the July issue of *QST*.

Current Conferences and Conventions

May—Dayton Hamvention®: The Dayton Hamvention® will be held as usual at the Hara Arena in Dayton, Ohio, May 18–20. For more information, please see the Hamvention®'s website at <http://www.hamvention.org>. Your editor is scheduled to be one of the speakers for the VHF forums, plus visit us at the CQ Booth in the main arena.

June—The annual **Ham-Com Hamfest** will be held June 8–9 in Plano, Texas. As always, the North Texas Microwave Society will present a microwave forum. For more information, see the Ham-Com website at <http:// www.hamcom.org/>.

July—This year's **Central States VHF Society Conference** will be held in San Antonio, Texas, July 26–29, at the Omni San Antonio Hotel. For more information, go to: <http://www.csvhfs.org/conference/lodging.html>. Also, please see the article written by former president Bill Tynan, W3XO, which starts on page 47 in this issue.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings,* or both. For more information, questions about format, media, hardcopy, e-mail, etc., please contact the person listed with the announcement. The following have announced a call for papers for their forthcoming conferences:

Central States VHF Society Conference: The Central States VHF Society is soliciting papers, presentations, and poster/table-top displays for the 41st Annual CSVHFS Conference to be held in San Antonio, Texas, on July 26–29. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested.

(Continued on page 78)

By Tomas Hood,* NW7USA

PROPAGATION

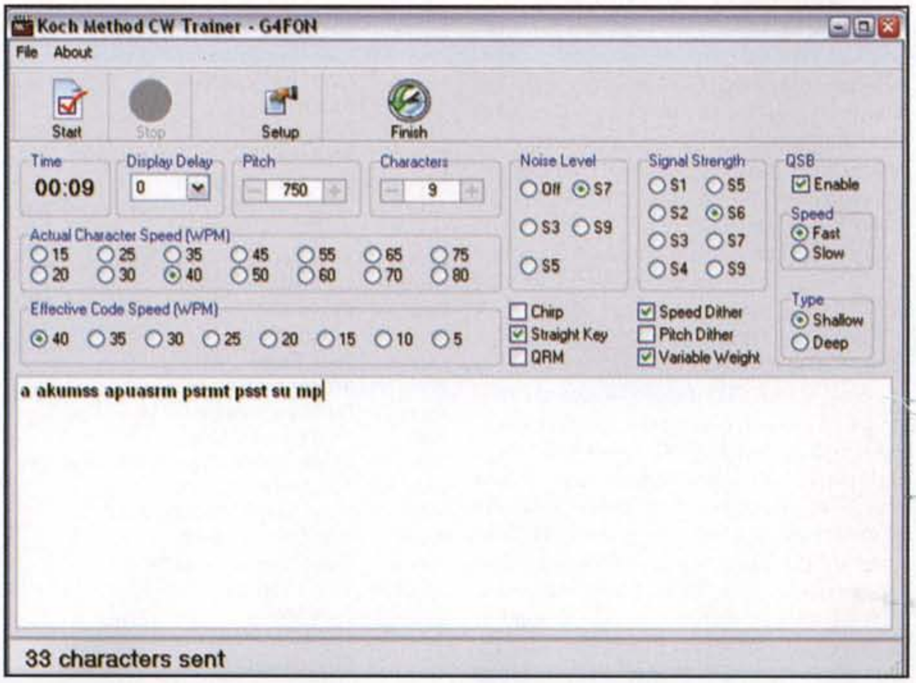
The Science of Predicting VHF-and-Above Radio Conditions

Trends, Reflections, and an Outlook

With the removal of the requirement to pass a Morse code exam in order to obtain an FCC-issued amateur radio license, you'd think that Morse code might fade into the dim light of history. However, amateur radio operators who are passionate about VHF weak-signal operation use the CW mode to accomplish those challenging communications. When we talk about the propagation of VHF, UHF, and smaller wavelength radio signals, we include modes of propagation that require alternatives in how the "intelligence" (voice, data, or simply our side of the conversation) is embodied (the protocol or mode) in the signal.

One of the many driving goals behind the research and experimentation in the science of radio-signal propagation is purely the desire to obtain efficient communications between two stations. Often when people talk about radio reception, signal strength is touted as the most useful factor in the effort to get a signal from the transmitter to the receiver. However, since the problem of reception is more complex than simply a power issue (just pump more watts into the antenna), the better way to get a handle on the problem is to use the signal-to-noise ratio (SNR) measurement of a radio circuit. (The radio circuit is the path between, and including, the transmitter and receiver.) The SNR is a real measure of effectiveness. With it, we can better understand how effectively a signal can get from point A to point B.

On an abstract numerical basis, the signal-to-noise ratio is inversely proportional to the width of the slice of frequencies in which we are detecting our signal. This slice is also known as the bandwidth we are receiving, and that bandwidth contains the intelligence we're trying to detect. A slice that is 10 Hz wide (we can also call this a 10-Hz channel) would give a signal-to-noise power advantage of 23 dB, or 210 times greater in strength than the level of inherent noise in a 2100-Hz channel (a typical bandwidth for single-sideband [SSB] voice communication).



This is the Koch Method CW Trainer by G4FON. Notice all of the extra features that help you build your skill. See text for links to information regarding the Koch method of Morse code training. (Source: NW7US, using the the software by G4FON)

In simplified terms, that means a signal that is transmitted with 1 watt in a very narrow 10-Hz wide channel is 210 times more efficient than a 1-watt (fully-modulated) SSB signal. Imagine the improvement you would get on your FM signal between your radio and a distant radio if you changed your antenna so that you would have a gain of 23 dB. That's like going from 5 watts to just over one kilowatt.

When we talk about using modes such as CW, we are interested in how effective that mode is compared to other modes. Again, when we want to get our VHF signal from point A to point B over long distances, perhaps by bouncing the signal off the moon, we want to find the most efficient modes and concentrate our signal propagation efforts on those modes. Over such great distances the signal will experience loss. The more "power" it has, the more chance we'll "hear" it on the receive side of that long journey.

The typical amateur radio operator utilizing the CW mode manually copies Morse code "by ear." The bandwidths commonly employed in receivers for CW operation are between 250 Hz and 500 Hz. This does decrease the SNR over our 10-Hz channel (meaning degradation in the efficiency of our signal). However, this bandwidth is still much narrower than that used by a single-sideband channel. It also has been postulated through research that the human brain acts like a special digital signal processing (DSP) filter, giving a weak signal detected in a 250-Hz bandwidth an even better SNR than what purely is available at the speaker.

That is why Morse code as a mode of operation will continue to be one of the viable options for weak-signal VHF and UHF communications. In addition to the

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ability for us operators to DSP a CW signal and succeed more efficiently than using a mode such as SSB on that same path with the same power and other operating parameters, there are modes based on CW that utilize the power of computer processing technology and other hardware advances. Coherent CW, high-speed CW, and other narrow-bandwidth digital modes are proving to greatly increase the signal-to-noise ratio of an already weak-signal transmission.

If you are interested in overcoming the odds inherent in the propagation of your VHF communications beyond line of sight, consider learning Morse code and increasing your skill in using CW for VHF operation. How? I strongly recommend using the Koch method, a method of CW training developed by a German psychologist named Ludwig Koch back in the 1930s. The Koch method is not only useful for learning "code" if you have not yet done so, but, it is very effective in improving your speed and skill if you are already using CW.

There is a well-tried, highly recommended training aid that uses the Koch method of learning Morse code. It is the software created by Ray Goff, G4FON, and is simply called "Koch Method CW Trainer—G4FON." Browse to <http://www.g4fon.net/> and look for the menu option that takes you to the "Koch CW Trainer." At the time this column was written, the current version is 9.

For details on how the Koch method works, check out David Finley, N1IRZ's article at <http://www.qsl.net/n1irz/finley.morse.html>. Once you have acquired the skill to work CW at 20, 30, or even 40 words per minute (yes, using the Koch method that is very possible for almost anyone), then you can apply your skill to your DXing efforts on the weak-signal subbands on VHF.

Aurora and Sporadic-Aurora-*E*

We are still seeing moments when coronal holes trigger geomagnetic disturbances, such as the one in the beginning of April 2006. The frequent occurrence of coronal holes may bring brief moments of life to 6 meters. Watch the spots on the OH2AQ DX Summit <http://oh2aq.kolumbus.com/dxs/> if the *K*-index rises above 4. If such a period of geomagnetic activity occurs, aurora-mode propagation (*Au*) as well as sporadic-aurora-*E* (*Au-Es*—like sporadic-*E*, except caused by highly ionized patches at the *E*-layer height, caused by auroral activity) may provide the opportunity for North American VHF operators to engage in quick QSOs.

Sporadic-*E*

Sporadic-*E* propagation is an exciting but mostly unpredictable mode related to "clouds" of highly ionized, dense, small patches in the *E* region of the ionosphere. Ten-meter operators have known *Es* propagation as the summertime "short skip." These "clouds" appear unpredictably, but they are most common over North America during the daylight hours of late spring and summer. *Es* events may last for just a few minutes to several hours, and usually provide an opening to a very small area of the country at any one time.

During periods of intense and widespread sporadic-*E* ionization, two-hop openings considerably beyond 1400 miles should be possible on 6 meters. Short-skip openings between about 1200 and 1400 miles may also be possible on 2 meters.

How can we know when a sporadic-*E* opening is occurring? Several e-mail reflectors have been created to provide an alerting service. One can be found at <http://www.gooddx.net/> and another at <http://www.vhfdx.net/sendspots/>. These sporadic-*E* alerting services rely on live reports of current activity on VHF. When you begin to hear an opening, you send out details so that everyone on the distribution list will be alerted that something is happening. They, in turn, join in on the opening, making for a high level of participation. Of course, the greater the number of operators on the air, the more we learn the extent and intensity of the opening. The bottom line is that you cannot work sporadic-*E* if you are not on the air when it occurs.

For a great introduction to mid-latitude sporadic-*E* propagation, visit the AM-FM DX Resource website: <http://www.amfmdx.net/propagation/Es.html>.

Tropospheric Ducting

Scattered reports of some very strong tropospheric openings were made during April (corresponding to severe spring weather), but we don't typically see widespread tropospheric ducting until summer. In tropospheric ducting, radio waves are trapped in a type of natural wave-guide between an inversion layer and the ground or between two inversion layers. Ducting causes very little signal loss, and often signals are only heard at each end of the wave-guide. Ducting via the troposphere can propagate signals long distances, such as from Hawaii to California. This ducting depends on large weather systems, however, that are more common during the late summer. With the early reports, though, it is worth watching for this mode of propagation. The summer weather season may well be violent and eventful.

Advanced visual and infrared weather maps can be a real aid in detecting the undisturbed low clouds between the West Coast and Hawaii or farther during periods of intense subsidence-inversion band openings. This condition also occurs over the Atlantic. There is a great resource on the Internet that provides a look into current conditions. Bill Hepburn has created forecast maps and presents them at <http://home.cogeco.ca/~dxinfo/tropo.html>, including maps for the Pacific, Atlantic, and other regions.

If you know that conditions are favorable for tropospheric ducting in your area, try tuning around the 162-MHz weather channels to see if you can hear stations way beyond your normal line-of-sight reception. It is possible to hear stations over 800 miles away. Amateur radio repeaters are another source of DX that you might hear from the other end of the duct.

These openings can last for several days, and signals will remain stable and strong for long periods during the openings. However, the duct may move slowly, causing you to hear one signal well for a few hours, to then have it fade out, and another station from another area altogether take its place.

Meteor Showers

The *Eta Aquarids* meteor shower will occur in May. The *Eta Aquarids* will peak the morning of May 6, but start around April 21. This shower is expected to have a peak rate of up to 60 meteors per hour this year. It is expected that the shower will have a broad period of maximum activity, starting as early as May 3 and extending out to May 10. Also, because of the low radiant, the meteors tend to have long ionized paths, making for strong signal reflections. Look for 6- and 2-meter openings off the ionized meteor trails.

June possibly will have a strong meteor shower, the *Boötids*. This shower will be active from June 26 through July 2, with the peak occurring on June 27. The hourly visual rate can reach as high as 100 or more. Following its unexpected return in 1998, when the hourly visual rate was between 50 and over 100 for more than half a day, this shower is worth watching for. Another occurrence of significant activity with an hourly visual rate between 20 and 50 was observed in 2004. The shower is from Comet 7P/Pons-Winnecke, which has an orbit that now lies around 0.24 astronomical units outside the Earth at its closest approach.

July will have only minor showers. These showers typically have not yielded much radio activity. For more information on them, take a look at <http://www.imo.net/calendar/2007/>.

TE Propagation

A seasonal decline in transequatorial (TE) propagation is expected during May. An occasional opening may still be possible on VHF. The best time to check for VHF TE openings is between 9 and 11 PM local daylight time. These TE openings will be north-south paths that cross the geomagnetic equator at an approximate right angle.

QUARTERLY CALENDAR OF EVENTS

(from page 75)

Deadline for submissions—For the *Proceedings:* May 7; for presentations at the conference and for notifying them you will have a poster to be displayed at the conference: July 2. (Bring your poster with you on the 26th of July.)

Further information is available at the CSVHFS website (http://www.csvhfs.org). Contact Lloyd Crawford, N5GDB, e-mail: <n5gdb@austin.rr.net>; alternate: Thomas Visel, NX1N, e-mail: <Thomas@neuric. com>. Snail mail: RMG, PO Box 91058, Austin, TX 78709-1058.

ARRL and TAPR Digital Communications Conference: Technical papers are solicited for presentation at the 26th Annual ARRL and TAPR Digital Communications Conference to be held September 28–30 in Hartford, Connecticut. These papers will also be published in the conference *Proceedings* (you do *not* need to attend the conference to have your paper included in the *Proceedings*). The submission deadline is July 31. Please send papers to: Maty Weinberg, ARRL, 225 Main St., Newington, CT 06111, or you can make your submission via e-mail to: <maty@arrl.org>. Papers will be published exactly as submitted and authors will retain all rights.

Current Meteor Showers

May: May minor showers include the following and their possible radio peaks: *ε-Arietids,* May 9 at 2000 UTC; May *Arietids,* May 16 at 2100 UTC; and *o-Cetids,* May 20 at 1900 UTC.

June: Between June 3 and 11, the *Arietids* meteor shower will once again be evident. This is a daytime shower with the peak predicted to occur on June 7 at around 2300 UTC. Activity from this shower will be evident for around eight days, centered on the peak. At its peak, you can expect around 60 meteors per hour traveling at a velocity of around 37 km/sec (23 miles per second).

On June 9 the *Zeta Perseids* is expected to peak around 2200 UTC. At its maximum, it produces around 40 meteors per hour. The June *Lyrids* is expected to appear between June 11–21, with a peak on June 16. The *Boötids* is expected to make a showing between June 27 and July 2, with a predicted peak on June 27, around 2000 UTC. On June 28 the *Beta Taurids* is expected to peak around 2100. Because it is a daytime shower, not much is known about the stream of activity. However, according to the book *Meteors* by Neil Bone, this and the *Arietids* are two of the more active *radio* showers of the year. Peak activity for this shower seems to favor a north-south path.

July: This month there are a number of minor showers. The most intense, the *delta-Aquarids,* is a southern latitude shower. It has produced in excess of 20 meteors per hour in the past. Its predicted peak is around July 28. The *α-Capricornids* are expected to peak on July 30.

August: Beginning around July 17 and lasting until approximately August 24, you will see activity tied to the *Perseids* meteor shower. Its predicted peak is around 0500–0730 UTC on August 13. A possible tertiary peak may occur around 1500 UTC. Amateur radio communications data could confirm or detect otherwise unobserved maxima. The *κ-Cygnids* meteor shower is expected to peak on August 18.

For more information on the above meteor shower predictions, see Tomas Hood, NW7US's "VHF Propagation" column beginning on page 76. Also visit the International Meteor Organization's website: <http://www.imo.net/calendar/2007/>.

The Solar Cycle Pulse

The observed sunspot numbers from January through March 2007 are 16.9, 10.6, and 4.8. The smoothed sunspot counts for July through September 2006 are 15.3, 15.6, and 15.6.

The monthly 10.7-cm (preliminary) numbers from January through March 2007 are 83.5, 77.8, and 72.3. The smoothed 10.7-cm radio-flux numbers for July through September 2006 are 80.3, 80.3, and 80.2.

The smoothed planetary *A*-index (*Ap*) from July through September 2006 is 8.7 for each month. The monthly readings from January through March 2007 are 6, 6, and 7.

The smoothed monthly sunspot numbers forecast for May through July 2007 are 11.4, 11.6, and 12.3. By this forecast, it looks like we are at the very beginning of the new solar Cycle 24.

The smoothed monthly 10.7-cm radio flux is predicted to be 75.6, 75.0, and 74.7 for the same months. If we look at these numbers, we still see that Cycle 24 is upon us. (Give or take about 12 points for all predictions.)

Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review.

Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-*E,* meteor scatter?). I'll create summaries and share them with the readership. You are also welcome to share your reports at my public forums at <http://hfradio.org/forums/>. Up-to-date propagation information is found at my propagation center, <http://prop.hfradio.org/>, and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing!

73 de Tomas, NW7US

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Vivaldi, Cell Phone Booster, and Discone Antennas

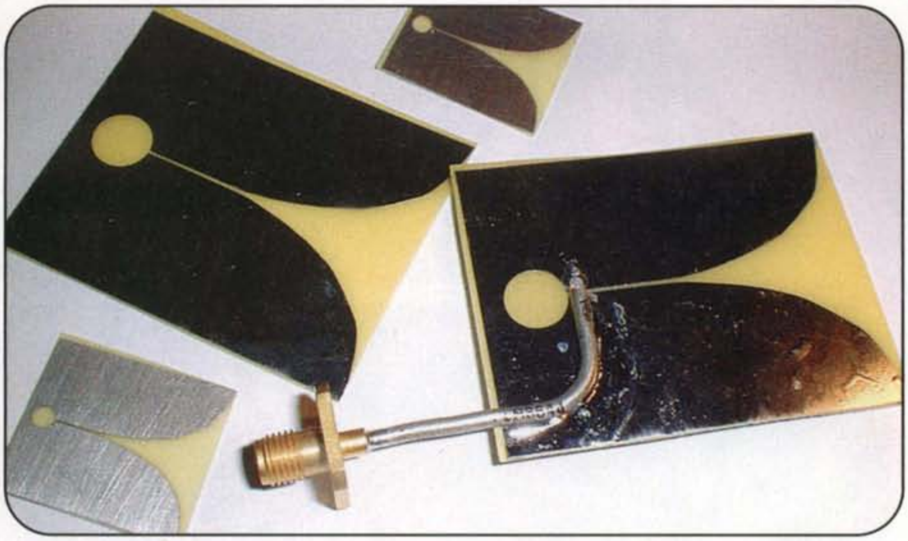

Photo A. PCB broadband Vivaldi antennas, 10–25 GHz and 20–30 GHz.

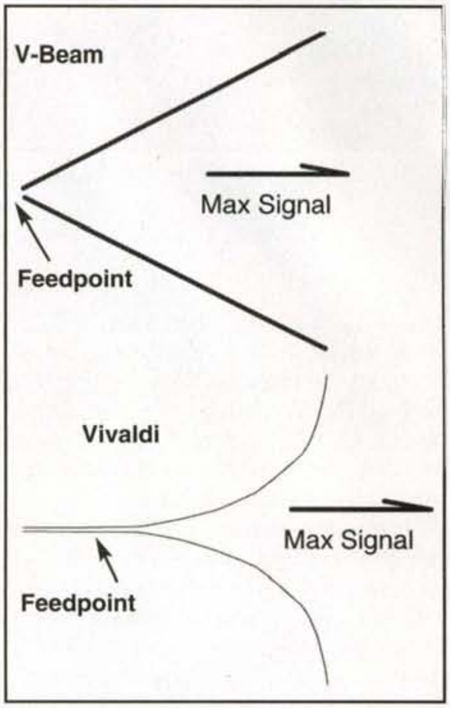

Figure 1. A V-beam and the Vivaldi equivalent.

This time we start off with Vivaldi antennas, and a 10–30 GHz version is shown in photo A.

The rhombic and V-beam antennas go back to the earliest days of radio. If you place two long-wire antennas in a V formation, then you have gain in the direction of the V.

In figure 1 you can see a typical V-beam. The longer and narrower you construct the V, the more gain you will have and the wider the bandwidth of the antenna. Bandwidths of 10 to 1 are possible. On HF this would be a beam antenna that would work very well on all frequencies between 3 and 30 MHz. The minor technicality that would keep this antenna out of most back yards is that it's 700 feet long and 400 feet wide.

To help reduce side lobes and for the antenna to have a smoother impedance transformation or SWR over this wide a range of frequencies, the V-beam wires are slowly tapered apart along an exponential curve. The wire forms of the antenna also should have the diameter of the wire increase as you progress toward the ends. This can quickly become impractical on HF, where the wire would need to be many feet in diameter. Wire cages can be used instead of 10-foot diameter copper wire, but Vivaldis are really not HF-type antennas.

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However, at about 1 GHz, exponential antennas of the Vivaldi type start to become much more practical.

One of the first uses was in horn antennas such as the ones shown in photos B and C. The exponential ridges will greatly increase the usable frequency range of a horn. A simple WR-90 horn antenna is typically rated at 8–12 GHz. The addition of exponential ridges results in a horn of the size similar to the ones shown in photo B, and they now have a usable bandwidth of 10 to 25 GHz. The much larger ridges shown in photo C give the horn a 2 to 18 GHz bandwidth.

You can think of the PC-board versions of a Vivaldi antenna as a ridged horn without the horn.

Vivaldis make great broad-band antennas with SWRs less than 1.5:1 over most of their bandwidth. Normally the coax would be soldered across the gap 1/4 wave from a back short. However, using the circle as a back short greatly increases the low SWR bandwidth over a 1/4-wave back short. Also, while the SWR starts to rise below 10 GHz, the antennas still have forward gain down to 3 GHz.

Exponential antennas of many types are becoming quite popular these days in the microwave range, and even 2.4–5.8 GHz WiFi service is taking advantage of their wide bandwidth.

Cell Phone Booster

Many of us have seen the advertisements for these stick-on antennas (photo D) in late-night TV commercials. Oh, the claims they make for them: works in sealed elevators, works underground, increases range, also cures gout and arthritis! However, I am most interested in how an antenna can reduce static on a digital signal.

I ran across a handful of these antennas at a hamfest for $1.00, which was within my price range, and did some experiments. The first thing I did was set up the network analyzer so that I could look at the stick-on antennas as a radar target. In

Photo B. 10–25 GHz ridged horn antennas.

Photo C. A 2–18 GHz ridged horn. →

photo E you can see where I used a .9–2.6 GHz log periodic to bounce a signal off the stick-on antenna. Wow, a reflection at 1.8 GHz. Thus, they are a tuned reflector at 1.8 GHz, or the PCS cell-phone band. Then I stuck it on the back of a phone and the reflection went away.

Just imagine a normal HF dipole antenna. It works fine when it's up in the air, but mount that same dipole only 1 inch off the ground and it stops working. When a stick-on antenna is attached to some plastic, its resonant frequency is greatly shifted and the return is greatly reduced (photos E and F). Put it against a battery or just over metal shields in the cell phone and it stops working entirely.

Photo D. Cell phone booster.

Discone Antennas

Recently, an antenna question came up at a hamfest. It seems that a new ham had put up one of the 25–1000 MHz discone antennas. He found that it worked pretty poorly on 10 meters and 6 meters, with performance a bit marginal on 2 meters.

I'm afraid the lad is another victim of carefully worded advertising. A more accurate advertising flyer might have read 150–1000 MHz and 27 MHz. Discone antennas typically are made for scanner use, with about 150 MHz as their low end. The upper frequency limit of a discone is determined by how accurately you can maintain the cone/disk junction construction. In figure 2 you can see how many antenna companies also place a base- or center-loaded CB antenna on top of the discone's disk. This added whip uses the rest of the discone antenna as a simple counterpoise, or ground plane. The whips usually can be tuned to your

Photo E. Testing the frequency response of a stick-on antenna.

Photo F. The installed stick-on antenna.

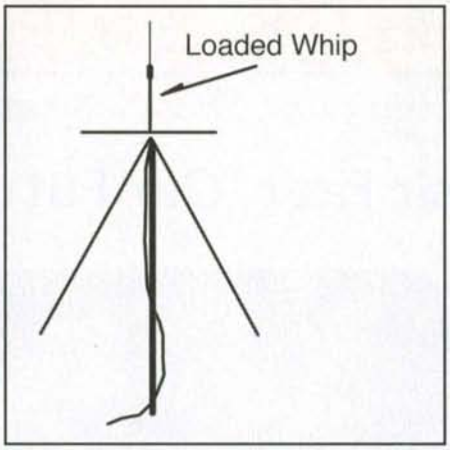

Figure 2. Discone antenna with an added loaded whip.

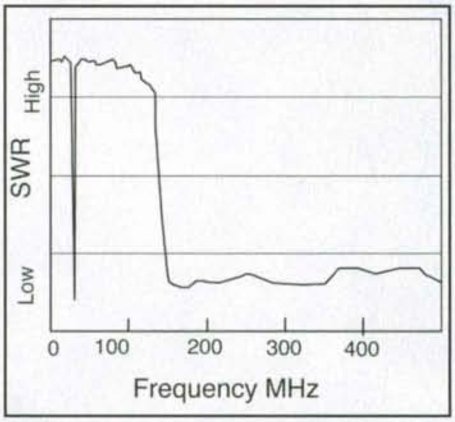

Figure 3. Typical SWR plot of a discone antenna with a loaded whip.

favorite frequency between 25 and 30 MHz, but for transmit purposes the SWR is only going to be low in a very narrow part of the band. An SWR plot of a discone with an added loaded whip has an SWR plot something like that shown in figure 3.

As always, feel free to ask antenna questions, plus I'm always looking for topics to write about. What VHF antenna projects would you like to see in future columns? Just send an e-mail to <wa5vjb@cq-amateur-radio.com> or visit my website (www.wa5vjb.com) for other antenna projects. It's springtime, so get some more antennas in the air.

73, Kent, WA5VJB

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

Their Past, Our Future

Often, SETI critics (and even some of its supporters) ask why an alien civilization would bother to beam messages our way. After all, we on Earth generally have not chosen to announce our presence to our cosmic companions.

Social scientists tell us that only two possibilities motivate all human actions: altruism and self-interest (although some argue that even seemingly altruistic acts are performed with an underlying selfish motive). Can we imagine selfish or altruistic reasons why another civilization would expend considerable resources on the deliberate transmission of electromagnetic signals over interstellar distances?

Successful altruistic civilizations, it has been theorized, harbor an innate desire to share their cultural wealth with those less fortunate. Such civilizations may consider it a cosmic imperative to undertake the transmission of their accumulated knowledge and experience to younger, emerging species. If this theory holds true, we stand on the brink of reception of *Encyclopedia Galactica,* a knowledge base that can transform human existence in ways we cannot begin to imagine. This justification for human SETI endeavors is only warranted if our cosmic companions are disposed to such generosity.

However, what of the other possibility—that our galactic neighbors might choose to transmit in our direction strictly out of self-interest? Of what possible benefit could such a transmission be to civilizations presumed older, wiser, and more capable than ours? It's easy to concoct scenarios whereby the very act of reception of interstellar signals is somehow damaging to humanity and advantageous to the transmitting species. Competition rules the jungle, so why not the cosmos? As Earth is, in essence, a paranoid, self-involved planet, will any such scenario that you can imagine easily attract a host of followers willing to embrace it? I believe this says far more about the human condition than it does the alien condition. Further, such speculations have served to inhibit the acceptance and growth of SETI science on Earth as though somehow one can believe that turning a deaf ear to the universe can protect us from harm.

Someday SETI experiments conducted from the Arecibo Observatory, or elsewhere, may well detect a cosmic "message in a bottle" from a civilization long extinct. What might we hope to learn from such a transmission?

There is a third possibility, little discussed in the literature, as to why we might someday find ourselves on the receiving end of an interstellar "CQ." We believe that time and space are finite. Civilizations, as far as we understand the laws of nature, can be long-lived but not eternal. Imagine a technologically advanced civilization facing its own inevitable demise. Might it not wish to put its entire history and culture into an electromagnetic time capsule—a modern message in a bottle—in hopes that someone else (maybe us) might pluck it out of the cosmic pond and simply know that they existed? Might not they transmit in the hopes of achieving a degree of immortality? Might not we?

Given the above possibility, I can envision someday receiving a beamed transmission from a civilization long dead. It would seek to inform us about its art, culture, society, history, spirituality, hopes, dreams, and aspirations. Such a transmission could be an unparalleled look into a neighboring civilization's past—and humanity's future.

73, Paul, N6TX

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e-mail: <n6tx@setileague.org>*

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