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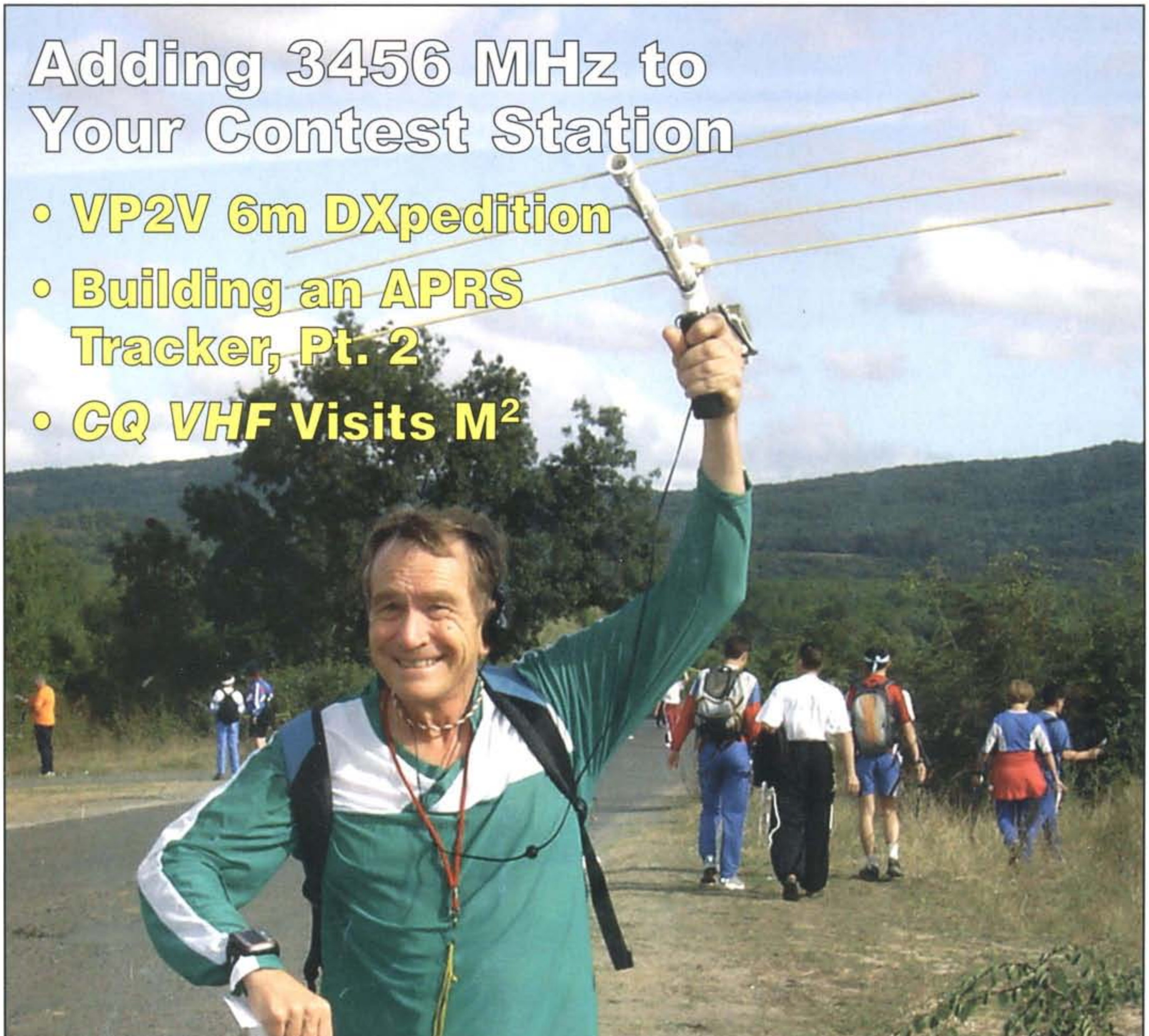
CQ VHF

Ham Radio Above 50 MHz

www.cq-vhf.com

Fall 2006

$6.50



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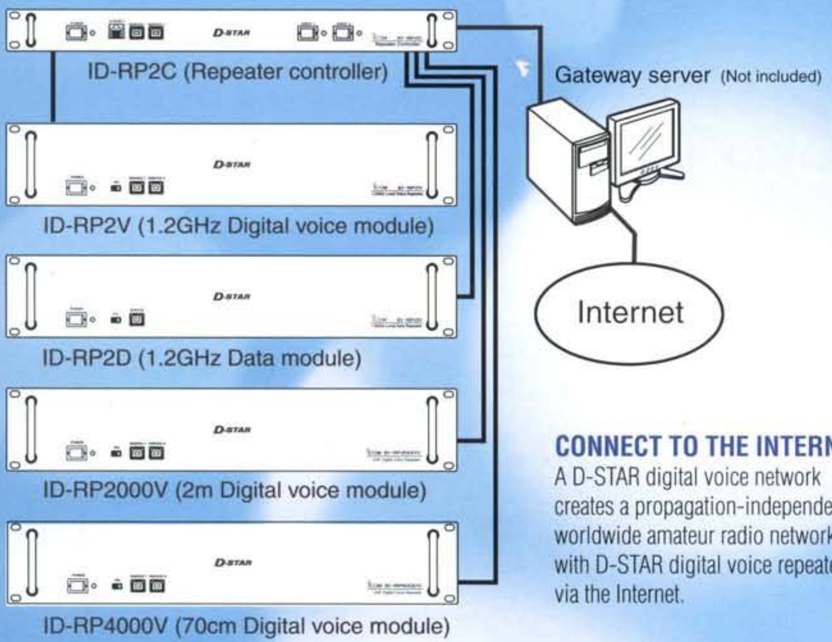

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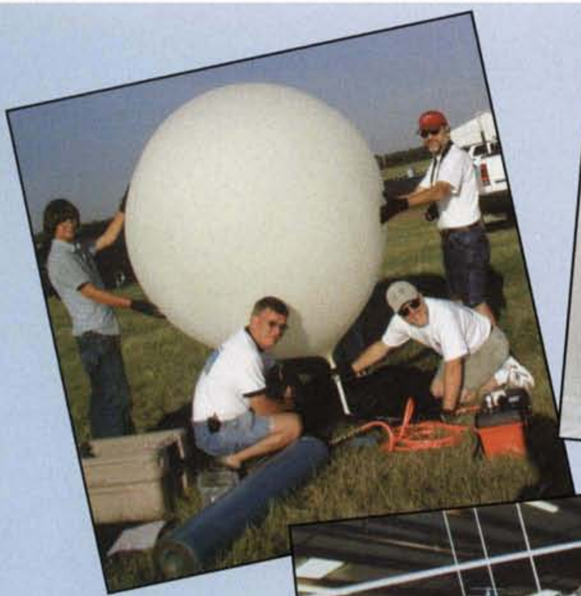
FEATURES



COLUMNS

DEPARTMENTS

On The Cover: Jay Hennigan, WB6RDV, tests his 2-meter RDF Yagi at a practice session in Bulgaria before the 2006 World ARDF Championships. For details see the "Homing In" column by KØOV on p. 56. *(Photo by Richard Thompson, WA6NOL)*

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Are You Someone's Hero?

Sometimes on our life's journey we experience a set of circumstances that lead to a wonderful conclusion. Such was the case for my wife, Carol, W6CL, and me as we journeyed home from the AMSAT Symposium this October.

On our trip home we were scheduled on a flight out of Denver that was overbooked. We volunteered to be bumped and subsequently ended up on the next Tulsa-bound flight, which necessitated our having to go to a new departure gate.

After arriving at the gate, we sat down and immediately began overhearing a conversation between two men behind us. One man was being friendly and asking the other man why he also was traveling to Spokane, Washington. The other man stated that he was scheduled to give a lecture at a community college on Tuesday on repairing the Hubble telescope while in space.

The mention of that topic caught the attention of both Carol and me. I turned around and looked at the man who was talking about his being an astronaut and then asked him his name. He told me who he was: Dr. Story Musgrave. I identified myself as an amateur radio operator and then told him that Carol and I were on our way home from a symposium in San Francisco where we had met astronaut Bill McArthur. I then asked him if he was a ham radio operator, because, as we know, almost all U.S. astronauts today do obtain their ham radio licenses.

Dr. Musgrave stated that while he was not a ham radio operator, he had flown on STS 51F with Tony England, WØORE, a name that immediately resonated with Carol and me because Tony is a hero in the ham radio community for being the second ham radio operator to communicate from space (the first was Owen Garriott, W5LFL).

During our all-too-brief conversation, Dr. Musgrave was an extremely gracious and unassuming person. As it is, he is one of the most accomplished astronauts, having flown on six missions, including each of the shuttles, during his 30-year career with NASA. Along with being a very fancy mechanic, he is also a surgeon and a poet, to name just a few of his accomplishments.

Even so, as with so many other astronauts, Dr. Musgrave recognizes that he has taken on hero status in the hearts of so many of us around the world. As such, he patiently takes time be engage in conversations with total strangers. Such was the case with Carol and me.

This was also the case with astronaut Bill McArthur. When we met Bill at the symposium, he could not have been more gracious to us and to the others with whom he conversed over the weekend.

In a conversation I had with Lou McFadin, W5DID, while at the symposium, he told me that he was so glad that Bill was a part of the symposium because he had been telling people about Bill's gracious manner for a long time. He stated that now others could see Bill's unassuming manner for themselves. I readily agreed with Lou's assessment of Bill.

Dr. Musgrave and Bill are true heroes because of their accomplishments. More than their accomplishments, however, they share their heroic adventures with young people by being involved with youth and young adults.

All of this commentary about Dr. Musgrave and Bill McArthur is leading me to ask my opening question: Are you somebody's hero?

My work as a United Methodist minister has reinforced for me the fact that we are living in a world that often is lacking in true heroes and role models for our children. Too often, today's children are products of broken and dysfunctional homes. As a result, these children know very few adults who serve as role models, let alone heroes.

This void of heroes has to be filled in some way. Unfortunately, too often this void is filled by those of less than desirable reputations, which only exacerbates these children's situations.

Here is where we as hams need to step in as role models and heroes for those children with whom we can have a positive influence. We can become these role models and heroes through a variety of different journeys. The easiest way is to invite children and youth to our amateur radio club meetings.

A more involved commitment may be by way of volunteering at a local school. For example, your school might have an opportunity where you can have lunch with one or more of the students via a program called "lunch buddies." You might also volunteer to be a teacher's aide for a science teacher.

Again, as a minister, I would also encourage those of you who are involved in your place of worship to volunteer to work with your youth department. Your priest, minister, or rabbi would be most pleasantly surprised to know of your interest in working with your congregation's youth.

If your interest is in small satellites, you might also be interested in volunteering for a program that professor Bob Twiggs, KE6QMD, announced at the AMSAT Symposium. Bob spoke of Stanford University's Small Satellite Program and how it has received a grant of $500,000 to be spent over the next three years in developing and nurturing graduate students in their work on small satellites. Bob indicated that he will be needing mentors from around the country to work with these students and that it is possible to receive travel remuneration for your work as a mentor. If you are interested in assisting Bob, then contact him at <bob.twiggs@standford.edu>.

Few of us can be heroes on the level of Dr. Musgrave or Bill McArthur. However, each of us can answer our individual calling to be a hero to someone—or even to a number of young people. Therefore, I urge each of us to consider just how we might be that special hero to those whom we can influence.

If you have a story to tell about being a hero to some young people, please let me know about it. If it has a VHF spin to it, you might find it published in a future issue of this, your magazine.

Until the next issue… 73 de Joe, N6CL

CNNSP Goes To GPSL 2006

Members of the Central Nebraska Near Space Program (CNNSP) attended this year's Great Plains Super Launch. Amateur Radio High Altitude Ballooning is KCØMWM's passion in ham radio, and here he tells the story of the group's experience at GPSL 2006.

By Roger Hammond,* KCØMWM

This year's Great Plains Super Launch, GPSL 2006, was held in Hutchinson, Kansas. It has become an annual event for ARHAB (Amateur Radio High Altitude Ballooning) with a conference on Friday and balloon launch on Saturday. This year's GPSL was organized and hosted by Zack, WØZC, of Project: Traveler. This was our second year of attending a GPSL. Six of us made the trip from Grand Island, Nebraska. including Jack, WYØF; his wife Anne; Jeff, KØJLR; Caleb; my wife Arlene; and me, Roger, KCØMWM. We all are part of a group I started known as CNNSP (Central Nebraska Near Space Program).

My whole purpose in becoming a ham was because of this aspect of amateur radio. I had read an article about MABEL-1, the Michigan Area Balloon Experimental Launch, and thought this sounded like a challenging and interesting hobby to get into. If you have any interest in science, weather, and electronics, and enjoy designing and building, this is the hobby for you. It's been said that this is the poor man's space program. With a latex meteorological balloon and a tank of helium, you can transport your electronic payload(s) to the stratosphere, or that area of our atmosphere called *near space.*

We flew our first near-space mission in May 2005 with help from another Nebraska group, NSTAR (Nebraska Stratospheric Amateur Radio), out of the Omaha area. We're one of the new kids on the block with regard to ARHAB, and we were looking forward to flying our seventh mission at GPSL, designated CNNSP-07.

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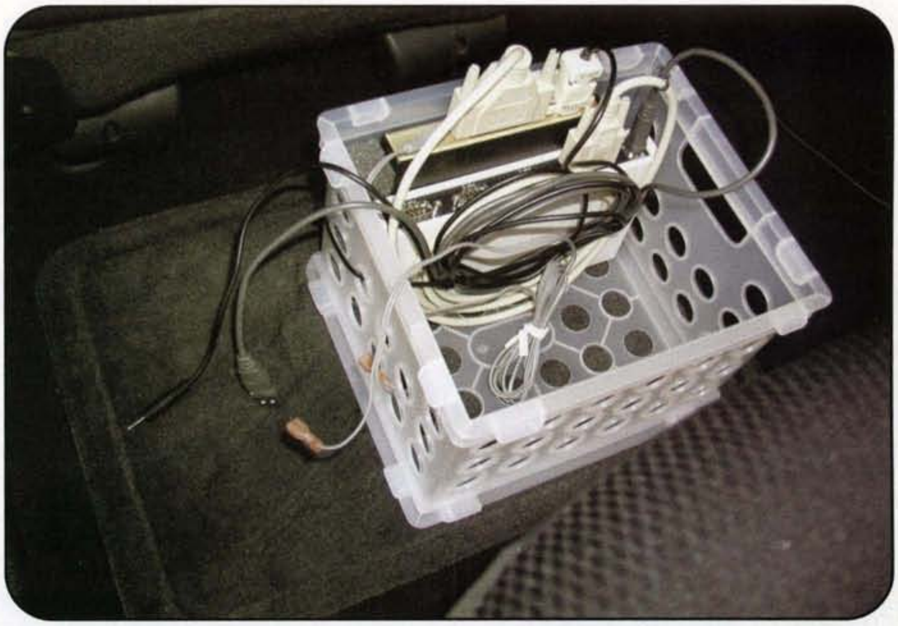
Filing the CNNSP balloon, left to right, are Caleb; Jack, WYØF; Roger, KCØMWM; and Jeff, KØJLR.

The Conference

The trip from Grand Island, NE to Hutchinson, KS is about a $4^1/_2$-hour drive. We decided to travel in a convoy and hit the road at around 11 AM. We kept in contact with the local repeaters until they faded and then switched to a UHF simplex frequency we all had agreed upon for the remainder of the journey. We managed to keep a QSO going among the six of us for the majority of the trip, commenting about the scenery (cornfields) and various other things along the way. We arrived in Hutchinson with plenty of time to wind down before meeting everyone for dinner at the hotel that evening.

Friday was the GPSL 2006 conference. Personally, I think there was a great turnout. A number of ARHAB groups from around the country were in attendance, including CAPnSPACE and Near Space Ventures from Kansas City, Edge of Space Sciences (EOSS) from Colorado, NearSys from Idaho, Oklahoma Research Balloons (ORB) from Tulsa, Taylor University from Indiana, and the "Father of ARHAB," Bill Brown, WB8ELK, from Alabama. The conference is a great place to learn about the latest projects and inventions that various groups are working on or creating. It's the perfect place to get those creative juices flowing. Presentations at the conference are given on a volunteer basis by individuals actively involved in the ARHAB community.

The first presenter this year was L. Paul Verhage, KD4STH, from Nearsys. Paul spoke about balloonsats and some of his ideas and experiences getting school-age students interested in building experiments to send into near space. Mike Manes from EOSS demonstrated his latest solution for releasing the remains of the balloon immediately after it bursts so as to avoid parachute distortion and tangling of the lines during descent. Troy Campbell with Near Space Ventures talked about the continuing development of the online flight prediction program that he has written, and Keith Kaiser finished the presentation by describing the finer points of the Google Map interface that he wrote for the program.



The tracking "crate" holding the Kantronics TNC and USB to serial adapter.

Bill Brown spoke of his latest flight experiences and some of the ideas and equipment he plans to use for future long-range flights. Jeff Dailey discussed the latest on nanosatellite development, testing, training, and flight operations that are happening at Taylor University. Another EOSS member, Nick Hanks, gave a presentation on Grid Calc Plus, a software tool designed specifically for amateur balloon track and recovery teams. Stephen Meer, also of EOSS, talked about his latest developments in the Balloon LAN, which is a low-cost, standardized, inter-flight, string wireless data communications system to facilitate both flight control and payload data sharing during flight. Zack Clobes from Project: Traveler finished the day with an interesting presentation on his software development and hardware implementation of solid-state attitude gyros and his goal of getting a model aircraft to fly autonomously to a waypoint and return. It was an interesting and thought-provoking conference.

Screen shot of UI-View tracking the CNNSP main payload KCØMWM-11 just before the balloon burst.

The Launch

It was decided to use Lyons-Rice Municipal Airport for Saturday's launch based on Friday's track predictions. This location was chosen in order to avoid having the payloads land in a populated area. We all met for dinner Friday evening at one of the local Mexican restaurants and then returned to the hotel to make preparations for the next morning's launch.

We arrived at the airport and immediately began unpacking and getting things ready to fill the balloon. Most of the groups had already arrived and were in the process of doing the same. We would be flying two payloads, both with APRS beacons, KCØMWM-11 and WYØF-11. My payload, the KCØMWM-11, consisted of a Yaesu VX-2R transceiver, TinyTrak3 module, a Garmin GPS-18 receiver, a digital camera, a Basic Stamp II microprocessor, and a 4-channel HOBO data logger. Jack's WYØF-11 payload started out as our backup APRS beacon, but Jack added an Aiptek digital video camera on our last flight, which provides us with a recording of video and audio for the entire flight. Jack used a PocketTracker (2-meter transmitter and TinyTrak3 module combination) along with a Garmin eTrex GPS receiver for our first few flights, but decided to switch to something a little more robust. For this

The remains of the balloon, still tethered to the parachute, drift into view at 27,000 feet up in the air.

flight he was planning to use a Yaesu VX-1 along with an OpenTracker module, instead of the PocketTracker.

Prior to filling the balloon, we powered up all of the electronics to ensure everything was working correctly. We checked to see that the APRS beacons were transmitting valid data and could be seen on the ground tracking stations. Jack had some difficulties getting his new setup to transmit, which had been working flawlessly when previously tested. He opted to quickly change the configuration back to the PocketTracker. As a last resort, we always fly a small self-contained CW beacon, in the event we have to resort to DFing.

It was a beautiful morning for a launch. We retrieved our designated tank of helium and started to fill the balloon. There was a slight breeze, so the filling process went well. The balloon acts like a 6-foot latex sail, so we favor light surface winds during the filling and launch process. It's quite a sight to see multiple balloons being filled at the same time. Every year the hope is to release all of the balloons simultaneously, but unfortunately we were running behind on filling as were a couple of others.

The first four balloons were released just after 8:30 CDT. We released ours along with ORB at 8:47 CDT. Our balloon and its payloads were ascending at a rate of over 1400 ft/min, which is about 400 ft/min more than what we planned for. Apparently, I misjudged the amount of helium we used and overdid it a little. Too much is better than too little. If you underfill the balloon and the ascent rate is very slow, it may take hours for the balloon to burst. Some of the groups have experienced this. and it can make for a long day of chasing over many miles. We packed up our gear and prepared for the chase.

Enlarged view in the bottom right is of the payload containers and the load line knotted and tangled.

The Chase

My mobile tracking station isn't anything fancy, but it has served us well. I have a laptop running UI-View APRS software, multiple mapping programs, a couple of GPS receivers, a Kantronics KPC-3 TNC, and a USB to serial converter. Earlier this year, for one of our other launches, I managed to hook up a few things incorrectly because I was in a hurry and hadn't planned well. I finally got things hooked up correctly and the chase and recovery went well. It was at that point I decided to consolidate the USB to serial converter, TNC, and battery. I found a small plastic crate that was just the right size to secure those items, in addition to pre-wiring as many of the connections as possible. I also found a nice long USB cable that allows me to set the crate of goodies behind the driver's seat, which is close to where the radio that I use for APRS and the GPS connector is mounted. The rest of the chase gear is my ICOM 2720 dual bander, a Kenwood TH-D7, a Yaesu VX-5, and a three-element Arrow antenna. I have two Comet C767 dual-band antennas, one for the ICOM and the other for APRS, which seem to do a good job mounted on the luggage rack of my Jeep. Add my wife, Arlene, and I have a complete payload-tracking, mobile-communication platform.

The forecast tracks were showing this to be a relatively short chase (possibly even shorter with the faster ascent rate), with the payloads landing 10 to 15 miles down range of the launch site. This was due to the light winds aloft, typical for that time of year. Duration of the flight would be approximately 2 hours, so we had plenty of time to figure out a route and hopefully be in place to see the payloads touch down.

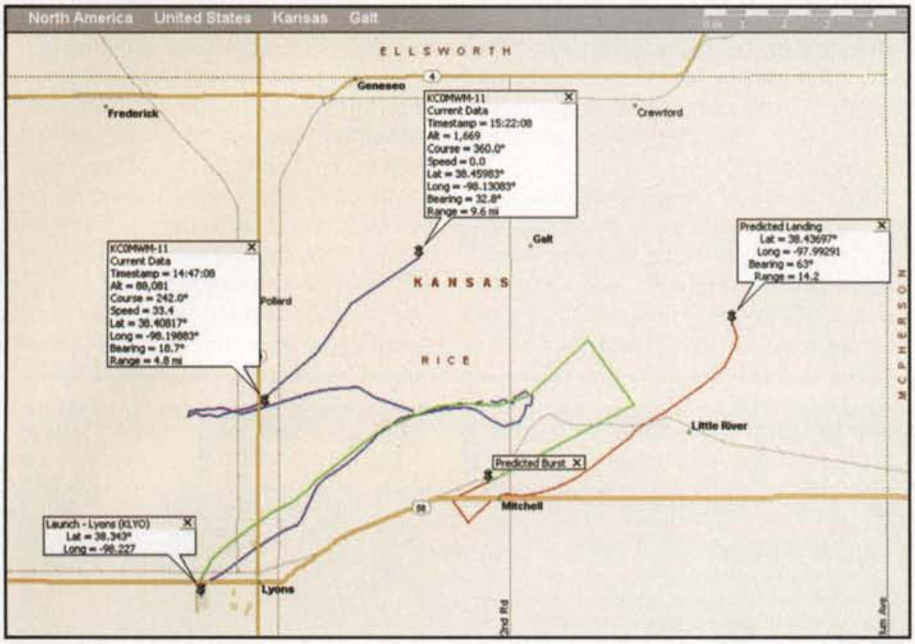
We left the Lyons-Rice Airport and headed east on highway 56 back towards Lyons. A quick stop at a convenience store in Lyons was in order for snacks and a restroom break, and then we hit the road and continued east on highway 56. The balloon didn't appear to be traveling as far east as the prediction indicated, so we turned and headed north. CNNSP typically travels in a convoy for the chase, and we communicate using UHF frequencies so as not to desense the VHF used for the APRS beacons.

We hadn't traveled very far in the northerly direction before deciding that we should probably head back to the west, based on the track we were seeing. Due to the slow speed of the balloon, we opted to pull over and see if we could get a visual of the balloon and wait for the burst. It didn't take long to find the balloon, or should I say balloons. They were all somewhere between 40,000 and 60,000 feet in the air and we had five of them in sight. It never ceases to amaze me that you can see something that size over 10 miles above you. They look like bright stars or planets, except with the sun shining. It was great that we could see our respective balloons. However, Murphy was at work and we were starting to not get regular updates from our only functioning APRS beacon. There was some sort of interference on the frequency that the majority of us were using for tracking. Other groups were reporting the same problem. I don't think it was ever pinpointed where the interference was originating, but later on I heard that it was coming from one of the balloon payloads.

Once our balloon burst at 88,000 feet, we resumed the chase. It appeared the payloads were going to land farther north than predicted, so we headed that way. The descent rate was noticeably quicker than what we usually experience and that had me wondering if the parachute was fouled. The payloads were now down to only a few thousand feet above ground, so we pulled over hoping to catch a glimpse of them returning to Earth. We didn't see them as they passed directly overhead, but we managed to see them only seconds before they landed about a half mile away. We went down to the next corner and tried to get a close look at the landing. All we could see was a milo field and trees—no brightly colored parachute or payloads.

I told the rest of the group that I would go up the road to the nearest house and see if I could find out whose property it and get permission so that we could go retrieve our gear. Arlene and I pulled in the driveway and were met by a friendly chocolate Labrador Retriever, which didn't seem to mind the intrusion as long as I kept petting him. I rang the doorbell several times, but no answer. After walking around and determining that nobody was home, I called the guys and told them I was headed to the next closest farmhouse. This time there were two small houses on the property, but again no one answered the door at either of those locations.

I was walking back to the vehicle when I heard some noise on the other side of



The green line is the predicted ascent track; red is the predicted descent track, and blue is the actual flight track. Tracks produced by Balloon Track for Windows®; map produced with Microsoft MapPoint 2006.

one of the houses and went to investigate. I found a gentleman in the process of unloading a riding lawn mower out of the back of his truck. I introduced myself and explained our predicament and asked him if he knew who owned the land down the road where our payloads had landed. He said yes and was kind enough to give me the owner's telephone number. The landowner, Kirk, granted us permission to retrieve our payloads, so I drove back to where the others were waiting and shared the good news.

Retrieval

While I was gone, Jack and Jeff had punched the landing coordinates into one of their GPS receivers so we could hopefully navigate right to the payloads. The GPS showed the distance to the payloads to be about three-eighths of a mile. Jack, Jeff, Caleb, Zack, and I headed towards the coordinates and the women stayed behind. We cut through part of the field, through some plum thickets, and across a dry creek bed, and within minutes we could see the parachute. Thankfully, it had missed landing in the trees, although not by much. The payloads were lying on bare ground right in the open.

It was pretty obvious what had caused the rapid descent rate. We brought back almost the entire deflated balloon. Over two pounds of Latex had managed to survive the burst intact and distort the parachute in addition to some major tangling of the load lines. The load lines were such a tangled mess that they had to be cut apart in several places. Everything had survived the landing, ready to make another near space journey. We grabbed the goodies and headed back to the vehicles. There I noticed we had picked up some company.

It was at that point that I had the pleasure of meeting Joe, N6CL, the editor of *CQ VHF*. As we were chatting and taking the obligatory post-recovery photo, another vehicle pulled up. It was Shelley, the landowner's wife. Shelley was curious about what we were doing and had a lunch proposal for us. It seems she and some of the other members of the United Methodist Church in Geneseo, Kansas had prepared a large quantity of food in anticipation of some motorcycle riders who were supposed to be coming through the area. Shelley asked us if we'd like to come to the church for lunch and to pass the word along. Zack did his best to try to contact someone from all of the balloon groups to tell them about our plans for lunch, and off to Geneseo we went. Geneseo is a small town of about 275 people. We found the church and went inside to discover plenty of delicious homemade food, that Midwestern hospitality, and a large quantity of balloon chasers sharing stories. It was a wonderful way to conclude the festivities of GPSL 2006.

GPSL 2007

CNNSP will be hosting GPSL 2007 in Grand Island, Nebraska. If you have any interest in the hobby of Amateur Radio High Altitude Ballooning or just want to join in the fellowship of amateur radio, please plan to join us. It will probably take place in early July. Check the GPSL website (www.superlaunch.org) for details.■

The tracking and recovery team (left to right): Roger, KCØMWM; Arlene, Anne; Caleb; Jack, WYØF; and Jeff, KØJLR.

QUARTERLY CALENDAR OF EVENTS

Quarterly Calendar

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

Nov. 3	Moon Perigee
Nov. 5	Full Moon; Good EME conditions
Nov. 12	Last Quarter Moon; Good EME conditions
Nov. 15	Moon Apogee
Nov. 17	Leonids Meteor Shower Peak
Nov. 19	Very poor EME conditions
Nov. 20	New Moon
Nov. 26	Moderate EME conditions
Nov. 28	First Quarter Moon
Dec. 2	Moon Perigee
Dec. 3	Moderate EME conditions
Dec. 5	Full Moon
Dec. 10	Good EME conditions
Dec. 12	Last Quarter Moon
Dec. 13	Moon Apogee
Dec. 14	*Geminids* Meteor Shower Peak
Dec. 17	Poor EME conditions
Dec. 20	New Moon
Dec. 21	Winter Solstice
Dec. 24	Moderate EME conditions
Dec. 27	First Quarter Moon
Dec. 28	Moon Perigee
Dec. 31	Moderate EME conditions
Jan. 7	Moderate EME conditions
Jan. 3	Full Moon.
Jan. 4	*Quadrantids* Meteor Shower Peak
Jan. 10	Moon Apogee
Jan. 11	Last Quarter Moon
Jan. 14	Poor EME conditions
Jan. 19	New Moon.
Jan. 21	Good EME conditions
Jan. 22	Moon Perigee
Jan. 25	First Quarter Moon
Jan. 28	Moderate EME conditions
Feb. 2	Full Moon
Feb. 4	Moderate EME conditions
Feb. 7	Moon Apogee
Feb. 10	Last Quarter Moon
Feb. 11	Very poor EME conditions
Feb. 17	New Moon
Feb. 18	Good EME conditions
Feb. 19	Moon Perigee
Feb. 24	First Quarter Moon
Feb. 25	Poor EME conditions
Mar. 3	Full Moon and Total Lunar Eclipse, Americas, Europe, Africa, and Asia
Mar. 4	Moderate EME conditions
Mar. 7	Moon Apogee
Mar. 11	Very poor EME conditions
Mar. 12	Last Quarter Moon
Mar. 18	Good EME conditions
Mar. 19	New Moon and Moon Perigee and Partial Solar Eclipse, most of Asia and Alaska
Mar. 21	Vernal Equinox
Mar. 25	First Quarter Moon; Poor EME conditions

—EME conditions courtesy W5LUU.

Current Contests

November: The second weekend of the **ARRL 50 MHz to 1296 MHz EME Contest** is November 11–12, 2006.

January: The ARRL VHF Sweepstakes is scheduled for the weekend of January 20–22, 2007.

For ARRL contest rules, see the issue of *QST* prior to the month of the contest or the League's URL: <http://www.arrl.org>.

Current Meteor Showers

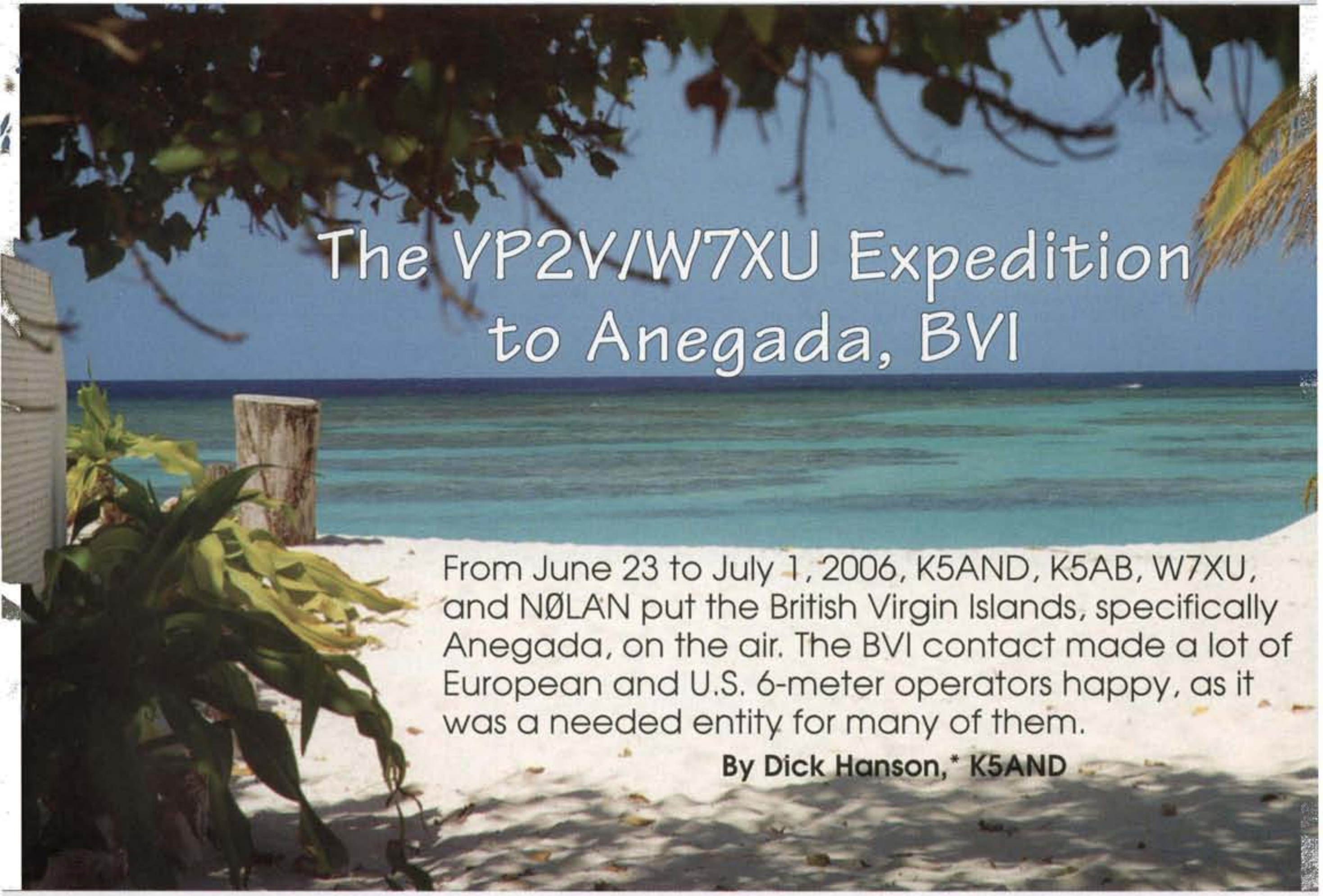
November: The *Leonids* is predicted to peak around 2050 UTC on November 17.

December: Two showers occur this month. The first, the *Geminids,* is predicted to peak on 14 December. The actual peak can occur 2.5 hours before or after the predicted peak. It has a broad peak and is a good north-south shower, producing an average of 100–120 meteors per hour at its peak.

The second shower, the *Ursids,* is predicted to peak on 22 December. It is an east-west shower, producing an average of greater than 10 meteors per hour, with the possibility of upwards of 90 at its peak.

January: The *Quandrantids,* or *Quads,* is a brief, but very active meteor shower. The expected peak is around 0030 UTC on 4 January 2007. The actual peak can occur three hours before or after the predicted peak. The best paths are north-south. Long-duration meteors can be expected about one hour after the predicted peak.

For more information on the above meteor shower predictions, see Tomas Hood, NW7US's Propagation column on page 64 in this issue. Also visit the International Meteor Organization's website: <http://www.imo.net>.



The VP2V/W7XU Expedition to Anegada, BVI

From June 23 to July 1, 2006, K5AND, K5AB, W7XU, and NØLAN put the British Virgin Islands, specifically Anegada, on the air. The BVI contact made a lot of European and U.S. 6-meter operators happy, as it was a needed entity for many of them.

By Dick Hanson,* K5AND

The trip to Anegada was planned to accommodate the high ranking of the British Virgin Islands on the "needed" entities list for European and U.S. 6-meter operators. Although several trips by 6-meter ops had occurred in the past, weak-signal contacts were made difficult by the extremely high QRN levels on Tortola, the main stopping-off island of the British Virgin Islands. Also, we later discovered that there is no active ham club in the BVI any more, and there are only about six active hams, none of whom operate on 6 meters. All of these factors combined to make the BVI more rare than it should be.

I had visited Anegada three years ago on a sailing venture and remembered that it is really off the beaten path and has little commercial activity. I thus felt that it might be electrically quiet, especially if a station could be situated somewhere on the north beach. The island is about 25 miles north-northeast of Tortola and about 12 miles due north from Virgin Gorda. It is a small island, only 2 miles wide and 11 miles long.

Anegada is mostly sand and rises approximately 28 feet out of the ocean. It is covered with sea-grape bushes, low-lying succulents such as Bay Lavender, and various salt grasses. The island is also covered with a yellow wildflower that looks like a daisy. There are no actual trees for antennas, and there is no problem for those who plan to erect a mast and beam. There are some friendly feral cows that wander the island, but because they wander, you have to be careful where you locate your mast and guy ropes!

Arliss, W7XU, went on the Internet to try to find a suitable hotel or cottage for us and finally discovered Loblolly Beach Cottages, owned by Kenneth Norman. Kenneth had built four new two-bedroom cottages in 2001, so we figured everything would be pretty new and well-maintained. Also, Kenneth, VP2VK, is an active ham and is incredibly accommodating and friendly. Two of the cottages feature airconditioning and ceiling fans in the bedrooms, a decided plus when visiting the Caribbean! His cottages also feature access to 240 VAC and good old U.S. of A. 120-VAC receptacles. No worries about connecting anything!

The Journey

Our journey began on two fronts: Alan, K5AB, and I both live in the Austin, Texas area, so all we had to do was get to Dallas-Fort Worth Airport to catch a plane to San Juan and then an American Eagle island hopper to Tortola. Arliss, W7XU, and his son Nolan, NØLAN, chose a much more exciting and challenging method of transport. They flew their own Cessna 182 from Sioux Falls, South Dakota all the way down there! Talk about adventures in flying! Believe it or not, Arliss only had to stop three times for fuel, overnighting in Tallahassee, Florida and again in Provo, Turks and Caicos.

You might imagine that Alan and I were mildly concerned about when we might rendezvous with Arliss, since we had mutually agreed to meet in Tortola at the Beef Island airport. Alan and I arrived about 10 minutes ahead of schedule, cleared customs in a breeze, and went looking for "Air Arliss." It turned out that my four-frequency world phone was rendered useless in BVI, so we had no way to phone or contact him.

Arliss was nowhere to be found, so I started by asking another airline counter person where and how private planes are integrated into the airport. A young lady at Fly BVI was most help-

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Arliss, W7XU (left), and Dick, K5AND (right), unload the Cessna 182 at the airport in Tortola.

ful and asked Air Traffic Control if a Cessna had landed recently. The ATC person said a plane had landed and the pilot was somewhere roaming around the (small) terminal. About 5 minutes later, I spied Arliss at the other end of the terminal looking for us. Thus, all in all it took about 15 minutes to find one another, and then we were off to load our gear aboard Arliss's Cessna. The flight to Anegada took all of about 15 minutes and was very smooth. For future reference, Air Arliss does not serve drinks. Perhaps on longer flights?

Then we were off to the rent-a-jeep place to load all of our combined gear in a vehicle and head to the cottage. By now it was about 4:30 local time on Thursday afternoon, so we knew we needed to make tracks to get unloaded and arrange supper for the evening. There are at least a dozen or so local restaurants that open for lunch and dinner on a request-in-advance basis. Our host, Kenneth, had phoned one nearby establishment, the Flash of Beauty, run by Miss Monica, so we were covered for the first night. We dined on fresh broiled Grouper, salad, and brown rice. Yumm! And yes, all the restaurants feature cold beer and mixed drinks. All in all, we had a great first impression of Anegada. Since this restaurant was so close to the cottage and the food was good, we ate all the rest of our suppers there.

We got back to the cottages in time to assemble our 24-foot rotating mast, the elements, and the boom for the 7-element Yagi, figuring we'd get a very early start on Friday morning, the 23rd, to be sure to be on the air as soon as possible. Then it was lights out about 10 PM.

Everything went very smoothly the next morning, so we had the antenna up by 8:30 Atlantic time (which is the same as EDT). We commenced operations at 1338Z, and the first contact was with John, KP2A, on St. Thomas. Alan worked with Kenneth to get an extension cord made for 240 VAC for Arliss's Acom 1000 amplifier. I recollect that we had the amp on line by about noon that first day. The rest of the gear included an ICOM IC-756ProIII, three sets of Heil Pro headsets, and a Kent keyer paddle. We used WriteLog (in DXpedition mode) for our logging.

We also had an ICOM IC-706 for HF operations and 2 meters, as well as an additional Yaesu FT-897 for backup on 6 meters.

We had already loaded all the European TV video offsets into the 756's memories so that we could check frequently for TV carriers, which often signal band openings. We had intermittent access to the Internet via Kenneth's broadband connection. As a result, we were able to check into DXer's info, ON4KST, and UKSMG from time to time. I installed Skype on Kenneth's computer, and I had brought along my Skype USB headset so we could make free calls to other Skype ham buddies—Johan, ON4IQ, Neil, GØJHC, and Jimmy, W6JKV. I highly recommend this tool if you have access to broadband Internet. It's also not a bad idea, in moderation, if you'd like to communicate directly with an expedition when the band is dead.

Contact Summary

The following is a summary of our contacts with dupes removed:

Friday, June 23: 64 contacts in 14 countries; farthest DX was Croatia at 4860 miles.

Arliss, W7XU (left), and Dick, K5AND (right), erecting the antennas outside the cottage.

The 24-foot rotating mast, elements, and boom for the 7-element Yagi.

Left to right: Kenneth, VP2VK, our host; Dick, K5AND; and Arliss, W7XU.

Saturday, June 24: Only managed 7 contacts in 5 additional countries; worked Lefty, K1TOL, for our first U.S. QSO.

Sunday, June 25: 80 contacts in 9 new countries; farthest DX with Cyprus at 5950 miles

Monday, June 26: The day started off well enough. Our first contact was with EI7IX at 1048Z. Although we had heard Neil, GØJHC, every day since we arrived, we saved his contact until this day, since it was his 40th birthday! (Just kidding about hearing Neil *all* that time.) Things were really going great until 1349Z, when the power was turned off for the entire island, just as we finally had gotten an opening to the U.S. and were busily logging folks up and down the east coast. Power didn't come back on for 5 1/2 hours! All that time Jimmy, W6JKV, was racking up the juicy contacts, so at least he was doing well. We logged some quality time at the beach and tried to keep hydrated in the heat.

Later that afternoon we almost had a real disaster when one of our guy ropes abraded and let go, causing our 2-inch aluminum mast to bend an unhealthy amount. Fortunately, we got to it before it was permanently bent and re-guyed it in a more substantial fashion. When the power came back on at 1927, we worked an additional 207 contacts and added 15 more new countries to the log. The best DX was R5TTU in European Russia at 5700 miles.

Tuesday, June 27: This was our biggest day yet at 288 contacts and 11 additional countries. Total number of contacts thus far was 640 with 54 countries. The best DX was 4X4DK at 6100 miles. We were at the halfway point of our trip, with only five more days to reach our goal of 1000 contacts. Would we make it?

Wednesday, June 28: Terry, K4RX, opened the band for us at 0949Z today. After that, we worked an additional 338 U.S. stations and 7 more new countries. We were also fortunate to have a second, evening opening, which let us work some W6 and W7s. Since that is well over 3000 miles, we stood by for them to help them try to get through. We hoped we could get some more in the log the rest of the week.

One thing that probably deserves mention is that this was our first experience on a trip being able to "see" signals on the Pro III bandscope. This may be somewhat of a new concept for VHF DXpeditioning, and we think it has value. Many of us have "visual" radios at home and have seen what they can do there, but this was a new thing on a trip for us and it definitely paid off. We probably worked 5% more stations and definitely picked up some countries that we would otherwise not have known about. Therefore, if you are considering a DXpedition, you may want to take along one of the "seeing" radios. Units that come to mind include the Flex Radio SDR-1000 and several of the ICOM products. Granted, some of these boxes are larger and heavier than some of the more standard choices, but they are manageable and worth the extra few pounds.

Thursday, June 29: Our goal-making 1000th QSO was with K2MUB at 1105Z. Thursday started out strong with a great opening to the U.S. and a number of W6 and W7 stations worked (K6MYC, K6QXY, and WB6NAN were among them). By 1924Z we were at 1401 Q's and the country total stood at 64. Over 600 Q's on that day alone!

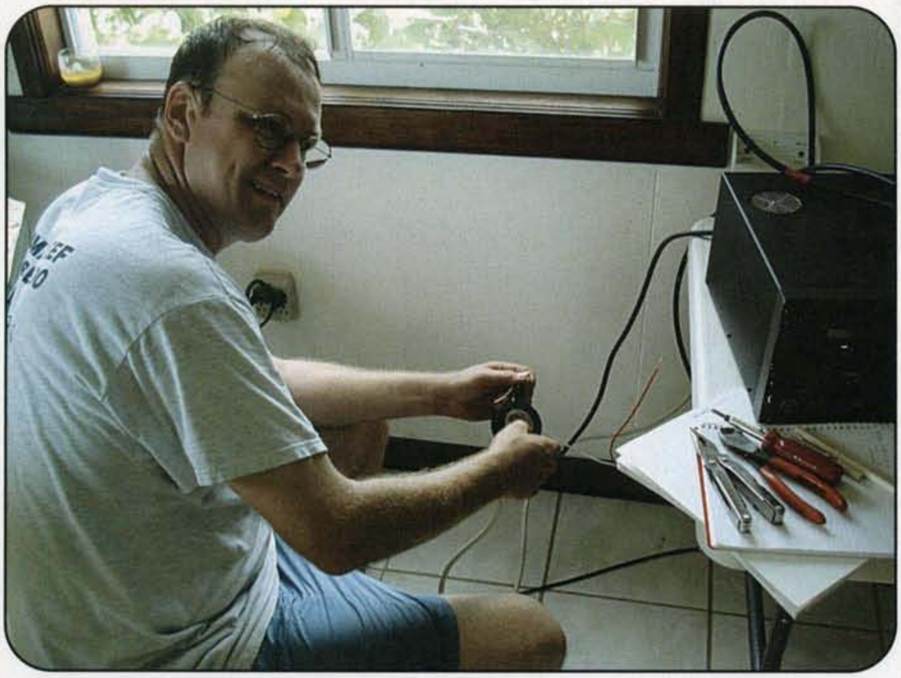
Friday, June 30: Not such a hot day, with only 19 Q's.

Saturday, July 1: Another lackluster day, with only 27 Q's.

Sunday, July 2: Sadly, it was now time to tear down and pack up to leave.

Trip Summary

A total of 1656 contacts (less dupes) and 64 countries. All in



Alan, K5AB, setting up one of the stations.

all, Anegada was a successful and fun venture resulting in a number of the faithful getting a new country. We would recommend Loblolly Cottages to anyone wanting to do a BVI radio trip. Kenneth is a great host and will steer you right for all your needs.

Thanks to everyone for all the contacts, for help with spotting us, and for the camaraderie on the bulletin boards, Skype, and e-mails. Here's to next spring's trip! A really big thanks also to Holly, NØQJM, for making and handling all the QSLs. ■

Packed up and ready to return home (left to right): Dick, K5AND, Arliss, W7XU, Nolan, NØLAN, and Alan, K5AB.

Radio Merit Badge Program at Ham-Com 2006

For the third time, this year's Ham-Com convention in June featured a special Technician license class and Radio Merit Badge session for Scouts. Here are the details of the programs, along with the current Radio Merit Badge requirements.

By James G. Alderman,* KF5WT

For the third year in a row, Ham-Com sponsored special programs for Boy Scouts, including a day-long Tech license preparation class and a half-day Radio Merit Badge (RMB) program.

The Tech class was taught by Allan Batteiger, WB5QNG, and Dick Raitt, WA5VKS, of the Plano Amateur Radio Club. The class consisted of 12 hours of instructional time. Although the class was open to everyone, Scouts in particular were encouraged to attend. The W5YI-VEC team offered free testing to Scouts, and four passed their Technician exams at Ham-Com 2006.

The RMB program was taught by James Alderman, KF5WT, and Richard Phillips, KB5YBQ. The course covered all of the required subjects for a Scout to complete the Radio Merit Badge. This year's class served 57 Boy Scouts and one Girl Scout. To date, over 300 Scouts have received their Radio Merit Badges through the popular Ham-Com program.

Ham-Com spent over $3800 on youth programs, offering free admission to any Scout or leader who came in uniform, and providing free lunch to those attending the Tech and RMB classes. Any Scout who came to Ham-Com with a copy of a successfully passed practice test could also take the Tech exam for free.

In this hands-on experiment, a signal generator is used to produce a sound wave. Then the frequency is tuned ever higher until a radio wave is detected on a radio receiver set to the 80-meter band. (Ham-Com 2006 digital photo by Barry A. Goldblatt, WA5KXX)

What is the Radio Merit Badge?

In the Boy Scouts there are awards (actually patches) that boys can earn for proficiency in certain subjects and activities. These awards are called Merit Badges and are given for activities such as camping, swimming, first aid, public speaking, and radio, to name a few.

Each progressive rank in Scouting requires a certain number of core badge requirements, plus a certain number of electives. A total of 21 badges is required for the highest rank of Eagle. Radio is one of those elective subjects that any Scout can take and apply towards rank advancement.

Since amateur radio and Scouting both heavily emphasize emergency preparedness, the two naturally fit very well together. The Radio Merit Badge program is a wonderful way for ham clubs to share the excitement of amateur radio with the next generation, and many of the badge requirements relate directly to material on the new FCC Technician exam.

The purpose of the RMB class is not to make radio experts out of the boys within a half day. It is designed to give them a basic familiarity with what radio technology is all about, and give them some additional emergency preparedness skills they might find helpful in the future.

As with any BSA Merit Badge, the badge requirements as published by Boy Scouts of America must always be followed to the letter. An instructor cannot add to or take away from the requirements. That makes a Merit Badge earned in one part of the country every bit as meaningful as one earned anywhere else.

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Instructors can talk about additional things to make the general subject more interesting, understandable, and relevant to the times we live in. However, he or she cannot "fail" a boy for not having a working knowledge of that additional material. The Ham-Com program does address some relevant topics that aren't specifically listed in the requirements, such as NOAA Weather Radio, FRS, Skywarn, cellular, power-line safety, and so on.

To complete the Radio Merit Badge, a Scout has the option of studying three different variations of the course: Amateur Radio, Broadcast Radio, or Shortwave Listening (SWL). At Ham-Com the Amateur Radio option is covered.

Although the requirements as listed appear to jump around from one subject to the other without any rhyme or reason, the Ham-Com class has carefully divided the information into three broad categories: Introduction To Radio, Electrical Components and Safety, and Amateur Radio In Emergency Communications. Each category takes about an hour to cover with an additional hour for on-the-air ham radio QSOs.

Instructor James Alderman, KF5WT, used lengths of rope to demonstrate wavelengths of various radio bands such as the aircraft, TV, and FM radio bands. (Photo by WA5KXX)

Hands-On Learning

The quickest way to ruin a class and make it absolutely boring is to turn it into a "note-taking" class. The RMB class at Ham-Com is no ordinary academic lecture. It is a fully "interactive" class and Scouts are encouraged to participate in the learning process.

PowerPoint images are projected on an overhead screen and illustrate each talking point. Items are shown and passed around the room. Various props that require assistance from the audience are used as well.

One of the favorite activities is the capacitor-discharge experiment, where a large electrolytic is charged up from a 12-volt supply. Then a brave Scout discharges it with a screwdriver. Only the "bravest" member of the audience is summoned forward for this one. ***Note:*** *Use extreme care if attempting this experi-*

Richard Phillips, KB5YBQ, addresses the Radio Merit Badge class. (Photo by WA5KXX) *ment on your own. Capacitors can hold a substantial amount of electricity, and can explode if mishandled.*

Workbooks

Since some of the requirements involve writing, listing, and drawing, workbooks are used to make the task easy (the Radio Merit Badge workbook is available in Microsoft Word format on the Ham-Com website: <http://www.hamcom.org>.). This workbook features spaces where each writing requirement can be filled in. The only things a Scout has to put in his workbook are things that the requirements say must be listed or drawn. If the requirements say to "discuss" something, that subject is covered in class.

At Ham-Com amateur radio operators volunteered to serve as roving "table mentors" during the class to help Scouts with their drawings. This assistance proved invaluable in keeping the class

Radio Merit Badge Requirements

Here are the current Radio Merit Badge requirements. For the sake of clarity, specific subjects are ***emphasized*** and editor's notes are contained in brackets.

1. Explain ***what radio is***. Include in your explanation: the differences between ***broadcast radio*** and ***hobby radio***, and the differences between broadcasting and ***two-way communicating***. Also discuss broadcast radio and amateur radio ***call signs*** and using ***phonetics***.

2. ***Sketch a diagram*** showing how radio waves travel locally and around the world ***[Sky wave, ground wave, line of sight, etc.]***. How do broadcast radio stations such as ***WWV and WWVH*** help determine what you will hear when you listen to the radio?

3. Do the following:

A. ***Draw*** a chart of the electromagnetic spectrum covering 100 kilohertz (kHz) to 1000 megahertz (MHz).

B. ***Label*** the MF, HF, VHF, UHF, and microwave portions of the spectrum on your diagram.

C. ***Locate*** on your chart at least eight radio services, such as AM and FM commercial broadcast, citizen's band (CB), television, amateur radio (at least four ham radio bands), and police.

D. Discuss why some radio stations are called ***DX*** and others are called ***local.*** Explain what the ***FCC*** and ***ITU*** are.

4. Explain how radio waves carry information ***[modulation]***. Include in your explanation: ***transceivers, transmitter, amplifier, and antenna.***

5. Explain to your counselor the ***safety precautions*** for working with radio gear, particularly direct current and RF ***grounding***.

6. Do the following:

A. Explain the differences between a ***block diagram*** and a ***schematic diagram***.

B. ***Draw*** a block diagram that includes a transceiver, amplifier, microphone, antenna, and feed line.

C. Explain the differences between an ***open circuit***, a ***closed circuit***, and a ***short circuit***.

D. ***Draw*** eight schematic symbols. Explain what three of the represented parts do. Find three electrical components to match to three of these symbols.

7. Do ONE of the following (A or B or C) (There are three options for this requirement: Amateur Radio, Broadcast Radio, or Shortwave Listening.):

A. Amateur Radio Option

1. Describe some of the ***activities*** that amateur radio operators can do on the air, once they have earned an amateur radio license. ***[Examples: Skywarn, emergency preparedness, portable operation at a camp, Echolink, etc.]***

2. Carry on a ***10-minute real or simulated ham radio contact*** using voice or Morse code; use proper ***callsigns***, ***Q signals***, and ***abbreviations***. (Licensed ham radio operators may substitute five QSL cards as evidence of contacts with amateur radio operators from at least three different call districts.) Properly ***log*** the real or simulated ham radio contact and record the ***signal report***.

3. Explain at least five ***Q-signals*** or ***amateur radio terms*** you hear while listening.

4. Explain some of the ***Technician Class license*** requirements and privileges. Explain who gives amateur radio exams ***[Volunteer examiners]***.

5. Explain how you would make an ***emergency call*** using voice or Morse code. Tell ***why*** the Federal Communications Commission has an amateur radio service ***[the purposes of Amateur Radio, in simple terms]***.

6. Discuss ***handheld*** transceivers versus ***home "base" stations***. Explain the used of ***mobile*** amateur radios and amateur radio ***repeaters***.

B. Broadcast Radio Option

1. ***Prepare a program schedule*** for radio station "KBSA" of exactly one-half hour, including music, news, commercials, and proper station identification. ***Record*** your program on audio tape using proper techniques.

2. ***Listen to and properly log*** 15 broadcast stations; determine for five of these their ***transmitting power*** and ***general area served***.

3. ***Explain at least eight terms*** used in commercial broadcasting, such as *segue, cut,* and *fade*.

4. Discuss the ***educational licensing requirements*** and ***career opportunities*** in broadcast radio.

C. Shortwave Listening Option

1. ***Listen*** across several shortwave bands for two four-hour periods, one in the early morning and the other in the early evening. ***Log*** the stations properly and ***locate*** them geographically on a globe.

2. For several major foreign stations (BBC in Great Britain or HCJB in Ecuador, for example), ***list*** several frequency bands used by each.

3. Compare your morning and evening logs, noting the frequencies on which your selected stations were loudest during each session. Explain the differences in signal strength from one period to the next ***[Propagation]***.

4. Discuss the ***purpose of*** and ***careers in*** shortwave communications.

8. ***Visit a radio installation*** approved in advance by your counselor (a ham radio station, broadcast station, or public service communication center, for example). Discuss what types of ***licenses*** are required to operate and maintain the ***equipment***, and the ***purpose*** of the station.

Scouts gathered in groups to take turns making radio contacts. (Photo by WA5KXX)

moving along smoothly and on schedule. These hams helped individual students without the main instructor having to spend a great deal of time answering minor questions.

On-the-Air Contacts

To complete the on-the-air contact requirement, the boys split up into four groups and made contact with one another on handheld and mobile units around the Ham-Com grounds. Some even made their contacts over the miniature UHF repeater that was used in class for demonstration purposes. (This mini-repeater will eventually be installed at a BSA camp in eastern Texas, where it will be used primarily for teaching purposes.)

Plans are already under way to make the youth programs at Ham-Com even better next year. ■

Wide-angle view of the Radio Merit Badge class. (Ham-Com 2006 digital photo by John-Thomas Beadles, N5OOM)

Building an APRS Tracker Part 2 – The "Powerhouse" Tracker

In the Summer 2006 issue of *CQ VHF*, in part one of this article, W3DOE described how he built a simple, what he calls "nimble," Automatic Position Reporting System tracker. This time he tells us about the first tracker he built, a high-power unit that turned into a challenging construction project.

By Carlton Doe,* W3DOE

Welcome to the second and final part of this series on building APRS trackers. In the first part (Summer 2006 *CQ VHF*, p. 15), I introduced the Automatic Position Reporting System (APRS), described what a tracker is, related the design criteria to be evaluated, and then detailed the construction of a low-power, portable APRS tracker—what I call a "nimble" tracker. This time I will cover the first tracker I built, a high-power unit that turned into an over-the-top experience during construction.

Recap of Part 1

If you missed part one, let me briefly recap. APRS was developed by Bob Bruninga, WB4APR, as an enhancement to regular packet-mode transmission oriented specifically for publishing location-based information via RF. There are two parts to an APRS system—one part transmits where the tracking object is (the job of a tracker), and the second part is the display software, such as UI-View (http://www.ui-view.org), which receives APRS transmissions and plots the position information on maps. An APRS tracker has four basic components:

- A Global Positioning Satellite (GPS) receiver to generate the location-based information.
- A Terminal Node Controller (TNC) to interface with the GPS receiver and translate its data stream into a signal that can be transmitted by a radio. The TNC also connects to and controls the radio, determining how often or under what conditions the tracker will "beacon" or send out its location information.
- A 2-meter radio able to transmit at 144.390 MHz, the APRS frequency for almost all of the United States.
- An enclosure.

Since a tracker can be built into almost any type of enclosure, building one requires balancing a number of factors such as radio power, battery capacity, size, weight, and so on. The relative importance of one factor versus another will determine the size, capability, power, and portability of the tracker. There isn't one set of "correct" answers to any of these issues. You as the builder have to decide what you want to do with the tracker and that will guide the rest of your decisions. As I mentioned at the end of part one, the most important components of a project such as this are the design goals and criteria. With these in place, you can build to your own specifications and enjoy a high chance of success.

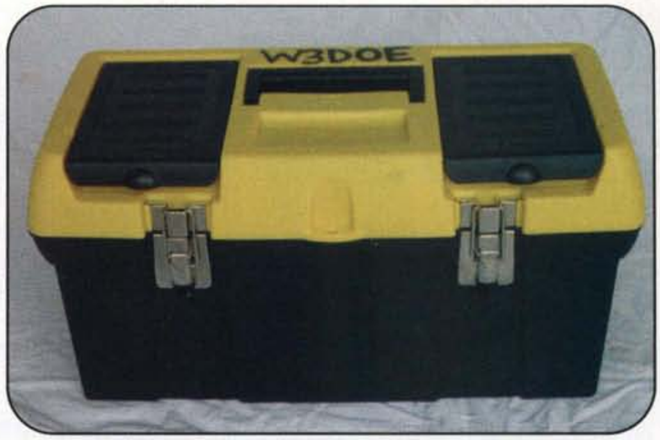

Photo 1. The author chose a toolbox that can be purchased from most any hardware store as the enclosure for the "powerhouse" APRS tracker. (Photos and figures by the author)

As I started to build this, my first tracker, I didn't have a clue what I was doing nor did I have anything in the way of a design specification other than I wanted to use a 50-watt radio. I thought I needed the RF power here in the Dallas, Texas area to get my signal out. It turns out I was wrong, but at the time I didn't know about APRS digi-peaters.

This lack of an overall design plan was quite costly from both a financial and time perspective. As I was putting together the tracker, I'd come up with an idea or see something in a picture and say to myself, "Hey, put that in, too!" Since these new ideas weren't governed by any design specifications to determine if they should or should not be used, I ended up throwing away or reworking most or all of the tracker several

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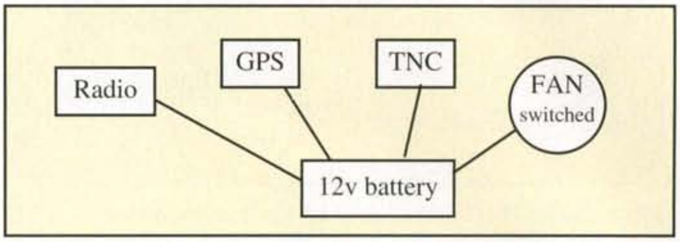
Photo 2. As a receiver for the tracker, the Garmin GPS-18LVC was chosen. It features bare-wire ends and gave the flexibility to create a customized connection that could also feed the sensor the power it needed.

Figure 1. The radio, GPS, TNC, and a fan shown here from an electrical perspective.



times. I'm not saying you can't or shouldn't adapt or modify your design if requirements change, but the changes should be evolutionary, not revolutionary as mine were.

To be somewhat fair to myself, though, I think the final result turned out quite well; the tracker has proved to be a highly functional unit. Now on to the component and construction details of building a "powerhouse" APRS tracker.

The Enclosure

This was the first component I went shopping for, and in some respects it became the overall guiding design element as I came up with new ideas. Could whatever I saw or thought of fit/work in the box?

I knew I was going to be using a 50-watt mobile radio with a rather hefty battery, so I wanted an enclosure that was large enough, could handle the weight of the radio and battery, and was reasonably rugged. As shown in photo 1, I chose a toolbox that can be purchased from most any hardware store. One of the things I liked about it was the four mini storage bays on the lid under the two black snap covers. I originally thought I'd only use the right-hand side to mount the antenna and GPS connections as well as a simple On/Off switch, but by the time I'd finished the fourth iteration of work on the tracker, all the bays were used.

The GPS Receiver

As I mentioned in the first part of this article, I am very familiar with GPS technology and have been using automotive products for several years. I also have a strong bias towards Garmin as a vendor, because in my opinion, this company builds the highest quality, most reliable GPS receivers and their customer service is second to none.

In picking a receiver for the tracker, I wanted a very basic, inexpensive unit that could be placed almost anywhere, including outside a vehicle, without being ruined by the elements. I looked at sensor-only receivers from a number of manufacturers, but most of them were pretty industrial (in other words, big and clunky) in nature. As luck would have it, as I started to build this tracker, Garmin released a new product, the GPS-18 (http://www.garmin.com/products/gps18oem/), which was exactly what I was looking for. Available in three models, differing only in their connectors, the GPS-18LVC features bare-wire ends. This gave me the flexibility to create a customized connection that could also feed the sensor the power it needed as illustrated in photo 2.

I had a problem, though: The GPS-18 only uses 5 volts! Since I didn't want to have two sets of batteries in the box, I had to find something to convert 12 volts in to 5 volts out. It turned out that there is an electrical component called a "voltage regulator" which can receive from 12 to 30 volts on the input side and outputs 5 volts. It does produce a bit of heat, though, so nothing should touch it while it's running. Now I had to figure out how to wire everything together.

Power

My original thought was to simply get a radio, GPS, TNC, and maybe a fan to

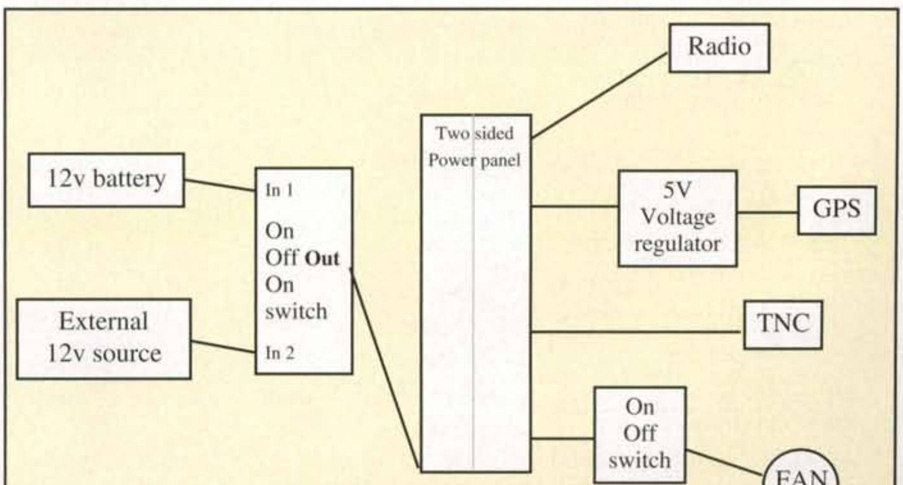


Figure 2. Some sort of modular power distribution panel was needed inside the box, which meant the original wiring harness and the components associated with it were useless. The new wiring diagram looked like this. However, there was another component change and rewire after everything was finished and tested.

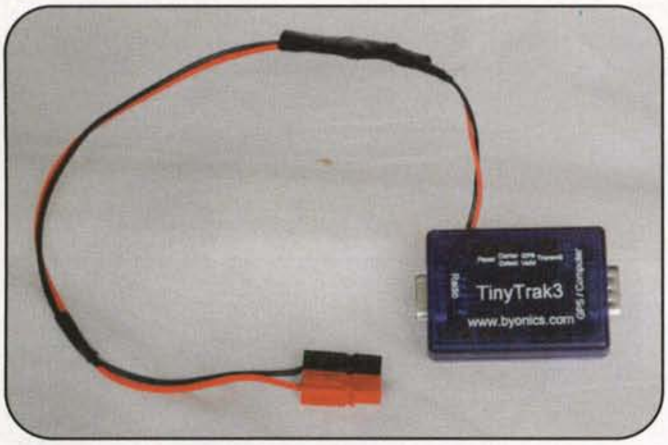


Photo 3. *The TinyTrak3 (TT3) by Byonics was used as the TNC.*

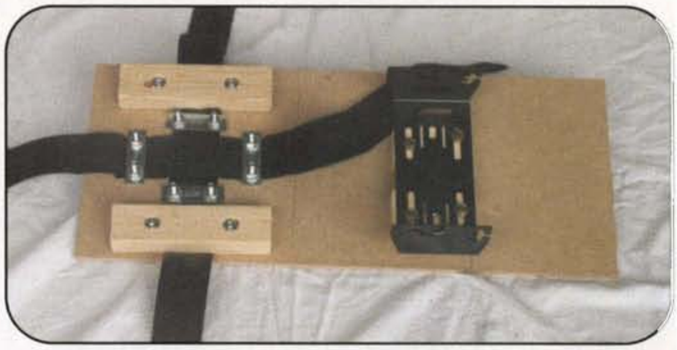


Photo 4. The bottom of the toolbox was measured and a platform built to mount the battery and radio; 2" × 2" lumber was into blocks and used as mount points for the radio bracket as well as a battery platform.

keep the box cool and hook them all up. From an electrical perspective, I thought it would look like figure 1. I would use a simple switch to turn the tracker on or off and maybe have one additional switch to control the fan.

Although I didn't have any sort of power requirement calculations, in order to provide enough electrical energy for a VHF mobile radio to beacon at a reasonable interval for a long day, I knew I'd need something more that a couple of AA batteries. After measuring the interior of my tool box and leaving room to mount the radio, I decided to get an 18-amp/hr gel-cell battery. Another important consideration in choosing this battery was that larger capacity batteries are much heavier and were too large to fit neatly into the tool box. Real-life testing has shown the battery will provide over 12 hours of power, although it then is severely depleted.

The first major change to the tracker revolved around power and wiring. I had mounted the battery and radio and wired the box, when at an event I saw a tracker that was powered by plugging it into a car's dashboard power port. I thought it would be a great idea if my tracker could use either its internal battery or, for longer use, some sort of external power source such as a larger capacity battery. By this time I had also discovered I needed a voltage regulator to provide power to the GPS receiver. With the heat it and the radio generated, I definitely wanted to control whether or not the fan was running.

As I contemplated how to re-wire the box, I also decided I wanted the ability to power up one component at a time for individual testing. With all these requirements, I realized I needed some sort of modular power distribution panel inside the box. It also meant my original wiring harness and the components associated with it were useless. My new wiring diagram now looked like what is shown in figure 2. This wasn't the end of my fiddling, though. As will be explained later, there was another component change and rewire after everything was finished and tested, and the tracker was to be used the next morning for an event.

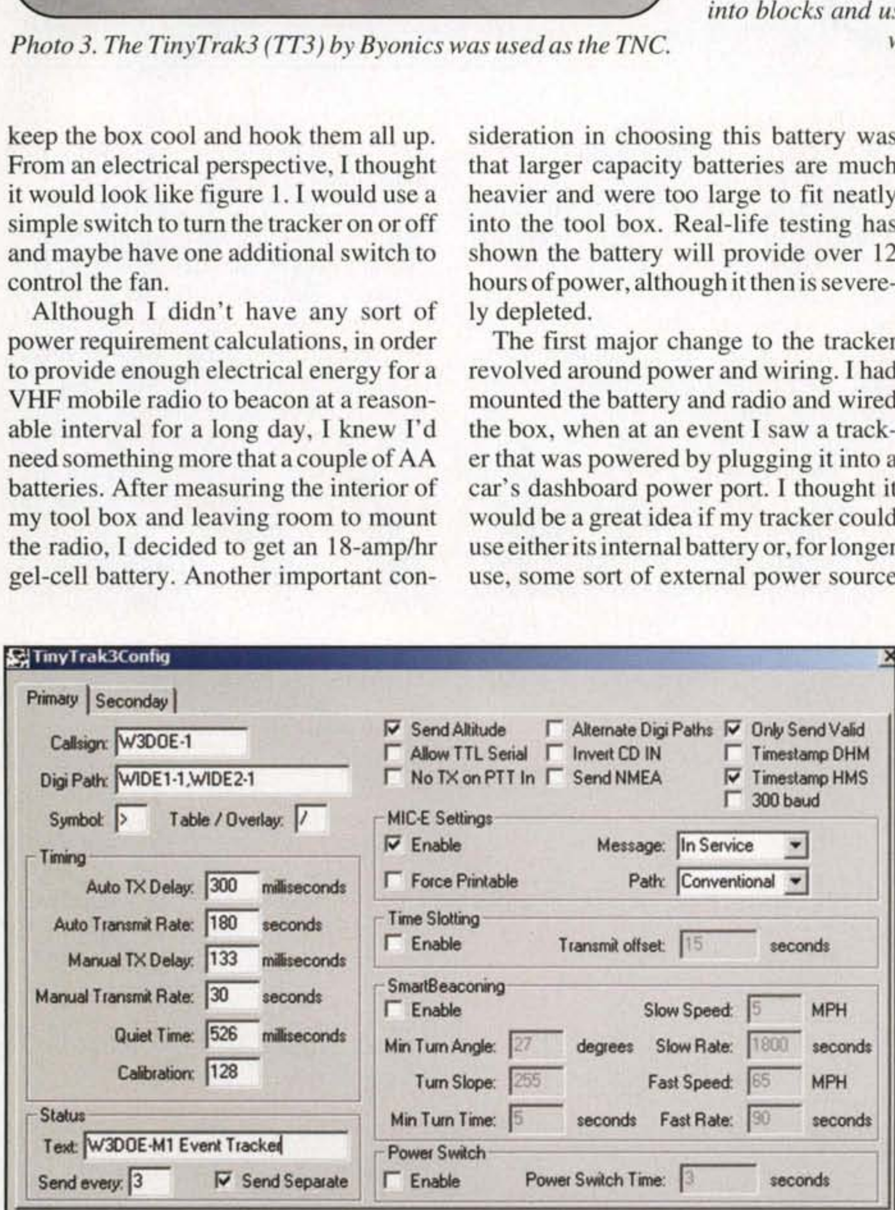


Figure 3. Screen shot of the TinyTrak3 configuration software.

The Radio

The radio and TNC decisions were very tightly coupled, since both were needed and options existed to have both integrated into the radio. Radios with TNCs are extremely expensive, however, and I didn't want to spend that much money. I just wanted a basic, no frills 2-meter mobile that could easily hook up to the TNC's serial port. Alinco's DR-135 (www.alinco.com/Products/DR-135/) non-TNC model was a perfect fit.

Available either with or without an internal TNC, both versions have a DB-9 serial data port on the back. Not only was there a direct connection to the TNC, but the connection features line-level audio I/O. This made tuning the TNC significantly easier, since it wasn't dependent on the radio's volume setting (which can be bumped or changed inadvertently), as happens when using mic and headphone jack connections.

The TNC

Early on I realized the TNC was the heart and soul of the tracker. It receives the position information from the GPS receiver and converts it into packet data the radio can transmit. In addition, the programming of the TNC determines how often the tracker will attempt to beacon, as well as what information is sent.

I found a number of general-purpose TNCs that could handle all the various packet modes, but they were either expensive, didn't have APRS functionality, or both. After scrutinizing a couple of other trackers, I was led to the TinyTrak3 (TT3) by Byonics (http://www.byonics.com/tinytrak) shown in photo 3. If you read the first part of this article, you'll recall I've also used the OpenTracker from N1VG (n1vg.net/opentracker) for that project. I very strongly prefer the TT3 because of its more advanced functionality and better programming software. This is simply a personal preference, as both will work well in a tracker.

Recently, the TT3 has received a firmware upgrade and the TinyTrak3Plus (http://www.byonics.com/tinytrak/tt3plus.php) provides 5 volts output power through a set of pins on its GPS connector, enabling it to power a GPS sensor. This would have been very nice to have, since I could have eliminated the voltage regulator with its heat output.

After selecting a TNC, the next step is to program it. This requires a Null Modem cable attached to a computer serial port. You probably will also need a female-to-female gender changer, since standard Null Modem cables have a male connector on the end you need to connect to the TNC. Figure 3 shows a screen shot of the TT3 configuration software. It is here that you set your callsign, the digipath, the icon you want displayed on APRS software with the symbol table and code options, any secondary text transmitted as part of the beacon, and the time interval of the beacon or under what conditions it should beacon. For example, while this was set to beacon every three minutes, I could have enabled beaconing if my speed fell into a certain range or I turned greater than X degrees.

Of particular concern in programming

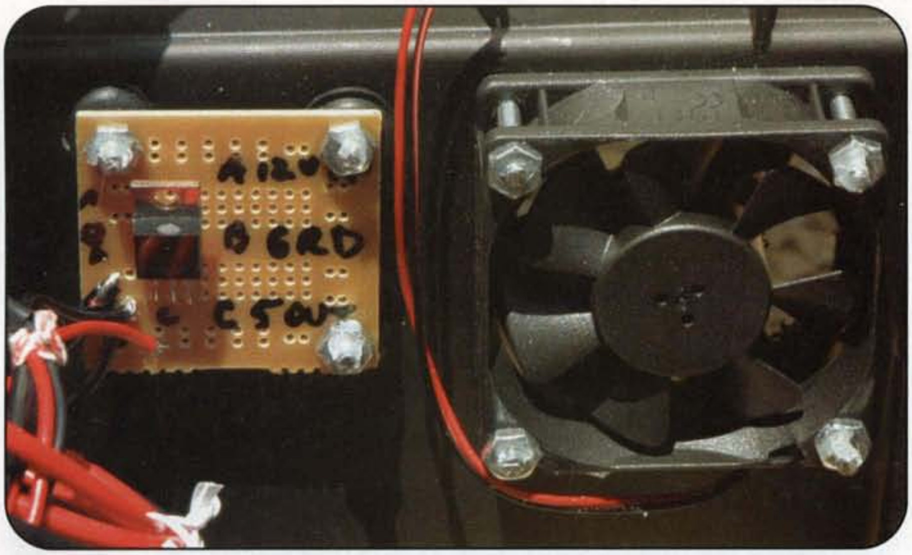


Photo 5. The fan and voltage regulator were mounted on the back right-hand side of the box.

the TNC is how a digi-peater handles the tracker's traffic. While you want to ensure adequate repeating in your immediate area, you don't want to waste bandwidth and block others by requesting a large number of repeats. This is set by the PATH parameter in the software. Recommendations for this parameter have changed as APRS has grown and expanded over the years. Bob Bruninga's current recommendations are as follows:

1. RELAY, WIDE, TRACE, TRACEn-N, and SS are obsolete and are being phased out. Use at your own risk.
2. Use WIDE2-2 for fixed stations. Use WIDE3-3 for fixed stations two hops or more from big cities.
3. Use WIDE1-1,WIDE2-1 for two-hop mobiles in dense areas and WIDE1-1,WIDE2-2 for three-hop mobiles in remote rural areas.
4. Use SS1-1,SSn-N for selected non-routine state or section nets or when human operators are present for large-area emergency needs.

This is only half of the TNC configuration. The TNC input and output levels must be set so it reads the radio correctly (a) to determine when someone else is beaconing at any given moment and (b) so it doesn't over modulate the radio when beaconing. Accomplished by turning some set screws on the TNC board itself, the TT3 software can trigger the TNC to send test tones to the radio. Naturally, you wouldn't want to do this on the APRS frequency. All you need to do is change to a non-APRS frequency and monitor from another radio. I followed my initial tune by connecting the monitoring radio to a computer with UI-View and programming the TNC to beacon on a very short time interval. I then "listened" to my beacon to make sure the packets were decipherable by the program.

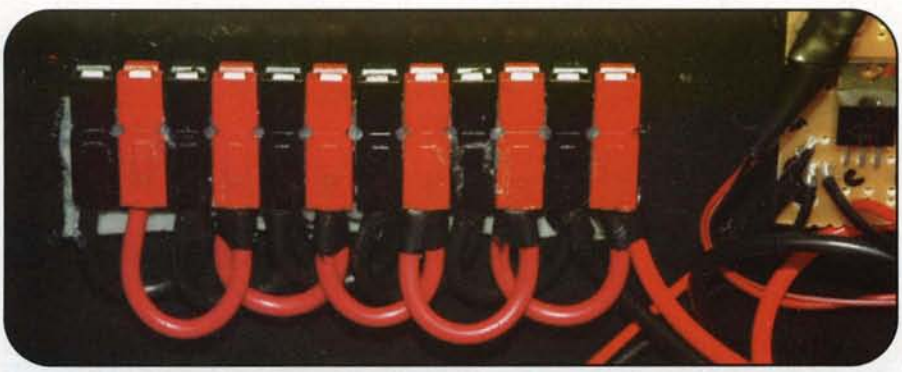


Photo 6. A daisy-chained panel fed from the master power switch was created. The panel was glued together and then mounted on a hook-and-loop fastener strip before being attached to the back of the toolbox.

Construction Details

One of my many and significant character faults is that I either dive into something full force or I don't touch it at all. Radio is no exception—from zero to Extra class license in a year, from no radios to, well . . . my wife might read this. Hopefully you get the idea. Building this tracker was no exception. I over engineered (or over geeked) it a bit, but it was fun!

To begin with, I measured the bottom of the toolbox and built a platform to mount the battery and radio. In photo 4 you can see I cut some 2" × 2" lumber into blocks and used them as mount points for the radio bracket as well as a battery platform so I could get my fingers around the battery to place or remove it from the box. Because I didn't want the battery sliding around, I used 2-inch wide hook-and-loop straps to wrap almost completely around and hold it in place. To secure the straps, I mated them along the width of the base board and then locked them in place with the flat brackets and the wooden blocks. Of course, I bought screws that were shorter than the block's width, as well as cut some recesses in the blocks so nothing would damage the battery or prevent it from lying down flat.

The fan and voltage regulator were mounted on the back right-hand side of the box as shown in photo 5. Using a high-speed cutting tool, I cut a series of holes in the toolbox that matched the fan's pass-through holes, and then I mounted the fan flush with the toolbox wall so it blew out of the box. The regulator's three leads (voltage in, 5 volts out, and common ground) were mounted on a circuit board so I could attach wire input and output feeds. Since there were solder joints on the back of the board, as well as to provide flow-around ventilation, I offset mounted the board from the toolbox by using rubber grommets as spacers. The ends of the fan and regulator screws were covered with silicon sealant to prevent cutting my hand if I wasn't paying close enough attention while working inside the box.

The most difficult part of the project was figuring out how to distribute the power to all the components. I built two or three different "systems" using off-the-shelf electronics parts, none of which

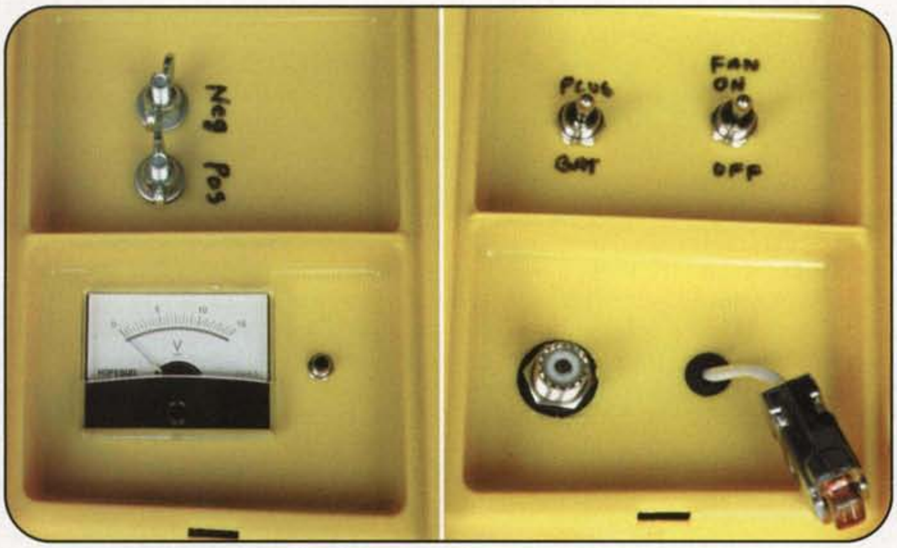


Photo 7. The right- and left-hand storage compartments on the top of the toolbox. (See text for details.)

worked well, before I stumbled upon Anderson Power Pole® (www.andersonpower.com/products/pp/pp.html) connectors. As a then-new ham, I didn't know these were the ARES and RACES standard for electrical connections. Once I learned what they were and how they worked, my power distribution problem was solved. I've since gone through and retrofitted all my radio and associated equipment power leads to use these connectors.

As shown in photo 6, I created a daisy-chained panel fed from the master power

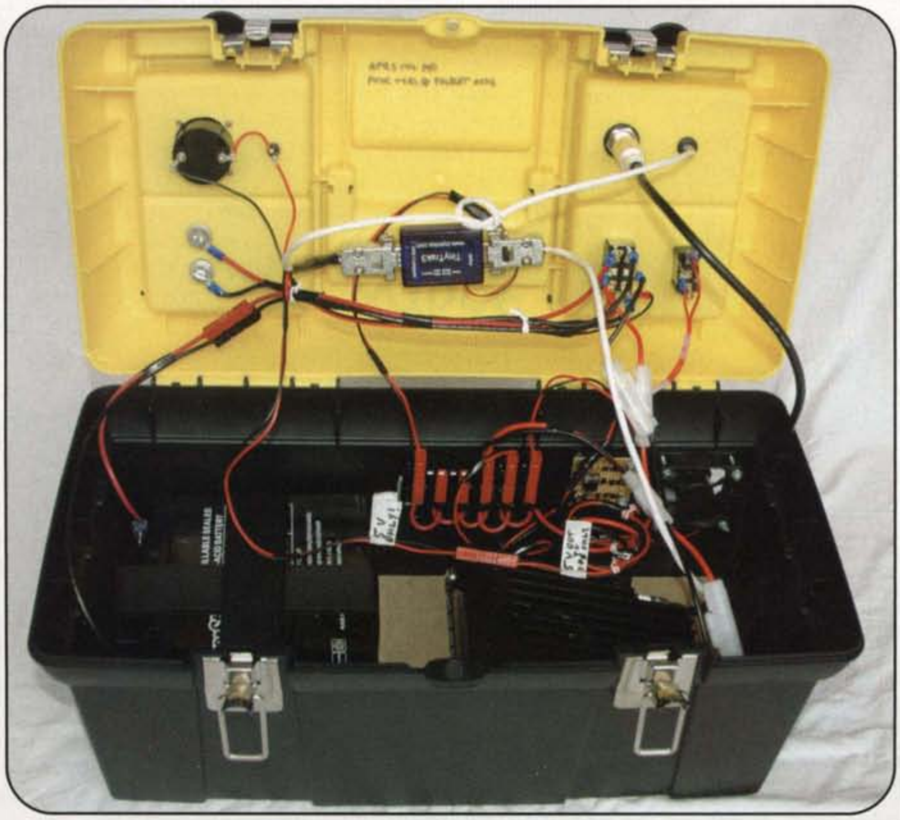


Photo 8. The inside of the completed tracker, including the mounting of the TNC to the bottom of the toolbox lid.

switch. The panel was glued together and then mounted on a hook-and-loop fastener strip before being attached to the back of the toolbox. Each component requiring power has its own set of Power Pole® connectors which plug into this panel. Both the main feed into the panel and the radio power connection are fused.

Photo 7 shows the right- and left-hand storage compartments on the top of the toolbox. On the top right-hand side is the single-pole, double-throw (On/Off/On) switch selecting the power option as well as the switch for the fan. In buying both switches, I did have to make sure each was properly rated to handle the expected current flow through it. In the compartment below is a SO-239 barrel connector for the antenna as well as the GPS connector. Since this picture was taken, I've added a warning label indicating this cable is *not* a standard serial connection. Although the barrel connector is attached to the toolbox, it was fed through a rubber grommet to isolate it electrically. Another grommet was used to protect the GPS cable from chafing as it passes through the box lid.

On the left side are the external power connectors as well as the final, last-minute change—a voltage meter. When I decided to add the external power option, I had some extra bolts, nuts, and washers from a previous project and I simply drilled the holes where I thought they would work and look best. To provide additional electrical isolation, both bolts passed through a rubber grommet before being locked into place. I originally had two nuts on the top—one to lock the bolt, grommet, and washers in place, and the second to hold the bare wire connection (or bare wire and Power Pole® pigtail) in place. Several days later it occurred to me that just finger tightening the nut might not be enough to hold the wire in place; I should use wing nuts instead, since you can get more torque to lock it down. Quick-thinking readers can probably guess what happened: I spun down the first wing nut without a problem, but as I tried to put the second one on, the wings touched each other because the bolts were too close together! Oops, that could cause an electrical problem! Thus, I cut down the wings on one of the nuts so it would work. The moral of this story? Think things through and plan ahead!

In the lower bay on the left-hand side is a voltage meter I added the night before I was to use the tracker for an event. It occurred to me that once the tracker was turned on, I would have no way of checking how much power was left in the battery. I had to change the wiring harness inside the box (again!) so the meter and switch were connected to an "always hot" feed from the battery. The meter is activated by the momentary switch (default "off") mounted next to the meter.

Photo 8 shows the inside of the completed tracker, including the mounting of the TNC to the bottom of the toolbox lid. I wanted to use a leftover piece of my 2-inch wide hook-and-loop fastener strip, but I couldn't get either the hook or loop side to adhere to the lid regardless of the adhesive used. I tried every one the hardware store close to my house had. As luck would have it, the last adhesive they had was Gorilla Glue (http://www.gorillaglue.com) and that finally worked. Do pay attention to the label's warning about the adhesive foaming during the curing process as well as not getting it on your hands, etc.

Summary and Parting Thoughts

This tracker is a tank! With that battery, you know something is in there when you pick it up! The flip side, though, is the battery enables the tracker to run for a very long time. The only thing I don't like about this tracker is its size; it's too big. I should have mounted the battery vertically so I could have used a smaller toolbox. However, at the time I didn't know how much wear and tear the tracker would undergo and if the battery would stay in place or come crashing down on the radio. If you're reading this to get an idea about building your first tracker, I would use a smaller toolbox by either mounting the battery vertically or using a smaller battery and taking the hit on run time.

Of course, as a first project, working with a box as large as this gave me enough room to figure out and work with all the components. Had I thought through everything first, I could have saved a lot of time and money, but that's part of the learning process. The "nimble" tracker described in part one benefitted from the experience gained building this tracker. If you read both articles, you won't make the same mistakes I did.

Although this tracker may be "over engineered," building a tracker is not hard. Get a radio, TNC, GPS receiver, and throw them in some sort of enclosure. Do your homework up front by reading articles such as this or look at other trackers to determine what kind of tracker you might want to build based on how you think it will be used. From there you can evaluate and play off all the equipment options— such as size, cost, power, weight, and so on—then build to the plan.

As I said in part one of this article, above all remember to have fun. The process of learning "how" is, in my opinion, more important than the final result. You'll mis-drill holes or cut wires too short. It's okay. Depending on what goes wrong, you may have to make drastic changes, but that's part of the adventure of this hobby, so enjoy it. ■

CQ's 6 Meter and Satellite WAZ Awards

(As of October 1, 2006)

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	1,10,18,19,23,31,32
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	K0SQ	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>*

CQ VHF Visits:

M² Antenna Systems

Beginning with this issue of *CQ VHF,* we will endeavor to highlight a factory tour of those VHF industry hams who contribute to our VHF/UHF/SHF operation. We start out with a tour of M².

By Gordon West,* WB6NOA

I first met Mike Staal, K6MYC, in the early 1970s, when he and two friends, Ken Holladay and Mel Leland Farrer, started KLM Electronics.

"We amassed $500 and purchased a radial arm saw and started to cut and fabricate aluminum antennas," commented Mike. KLM grew and expanded into the field of VHF and UHF solid-state amplifiers, and eventually went big-time into the TVRO market.

How many of you remember one of the first synthesized multimode 2-meter SSB transceivers, the KLM Multi 2000? This was *my* first 2-meter SSB synthesized transceiver! How many of us still run the KLM KT-34?

The success of KLM allowed the sale of the company in 1984, so Mike took a year off and spent time with famous Hawaii tropo DXer Lou Anciaux, WB6NMT. Mike became fascinated with weak-signal propagation and all of the aluminum needed to make it happen.

While Mike traveled with Louie, Mike's XYL, Myrna, kept busy starting up her own printing business when she wasn't teaching high school. "I purchased a computer graphic printing machine and began doing business cards, letterhead, and Mike's QSL cards," said Myrna, smiling, and just as 24/7 energetic as Mike is.

In late 1985, Mike started work on a project for the University of Alaska fabricating a 150-foot cylindrical dish and steerable feed system. Mike and Myrna's sons, Matt and Kenny, came aboard, and when the Alaska project was completed, they decided to concentrate on VHF and UHF antenna systems, both ham and commercial.

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Mike Staal, K6MYC, is a hands-on kind of guy! (Photos by the author)

"During the following three years, we outgrew our 1000-square-foot shop in San Martin, California, and we moved the building and our residence to Fresno for 11 more years of antenna building on Del Mar Avenue," commented Mike. "But in those 11 years, a huge shopping center began to emerge all around us; and my antenna range was now overshadowed by a 15-foot high chain-link fence and huge cement buildings. Time to move again!" continued Mike.

The new location is in West Fresno on Selland Avenue, a brand-new commercial area *so new* it doesn't even show up older GPS mapping programs.

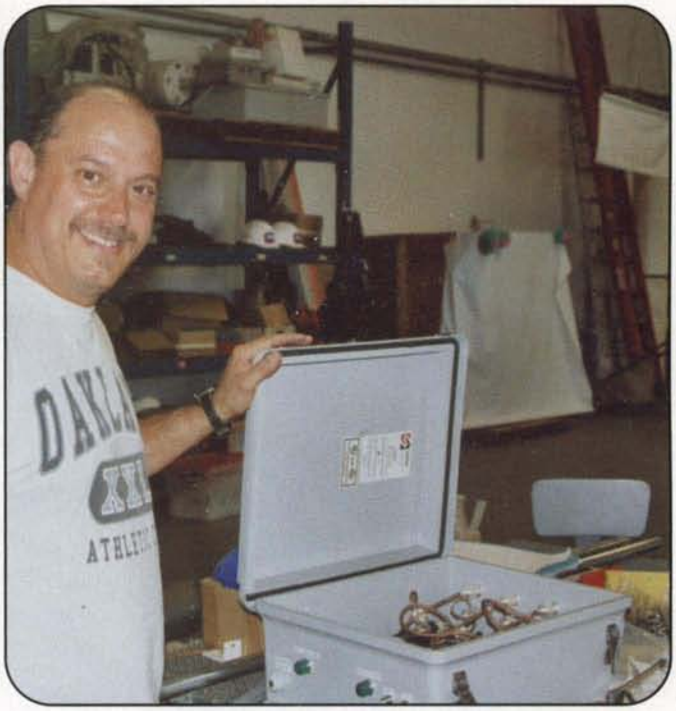
Our visit to the M² facility found that the business is continuing to grow! The new facility now occupies two 1000-square-foot buildings facing each other.

"The original building contains the aluminum cutting machinery for the antennas, aluminum forming, and drilling equipment for our product line," commented Myrna. "Mike now has a custom three-axis boom drilling machine and massive swaging machine center stage in the area. Rotators, elevation mechanisms, and controllers are assembled in the mid section of the building," she continued.

The parts and products then flow toward the front of the building, where parts are kitted, and antennas and parts are boxed and stored as finished goods inventory. Shipping and receiving are also accomplished there.

"Our front offices contain manufacturing process control, sales and marketing, as well as accounting," said Mike. "The

M^2 Antenna Systems is a family affair. Here Mike's son Matt, KD6KIG, and Mike's wife Myrna, K6MYM, look over a finished special-order antenna.



Matt, KD6KIG, inspects a waterproof polarity switch box.

other building houses the entire machine shop with two CNC mills, a CNC lathe and bar feeder, and several manual mills and lathes. The complete welding area for MIG and TIG is located at the rear of the building," he commented.

The antenna prototype department is in the middle section, and M^2 has expanded its capability to commercial wireless equipment, which means complete tower installations and climbing capability.

"The front offices contain engineering and documentation. Both shop manuals and customer manuals are created in this area. In engineering, we use the powerful SOLID WORKS program almost exclusively for mechanical design and documentation," added Mike, showing off how the computer can model every part the company manufactures.

M^2 generously agreed to be the sponsor of the 2006 ARRL June VHF QSO Party. "As M^2 Antenna Systems continues to capture more of the amateur radio and commercial antenna markets, the ARRL is delighted that M^2 has agreed to support an operating event that so many of its customers pursue with a great deal of passion," said ARRL CEO Harold Kramer,

Wyatt Lyzenga, KF6VMW, is the sales and Marketing Manager of M^2 Antennas.

Robin does the final soldering on the RC2800 rotor controller board at M^2.

There is plenty of computerized equipment for antenna building at M² Antennas.

Finished ham antennas ready for shipment.

WJ1B. M² Antenna Systems Sales and Marketing Manager Wyatt Lyzinga, KF6VMW, says that amateur radio makes up nearly two thirds of the business of M².

M² Antenna Systems supports the VHF/UHF annual open house and barbecue each spring, which is usually attended by more than 300 ham operators who come from all over the country!

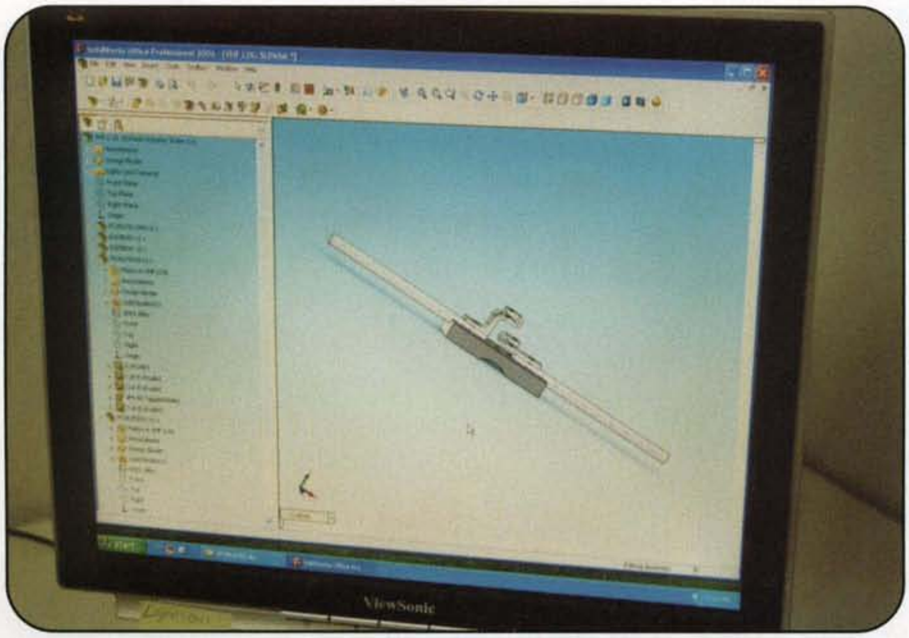
The Central States VHF Society presented the 2002 Chambers Award to Mike for his many years of superior antenna design, development, and production benefiting VHF and UHF operators.

Matt Staal, KD6KIG, took my wife Suzy and me through the many features of the SOLID WORKS computer program, modeling M² antenna parts all the way down to the tiniest detail. Matt keeps the pace rolling in high gear at M², and he was proud to present the many innovations that he and his mom and dad have developed in their shop. "Here at M² we are a polished team of antenna enthusiasts, and everyone loves the many jobs that they do in our twin buildings," added Matt.

After the tour, Suzy and I followed Mike and Myrna up to their ranch homestead and operating station high in the hills above Fresno—*very* high. Plenty of hills, a wonderful view, and here is where Mike regularly tests new antenna designs, bouncing signals off the moon, running tropo for hundreds of miles down south and up north, and working meteor scatter and rain scatter. In this rural location there are no neighbors in sight!

Best of all, the M² antenna manufacturing is a family affair, and everyone shares the enthusiasm of assembling the finest of weak-signal antenna systems.

Thanks to the Staal family for the great antenna tour and the hospitality that Suzy and I enjoyed in Fresno! ■



The SOLID WORKS computer program used for product design.

Observing the Relationship Between Aurora and Sporadic-E Events on 6 Meters

Is there a relationship between aurora and sporadic-E events on 6 meters? WB2AMU and NØJK think so. Here they explain why, based on their observations.

By Ken Neubeck, WB2AMU,* and Jon Jones,† NØJK

Those hams with the benefit of many years of observations on 6 meters have noticed that there is a very interesting relationship between aurora propagation (*Au*) and sporadic-*E* (*Es*). Such a relationship appears to be complex, with many variations observed on 6 meters both during and following a significant aurora event. Indeed, it appears that 6 meters is probably the only amateur radio band for which observations can be made connecting the two phenomena.

The role of metallic ions located in the ionosphere plays a major part in this complex relationship, and it is worthwhile to review the movement of these ions during a sporadic-*E* formation.

The Role of Metallic Ions in Sporadic-*E* Formations

Dave Ripton, K2SIX, recently brought to our attention an amazing new search engine for locating scientific papers. It is called scholar.google.com. Upon typing in "sporadic-*E*," thousands of hits came up. By refining the search a bit, we found a most interesting paper entitled "Global transport and localized layering of metallic ions in the upper atmosphere," written in 2000 by Professors Carter and Forbes. Since this is a very in-depth paper, we won't go into it in detail here. It can be found at the following link: <http://www.copernicus.org/EGU/annales/17/ag17/190.pdf>. It is strongly recommended that any ham who has observed the sporadic-*E* phenomenon on the VHF bands and who is interested in the various nuances of *Es* go to this link and print a copy of the paper. It provides answers to about 90 percent of the questions surrounding the sporadic-*E* phenomenon.

The paper explains in detail many of the previous scientific studies of the phenomenon and provides models and schematics of the vertical transport of metallic ions (primarily iron and magnesium ions) in the ionosphere for the different zones of the Earth (equatorial, temperate, and aurora). These metallic ions have been detected during many rocket launches into the *E*-region over the past 40 years. A detailed schematic diagram of the transport model is provided in this paper.

A pictorial description of the transport model was featured in an article by WB2AMU in the Spring 2004 issue of *CQ VHF* on page 36 and is in the book *VHF Propagation, A Guide for Radio Amateurs,* by WB2AMU and Gordon West, WB6NOA (available from CQ Communications). A simplified schematic of this model is provided in figure 1.

Another interesting fact brought out by this paper is that approximately 100 tons of meteoritic particles enter the ionosphere daily. This amount is independent of the major meteor showers. It is noted that there is no significant difference in sporadic-*E* activity when there is a major meteor shower. This potential source of sporadic-*E* ions appears to come from the daily influx of meteor debris. However, the meteor debris does not instantly become metallic ions; instead, there is a subsequent process in which the ablated particles ionize at the 90-km mark.

What may have been a stumbling block for those studying sporadic-*E,* particularly hams who have come up with possible theories, is that the phenomenon is significantly more far reaching than just the *E*-layer. Indeed, it is indicative of a major series of processes occurring in the entire ionosphere!

Current thinking is that the sun plays a role in sporadic-*E* development, but more in terms of daily solar radiation rather than solar sunspot activity. As observed by amateur radio operators, sporadic-*E* appears to generally be independent of the sunspot cycle, with its consistent behavior pattern year after year. Thus, there does not seem to be any connection between sunspot activity and sporadic-*E* behavior.

The paper by Carter and Forbes, along with other works, relates how the increased solar radiation that occurs during the summer months has been shown to be the major factor contributing to the significant summer *Es* season. Ninety kilometers above Earth is where metal ions are created through the recombination of metal particles with oxygen ions. As there is more solar radiation during the summer months, more ions are created and subsequently are available for vertical transport back into the different regions of the ionosphere.

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Six Meters Still Smoking in Summer 2006!

By Ken Neubeck, WB2AMU

This is a follow-up report to the article that I wrote about the summer sporadic-*E* season through the end of June ("Six Meters Goes Wild!" Summer 2006 *CQ VHF*, p. 6). It is written from a personal perspective, with some input gathered from others.

As reported in that article, there were some decent sporadic-*E* conditions during June, highlighted by a Texas to Japan opening on the evening of June 4th. Besides Texas, there were a number of other midwestern states that contacted one or two of the Japanese stations. Since that time, I was informed by José, N4BAA, in Virginia that he worked JM1DTF at 0051 UTC on June 5, 2006, when he peaked for less than a minute, enough to make the QSO. José believes that this may be the first Japan to Virginia QSO on the 6-meter band.

As I have done in the past, and this year as well, I took vacation the first two weeks of July. This has allowed me to take advantage of some pretty good sporadic-*E* openings over the years. However, this year July started off relatively slowly for us here on Long Island, New York. On July 1st we had a short double-hop opening into parts of southern Texas and into Mexico, with XE2YWB in DL82 coming through on SSB.

Perhaps the biggest opening that I have ever observed on 6 meters during the summer was the July 12, 2006 opening into Europe. During the morning hours of that day, I did hear and try to work IØJX in Italy, but to no avail. At about 4:45 PM local time, I saw a spot by Lefty, K1TOL, on the dxers.info chat page that CT1HZE was in the DX window on CW. I went downstairs to my shack to work him, and then the band really started to take off! I worked some very strong stations, such as Johan, ON4IQ, at 599, but many of the DX stations were about the same signal strength, 569 to 579 on CW. I worked two new countries in eastern Europe—Slovenia (S59A) and Serbia (YU1EU). Later I saw on the chat page that Bulgaria was also on.

I heard 9A7V in Croatia. I tried to get him several times, but he apparently was hearing the W4s better. At one point during the opening, I thought that I actually had worked him, that he had come back to me, but as I later found out from my returned QSL card, it was not he who had come back to me. Again, the signal strengths of the European stations were all about the same, so it did get confusing when there was more than one DX station on the same frequency!

The CQ WW VHF Contest took place over the weekend of July 15th and 16th, and conditions on 6 meters were very similar to the openings that took place during the June ARRL VHF QSO Party. I could only operate for certain periods of the CQ contest and had a nice stretch of working ten stations while mobile, including AF6O in California on the evening of July 15th. I would find out later during my talk on VHF propagation at the Boxboro, Massachusetts convention in August that many hams experienced conditions during the contest that were the best they had ever heard on 6 meters. Single-hop sporadic-*E* was so strong that it was easy to work many stations, and there were double-hop conditions towards the Caribbean and the west.

I finally was able to work Italy on 6 meters after many misses over the years. This happened when I set up my portable two-element beam with about 80 watts from my FT-100 in my car at my work location. I saw that Italy was spotted on the dxers.info chat page. It was just before lunch, and I heard IKØFTA. Signals were a little better than EME (earth-moon-earth) levels, and it took many repeats for me to finally work IKØFTA at 1535 UTC. The same was true when I finally worked IØJX at 1601 UTC after many repeats of my callsign. Granted, the setup was nothing like a base-station setup, but there is always hope!

Many stations in the U.S. participated in the DX Marathon (which runs from May through the first week of August every summer) sponsored by the Finnish Six Meter club. Because of the good conditions during July, they were able to really build up their totals compared to previous years. The top five U.S. stations are listed here, each followed by the number of DXCC countries they worked: W1JJ, 82; N3DB, 77; N4BAA, 70; K3TKJ, 69; and N4IS, 65.

Some interesting DX was observed on 6 meters during July. I, along with other U.S. stations, was able to work Bo, OX3LX, on July 26th during his visit to Greenland. On the morning of July 28th, the Caribbean came in very strong, and I worked NP3CW, WP4N, and PJ2BVU using my portable setup, again from work. There were a few good days during the beginning of August, but the band died down after that. Aurora came in on August 19th, and I worked K7BV/1 and WA1T pointing my antenna north and bouncing off the aurora.

I counted at least 11 days in July when double-hop sporadic-*E* was present towards somewhere. The majority of the time it was in the direction of Europe. In fact, we were able to work two stations from Europe on a consistent basis: F8DBF in France on the 11th, 15th, 17th, and 26th, and CT1HZE on the 12th, 23rd, and 24th.

Lefty, K1TOL, in Maine, who is always in on the action for any transatlantic openings to Europe, worked around 300 European stations in July, his best-ever total. He noted that the longer haul DX to 4X, ZC4, SV9, 5B4, and UT was much better in July than it was in June for me. Also, he had many more hours of strong TV videos in July than in June and thinks this year's TV videos were more consistent and stronger. Also, in July Lefty had longer and stronger openings to the West Coast. It is hard for him to compare this year with the last three years, as they were so bad! Lefty surmises that the lack of magnetic activity really aided the *Es* this summer, so it may be that there was a "normal" *Es* season again on 6 meters!

Sporadic-*E* activity really dropped off after mid-August, although a few surprise openings came up during early September. I heard Ken, AC4TO, from northern Florida come in on 6 meters into my area on Long Island on the evening of September 7th, two days before the ARRL September VHF QSO Party. During the contest itself, I did not experience any sporadic-*E* activity from my area, nor did most of the northeast U.S. stations. However, a number of stations in the South, such as KC4PX in Florida, had a two-hour opening on the afternoon of Sunday, September 10th. September sporadic-*E* is rare, but when it does occur during the VHF QSO Party, it can make for an exciting time!

For years, many hams, and some scientists from India, believed in a connection between thunderstorms and sporadic-*E*. Indeed, many observers pointed out the existence of sprites that extend upward from the top of thunderstorms toward the ionosphere. Some believed that this particular phenomenon may have been a mechanism for charging or creating sporadic-*E* layers, even though sprites would have to travel upwards of 60 miles to reach the *E*-region.

What is more likely is that at best there may be an indirect correlation between thunderstorm activity and sporadic-*E*, where thunderstorms are a possible indicator of certain types of activity in the *E*-region. Current theories suggest that there are a multitude of sporadic-*E* ions in the *E*-region reservoir. They need to be collected into layers by a mechanism, and wind-shear activity by the right combination of the neutral and zonal winds in the *E*-region is an important ingredient in the process.

The only thing that was not directly explained by the Carter and Forbes paper is the lack of sporadic-*E* activity during the equinoxes. However, there is a lot of information presented that would suggest

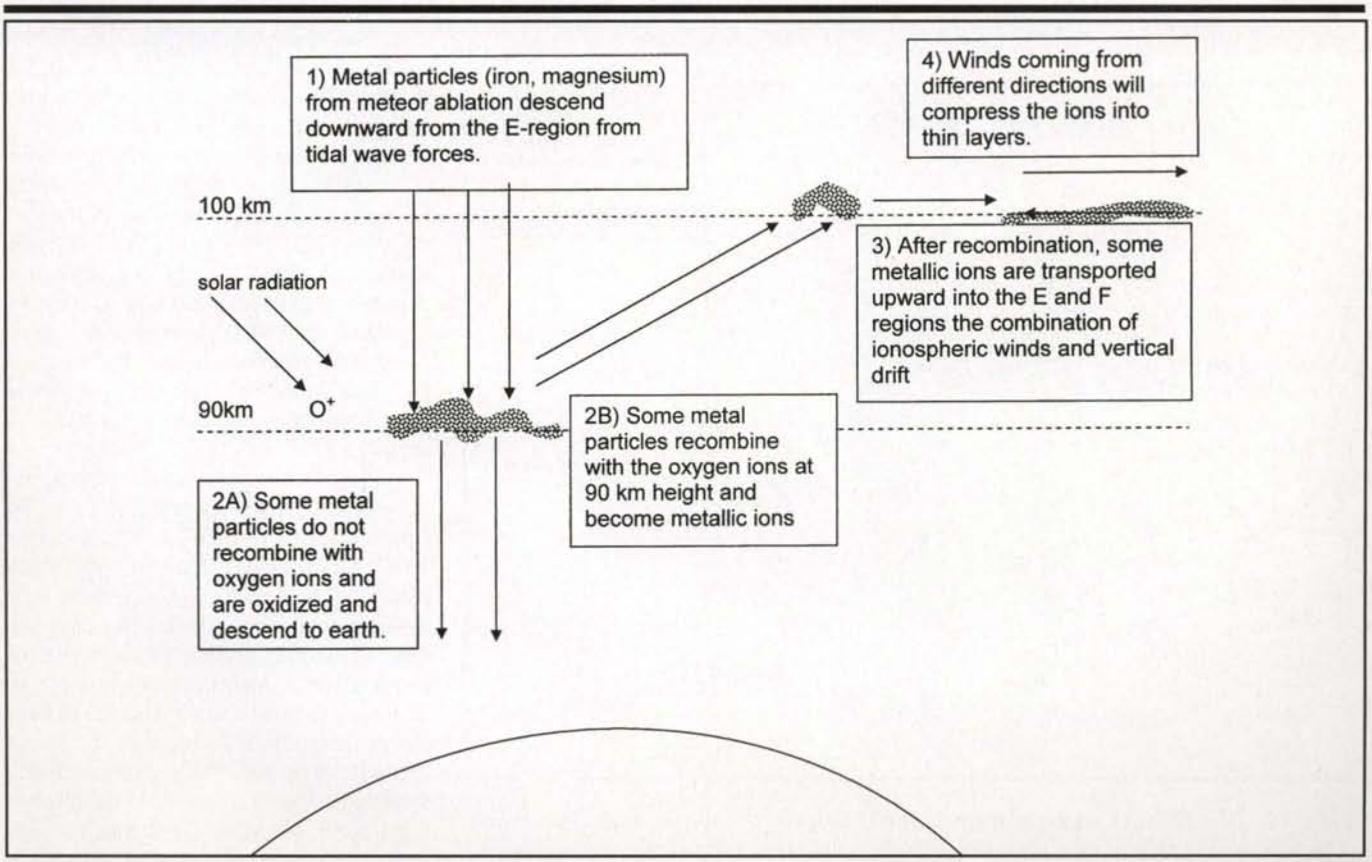

*Figure 1. A pictorial description of the ion transport theory of sporadic-*E *ions that reflects current scientific thinking about the phenomenon. (Figure by WB2AMU)*

Time (UTC)	Spotter callsign	Grid	Station heard/worked	Grid
0002	N8CJK	EN84	WB5LLI/b	EM40
0004	N3DB	FM18	KØUO/b	EM07
0006	K3HX	FN00	W6OAL	DM79
0008	K8ROX	EN80	K5SM	EM03
0018	NØJK	EM17	NW7O	DN47
0022	W5ZN	EM45	NW7O	EN47
0023	K5IX	EL29	N8PUM	EM66
0026	K5IX	EL29	KKØCQ	EN08
0028	K4RX	EM70	WØGHZ	EN34
0030	KE7V	CN88	WNØL	EN11
0032	W4TRH	EM85	KØHA	EN10
0034	W4TRH	EM85	KCØRUR	EM29
0041	NØJK	EM17	N1GC	EM95

*Table 1A. November 10, 2004 six-meter sporadic-*E *activity.*

Time (UTC)	Spotter callsign	Grid	Station heard/worked	Grid
0210	K1HTV	FM18	KØKP/b	EN36
0354	NØJK	EM17	KØHA	EN10

Table 1B. November 10, 2004 six-meter aurora activity.

Time (UTC)	Spotter	Grid	Station worked/heard	Grid
0649	KØHA	EN10	NL7Z	BP51
0650	KØHA	EN10	VE7DUB	CO88
0651	KØHA	EN10	KL7HBK	BO49
1006	N8CJK	EN84	VE4VHF/b	EN19
1008	N8CJK	EN84	VE4ARM/b	EN09
1010	N8CJK	EN84	K2MUB	FN21

*Table 1C. November 10, 2004 six-meter aurora-*E *activity.*

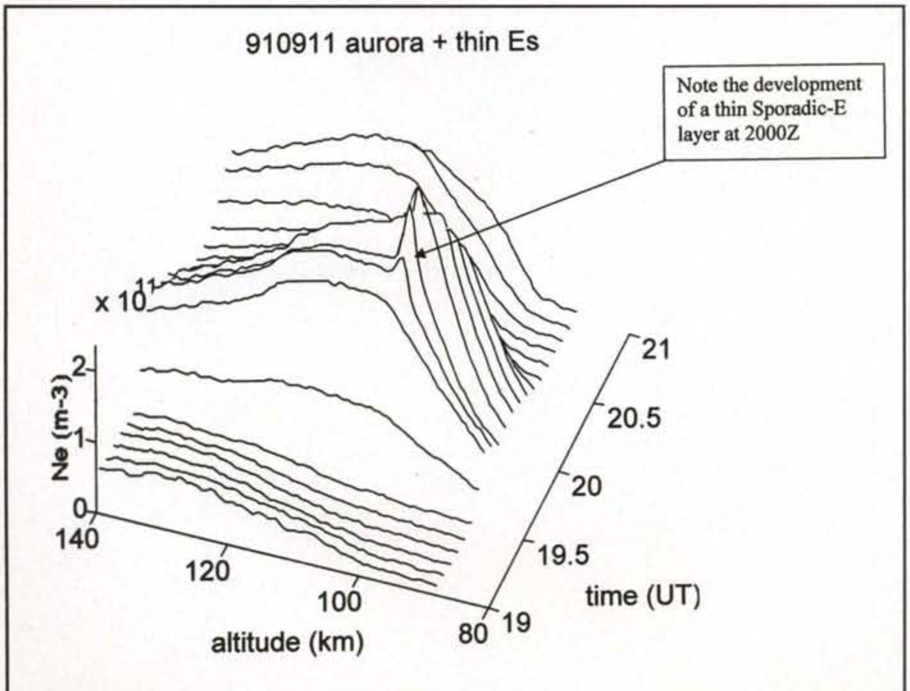

*Figure 2. This EISCAT radar plot of the ionosphere above northern Europe shows a broad aurora formation developing between 100 km and 120 km shortly before 2000 UTC on September 11, 1991. At 2000Z a thin sporadic-*E *layer can be detected in the midst of the aurora formation at 120 km. (Figure courtesy of S. Kirkwood)*

a physical change in the Earth for those times of year in the way of zonal winds or electric field lines. Remember, the meteor-particle influx into the ionosphere is still consistent on a daily basis.

Continued amateur radio observations on the VHF bands, coupled with scientific studies and improved instrumentation, will eventually help determine the reasons for this lack of sporadic-*E* activity during the equinoxes. From subsequent e-mail correspondence we have had with Jeffrey Forbes, it was discovered that this paper was a doctoral thesis by Carter and neither of them are currently doing any more research on sporadic-*E*.

The knowledge that there is significant movement of sporadic-*E* ions in the ionosphere will be beneficial in understanding some of the 6-meter observations in recent years involving the interaction between aurora and sporadic-*E*.

Aurora, Aurora-*E*, and Sporadic-*E* Events

It generally has been observed that fairly high levels of geomagnetic activity (where the *K*-index exceeds 4) are a detriment to sporadic-*E* activity on 6 meters in the northern latitudes, where this activity develops into aurora formations. However, there seems to be a special case in which the opposite is true, and it involves extremely high levels of geomagnetic activity (*K* values of 8 or 9).

Figure 2 shows an imbedded sporadic-*E* formation developing inside an aurora formation. Thus, the question is whether the sporadic-*E* ions were already present in the area of the aurora or the sporadic-*E* ions were pushed into one area by the aurora. During some aurora openings on 6 meters it has been observed that when the aurora subsides, a sporadic-*E* formation is still present, resulting in aurora-*E* or sporadic-*E*.

During rocket launches into the active aurora that were conducted at Ft. Churchill in Manitoba, Canada during the 1960s, there were instances in which metallic ions, typically magnesium, were detected at around 100 km from the surface of the Earth. It therefore would not be unreasonable to assume that the metallic ions inside the aurora could have been tied to sporadic-*E* formations or a near-sporadic-*E* formation situation similar to what is shown in figure 2. Thus, through some of the scientific work that has been done in the past, we have an idea of the complex relationship between sporadic-*E* and aurora. Through amateur radio observations on 6 meters, we see more evidence of this complex relationship.

Case Study #1

One case in point that describes the complex relationship between aurora and sporadic-*E* is the series of events that occurred on May 29, 2003 and lasted for several hours.

Significant solar activity occurred a few days earlier, with a classification X3.1 flare observed on the sun; it was in a geo-effective position with the Earth. On the May 29th, the planetary *K*-index reached 8 and the aurora extended into the temperate zones, where activity occurred on both 2 and 6 meters beginning in the mid-afternoon for the northeast U.S. WB2AMU in FN30 was able to work K1TOL in Maine via aurora backscatter on 6 meters. On 2 meters, into the early evening hours he worked a number of stations—K4QI (FM06), K1ZC (FN43), and W3MRG (FN10)—using a portable antenna set up in his driveway and running 45 watts from an FT-100D in the car.

Then things got even more interesting. There was geomagnetic-induced *F* skip, with stations from both Central America and the northern part of South America being heard at night. WB2AMU was able to hear ZF1DC at 1 AM. Also, NØJK worked YV1DIG (FK60) at 0606 early in the morning on May 30th. Later, at 0721, Jon worked N3DB in FM18. Jon still heard 3- and 8-land 6-meter beacons when he went QRT at 0900 UTC!

At 5:30 AM local time on the morning of the 30th, WB2AMU listened on 6 meters in the parking lot of his work location in central Long Island, New York. He heard many beacons from the Midwest via an apparent sporadic-*E* opening; among them were KØKP, N8PUM, WR9L, and KB9CG. Unfortunately, there were no stations to work! Finally, by 6:30 AM, WB2AMU began to work a slew of stations, starting with WA8FTA in Illinois, N9CJK in Michigan, KØRLM in Iowa, and VE3DBP in Ontario. The band remained open for several hours until it finally shifted toward the southeast, Georgia, at noontime.

Case Study #2

Another case study that shows the ebb and flow between aurora and sporadic-*E* activity is the series of openings that occurred on November 9th and 10th 2004, presented here through a series of tables (Tables 1A, B, and C). Initially, on the 9th, some aurora activity was noted on the internet, with an early spot showing K7AWB in CN87 working K7CW in DN17 on CW via aurora at 2204 UTC.

Shortly after this aurora opening, a sporadic-*E* opening occurred, with various internet spots at 0000 UTC on November 10th, as shown in Table 1A. Then the aurora made a brief second appearance and the sporadic-*E* activity shut down altogether (Table 1B). The evening ended with some aurora-*E* openings as shown in Table 1C.

This particular case study shows the give-and-take relationship among aurora, aurora-*E*, and sporadic-*E*. As mentioned earlier in this article, figure 2 may provide a plausible explanation of this type of event, with the imbedding of a sporadic-*E* formation inside an aurora formation, where the sporadic-*E* formation becomes dominant when the aurora fades.

Time (UTC)	Spotter callsign	Grid	Station heard/worked	Grid
0210	K9MU	EN44	VA2MGL/b	FN47
0212	K9MU	EN44	VE8BY/b	FP53
0216	KØGU	DN70	KØKP/b	EN36
0238	N8CJK	EN84	K9MU/b	EN44

*Table 2A. February 18, 2005 six-meter aurora-*E *and aurora activity.*

Time (UTC)	Spotter callsign	Grid	Station heard/worked	Grid
1201	K4SO	FM18	W5GTA	EM20
1202	KD4ESV	EL87	K8UK/b	EN52
1226	K8KS	EN82	W5GTA	EM29
1236	N8UUP	EN82	C6AFP/b	FL16
1244	K8KS	EN82	WA8UF/m	EL89
1246	K8KS	EN82	KI4HIS	EL87
1248	N8UUP	EN82	WA4DOS	EL86
1302	K4RX	EM70	VE3ROR	FN25

*Table 2B. February 18, 2005 six-meter sporadic-*E *activity.*

One feature of aurora-associated *Es* openings is that sporadic-*E* appears to occur during the night or early in the morning. Sporadic-*E* seems to occur during "lulls" in aurora activity and then promptly "shuts down" when aurora activity picks up.

Case Study #3

The previous case study covers a series of events that occurred during the winter sporadic-*E* season. Another situation worth exploring is when such events occur during quieter months of sporadic-*E* activity.

Through observations on 6 meters, it appears that such back-and-forth action is more easily noticed during the "minor *Es* seasons." Indeed, sporadic-*E* is rare during the month of February, so when a sporadic-*E* event follows an aurora event, it is reasonable to suspect a connection or correlation.

For this particular example, aurora activity was initially observed at 0200 UTC on February 18, 2005, as seen in Table 2A. Sporadic-*E* activity appeared less than ten hours later, early the following morning local time in North America with spots starting at 1200 UTC, as shown in Table 2B.

Now one might ask if there is a cause-and-effect relationship of a strong sporadic-*E* event following aurora. Did the aurora stimulate the metallic ions in the *E*-region to collect into a sporadic-*E* formation? With February being a generally quiet month for 6-meter activity, the occurrence of aurora followed by sporadic-*E* activity on back-to-back days would tend to confirm our suspicion of a possible correlation.

Additional Events

During 2005 there was a fairly significant amount of geomagnetic activity and subsequent sporadic-*E* events. For example, a significant aurora opening occurred during the latter part of March 8th. The following day from 1600 to 1900 UTC, many stations in Texas worked stations throughout the south via sporadic-*E*. Figure 3 shows the plot of some of the stations that were worked.

The question is whether the aurora may have stirred sporadic-*E* ions to the point that they seemed to be "pushed" into position for the sporadic-*E* opening. As we stated before, sporadic-*E* openings during February and March are very rare, and when there is aurora activity only 24 hours before, one suspects a cause-and-effect relationship of some sort. While the aurora does not directly cause sporadic-*E* openings, it appears to either stimulate the *E*-region such that a sporadic-*E* formation develops inside the aurora (as in figure 2) or push sporadic-*E* ions (as in figure 3). As hams, we are very fortunate to have a band such as 6 meters, which is generally quiet during certain times of the year and allows us to observe these various propagation modes and the effect they may have on one another.

Even during the summer 2005 sporadic-*E* season, a major aurora opening was observed. On August 24th the planetary *K* value reached 9. Beginning at 1950 UTC, WB2AMU in FN30 was able to work VE3GIB in FN25 and N8CJK in EN84. Over the next few days, some significant sporadic-*E* openings were ob-

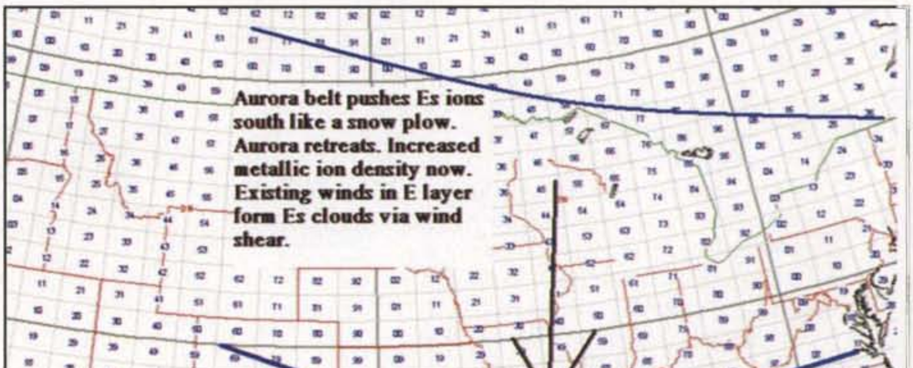

*Figure 3. The plots of a sporadic-*E *opening that occurred in the southern tier of the United States on March 9, 2005, shortly after an aurora opening in the northern United States. (Figure by Jon Jones, NØJK)*

On September 16, a group of 6-meter operators attended SMOGfest 2006. Approximately 100 ops plus guests made the journey to share insights and special presentations on 6 meters at an outdoor barbeque restaurant in Saunderstown, Rhode Island. A full write-up of this event is in the works for the next issue of CQ VHF. *(Photo by WB2AMU)*

served, including some paths between the northeast U.S. and the Caribbean; even a few European stations were spotted. August is a month of modest sporadic-*E* activity, and like the other examples described, one would suspect a connection of some sort.

The Summer 2005 Sporadic-*E* Season: Summary and Notes

The opinion of U.S. and Canadian VHF hams regarding the summer 2005 sporadic-*E* activity was almost unanimous: It was one of the worst seasons ever. The month of June was exceptionally poor. At WB2AMU's location on Long Island, he observed only ten days of sporadic-*E* activity in June, the lowest number that he had measured in 15 years on 6 meters. He saw decent sporadic-*E* activity during Field Day weekend, but none during the ARRL VHF QSO Party earlier in the month. In lieu of a sporadic-*E* opening during the VHF contest, we were treated to a significant aurora opening that took place during the latter part of that weekend.

Did aurora play a part in the reduced amount of sporadic-*E* activity? As we have discussed, sporadic-*E* is fairly consistent during the summer months and is generally independent of the solar sunspot cycle. However, in July 2004, when there was significantly less sporadic-*E* activity, there was a lot of geomagnetic activity (there were five days of aurora activity observed on Long Island in July 2004!).

Indeed, there was the major aurora opening observed during the latter part of the 2005 June VHF QSO Party, and a month later another aurora opening was observed on July 10th. Moderate to fairly strong levels of aurora seem to be detrimental to sporadic-*E* formations occurring in the same area. The exception is major aurora activity that triggers aurora-*E* and subsequent sporadic-*E*. While the high geomagnetic activity was a contributing factor on some of the days that did not have sporadic-*E*, it alone cannot explain the decrease for the entire month.

Our knowledge of the sporadic-*E* phenomenon as a whole has been increasing, but there are still many questions, such as why poor conditions—for example, those of June 2005—occur. Because of the complex relationship between sporadic-*E* and aurora, there is reasonable suspicion that a certain amount of geomagnetic activity could be a disrupting factor with regard to sporadic-*E* ion movement in the ionosphere for several days.

While the summer of 2005 may have been one of the worst summers on 6 meters for sporadic-*E* activity, it may not have been a unique event, based on years of ionosonde sporadic-*E* data. In a paper that WB2AMU wrote for the *Journal of Atmospheric and Terrestrial Physics*,[1] the large amount of hourly sporadic-*E* critical frequency data from a number of ionosondes was examined. For example, 22 years worth of data from the Boulder, Colorado ionosonde were used, and it was seen that there were a few years when there were only 20 days of sporadic-*E* that reached an MUF (maximum usable frequency) of 28 MHz for the months of June and July (based on hourly data).

Our knowledge base will continue to grow through use of the tools available on the internet, such as 6-meter spotting sites (for example, dxers.info). These internet sites have contributed greatly to catching short and elusive sporadic-*E* openings, particularly those during the wintertime *Es* season. In 2003, through this site and WB2AMU's own observations, he was able to spot eight days of *Es* activity during December. In 2004, it seemed as if there were more users on this site, and he observed 10 days of *Es* activity during December. That may not necessarily be an indication that more sporadic-*E* activity was occurring, but rather that there were more spotters and better spotting networks.

Aurora and sporadic-*E* events together have a history, and as seen in the case studies, along with the radar plots, they can overlap on occasion. Under the right conditions, we see that a sporadic-*E* formation can actually be imbedded inside an aurora formation, and this can lead to the interesting observations that were described in this article. ■

Note

1. Neubeck, K. E., "Using the combined resources of amateur radio observations and ionosonde data in the study of temperate zone sporadic-*E*," *Journal of Atmospheric and Terrestrial Physics*. Vol. 58, No. 12, August 1996, pp. 1355–1365.

Adding 3456 MHz to the Contest Station

At first, adding another microwave band to your contest station may seem daunting. However, N5AC explains how easy it was to add 3456-MHz capability to K5QE's contest station.

By Steve Hicks,* N5AC

Every contester entertains ideas from time to time about how to improve his score . One afternoon, Marshall Williams, K5QE, and I were having just such a conversation about how to improve our VHF-and-up contest scores. Marshall's station was already impressive, with several tall towers, amplifiers on every band, and multiple operating positions on 50 MHz through 1296 MHz. As a rover with several microwave bands, I encouraged Marshall to add 2304 MHz and 3456 MHz to his station. Not only could he increase his score with contacts with other fixed and rover stations on these bands, but it would also help my score, since I would be able to work him from a number of grids on both bands. Marshall agreed that it was a good idea to add the bands, but only if I helped him get on the air!

We felt as if getting some power on these bands would be good, so we took a look at amplifiers. There are some good surplus solid-state amplifiers for both of these bands, and I felt that they would be easier to keep running at a multi-op station than a TWT. Over the next few months, I built up both 2304 MHz and 3456 MHz for Marshall's station. This article focuses on the 3456-MHz box, because the design is considerably more complex since we put much of the hardware on the tower. For amateurs the predominant surplus amplifier available for this band is the Toshiba 40-50W amplifier. These are an excellent value at \$125–150, are available through a number of sources on the Internet, and are actually designed for the 3456-MHz band and require no tuning. The Toshiba amplifier is also fully protected with internal thermal shutdown and an integrated full-power isolator with a load. This means you can drop the antenna off the end of the feedline and still not hurt the amplifier, although I have no plans test this!

With the amp chosen, Marshall took a hard look at feedline loss. It became appar-

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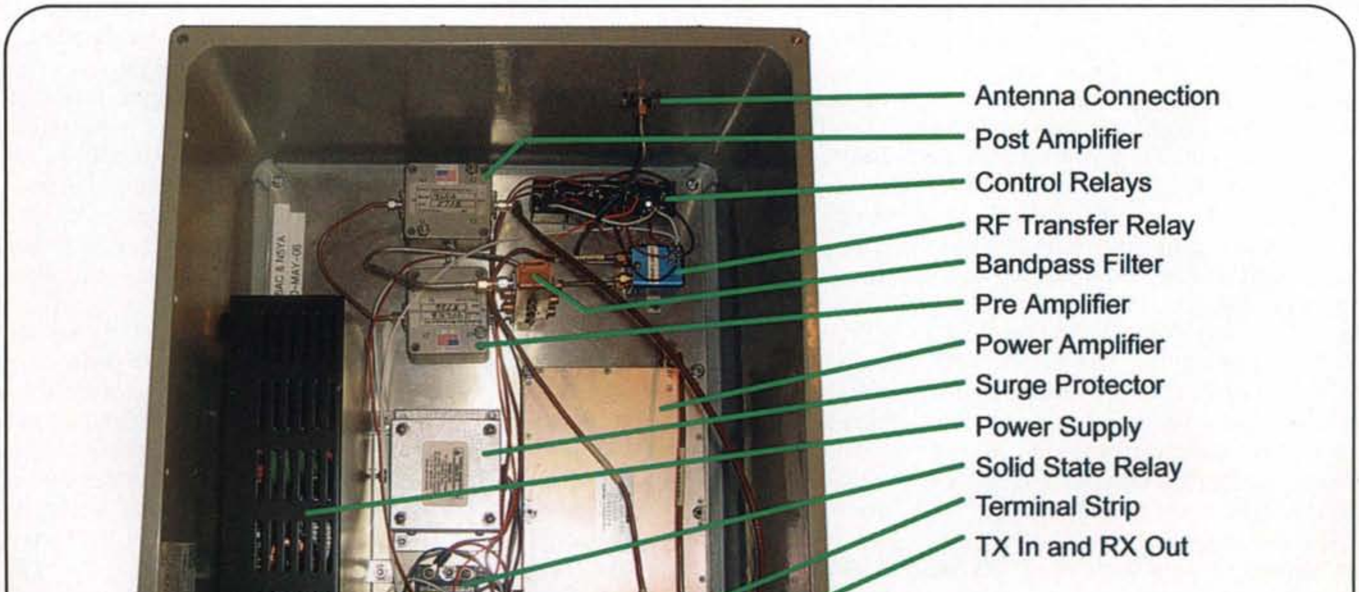

Photo A. The completed box.

ent that there was going to be considerable feedline loss with the transverter and the amplifier on the ground; Marshall's microwave tower is 130 feet tall. The cut-off frequency for anything larger than $^7/_8$-inch hardline prevented us from using the larger hardlines to manage the loss. The loss on $^7/_8$-inch hardline for the run we were going to have to the top of the tower (about 200 feet) was 9 dB at 3.4 GHz. This means that with our 50-watt amplifier at the bottom of the tower, we would end up with around 6 watts at the antenna! Not only that, but 9 dB of loss on receive would not be a good thing either. If there was a way of getting the amplifier and a preamp up on the tower, it would probably be worth the effort.

I agreed to get started and see if I could figure out a way to get everything running up on the tower. Since the Toshiba amplifier needs only about 1 mW to produce 40–50 watts of power, we could stand quite a bit of loss in our feedline provided we had some reasonable power at the bottom of the tower. Marshall had plenty of $^3/_8$-inch flexible hardline, which would have a loss of 14 dB at 200 feet. We would need transmit power of 25 mW (25 mW less 14 dB is 1 mW) out of the transverter to drive the PA at the top of the tower, so Marshall ordered a 3456-MHz transverter from Down East Microwave (http://www.downeastmicrowave.com) with 25 mW output power. We would also need to be able to overcome the same loss on receive if we used the inexpensive flexible hardline on receive. We acquired a couple of preamps from Down East as well, one as a preamp and one as a "post-amp," the 9ULNA and 9LNA, respectively. I don't believe the 9LNA is still available, but two 9ULNAs can be used.

Putting Together the Pieces

To switch the antenna from receive to transmit, Marshall found an SMA transfer relay on eBay. Initially, we were told that this transfer relay was momentary, but after some experimentation I found out that it was latching. This would make controlling the relay more complicated, so we looked for some other options. We didn't have much luck finding a good alternative, so in the end I decided to use the original relay and find a way to make it work.

The Toshiba amplifier prefers 12.6 VDC and will generate more heat if more voltage is provided. It didn't make a lot of sense to run 12 VDC at 20 amps up the tower, as the resistive losses would be substantial. If we accounted for the voltage drop from the resistive losses from the bottom to the top of the tower (for example, set the voltage higher at the bottom of the tower so that after the resistive losses we would have 12.6 volts at the top of the tower), all of our other devices at the top would be subjected to a higher voltage when the amplifier was not keyed and the current was lower. I looked around for a small, compact power supply that could provide the 11 amps we needed to run the amplifier and that would also be adjustable down to 12.6 volts. The Astron SS-25 met all of these requirements. A pot inside of the supply allows for easy adjusting down to 12.6 volts. In the end, putting the supply on top of the tower seemed to be the best solution.

I also wanted a way to turn the power supply at the top of the tower on and off from the shack. One way would have been to disassemble the supply and somehow run the switch wires down to the shack. Instead, I opted to use a solid-state relay in the box and use the same 12-VDC enable line that turns on the preamplifiers to also turn on the power supply. I had a small stash of Crydom solid-state relays I had purchased on eBay; they would handle 10 amps at 110 VAC, so I was able to use one of these. The 12 VDC enable from the shack allows the 110 VAC to flow to the power supply that supplies the rest of the enclosure.

We've had some trouble with RF from one band getting into another and destroying a preamplifier. We decided that in most circumstances we need to put a bandpass filter in front of each band before the preamplifiers to protect them to some extent. This is probably not necessary if you have bands separated on different towers or there is enough separation vertically so the bands will not get interfere with one another. In this case, we knew we could have a couple of hundred watts of 2304-MHz energy next to the 3456-MHz antenna, so we opted to place a filter inline. I had a couple of 3–5 GHz filters that had been used in some Rockwell microwave-link equipment, so I tuned one to 3456 MHz. The filter has about 1.5 dB of insertion loss, but this beats the other alternative—a dead preamp in a contest.

Finally, I needed a box that would hold everything, would weather the elements, and would also mount easily on the tower. I looked at a few metal boxes and thought about the additional shielding they would provide, but I figured that a metal box on the tower might get hotter than a composite box. I focused on a line of fiberglass boxes that are NEMA 4X compliant (waterproof). The Hammond box I selected has a hinged cover, mounts on the back that work well for the tower, and a removable aluminum plate that could be used as a mounting surface for all of the components. At about $100, this box isn't cheap, but it is built well and suits our needs. We also discussed putting fans in the bottom of the box and placing a septum down the middle of the box to force air around all of the components. After discussing this with a seasoned broadcast

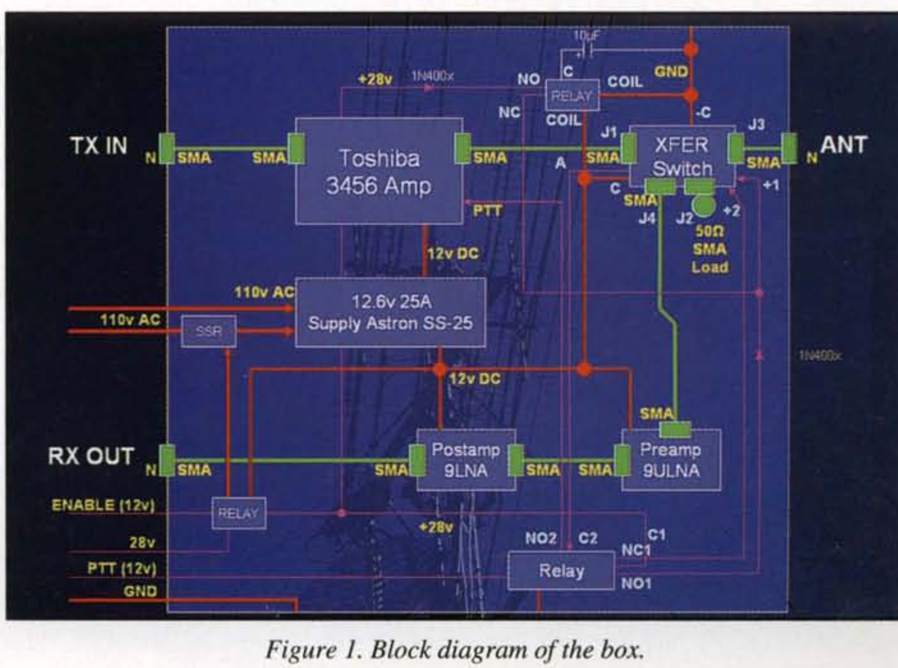

Figure 1. Block diagram of the box.

RF engineer, Jim Reese, WD5IYT, we decided to take his advice and seal the box and heat sink the amp well inside the box, and not allow anything additional (water, bugs, etc.) to get into the box.

Since all of the internal components are connected with SMA connectors and all of the external feedlines have N-connectors, I opted to use bulkhead N-to-SMA connectors for all three egresses from the box: the antenna, the RX port, and the TX port. I purchased these for around $10 each from Mouser Electronics (http:// www.mouser.com), but you could use other connectors or put something together from whatever you happen to have on hand. I made most of the internal connections with semi-rigid coax that was obtained from various sources and is readily available at hamfests. For the relays used to switch connections inside the box, I used the VF4, which is used quite often in auto and RV applications. It has a 12-VDC coil and will switch up to 30–40 amps of 12 VDC. The particular stash I have was purchased in a large quantity (50, as I remember) on eBay for something like 50 cents each, but they are also available from Mouser and other sources.

I'm not great at mechanical projects such as mounting, so I enlisted the help of Bill Simpson, N5YA. Bill has been building towers and other projects for as long as I can remember and is very good at making things come out right. I handed Bill the box and all of the components that went into it, and away he went. He brought back everything securely mounted and ready to be wired. Bill used JB Weld to seal the gaps around the connectors on the outside of the box to keep the box watertight. Any epoxy or similar compound should work, provided it will adhere to metal and fiberglass and can work at the temperatures the box will be exposed to on the top of the tower.

Wiring the Box

Most of the wiring in the box is fairly simple. The transfer relay needed a way to always revert back into the transmit position when power was removed. This would prevent the preamp from being exposed to the elements during a thunderstorm. Marshall calls this method "energize to receive," and it works like this: Any relays in the system always default to the transmit position (on the RF coax side) except when the receiver is on and receiving should be taking place. Generally, this involves just wiring the relays so that the normally closed position is transmit and normally open is receive. I had an additional problem with the transfer relay, however, since it was latching. The system could be in a receive position when the power was pulled and it would then remain there. To solve this problem, I charge up a capacitor when the system is in receive and if power is pulled, a relay shorts this capacitor across the transmit set of terminals on the transfer relay, sending it to the transmit position as the box's last operation whenever power is pulled. There are other ways of doing this, but this one worked well and we already had the transfer relay.

The only other tricky part was wiring the power connector on the Toshiba amplifier. It is a high-density DB-15 connector (the same as a VGA monitor) and it has eight power pins. I needed to run +12.6 volts to four pins, ground to four, and PTT to one. This is difficult with the close proximity of the pins, so I would recommend using Teflon® shielded wire so you don't melt away the insulation and short any wires together in the process.

One additional safety feature I wired into the system involves the transfer relay's indicator lines. There are three wires on the transfer relay that indicate if it has successfully switched to one position or the other. I used the transmit side of the indicator lines as part of the PTT circuit. This prevents the PA from energizing unless the relay has connected the antenna to the output port of the amplifier. If this was not done and there was a fault, the PA could end up transmitting in our 1-watt 50-ohm load connected to the preamp when the system is in transmit. A photo of the completed box is shown in photo A and a block diagram is shown in figure 1.

Photo B. The box mounted at the top of the microwave tower at K5QE.

Testing

After wiring up the box, it was taken to Marshall's shack for integration testing. With the actual transverter and rig that would be talking to it, all power levels were adjusted. The power amplifier is Class A, and when PTT is actuated, it draws maximum current until PTT is removed, regardless of the RF input to the amplifier. Somewhere along the way, I had forgotten to remove PTT from the amplifier when I was testing it, and it was pistol hot when I discovered my error. It had been keyed down for about 10 minutes solid, and I nearly burned my hand on it. When I checked the amplifier immediately after this, it would not put out any power. After cooling down, though, it once again put out full power. This amplifier is truly rock solid with protections—not that I would recommend repeating my "experiment"!

After testing was complete, the box was mounted at the top of the microwave tower at K5QE as shown in photo B. At this point, it had received no testing with remote stations. I drove back to Dallas, my home QTH, before the box had made it to the top tower, so I was able to make the first 3456-MHz contact on the rig from EM13 to EM31, a distance of 215 miles. Signals were good (3–6 dB out of the noise) and reports were easy to exchange

Figure 2. A map of the contacts made in the ARRL June VHF QSO Party.

(this was from my rover to the fixed station), even without enhancement.

Contest Performance

The first real test occurred just a week after the box was mounted on the tower. In the ARRL June VHF QSO Party, Marshall and the station operators made 19 contacts on 3456 MHz, with the longest being from 275 miles away. In total, 14 different grids were worked and the total added to the station score was roughly 50,000 points. A map of the contacts made is shown in figure 2.

By placing the preamplifier and amplifier at the top of the tower, we were able to achieve the best performance we could hope for with minimal sacrifices. Although we spent extra money on the housing, additional components, and the separate power supply for the PA, Marshall also saved money by running $^3/_8$-inch feedline up the tower rather than using the more expensive $^7/_8$-inch. This was an enjoyable project, and we all are pleased with the contest results. ■

By Dr. H. Paul Shuch,* N6TX

THE ORBITAL CLASSROOM

Furthering AMSAT's Mission Through Education

"Hams in Space"

Remember the Muppets? From 1976 to 1981, these puppet creatures, created by the late Jim Henson, had their own TV variety show. One humorous recurring segment was the "Pigs In Space!" science-fiction spoof starring Kermit the Frog's longtime romantic interest, Miss Piggy Lee (a porcine torch singer loosely based upon a popular, but slightly overweight, singer of the time with a similar name) and set aboard the *S.S. SwineTrek.* This Muppet sketch in turn inspired a popular "Hams In Space!" T-shirt sold as an AMSAT fundraiser for a few years. It depicted amateur radio satellites in orbit, being operated by, well, hams. I still wear mine to hamfests.

Who, in fact, was the first actual ham in space? Legend has long held that Col. Yuri Gagarin, hero of the Soviet Union and the first human to orbit the Earth, held amateur radio callsign UA1LO. I, in fact, inadvertently helped to disseminate this legend (the veracity of which is now in doubt) in a letter to an aviation journal.[1] It turns out that my claim, which has appeared widely in the amateur radio literature, resulted from an interesting misunderstanding.

At a time when radio contacts across the Iron Curtain were relatively scarce, Soviet QSL cards were considered quite the prize in the U.S. One, received in the mid 1960s by a U.S. ham, documented a contact with UA1LO. It sported a photo of the famous cosmonaut and was signed "73, Yuri." Although Gagarin's tragic death in an airplane crash in March 1968 made the assumption impossible to verify, many of us accepted this QSL card as proof that the first man in space had indeed been a ham.

Recent discussions on the amsat-bb e-mail reflector have shed some light on what now appears to be a legend born of good intentions. Printed QSL cards, a costly commodity, were a luxury that most Soviet hams could ill afford. It was common practice to add one's callsign, by linoleum block printing, to purchased picture postcards and to inscribe all relevant QSO information on the back. Tourist postcards of the day featured breathtaking natural landscapes, architectural masterpieces—and, of course, the faces of heroes of the Soviet Union. A popular postcard featuring Gagarin's countenance apparently was used for this purpose. The fact that he and UA1LO shared the relatively common given name "Yuri" gave this appealing rumor a life of its own. However, it now appears that the Yuri who operated as UA1LO, and the first human in space, were not one and the same.

W5LFL operating from orbit, December 1983. The inscription on the photo reads "To Paul Shuch N6TX, and all the students, San Jose City College—from the spacecraft Columbia. 73 Owen W5LFL"

Gagarin notwithstanding, there is no controversy at all surrounding the identity of the first radio amateur to *operate from* space. That honor fell to Dr. Owen Garriott, W5LFL, aboard the Space Shuttle Columbia on its mission STS-9, in early December of 1983. Garriott previously had tried unsuccessfully to obtain authorization for ham radio activity aboard the Skylab space station during its second manned mission a decade earlier. By the time STS-9 flew, small HT technology had made amateur operations from space far more feasible.

W5LFL's shuttle operations were far more than a space DXpedition. He justified the equipment to his NASA colleagues as a necessary backup communications system. However, as an electrical engineering professor at Stanford, Owen Garriott was interested in the educational opportunities his mission could afford, and he worked hard (through both NASA and AMSAT) to involve schools in his historic flight. During the months preceding the STS-9 mission, secondary schools, colleges, and universities around the world rushed to complete stations for the sole purpose of contacting the first ham in space. Those that succeeded received not just QSL cards, but personalized, autographed photos of W5LFL operating his HT on-orbit (see photo).

Thus was born SAREX, the Shuttle Amateur Radio EXperiment, a joint NASA/AMSAT initiative to include amateur radio activity on as many subsequent Space Shuttle missions as possible. Most astronauts hastened to earn their ham radio licenses. Many continued the proud tradition of conducting school contacts from space. Russian cosmonauts similarly installed ham radio equipment aboard their long-lived MIR space station, and routinely contacted school groups, as well as ham club stations and individual amateurs, from low-Earth orbit. The SAREX and MIR traditions continue today, through ARISS (Amateur Radio on the International Space Station), involving a permanent ham station aboard the ISS and providing hundreds of opportunities for school groups around the world to talk to hams in space.

**Director of Education, AMSAT*
e-mail: <n6tx@amsat.org>
<www.AMSAT.org>

To most students, the holy grail of ARISS and its predecessors has been that coveted QSL card, along with the contact that enabled it. However, to their teachers and advisors, a ham contact with a manned spacecraft represents a unique educational opportunity. From radio communications to orbital mechanics to geography and language, ARISS contacts provide an impetus for the development of interdisciplinary curricula at all levels. It is my role, as AMSAT Director of Education, to help coordinate these efforts. If you are involved with an ARISS contact—as a teacher, parent, control operator, mentor, or advisor—I hope you will register as an official AMSAT Educator (forms for that purpose are available on the AMSAT website).

Your mission (should you decide to accept it) is to make sure that the educational opportunities do not end with Loss of Signal. Hams In Space are here to stay. Let's exploit the attendant educational opportunities to the max!

Note

1. Shuch, H. Paul, "1st ham in space" (Letter). *Western Flyer* 29 (22): 10, December 25, 1987.

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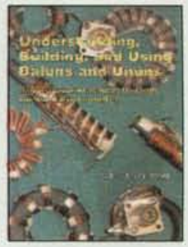

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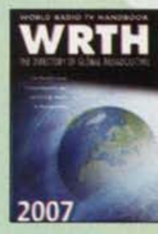

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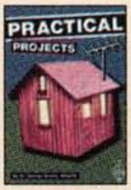

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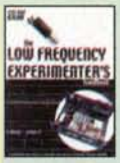

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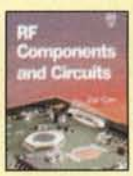

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By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

The Big Opportunity

Photo 1. The 1840-foot broadcast tower.

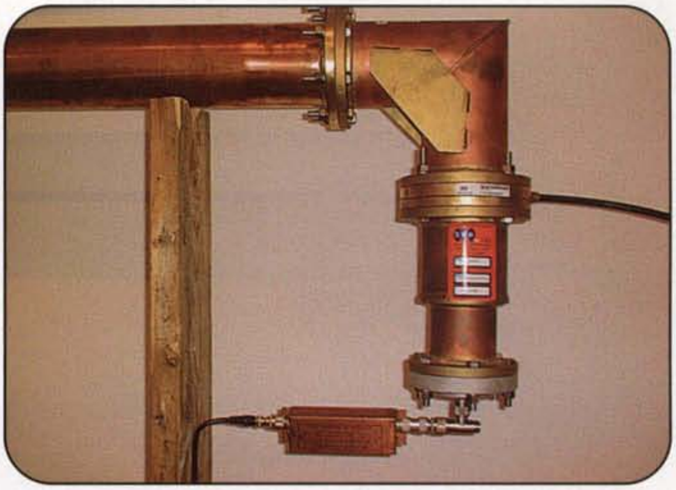

Photo 2. The other end of the 1750 feet of transmission line.

It was one of those rare opportunities. The local TV Channel 2 was building a new transmitter site. Yes, analog TV is supposed to go away, but they could economically justify a new transmitter and a new antenna even over just a two-year operating period.

The antenna went up two weeks behind schedule. However, the transmitter was running three months behind schedule. Oh, how horrible. Here was a 12-panel array for 56 MHz at 1631 feet, 1750 feet of 4$^1/_2$-inch feedline with .875 dB of loss at 55.125 MHz, and nothing connected to it. It also didn't hurt that the Director of Engineering for the network is N5UUE. He was kind enough to supply the 4$^1/_2$-inch hardline to Type N adapter. I don't have many of those in my junk box. Somehow I feel like I should do penance. Adapting hardline like that to a PL-259 connector for 6 meters is just plain wrong.

Using the Big Antenna

Using a broadcast antenna on the ham bands is not that easy and can easily bring along with it some expensive learning experiences.

Rule 1: *Never connect your rig directly to the feedline!* You'll fry it! At one location we measured nearly 20 watts coming back down that coax. In our case there are over 50 TV transmitters and over 30 FM stations within a mile or so. We're talking a couple of megawatts here, and the antenna was picking up 20 of those watts! Connect a rig to the coax without a good filter, and say goodbye to those front-end parts.

Rule 2: *Good filters.* For 6 meters I was able to use a Drake 6-meter low-pass filter. It was marginal, but kept the front end of my IC-706 Mark II from smoking. The old TV Channel 2 is still putting out full power about a mile away, and signal levels were incredible. Even with the Drake filter, the noise floor was S5 to S7 on 6 meters. As I tuned up the band, the noise level increased. With the help of WB5KGL, we've whipped up some new filters. At TV Channel 2, the skirts are now over 70 dB down, the limits of my test equipment. I hope it's enough, and we will be trying them out shortly, but I had to finish this column first!

Cavity Filters

On 144.2 MHz and 432.1 MHz, I used 144- and 450-MHz FM passband cavity filters from repeater diplexers. They worked great and the noise was way down compared to 6 meters. On 2 meters the noise floor was S1 to S2; on 432 MHz the noise floor was S0. The quest continues. I have a lead on a 50-MHz passband cavity filter and hope to give one a try soon. Even so, I am still scrounging. We also plan to test 222.1 MHz in the near future.

Local Stations

While the tower currently has five FM transmitters running just a few feet above the new TV Channel 2 antenna, their signals were actually less than the FM transmitters about a mile away. Those tables showing that dBs of vertical isolation are

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Photo 3. Cavity filter to the right of the transceiver.

much greater than horizontal isolation between repeater antennas are true!

Test Your Filters

The first 6-meter low-pass filter I tested looked good out to a couple of hundred MHz. However, it started passing signals again. Most of those TVI filters never were designed to keep out kilowatts of power from UHF TV transmitters. Additionally, many cavity filters will pass their harmonics as well. Check out the filters first; the rig you save may be your own. Don't be surprised if you need more than one filter—one sharp filter, and then a broad one to keep out the other filter responses.

Upper Frequency Limit

It's hard to grasp at first, but there is an upper frequency limit to the bands you can use with a broadcast antenna. At about 1 GHz, 6-inch hardline starts to look like waveguide, not coax. Loss goes up very fast. Therefore, don't plan on bringing along a 1296-MHz or a 10-GHz rig; the feedline won't pass it.

Other Bands

The antennas are designed to be very broadbanded. A quick try on 10 meters didn't get any responses. However, the band wasn't open. On 20 meters the signals were weak but in there. Due to their waveguide type construction, I wouldn't expect many UHF TV antennas to work on the ham bands. However, TV Channels 2 through 13 and FM broadcast antennas are pretty broad and can be used on many ham bands. Furthermore, just look at that height advantage. The antenna gain may be only a little better than a rubber-duck antenna. However, it's a rubber-duck antenna at 1631 feet!

"What was the SWR?"

That question came up in one of the QSOs. I have no idea, and with all that power coming back down the coax from other stations, most SWR meters would have had a seizure. The rig's SWR warning light never came on, so I didn't worry about it.

Noise Blankers

"If the noise was so bad, why didn't you just turn on the noise blanker?" That was another question during the first test. The combined energy from that many TV signals does not look like impulse noise. No settings of the noise blanker or DSP filters helped. The rig was just getting blasted!

Static Electricity

Every time a cloud floated by there was a corona discharge from the tower to the cloud. The tower is very well grounded, so it's not going to hurt the rig. You learn to get used to the noise real fast.

Rig Bypassing

Again, this is an incredibly strong RF field. Adding RF chokes to my external speaker leads, and some ferrite chokes on the 12-VDC line knocked the noise down a little bit. Not all of it was coming in the front end. Nobody complained about video buzz on my TX audio, so I just left that alone and put an extra ferrite choke on the 12-VDC line.

Operating

If the tower crews had finished on schedule, we could have use the antenna during the September ARRL VHF QSO

Photo 4. Another cavity filter.

Photo 5. These filters combine five transmitters onto one antenna. Three of the transmitters go out right-hand circular polarized and two of the transmitters go out left-hand circular polarized.

Party. Even so, with another slide in schedule on the transmitter, we just might get to use the antenna again during the January VHF QSO Party. Therefore, this story is ongoing.

Running about 50 watts on 6 meters, I had no trouble even with the high noise floor talking out 200 miles. I even worked K5OPB running a 1960s AM rig on 50.4 AM. On 144.2 MHz the antenna pattern was a little lumpy, but again 200-mile QSOs under flat conditions were easy. Signals were a lot weaker as compared to 50 MHz, but the noise floor was so much lower. I have made only one QSO on 432 MHz thus far. A barefoot FT-817 is not going to blow many holes in the band. The 450-MHz cavity filter tweaked down to 432 MHz worked fine, and I heard K5VH nearly 200 miles away. Next time I'll have more DC power, better 50 MHz filters, and more stories.

Broadcast Filters

Broadcast filters and their associated plumbing were also in the room. They combine five FM broadcast transmitters onto those two large transmission lines. When they get up to the circularly polarized antenna, three of the transmitters go out right-hand circular polarized and two of the transmitters go out left-hand circular polarized. I'm glad I didn't have to calculate phasing lines for that one!

Cheap Yagis and Homeland Security

I received some interesting feedback from a chap who works for a company that has a contract with one of those "three-letter agencies."

It seems that the Taliban needed a bunch of walkie-talkies for their front-line freedom fighters. Where do you get a couple of hundred talkies? Furthermore, it seems that under Afghan FCC regulations for 2 meters and 70 cm, killing infidels and Americans is considered a hobby activity!

Just after 9/11, this chap was sent to a listening post along the Afghan border. He had access to wonderful receivers connected to discone antennas. The signals were there, but they were very weak. He downloaded the dimensions for 146- and 440-MHz Cheap Yagis. Then using "requisitioned broom sticks and coat hangers," he built up a pair of Cheap Yagis. "Signals I could work with!" he exclaimed.

He reported back to his superiors what he had to use for antennas, and a government contractor custom built some government-grade antennas for him. A few weeks later the antennas were dropped in air freight, and as a taxpayer I hate to think how much they cost. Up they went, and within the hour the Cheap Yagis were returned to service and they were working better. I'm told photos of the installation were taken, but it may be a decade or two before we can publish them.

Keep those ideas for antenna articles coming, and many of the Cheap Yagi designs can be downloaded from my website, <www.wa5vjb.com>. Now go get some more antennas in the air!

73, Kent, WA5VJB

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Medals and More at the National and World ARDF Championships

"These were the most difficult courses that I have ever seen!" That's how Charles Scharlau, NZØI, described the 2006 World Championships of Amateur Radio Direction Finding (ARDF). Charles and his wife Nadia had just returned from Bulgaria, where for the 13th time, the world's best on-foot transmitter hunters had gathered to see who would capture gold, silver, and bronze medals.

ARDF, also called foxtailing and radio-orienteering, is a worldwide sport among radio amateurs and SWLs. The goal is to find up to five hidden transmitters in a large forest, each keying for a minute at a time in sequence on one frequency.[1] A continuous transmission on another frequency helps foxtailers find the finish line. There are separate events on the 2-meter and 80-meter bands.

As a nation, the U.S. is a relative newcomer to ARDF. The first World Championships took place in 1980, but the U.S. didn't participate in this biennial event until 1998. This year marked the fifth time that stateside foxhunters have gone up against the rest of the world, and for the first time the Stars and Stripes were raised on the podium during the awards ceremony.

Bearings on the Black Sea

ARDF teams from European countries usually travel to international championships as a group. By contrast, Team USA members came from eight states and arrived in Bulgaria over a six-day period. The closest major airport is in Sofia, necessitating a seven-hour bus ride cross-country to the coastal resort village of Primorsko. Only weeks before, its beaches had been blanketed with vacationing Europeans.

Seven Team USA members participated in training sessions provided by the Bulgarian organizers. For up to a week before the championships, they joined dozens of others who were working to improve their RDF and orienteering skills in woods and fields next to the Black Sea. Unfortunately, some of the early arrivers encountered contaminated food in the cafeteria. On our team, Harley Leach, KI7XF, and Vadim Afonkin came down with severe stomach and intestinal symptoms that lasted through the 2-meter competition day.

The first formal competition was September 14 on 2 meters. AM transmitters with tone-modulated CW and horizontally polarized antennas are the international standard for ARDF on this band. The courses were a bus ride away from the coast and encompassed more than 4800 acres of well-mapped forests and fields. The shortest point-to-point distance for the full 5-fox course was 7.5 kilometers.

*P.O. Box 2508, Fullerton, CA 92837
e-mail: <k0ov@homingin.com>

Jay Hennigan, WB6RDV, tests his 2-meter RDF Yagi at a practice session in Bulgaria before the 2006 World Championships. He made this antenna using fiberglass elements covered with braid. (Photo by Richard Thompson WA6NOL)

Bob Cooley, KF6VSE, finished ninth in the category for men over age 60, finding all three of his required foxes and missing a medal by less than 3½ minutes. "The first two foxes were easy, but #5 presented much more opportunity for error," Bob wrote. "I should have gone northeast to bypass most of the medium green[2] on the map and get on the trails going toward that fox. But I followed the bearing north and spent more time in the medium green than I should have."

Bob continued, "Because of signal reflections, it is always a bad idea to hunt a 2-meter fox from the bottom of a stream bed, but that is what I did next. I led four people into a dead-end clearing 150 meters northwest of #5. That would have been funny, except that I was in there, too. I should have approached #5 on the higher trail that pointed right at it. This would have saved me more than one five-minute cycle."

Jay Hennigan, WB6RDV, finished 16th out of 42 in the category for men between ages 50 and 59. Jay has greatly improved since his first World Championship appearance in 2004. In addition to ARDF practice, he enters many classic orienteering meets to develop his map-and-compass skills.

Carrying USA's flag, Nadia Scharlau stands on the winners' podium at the 13th ARDF World Championships in Bulgaria. Next to her is Jitka Simackova of the Czech Republic, who tied for third place in her category. (Photo by Charles Scharlau NZØI)

Horizontal polarization on 2 meters is standard at international ARDF events. Although "turnstile" crossed-dipole antennas are the most popular way to achieve an omnidirectional radiation pattern with horizontal polarization, Charles Scharlau, NZØI, used crossed-loop "eggbeater" antennas with equal success. (Photo by Joe Moell, KØOV)

"These were extremely tough courses, physically and mentally," noted Charles Scharlau, NZØI, who found his four required foxes in just under two hours. "The locations of the foxes made it difficult to select the optimum order. On one course, the top three finishers in one category each took the transmitters in different order. That is very unusual."

Charles discovered ARDF in the Puget Sound area of Washington State and competed in our National Championships for the first time in 2001. His wife Nadia learned ARDF as a youth in the Soviet Union and won her first gold medal by competing for the USSR at the European Championships in 1984. Both of them represented the USA at the last two World ARDF Championships, where Nadia was our team's top performer. In 2002, she took fourth place in her category on one band, finishing within two minutes of the bronze medallist.

In 2004, Nadia was again close to a medal when the battery fell out of her 80-meter receiver on the way to her final transmitter. Without it, she had to find the last fox and get to the finish using just her previously marked bearings. The lost time put her in 11th place instead of perhaps earning a trip to the medal podium. Now on the first competition day in Bulgaria, Nadia finished 7th in her category, taking just ten minutes longer than the gold medallist to find her required four foxes.

Nadia agreed with Charles that the 2-meter event was very difficult, but she was happy about it. "I knew it would be to my benefit if the courses were hard," she said. "Hard courses favor mental skills over physical skills." Nadia usually places better on 80 meters than on 2 meters, so she was excited about her prospects for the next event.

After a day of rest and touring, everyone climbed back on the bus for a ride to the HF hunt on Saturday, when Nadia had to overcome adversity again. According to the electronic scoring records,[3] she found her four required foxes in silver-medal time, but just as she was ready to go to the end, the Bulgarians' beacon transmitter failed for about 15 minutes.

With no RDF help and no nearby roads on the map, Nadia had to navigate cross-country in the forest to find the finish. Even though she is a skilled orienteer, this put her at a severe disadvantage when compared to those before and after who could use the beacon to find the exact direction to go. Only two competitors in her category were headed for the finish in that time period and the other wasn't a medal contender. A protest was filed and, after an hour of deliberation, the international jury adjusted Nadia's time such that she tied for third place.

Almost Professionals

From its beginnings in Scandinavia after World War II, ARDF grew into a major European sport during the Cold War years. That legacy remains, as eastern European countries continue to dominate the medal count. Of this year's 55 individual gold, silver, and bronze medals, 43 went to runners from three

Harley Leach, KI7XF, heads for the 2-meter finish line at the USA ARDF Championships in North Carolina. A retired professor of electrical engineering, Harley has fabricated a rugged 2-meter RDF antenna and customized his receiver with a home-built synthesizer. (Photo by KØOV)

Emily DeYoung, K4MLE, was the youngest competitor at the 2006 USA ARDF Championships in North Carolina. She took home two gold medals. (Photo KØOV)

countries: Ukraine, Czech Republic, and Russia. All but one of the 18 team gold medals went to those three nations.[4] Nineteen of the 30 countries won no medals at all.

"When I was growing up in Russia, there were many clubs in cities such as Moscow and St. Petersburg," recalls Nadia. "We had clubs for knitting, music, singing, soccer, and many other activities. There were also clubs for radio and ARDF. They were well organized. I would go there at least two times a week."

Before long, Nadia was doing little else in her free time. "There were lots of practices. In fact, in Moscow almost every Sunday somebody would put out a course. Everybody was welcome to run and there were a lot of participants."

Many European ARDF stars are in the military. Nadia explains, "In Russia, if you are an officer, and if you are a winner in the Europe or World Championships, you bring points to your part of the military. Competitors from the military are mostly in the older age categories, while the young competitors are mostly students.

"ARDF equipment is not expensive in Europe nowadays," Nadia adds. "For 20 dollars you can buy a very simple receiver and for 30 dollars a simple transmitter. You have to be in many competitions in Russia to get on the team. There are opportunities in many cities. I understand that there were more than 300 competitors at Russian national championships. They have to pay their own way in national competitions, but team expenses to World Championships are paid for."

With that in mind, the USA's progress in ARDF is quite remarkable. All Team USA members are true amateurs, who train mostly at home and pay their way to all events. This includes Charles and Nadia as well.

"It has been very hot here, sometimes 100 degrees," says Nadia. "I tried to run five or six miles on the streets every day after work, but Charles and I didn't have many opportunities to go practice RDF in the woods because of the heat and humidity. Sometimes we would take a couple of transmitters to the park. He would hide one transmitter and I would hide the other one. As soon as I would find his, I would move it. He would do the same and we would repeat five or six times. By then we felt dead because of the heat."

From the Appalachians to Bulgaria

By international rules, ARDF competitors are divided into nine age categories, five for men and four for women. Up to three competitors in each category may represent a national amateur radio society at the World Championships. All but three of the 13 competitors on this year's Team USA earned their places at the 2006 USA ARDF Championships, held April 7 through 9 near Durham, North Carolina. The remainder qualified at last year's national championships near Albuquerque, New Mexico. Two of them were Charles and Nadia Scharlau, who were co-chairs of the organizers of the North Carolina championships.

North Carolina forests are nearly ideal for ARDF, as the Scharlaus are well aware. They reside in the town of Cary, which is next door to William B. Umstead Park. Its 5300 acres of hills, trees, and trails made it an excellent choice for our national championships this year. With help from the Backwoods Orienteering Klub (BOK), the two designed challenging courses on both ARDF bands, with excellent maps.

Such a large navigable forest in hilly country provided contestants with the opportunity to make route choices and "run the contours" in hopes of minimizing point-to-point distances and time. There was lots of room for jogging and walking in the tall timber, although some care was required to avoid tripping over trees blown over by Hurricane Fran, or falling into holes left by rotted tree stumps. The other minor peril was an abundance of ticks. April Moell, WA6OPS, the event's Field Medic, got a lot of use from her tweezers, especially on runners who crashed through the brush instead of staying on the trails.

As many European countries do, the USA holds an open national championship, meaning that visitors from other countries are welcome. They compete on an equal basis for the gold, silver, and bronze medals. Visitors this year included three men from England and a married couple from Germany. Stateside radio-orienteers enjoyed comparing notes on ARDF equipment and techniques with them.

A practice and equipment checking session kicked off our national championships on Friday, followed by a cookout and a briefing on safety and other important information about the hunts to come. The VHF competition took place Saturday and the HF event was on Sunday. Thanks to electronic scoring, it was possible to hold the medal awards ceremony immediately after the last hunt concluded, to accommodate participants who had flights home that evening.

Forecasted thunderstorms failed to materialize during the VHF event on Saturday. Skies were mostly cloudy with occasional light rain, making for good running conditions. Twenty-eight radio-orienteers took to this course beginning shortly after 10 AM. It was intended to be difficult, on par with courses at world championships. However, due to a possible technical problem with transmitter #4, it was announced that this transmitter was not required to be found.

Matthew Robbins, AA9YH (left), receives a gold medal from Charles Scharlau, NZØI, for his 2-meter performance at the 2006 USA ARDF Championships. (Photo by KØOV)

The best overall time on Saturday was posted in the prime age category by Vadim Afonkin of New York. His performance was remarkable, because he found all five transmitters in spite of the fact that he didn't have to get #4. He was almost seven minutes faster than silver medallist Jay Thompson, W6JAY.

A cold front brought frigid air to the park on Saturday night. The temperature was just 36 degrees with completely clear skies as competitors entered the park for the HF event Sunday morning. That must have encouraged everyone to run faster, because the majority completed this course in less than two hours, compared to times in the two- to three-hour range the day before.

Once again, Vadim Afonkin took gold in the prime age category. George Neal, KF6YKN, won his category with an excellent time, especially remarkable because he went out of his way to punch the fifth transmitter, which was not required for his category. "For practice," he explained.

Other category gold medal winners, in alphabetical order, were Bob Cooley, KF6VSE; Emily DeYoung, K4MLE; Jennifer Harker, W5JEN; Karla Leach, KC7BLA; Matthew Robbins, AA9YH; Brigitte Roethe (Germany); Nick Roethe, DF1FO; and Steve Stone (England).

ARDF, the Movie

ARDF is not a spectator sport. It's difficult to convey its excitement with words and still photos. Plenty of video has been taken at our local and national events, but until this year no one had put it together into a program that explains the principles to beginners in an entertaining way. Now it's ready.

Gary Pearce, KN4AQ, who lives near Umstead Park, documented every aspect of the 2006 USA Championships with help from Steve Worley, KB4HDQ. Then Gary, who freelances in audio-video production and is a former *CQ VHF* columnist, edited all this footage into almost 40 minutes of tutorials and fast-paced action. You can see just what it's like to get bearings on 80-meter transmitters with null-seeking antennas and to resolve 2-meter bearings in multipath conditions. Gary and Steve went into the woods to follow speedy competitors such as Jay Thompson, W6JAY, and to watch skilled hunters approach the fox transmitters.

I just gave a sneak preview of Gary's video as part of my ARDF forum at the 2006 ARRL Southwestern Division Convention in San Diego, and everyone liked it. It's available for purchase and would make an excellent program for your local radio club. To find out how to get it on DVD, contact KN4AQ directly.[5]

Next Year, Go West

As I write this, preliminary plans are coming together for next year's USA ARDF championships. The most likely site will be in the mountains near Lake Tahoe, which is on the California/Nevada border. Despite high elevation, these well-mapped forests are excellent. They are so good that the US Orienteering Federation held its national championships of classic orienteering there in 2003.

These mountains are too wet in spring and too crowded in summer, so the most likely dates will be a three-day weekend in September. Most of USA's leading foxtailers have already indicated their plans to attend, so newcomers will have an outstanding opportunity to learn from them. Watch for the formal announcement at my website and in the amateur radio press. Also check my site <www.homingin.com> for news of other events and for basic information about all RDF-related topics.

I appreciate receiving your stories and photos of mobile and on-foot transmitter hunts, including reports of CQ National Foxhunting Weekend activities. I also like to get your reports of RDF adventures in interference tracking and search/ rescue. Keep them coming! 73, Joe, KØOV

Notes

1. Details of international ARDF rules are at <www.homingin.com>.
2. Vegetation is color-coded on orienteering maps. A medium shade of green indicates brush or undergrowth that is difficult to navigate in the absence of trails.
3. Competitors carry RFID tags that they register in the transponders at each fox and at the finish, providing exact timing at each point. More on "e-punch" is in "Homing In" in the Summer 2004 issue of *CQ VHF*.
4. Team scores are aggregates of the individuals' scores in each category. Team members may not assist one another on the courses.
5. ARVN – ARDF Video, 508 Spencer Crest Court, Cary, NC 27513; e-mail: <kn4aq@arrl.net>.

Before the 2-meter competition at the USA ARDF Championships in April, Dick Arnett, WB4SUV, was interviewed by Gary Pearce, KN4AQ, for a comprehensive video on ARDF that is now available for showing to your local radio club. Beside Dick is Karla Leach, KC7BLA. Both competitors went on to win medals. (Photo by KØOV)

By Del Schier,* K1UHF

AIRBORNE RADIO

Using Amateur Radio to Control Model Aircraft

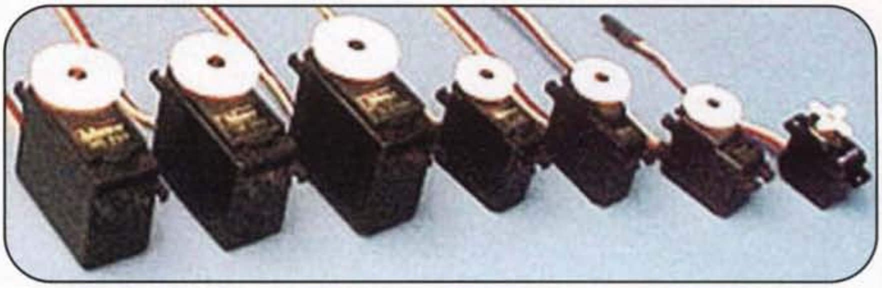
Servos—Installation and Rigging Tips

Smaller full-scale airplanes have controls linked to the airplane's control surfaces by rods or cables to mechanically control the airplane with just the muscle power of the pilot. Bigger airplanes have hydraulic servo control systems to amplify the pilot's strength in order to control the airplane. Modern fighter planes and airliners now have fly-by-wire controls where the pilot's controls are linked electronically to hydraulic pumps or electric motors. Fly-by-wire systems are used in conjunction with a flight computer to assist in safely stabilizing and controlling the airplane. The fly-by-wire system is very similar to radio control, except in the latter case radio is used instead of wires—call it fly-by-radio, hi. There are computer functions in the better RC (radio control) transmitters, but they do not stabilize or fly the airplane. Gyros are used in some RC airplanes and most RC helicopters to stabilize the flight.

An RC servo is an electro mechanical device that uses an electronic control circuit to proportionally position the output shaft by controlling a DC motor connected through gear reduction. A servo has feedback from a potentiometer on the output shaft that "tells" the amplifier the position of the shaft. The amplifier generates an error signal by comparing the potentiometer position to the transmitter pulse position and then quickly runs the motor the correct direction and amount so the relative position of the servo's output shaft is matched. All but the very cheapest RC systems provide fully proportional control of the airplane. Unlike a real airplane, there is no force feedback on the control sticks. Some computer game controllers have this feature, and I would like to fly a model airplane with feedback to the transmitter sticks.

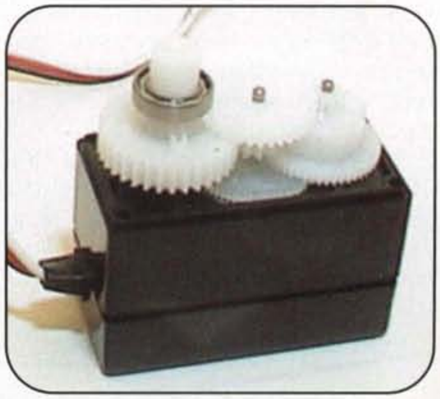
Early RC systems were not proportional. The controls just flipped one way or another and back to center. Today's proportional control is very precise and effective, but it depends to a great extent on the quality of the installation and setup.

For RC servos to work properly, they must be chosen for the proper airplane, for proper mounting, and for power output (torque). The airplane's specs should be appropriate or you may choose what you prefer. Choosing servos may be a bit bewildering, as there may be dozens of suitable choices from the hundreds of makes and model servos available. One manufacturer, Hitec, makes 46 different models, and there are about a dozen manufacturers. Servos range in size from that of a postage stamp to half the size of a brick. They have generic sizes, such as

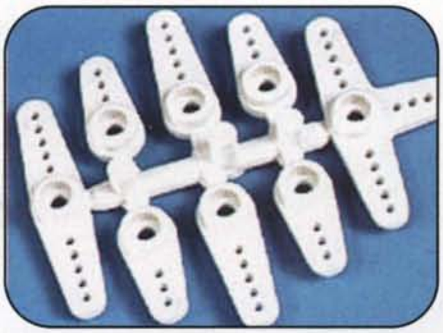


Servos come in sizes from sub-mini to giant.

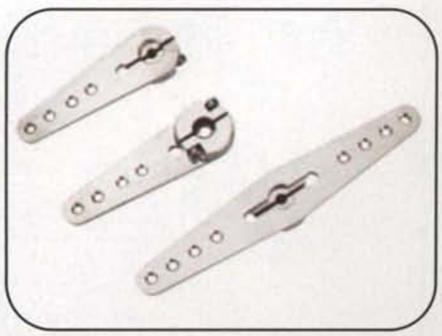
A special flat-wing servo for thin sail plane wings.



Inside a servo with a ball bearing but plastic gears.

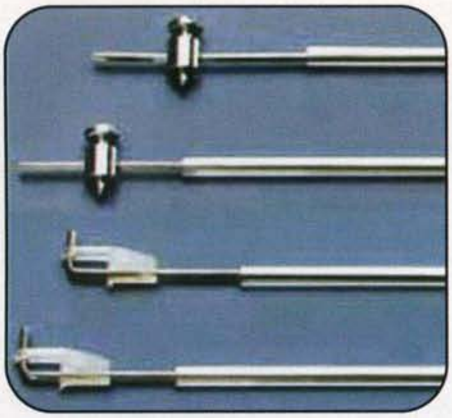


Standard servo arms supplied.

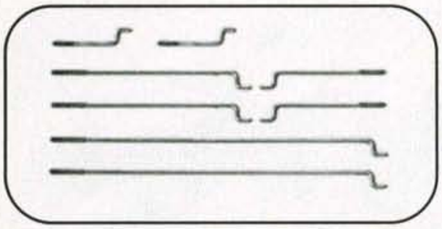


Heavy-duty custom metal servo arms.

*e-mail: <k1uhf@westmountainradio.com>



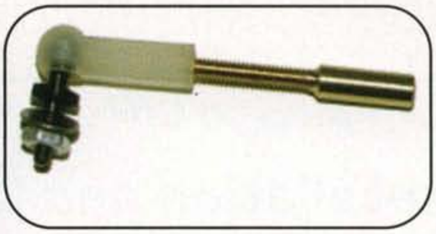
Various pushrod ends.



Z-bend wire pushrods.

sub-micro, micro, sub-mini, mini, standard, giant scale, etc. Check the dimensions and torque specs to determine if they will fit an airplane. Special wing servos are made to fit flat in a thin wing, and other styles would be better to mount in the fuselage.

The torque outputs range from less than 10 inch/ounce of torque to over 350. Servos vary in speed and centering accuracy, digital servos having the claim for better performance. High-performance



A ball swivel pushrod end.

Clevis-style pushrod ends.

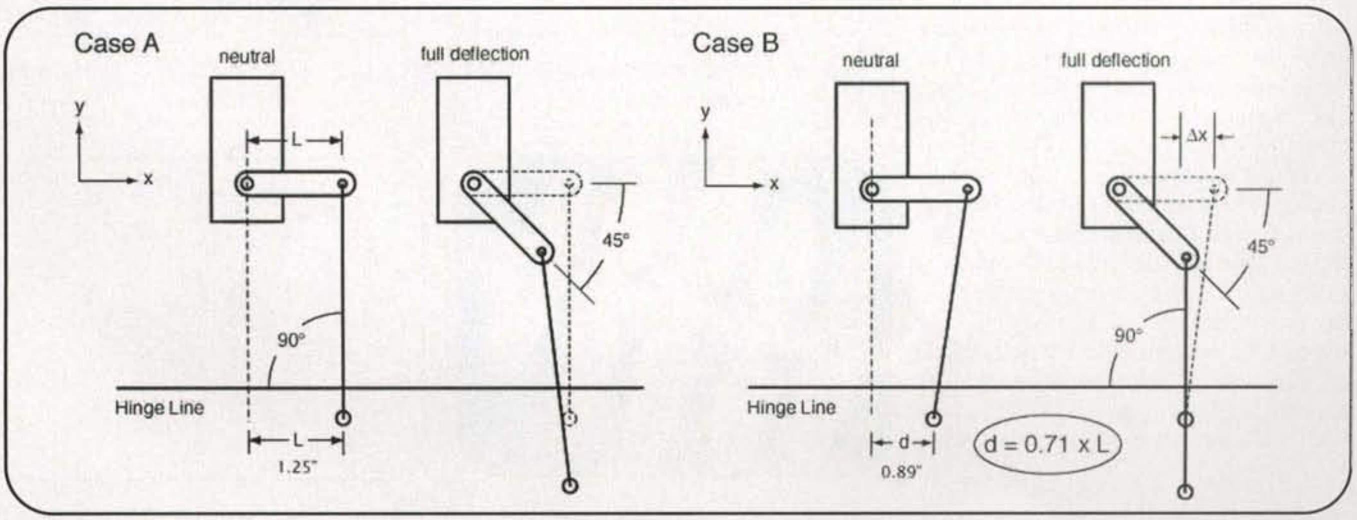
servos generally are needed for high-performance aircraft and helis. Servos come with your choice of plastic or metal gears and may or may not have ball bearings. Generally, they all operate from a 4.8-volt battery pack and have the best performance if operated closer to 6 volts.

Electric motor speed controls (ESC) have battery eliminator circuits (BEC) that supply 5 volts. This regulated output or a flight battery may be used to power both the receiver and the airplane's servos. Receivers have a row of three pin connectors, each to connect the appropriate channel and supply the power for each servo. The connectors are not exactly standard, and you must use a compatible system or adapt the connections. The connectors must be plugged in with the correct polarity, but it is almost impossible to damage anything by plugging in things wrong; the servos just will not work. The connections are fragile. Therefore, never pull on the wires to get the connectors out. Always be sure that they are fully connected before flight. If the servo wiring is not long enough, you will need servo cable extensions that can be soldered on or plugged in.

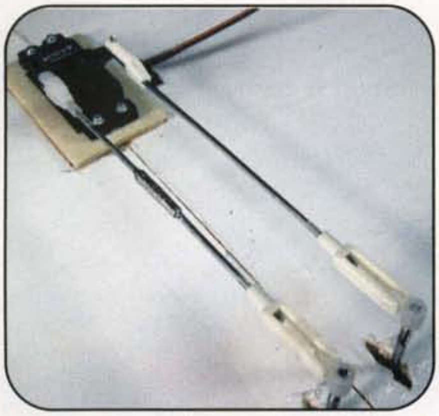
Mounting Servos

Mounting servos is accomplished with either screws, glue, or double-sided tape. Before mounting servos, especially with glue, you must select a proper servo arm from the assortment of arms that come with a servo. Before installing the arm positioned correctly on the servo's splined output shaft, you must center the servo. Centering a servo involves powering up the system on the bench and centering the radio's controls before installing the arm. Don't forget to put the screw back in the arm!

The servo arm is connected to a pushrod, either a flexible one in a sleeve, a stiff wire, or a carbon fiber rod. Dual pull-pull cables are also used. The other end of the linkage is connected to a control horn that is securely mounted near the pivot point of a control surface's hinge. The pushrod is connected to the control horn with a clevis or perhaps a "Z" bend in the wire. The pivot point of the control horn should be directly over the hinge axis. The pushrods and control



Arm installation and geometry affect the linearity of the servo movement.



One servo rigged to operate two ailerons.

Rear-fuselage mounting of a rudder servo.

One servo on one aileron.

horns have multiple holes to determine the mechanical advantage and thus determine the range of travel. Consider the range of travel that is required and be sure that there will be no mechanical interference in the control system as the servo arm rotates through its full range of travel. Use longer arms and control horns to minimize the play in the pivot points. You must ensure the proper operation and serviceability of the installation.

Temporarily install the servo and test the movement of the linkage before doing a glued-in installation. There is a handy electronic gadget that I use to set up everything. It is called a Servo Lab and is made by FMA. The servo lab lets you center the servo without using the radios, and it will manually or automatically cycle the servo through the range of travel.

A single servo may be rigged with multiple linkages so that one servo can control two ailerons or two flaps or perhaps a rudder and nose wheel steering. The deluxe way to equip an airplane is to use separate servos for each control surface and then electronically link them with the programming capability of a computer radio. A "full house" airplane will have two aileron servos and two flap servos, one for the rudder and another for the elevator.

Individual aileron servos may be installed as a mirror image, and the radio may be programmed so that one servo moves up when the other servo moves down. Instead, two aileron servos may be connected with a Y cord to a single channel. However, in that case they must not be installed as a mirror image for the ailerons to move correctly.

Aileron Differential

Ailerons usually work better if they move up more than they move down. This is called aileron differential. Differential is necessary to minimize the adverse yaw caused by the drag of the ailerons. Setting up aileron differential is easily done with two servos and a computer radio, but the mechanical equivalent requires that the geometry of the pivot points be asymmetrical. The setting of the exact neutral (trim) position may be adjusted electronically with a computer radio, but it is good to get it right with the linkage adjustments before trimming it with the radio.

It is important that the controls move in the correct direction: up is up and down is down; right is right and left is left. The linkages should be friction free and have the minimum of slop or play. The controls must travel both directions the correct amount and end up with the correct neutral trim position. After a while you will learn what airplanes need for control movement range, but refer to the airplane's setup instructions as a starting point. After a few flights, and with careful observation, you usually will want to make some changes to make your airplane fly perfectly. The attention to detail and flight-testing is half the fun of building and flying model airplanes. The other half is flying and making friends with the other RC pilots, many of whom are also amateur radio operators. Happy flying!

73, Del, K1UHF

Links

Airtronics: http://www.airtronics.net
FMA Direct: http://www.fmadirect.com
Futaba: http://www.futaba-rc.com
JR/Horizon Hobby: http://www.jrradios.com
Hitec: http://www.hitecrcd.com

By Tomas Hood,* NW7US/AAA0WA

PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

It's All Backwards!

Since the start of 2006, we've been seeing a steady decline in the sun's activity. Sunspots, one of the solar events that we use to gauge the activity level of the sun, are occurring less frequently and they are generally much weaker than they were during the peak of the current sunspot cycle. There are periods now when we don't see any sunspots for days on end. This has signaled the end of solar Cycle 23, but how will we know when Cycle 24 is starting up?

On July 31st, the anticipated sign that Cycle 24 is possibly beginning was observed. The sign came in the form of a short-lived tiny sunspot that bubbled up from the sun's interior, floated around a bit, and vanished again in a few hours. This particular sunspot was special: It was backward. However, it was too small and short-lived to be numbered as an official sunspot.

"We've been waiting for this," says David Hathaway, a solar physicist at the Marshall Space Flight in Huntsville, Alabama. "A backward sunspot is a sign that the next solar cycle is beginning."

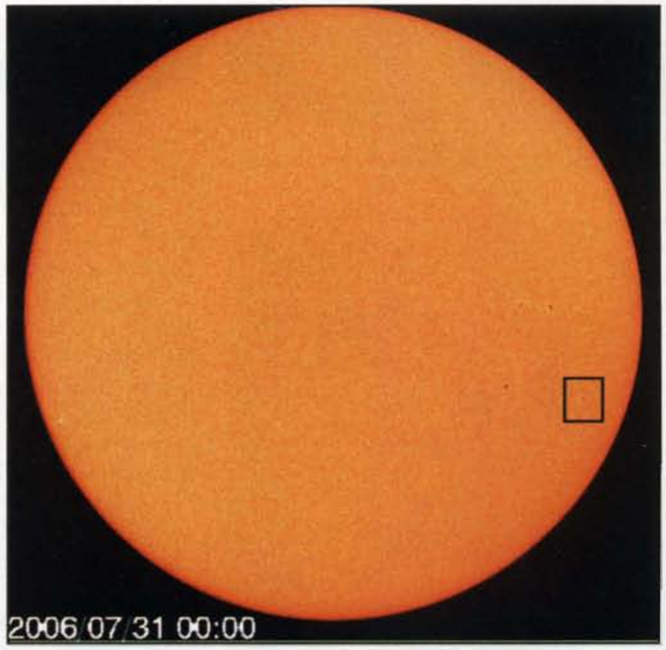
"Backward" means magnetically backward. Sunspots are magnetic regions on the sun with magnetic field strengths thousands of times stronger than the Earth's magnetic field. Plasma flows in these magnetic-field lines of the sun. Sunspots appear as dark spots on the surface of the sun. Temperatures in the dark centers of sunspots (the *umbra*) drop to about 3700°K, compared to 5700°K for the surrounding photosphere. This difference in temperatures makes the spots appear darker than elsewhere. Sunspots typically last for several days, although very large ones may live for several weeks. They are seen to rotate around the sun, since they are on the surface, and the sun rotates fully every 27.5 days.

Sunspots usually form in groups containing two sets of spots. One set will have a positive, or north, magnetic field while the other set will have a negative, or south, magnetic field. The magnetic field is strongest in the darker parts of the sunspot. The field is weaker and more horizontal in the lighter part (the *penumbra*).

During the course of a solar cycle, sunspots are magnetically oriented much the same way, sunspot after sunspot. However, when the sunspot of July 31st popped up at solar longitude 65 degrees west, latitude 13 degrees south, it was opposite the normal orientation for sunspots in that region of the sun. Sunspots in that area are normally oriented N-S. This sunspot was oriented S-N.

During the course of the average 11 years of a solar cycle, where solar activity rises and falls, swinging back and forth between times of quiet and storminess, the magnetic structure of the sun reverses itself. Right now the sun is quiet. During the peak of a solar cycle, the sun is very active and stormy. Right after the peak, the sun's magnetic poles actually flip. At the end of a cycle, or at the start of a new cycle, sunspot magnetic poles flip.

*P.O. Box 213, Brinnon, WA 98320-0213
e-mail: <cq-prop-man@hfradio.org>



A view of the sun that reveals the magnetic orientation of several sunspots occurring on July 31, 2006. The darker areas indicate a south magnetic "pole," while the lighter areas indicate a north magnetic "pole." The sunspot that has a backward-oriented polarity is the likely signal that a new solar cycle is approaching. (Source: NASA/SOHO)

This backward sunspot lasted only three hours. Typically, sunspots last days, weeks, or even months. Three hours is fleeting in the extreme. "It came and went so fast, it was not given an official sunspot number," says Hathaway. Additionally, the location where the sunspot appeared is suspicious. New-cycle sunspots almost always pop up at mid-latitudes. This one did not. Therefore, scientists are cautious about putting too much weight on this one sunspot as the official start of Cycle 24. However, it does signal the arrival of the new 11-year cycle. Since this first backward sunspot, others have occurred. This leads scientists to confirm that we are at the very edge of the new sunspot cycle, solar Cycle 24. Also, as reported in past months, the new cycle may well be the strongest since the 1950s.

When will solar Cycle 24 actually begin? Since the first sunspot of a new solar cycle is always backward, solar physicists look at July 31, 2006 as a very likely start of the new cycle. However, this does not mean that solar activity is going to immediately do an about-face. It can take up to five years for the next solar cycle peak to arrive.

This is welcome news for VHF DXing enthusiasts, who are longing for the potential *F*-layer openings typical of the peak sunspot years of each solar cycle. Cycle 24 is predicted to be very active, possibly as active as the solar cycle that occurred in the 1950s. That was a memorable cycle because of the worldwide openings on 6 meters that occurred for long periods of time.

Autumn Outlook

Autumn (November through January) is a relatively quiet season, with very little, if any, transequatorial propagation (TEP). TEP, which tends to occur most often during spring and fall, requires high solar activity that energizes the ionosphere enough to cause the *F*-layer over the equatorial region to support VHF propagation. The normal TEP signal path is between locations on each side of the equator. However, without the level of solar activity needed to keep the *F*-layer energized enough for VHF propagation, these paths don't materialize. The fall season of TEP usually tapers off by mid-November. This year, though, TEP will be rare, if it occurs at all.

Tropospheric ducting propagation during this season is fairly non-existent, as the weather systems that spawn the inversions needed to create the duct are rare. On the other hand, using tropospheric scatter-mode propagation is possible, but one needs to have very high-powered, high-gain antenna systems. Having dual receivers in a voting configuration would also help. The idea is to use brute force to scatter RF off water droplets and other airborne particles, and capture some of that signal at the far end with dual-diversity, high-gain receivers—not everyone's cup of tea.

Since we're at the very end of solar Cycle 23, and possibly at the start of solar Cycle 24, aurora is very unlikely. Even if there are periods when the solar wind speed is elevated and is magnetically oriented in a way to impact the geomagnetic field, this is the season where we statistically see very few aurora events.

The Autumn Meteor Shower Season

There are a number of opportunities during this period to try your skill and employ your equipment in meteor-scatter propagation. One of the largest yearly meteor showers occurs in November.

The *Leonids* meteor shower is typically the big event for November. This year it is expected to peak on November 17 at 2050 UTC. There is a possible second outburst from a side trail, due at 0445 UTC on November 19. The full *Leonid* period is from about November 14 and continues through November 21.

There are some experts predicting that this year's shower may be more active than the showers of the last few years. An expected rate of over 100 bursts per hour may occur, which will make the prospect for exciting meteor-shower radio propagation probable. We just cannot know for sure, since it takes a direct interaction with the comet dust trail by the Earth in order to see such a high rate of meteors entering the atmosphere.

The chances of Earth hitting a dust trail that is so narrow and filamentary are slim. This has proven true for most of the *Leonids* of recent years in November, when we have missed the trail nearly completely. During these misses, Earth slips between the clouds, where there is only a sprinkling of meteoroids. At such times *Leonid* rates remain low—only 10 or 15 meteors per hour.

Remember that the *Leonid* radiant is best around local midnight in the Northern Hemisphere. Working VHF propagation off meteor tails (the highly ionized plasma trails left by the meteor) requires some reasonable power and gain, and good operating skill. With the latest high-speed burst-mode CW software, you can possibly work even the smaller meteors.

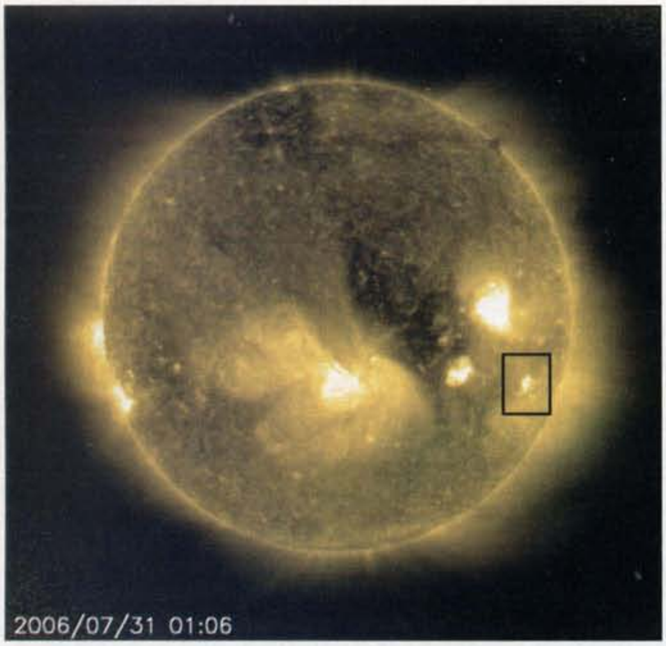
After the *Leonids,* the annual *Geminids* meteor shower from December 7 to December 17 will peak on December 14 at 1045 UTC. This is one of the better showers, since as many as 120 visual meteors per hour (ZHR, or zenith hourly rate) may occur. *Geminids* is a great shower for those trying the meteor-scatter mode of propagation, since one doesn't have to wait until after midnight to catch this shower. The radiant rises early, but the best operating time will be after midnight local time. This shower also boasts a broad maximum, lasting nearly one whole day, so no matter where you live, you stand a decent chance of working some VHF/UHF signals off a meteor trail.

Finally, check out the *Quadrantids* from December 28, 2006 to January 7, 2007, peaking on January 4 at 0030 UTC. This meteor shower is above average, with peaks of around 40 meteors per hour. The best time should be the morning of January 4, just after midnight, and working through predawn.

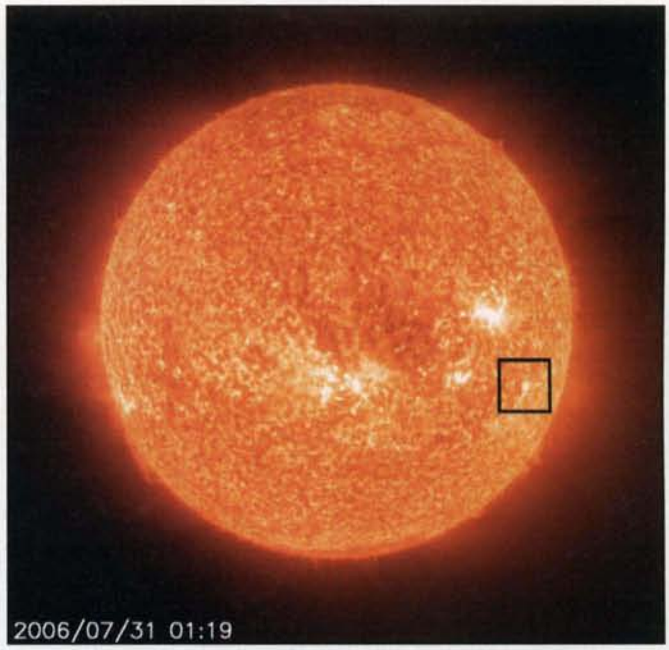
Go to the website <http://www.imo. net/calendar/> for a complete calendar of meteor showers.

Working Meteor Scatter

Meteors are particles (debris from a passing comet) ranging in size from a speck of dust to a small pebble, and some move slowly while some move fast. When you view a meteor, you typically see a streak that persists for a little while after the meteor vanishes. This streak is called the *train* and is basically a trail of glowing plasma left in the wake of the meteor. The *Leonids* are fast meteors and they leave a large number of long trains. They enter Earth's atmosphere traveling at speeds of over 158,000



This view of the sun shows the small sunspot, indicated by the box, that had a backward magnetic polarity. It did not last long enough to be numbered in the official record, but it did alert solar scientists that a new solar cycle may have begun (see text). (Source: NASA/SOHO)



An Extreme ultraviolet Imaging Telescope (EIT) image of the solar atmosphere at a wavelength of 304 Angstroms that shows the backward sunspot (boxed). The bright material is at 60,000 to 80,000°K. (Source: NASA/SOHO)

miles per hour. Besides being fast, the *Leonids* usually contain a large number of very bright meteors. The trains of these bright meteors can last from several seconds to several minutes.

Meteor-scatter propagation is a mode in which radio signals are refracted off these trains of ionized plasma. The ionized trail is produced by vaporization of the meteor. Meteors no larger than a pea can produce ionized trails up to 12 miles in length in the *E*-layer of the ionosphere. Because of the height of these plasma trains, the range of a meteor-scatter contact is between 500 and 1300 miles. The frequencies that are best refracted are between 30 and 100 MHz. However, with the development of new software and techniques, frequencies up to 440 MHz have been used to make successful radio contacts off these meteor trains. On the lower frequencies, such as on 6 meters, contacts may last from mere seconds to well over a minute. The lower the frequency, the longer the specific "opening" made by a single meteor train. A meteor train that supports 60-second refraction on 6 meters might only support 1-second refraction for a 2-meter signal. Special high-speed methods are used on these higher frequencies to take advantage of the limited available time.

A great introduction by Shelby Ennis, W8WN, on working high-speed meteor-scatter mode may be found at <http://www.amt.org/Meteor_Scatter/shelbys_welcome.htm>. OZ1RH wrote "Working DX on a Dead 50 MHz Band Using Meteor Scatter," which is a great working guide (http://www.uksmg.org/deadband.htm). W4VHF has also created a good starting guide at <http://www.amt.org/Meteor_Scatter/letstalk-w4vhf.htm>. Links to various groups, resources, and software are found at <http://www.amt.org/Meteor_Scatter/default.htm>.

The Solar Cycle Pulse

The observed sunspot numbers from July through September 2006 are 12.2, 12.9, and 14.5. Even though this looks like a rise in activity, the overall trend over the last year is clearly showing a decline in solar activity. The smoothed sunspot counts for January through March 2006 are 20.8, 18.7, and 17.4.

The monthly 10.7-cm (preliminary) numbers from July through September 2006 are 75.8, 79.0, and 77.8. Notice how the flux readings are more clearly revealing the steady decline in solar activity, compared to the sunspot counts for the same three months. The smoothed 10.7-cm radio flux numbers for January through March 2006 are 84.0, 82.6, and 81.6.

The smoothed planetary *A*-index (*Ap*) numbers from January through March 2006 are 9.9, 9.2, and 8.4. The monthly readings from July through September 2006 are 7, 9, and 8.

The smoothed monthly sunspot numbers forecast for November 2006 through January 2007 are 9.1, 8.2, and 7.7, while the smoothed monthly 10.7 cm is predicted to be 73.2, 72.4, and 71.9 for the same period. 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 may be found at my propagation center at <http://prop. hfradio.org/> and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing.

73, Tomas, NW7US

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

Working AO-51 Mode L/S, Eagle Update, CubeSat Launch a Failure, HITSAT Launched Successfully

This time in satellite news we will cover working AO-51 Mode L/S, the latest developments of the Eagle satellite, the failure of the massive CubeSat launch, the demise of SuitSat-1, and the successful launch of HITSAT. We'll start out with AO-51 mode L/S.

Working AO-51 Mode L/S

AO-51 recently completed another successful round of mode L/S operation. This mode, more than any other used so far, points out the necessity for computer control of radios and antennas for successful operation.

A number of sessions of mode V/S have proven to be very popular on AO-51, and many operators have trained themselves to correct for ±53 kHz of Doppler on the S-band downlink while ignoring the ±3 kHz on the V-band uplink. Of course, one must not forget antenna control at the same time, and again, the V-band uplink can usually be ignored by using a simple antenna and a little more power. With normal manual dexterity, one can often adapt to all of this and have many successful contacts on mode V/S.

Now back to mode L/S. The ±28 kHz of Doppler on the uplink cannot be ignored, and a directive antenna is usually required on the L-band uplink as well as on the S-band downlink. To summarize, one is now faced with ±53 kHz of Doppler on the downlink, ±28 kHz on the uplink, and control of two directive antennas, not to mention holding a microphone, talking, and taking notes for the log. I ran out of hands to do all of this a while back! Remember, this is still FM on AO-51, and Doppler tracking need not be nearly as precise as it would be for SSB or CW.

Fortunately, a computer can be trained to do the tracking tasks while freeing the operator to do the communications tasks. Actually, the computer can also be trained to do the communications tasks for the digital modes. Unfortunately, in addition to the computer, one must also have the proper computer software and hardware interfaces to the radios and rotators.

A number of good tracking programs for the computer are available. Personally, I find SatPC32 from AMSAT fills the bill nicely on all fronts. I am able to run it in my old notebook computer and control the antennas through a USB port and the Lab Jack and Lab Jack Piggyback interfaces to my G-5500 rotor while controlling the uplink and downlink frequencies through a serial port to my FT-847 radio. Of course, this also requires the obvious up and down converters between the radio(s) and the antennas. Depending on the intermediate frequencies of the converters, alternate radios may be used. Variations on this scheme may be required for your hardware due to different interfaces, etc. SatPC32 contains the drivers for a number of popular rotor and radio interfaces.

Calibration of the setup becomes important and is accomplished by changing constants in the tracking software to compensate for pointing errors and the frequency calibration of your radio/converter configuration. Since your down converter, and possibly your up converter, is usually located at the antenna, temperature drift becomes very important and at least seasonal changes to the compensation must be made. You may even want to consider temperature control of the remotely located equipment.

Don't let all of this intimidate you. It sounds complicated, but it is really quite straightforward, even though a little challenging. Remember: "If you're not careful, you learn something every day."

Eagle Update

In June 2006 another Eagle design review meeting was held in San Diego, California. The Eagle Design Team and invited experts convened to perform an in-depth review of the design with the primary purpose being to check the link budgets, power budgets, produce ability issues, antenna real estate, frequency allocation issues, etc. Not the least of these review items were "sanity checks" for apparent violations of the basic laws of physics. As a result of this review, major changes to the physical size and shape were recommended. The C-C Rider concept (C-band uplink and downlink) was found to not be producible within the size and weight constraints of the satellite. To preserve the overall concept, a change to an S-band uplink and a C-band downlink was made.

Current and predicted activity (over the 15-year predicted design life of the satellite) within the L, S, and C bands has forced the team to take a serious look at these and other bands and their usage. Again, major changes were recommended to the design.

Preliminary results of this meeting were reported by Tom Clark, K3IO, and Bob McGwier, N4HY, at the Central States VHF Society Conference in Minneapolis, Minnesota last July. Subsequently, reports have been published in the *AMSAT Journal,* in Eaglepedia (on-line documentation of the Eagle design, see <http://www.amsat.org>), and via long threads on amsat-bb. The Eagle Design Team is now moving forward with these and other design modifications.

Discussions of these design issues, fund-raising issues, and other Eagle topics are certain to be some of the highlights of the 2006 AMSAT Space Symposium and the AMSAT Board of

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The CubeSats' Stories

By Joe Lynch, N6CL

The CubeSats that were lost are AeroCube-1, CP-1, CP-2, ICE Cube-1, ICE Cube-2, ION, HAUSAT-1, KUTESat, MEROPE, nCube-1, RINCON, SACRED, SEEDS, PiCPoT, and Voyager. Each of these CubeSats has a story. Here I will tell their stories using the text from the Cal Poly website as well as the websites associated with the CubeSats:

AeroCube-1: This was the lone commercial satellite in the group and was to be the first CubeSat from the Aerospace Corporation (http://www.aero.org). It was to operate on 902–928 MHz using spread-spectrum modulation.

CP-1: CP-1 was the first satellite developed and built by California Polytechnic State University San Luis Obispo (Cal Poly, website: <http://polysat.calpoly.edu>). It was designed with the objective of providing a reliable bus system to allow for flight qualification of a wide variety of small sensors and attitude control devices. It had been patiently awaiting launch for four years.

CP-2: CP-2 was the second satellite developed and built by Cal Poly. The primary missions of CP2 were an energy dissipation experiment as well as a field test of what they dubbed the CPX Bus. CP2 marked their first attempt at "standardizing" a CubeSat bus to enable easier integration of a wide variety of payloads. CP3, their next CubeSat, will use a slightly upgraded CP2 bus.

ICE Cube-1 (Ionospheric sCintillatin Experiment CubeSat Project): ICE Cube-1 was the first satellite developed and built by Cornell University's College of Engineering (http://www.mae.cornell.edu/cubesat/). ICE Cube-1 was to be a mission to collect data for use in estimating electrical strength of clouds in the ionosphere. These clouds are restrictive to GPS, so the mission would have allowed for a better understanding of the limitations these clouds impose. The satellite had an onboard GPS system. The satellite also had full onboard ADCS system for X, Y, and Z stabilization.

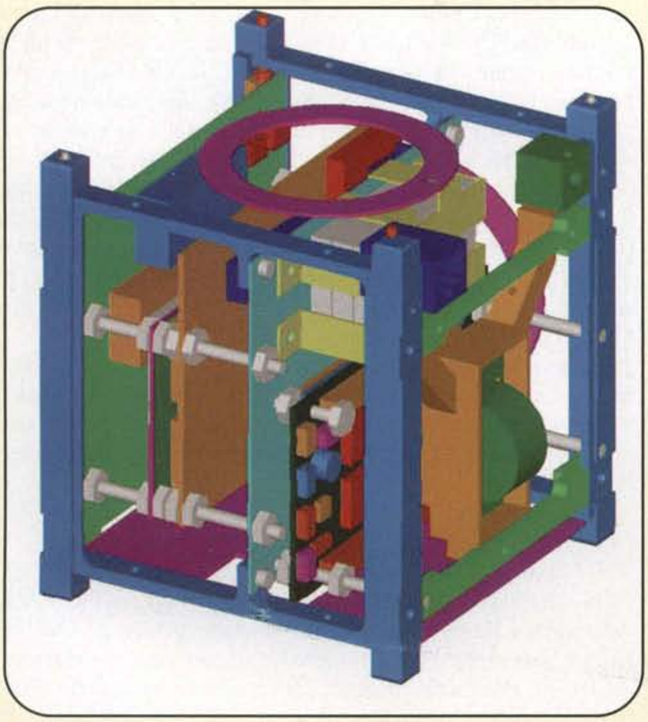
ICE Cube-2: ICE Cube-2 was the second satellite developed and built by Cornell University's College of Engineering. It was also to be a mission to collect data for use in estimating electrical strength of clouds in the ionosphere. The satellite had an onboard GPS system. It also had full onboard ADCS system for X, Y, and Z stabilization.

The ICE Cube satellites were projects of two different engineering classes at Cornell's College of Engineering. Their objective was to design, build, test, and operate a fully functional 10-cm CubeSat for GPS scintillation science in Low Earth Orbit. For more information on the satellites and the student participants, please see the Cornell website listed above.

ION (Illinois Observing Nanosatellite): ION was the University of Illinois at Urbana-Champaign's first satellite of the Illinois Tiny Satellite Initiative (ITSI), which is organized as an interdisciplinary senior design course. The course objectives include training students to identify, formulate, and solve engineering problems as part of a large multi-team project. For more information on this CubeSat, see the website <http://cubesat.ece.uiuc.edu/>.

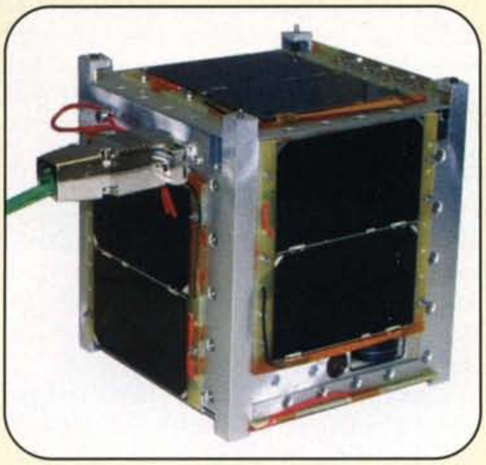
HAUSAT-1 (Hankuk Aviation University SATellite-1): Developed in conjunction with Hankuk Aviation University, HAUSAT-1 was the first picosatellite in Korea to be developed by graduate students. For more information on this CubeSat, see: <http://134.75.55.85/new_version/english/hausat_1/index.php>.

KUTESat (Kansas Universities Technology Evaluation Satellite): The primary mission of KUTESat was to measure the radiation in LEO (Low Earth Orbit) and take photographs with an onboard camera. The second phase of the program was to build an engineering demonstration of the satellite

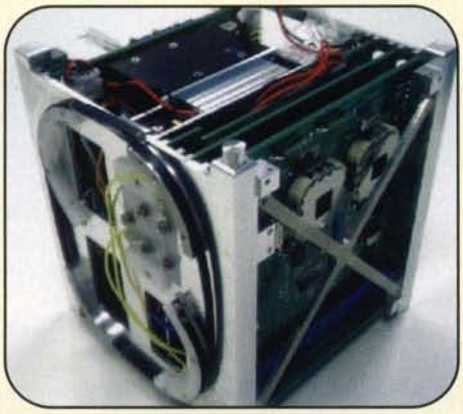


Internal view of the ICE Cube CubeSat. (Photo courtesy of Cornell University College of Engineering)

The ION CubeSat. (Photo courtesy the University of Illinois Urbana-Champaign)



The CubeSat of Montana State University. (Photo courtesy of Montana State University)



The CubeSat developed by Nihon University of Japan. (Photo courtesy of Nihon University)

with an onboard attitude control system using miniature thrusters. This CubeSat was built by graduate and undergraduate students at the University of Kansas.

MEROPE (Montana EaRth-Orbiting Pico-Explorer): A project of Montana State University, the MEROPE satellite was to have mapped the Van Allen belts and test hardware and ideas not yet flown before in space. For more information on this satellite, go to: <http://www.ssel.montana.edu/merope/mission/overview.html>.

nCUBE-1 (Norwegian Student Satellite): The Norwegian Student Satellite Project aims to design, build, integrate, test, and launch a small satellite in order to provide students in Norwegian educational institutions with hands-on experience, space industry contacts, and long-term space development. On top of this, nCUBE-1 was to have demonstrated the possibility of receiving navigational messages from ships at sea using the limited AIS storage. For more information on the satellite, see the following:<http://www.ncube.no/project_documents/NCUBE-GS.pdf>.

RINCON (Rincon Research Corporation, Tucson, AZ): This University of Arizona Student Satellite Program CubeSat was designed in cooperation with Rincon Research Corporation. As its primary mission it was to function as an engineering satellite that would test all the basic functions. The payload would have been able to act as a redundant communications system, downlinking all 24 telemetry signals.

SACRED (Study the Action of Cumulative Radiation on Electronic Devices): This University of Arizona Student Satellite Program CubeSat was designed to study the action of cumulative radiation on electronic devices.

SEEDS: SEEDS, a CubeSat developed by Nihon University, had as its primary mission to utilize a three-axis geomagnetic sensor and three-axis gyros to obtain satellite attitude data. The satellite would also monitor its thermal situation. Additionally, according to its website (http://cubesat.aero.cst.nihon-u.ac. jp/english/seeds_e.html#01), the mission given to SEEDS was divided into three parts: the communication mission, the sensing mission, and the orbit analysis mission.

VOYAGER: This CubeSat, developed by students in the College of Engineering of the University of Hawaii, was designed to test an active antenna. According to their website (http://www.ee.eng.hawaii.edu/~cubesat/):

> The University of Hawaii CubeSat will incorporate the following experiments as its payload. Active antenna: CubeSat communications currently operate at VHF/UHF frequencies. However, to support increased data rates, higher frequency communications are desired. Thus, an active antenna will be flown to determine its feasibility for use in space.

PiCPoT (Piccolo Cubo del Politecnico di Torino, CubeSat of the Politecnico di Torino): The following is from the Southgate Amateur Radio Club website (http://www.southgatearc.org/news/july2006/italian_cubesat.htm):

> This is the forerunner of what is hoped will be a constellation of satellites to be built by Italian universities. The satellite, which is just 13 cm square and weighs 2.5 kg, carried three cameras with JPEG compressor and storage for up to five images.

As you can see, each of these satellites has a story behind it. The purpose of telling their stories here is to celebrate the work that the students and faculty accomplished in the run up to the failed launch. It is also to encourage others to get involved in CubeSat development.

Directors Meeting to be held in the San Francisco Bay Area October 5–8, 2006. All facets of the satellite and ground-station development will be covered in the papers presented at the symposium. A detailed report of the 2006 AMSAT Space Symposium will be in my next column.

Massive CubeSat Launch Ends in Failure

The planned massive CubeSat launch reported in my last column occurred on July 26, 2006. Unfortunately, the launch vehicle developed a problem early in the launch sequence, and the 14 CubeSat payloads failed to reach orbit. The launch agency has investigated the incident and corrective action is being taken. Meanwhile, further launches of the Dnepr launch vehicle are on hold.

Additional details of these and other CubeSats are available at: <http://www. cubesat.org> and <http://showcase.netins.net/web/wallio/CubeSat.htm>. Also see the "VHF Plus" column by N6CL in the November 2006 issue of *CQ* magazine.

SuitSat-1 is a Silent Key

On September 7, 2006 at 1600 UTC, SuitSat re-entered the Earth's atmosphere over the Southern Ocean at 110.4° east latitude and 46.3°south longitude. It was over a point some 1400 km south-southwest of Cape Leeuwin (Augusta), Western Australia. As far as we know, there were no eye-witnesses to the event and no debris landed on Earth.

Thanks to ARISS (Amateur Radio on board the International Space Station) for the above information. Additional information, including the winners of the "Chicken Little" contest, are available at the URL: <http://www.amsat.org/amsat-new/ariss/suitsatContest.php>.

HITSAT Launched Successfully

HITSAT, a new amateur radio CubeSat, was successfully launched from Japan on September 22, 2006. HITSAT was developed by the Hokkaido CubeSat Development Ham Club at the Hokkaido Institute of Technology under the guidance of Assistant Professor Mitsuhashi Ryuichi. It rode to orbit as a secondary payload aboard a Japanese Space Agency launch of the Japanese Solar-B mission.

Satellite Callsign: JR8YJT. CW telemetry downlink: 437.275 MHz. 1200-baud FM packet downlink: 437.425 MHz. Thanks to the AMSAT News Service and the HITSAT Team for the above information.

After deployment, many amateur radio operators from around the world reported hearing HITSAT and copying the telemetry. After a few orbits, the transmitters were turned off to conserve power for an attitude control period. Many operators became concerned when nothing was heard for a while after the planned attitude control period was over. On September 26 the transmitters were turned on again only when the satellite was within range of Japan. More details will follow. Hopefully, HITSAT will have a long and useful life.

AMSAT Space Symposium and ARISS Meeting

I will be attending the AMSAT Space Symposium and the ARISS International Meeting in the San Francisco Bay area October 5–10, 2006. The AMSAT Board of Directors meets October 5–6, the symposium is in session from October 6–8, and the ARISS International Meeting will be held October 9–10. As mentioned earlier, a full report of these meetings is planned for my next column.

Summary

As usual there are satellite activities around to keep you busy at any time of the year. Support your area hamfests and, by all means, support the efforts of AMSAT to build our new projects—P3-E and Eagle.

73, Keith, W5IU

By John Champa,* K8OCL

Communicating Voice, Video, and Data with Amateur Radio

What is Happening to the HSMM Working Group?

At its January 2006 meeting, the ARRL BoD directed that the HSMM (High Speed Multi Media) Working Group summarize its accomplishments and submit its final recommendations by year's end. With that directive in mind, and with dissatisfaction within the Working Group regarding how its recommendations concerning permitted radio network protection methods (e.g., encryption) for the Amateur Radio Service are being communicated by the League, most of the group members simply left.

The ARRL HSMM website (http:// www.arrl.org/hsmm/), which has been in operation for the past five years, has been transferred to the Technical Information Services (TIS). However, the HSMM public discussion reflector (ARRL-80211B@listserv.tamu.edu) remains in full operation.

Some of the Working Group membership who left have since formed a new digital radio networks research organization, the Amateur Radio Broadband Alliance (ARBA) in association with Texas A&M University in College Station, TX. More on this new organization will be covered in this column in the next issue of *CQ VHF*.

What is 802.16 (WiMAX)?

According to its web page "The IEEE 802.16 Working Group on Broadband Wireless Access Standards develops standards and recommended practices to support the development and deployment of broadband Wireless Metropolitan Area Networks *[that's WMANs vs. WLANs covered by 802.11 standards, i.e., more range—ed.]*. IEEE 802.16 is a unit of the IEEE 802 LAN/MAN Standards Committee, the premier transnational forum for wireless networking standardization."

The following is a report from the HSMM Working Group Project Leader for 802.16 investigations, Gerry Creager, N5JXS (e-mail: <gerry.creager@tamu. edu>) of Texas A & M University:

We've installed a Solectek link here at TAMU. We're operating under both Part 97 and Part 15 for testing in the 5.7 GHz region. So far we've deployed a point-to-multipoint installation and are working with a point-to-point operation over a 3 mile path.

We're achieving data rates of up to 72 Mb/s on the point-to-multipoint configuration, and we're locking at 36 Mb/sec on the point-to-point link for political reasons. Note that this experiment is co-sponsored by the university's campus networking folks, so the Part 15 stuff is highly subject to politics.

The Part 97 aspect is being tested in concert with AG5GY. His was the first link up, at about 2.8 miles. The client end uses a panel antenna with 24 dBi gain and a 9 degree beamwidth. Power output on the clients is 100 mW. It's mounted about 14 feet off the ground. There's a clear line of sight to the base.

My house is 5.0 miles from the base, in a hole, and behind some 40 foot tall oak trees. This is a real test of non-line of sight (NLOS) wireless technology. I'm seeing marginal signal but we're getting 72 Mb/sec most of the time, and even with excessive retries, the performance is pretty good. I'll be expanding into voice-over-IP (VoIP) and video soon to see about packet loss, jitter, and congestion in the face of real applications.

The base unit produces 400 mW. We're using a 27 dBi panel with a 90 degree beamwidth. All polarization is vertical. The base is mounted at approximately 240 feet AGL . . . and about 550 MSL. That places it at about 200–220 foot height above average terrain (HAAT).

The subtended angle between AG5GY's site and mine is on the ragged edge of 90 degrees. I've tweaked the antenna slightly to favor Tom. We're awaiting a 120 degree panel, which should improve both operations.

We're ordering in a pair of dedicated point-to-point radios (9 degree beamwidth, 17 dBi, 400 mW) for some link testing to two sites. Also, all of our additional client-side radios will be 200 mW or 400 mW ("medium" or "long" range clients) as there's not much purpose, based on testing so far, to have short range radios for paths of unknown distance.

Solectek has been pretty easy to work with, although they're a start-up and their software's pretty much in flux. I think I'm going to be able to forge a working relationship with them on both the university and amateur areas; I've already pointed out that their operation under Part 15 resides in our band, and we're now talking about getting the "secret" codes they do not release to Part 15 customers.

We've suffered a couple of failures. A power-line hit at AG5GY's house apparently fried a client. Solectek is revisiting that system and owes me a complete post-mortem . . . and another client. Their warranty is pretty good. *Also,* Solectek "upgraded" their firmware release and suggested we reflash the units. Things worked fine up until the reboot after we reflashed, then *nothing* worked. We lost a couple of days trying to figure that out, and finally suggested to Solectek they have a bad software release . . . reflashing to the previous release restored operation. And, to add insult to injury, a loaner system they'd sent needed to be reflashed. After rebooting it, it's doing a good impression of a recently sprayed cockroach . . . on its back with its legs in the air, not responding. That's going home for postmortem, too.

Over all, after a couple of weeks of playing, I think it's going to work. I intend to have high-speed Internet at my house and Tom's. I plan to link the hospitals and Emergency Operations Centers (EOCs) with 802.16. The university is already happy enough with the system to plan to employ it for a lot of our wireless dedicated link requirements. We're cooperating between the amateur and official interests to keep links orthogonal and manage frequencies. And, it helps to be the 802.16 "guy" on campus when the production folks need help.

Future plans:

1. Go from 20 MHz spreading to 40 MHz spreading and look at effects on range, bandwidth, and NLOS operations.
2. Go to higher power radios for similar evaluations.
3. Get the 120 degree sector antenna in and improve Tom's and my operations.
4. Continue evaluations and connectivity for the university side, to get more datapoints.
5. Hook up the EOCs and hospitals (and I'll admit that that's a total of six links, so it's pretty easy. We're a relatively small geographical entity) and enable Part 97 operations on the links from there, for Voice/Video, data, and Internet. These hookups will be made with appropriate controls.
6. Mobile tests, similar to those Solectek has on its Whitepapers section of the website, to see where we can and cannot put up instant links.

With the ending of the ARRL Working Group and the changes occurring in HSMM communications, it seems that amateur radio based HSMM communications is in a deep transition period. While change is always challenging, it is also a time when new, cutting-edge developments emerge. We are looking forward to reporting on new developments in future editions of this column.

73, John, K8OCL

**Chairman of the ARRL Technology Task Force on High Speed Multimedia (HSMM) Radio Networking; Moon Wolf Spring, 2491 Itsell Road, Howell, MI 48843-6458*
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By Rich Arland,* W3OSS

BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

Changing Lives with Radio

Every now and then I take time out to pontificate about the state of our radio hobby. Lately I have been ruminating over the state of our hobby, where we have been and where we are going.

Many of us started out listening to international broadcasts on shortwave. Unfortunately, many of the long-time international broadcasters no longer maintain a presence on the shortwave bands, or if they do, their broadcasting schedules are drastically reduced compared to earlier years. I was deeply saddened recently when I learned of the demise of HCJB's English language programming. You see, HCJB was the first station I ever heard on international shortwave and from which I received a QSL card. What made this reception report so interesting was the fact that I was using a Heathkit radio that I built in 1961. While I started my shortwave listening hobby when I was only 10 in 1956, using a radio I built myself from a kit opened a whole new facet of the radio hobby for me.

While we ham radio operators have a lot of fun building cutsie little rigs and running around playing radio, we need to look back and review what got us to where we are today. Why did we take the "road to radio" rather than take up some other hobby interest such as stamp collecting or basket weaving? Think about it. Then ask yourself how your life changed due to your involvement in the radio hobby. Have you managed to infect anyone else with the dreaded radio bug? No matter what your answer to that last question, read on, for as a group of active hams within the radio hobby, we have some serious work to do if the future of our hobby is to endure.

Who was your Elmer? Who helped and guided ("Elmered") you when you first started out in the radio hobby? We've *all* had an Elmer. I had three: George Comstock, W7CJ; Mike Brabb, K7TWS; and his mom, Jessie, K7TWR. These three people were responsible for my first baby steps in the radio hobby, from erecting my first dipole antenna for 80 meters to helping me debug a poorly built Knightkit T-50 transmitter that got me my first (and only) FCC "pink slip" (but that's another story).

One summer afternoon, George dropped by the house to ask if I wanted to go to Spokane, Washington with him. It was a business trip and he was planning to stop by HCJ Electronics before coming home. Since I had just received my Novice ticket at the tender age of 16, I was excited about seeing the hallowed halls of HCJ Electronics on Sprague Avenue in Spokane.

HCJ Electronics was our local ham emporium. Owned and operated by Ralph Farano, W7HCJ, HCJ Electronics was *the* place to go for new and used ham gear. There was a bottomless coffee pot along with a Coke™ machine in the display room, and hams from all over the area found their way to HCJ each week. Ralph had much of the latest gear set up to try out. If you decided on a used piece of gear, he could also fire that up on an antenna so you could actually try it out before perhaps purchasing it. HCJ Electronics was Mecca for those of us who live in eastern Washington State.

Did I want to go? Does a bear go poop in the woods? I hopped into George's Olds 98, complete with a set of Gonset Twins and a Webster Bandmaster HF antenna and off we went to Spokane. In 1963, AM hadn't quite lost the battle to single sideband. The chromed Gonset Twins held me transfixed as we rocketed northward. Sensing my eager anticipation, George warmed up the radio gear and dialed in a 75-meter AM frequency that the hams at HCJ monitored. Handing me the mic, he said, "Go ahead. Give HCJ a call, and don't forget to use my callsign. And Rich . . . relax, it's only a radio."

"W7HCJ, W7HCJ, this is W7CJ mobile, with KN7YHA at the mic, over," I said sheepishly, keying the big Gonset microphone.

"W7CJ here is W7HCJ. You must be Rich. George said he might be bringing you along on this trip. We're looking forward to meeting you. How does it feel to be using phone instead of CW? W7HCJ," came the immediate reply from the dash-mounted speaker.

At that precise instant in time my life changed forever. From that moment on, I was hooked. Forty-three years later, I still marvel at this mystical medium we call *radio.* Had it not been for George, Mike, and Jessie, I would never have pursued a career in electronics with 20 years active duty with the US Air Force and 17 years as a VoEd Electronics instructor, written five books on ham radio and the monthly QRP column in *QST* (not to mention the Homeland Security column in *Popular Communications,* and this Beginner's column in *CQ VHF*), operated and DXed from some great foreign locations, made hundreds of friends, and heard Port Moresby, Papua New Guinea on 90 meters while eating breakfast in Hampton, Virginia! No, my world would have been drastically different from what I now enjoy.

What About Radio's Future?

Virtually all of us who have been involved in the radio hobby for any length of time can dredge up similar memories, many thanks to our "Elmers." My question to you is what have you done to further the radio hobby in the last 12 months. Who have you helped or "Elmered"? What have you done to introduce some aspect of the hobby to a neophyte?

We all complain that our radio hobby is in danger of becoming extinct. The average age of the ham radio population is in the late 50s. Young people often prefer instead to play on their video gaming machines, spend countless hours in front of their computers surfing the Internet, or rip CD tracks for their MP3

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players. To be sure, today's young people are not afraid of technology, but they don't tend to gravitate to the ham radio side of the technical hobby in great numbers either. Without an influx of newcomers, our radio hobby is doomed. That much is for certain.

Shortly after the 17th Annual SWL Winterfest—a gathering of the shortwave faithful near Landsdale, Pennsylvania each March—my 11-year-old grandson, Chris, expressed interest in learning about shortwave listening. I was stunned! Quickly recovering, I told him that I had a spare SW receiver (an old Realistic DX-150A) and some beginning books on the subject that I would gladly loan him to get him started. He was ecstatic—and so was I!

The DX-150A had just undergone a complete alignment and was working great. I included a basic book on SWL by Harry Helms, along with the NASWA (North American Shortwave Association) countries list, a current copy of *Passport to Worldband Radio,* and some other material that I had lying around. I added 50 feet of wire for an antenna and we proceeded to his house to set up his radio monitoring station.

At one of the first Winterfests I was the lucky (?) recipient of the dreaded "Barto Bag." This is the booby prize of the event, often consisting of lots of meaningless "stuff" that couldn't be given away or auctioned off during the festivities. My "Barto Bag" consisted of a Radio Beijing bag (no, really . . . it was a real live bag from R. Beijing!) full of SW station pennants. My wife gave this bag to Chris so he could decorate his room with the SW pennants. Chris, to my amazement, handed the bag back to me stating, "I'd like to earn these by logging these stations, and then you can give me the pennant for each station." What's this? A kid who actually doesn't require instant gratification! Good Lord, we may not be in as bad shape as I had originally thought!

Presently, Chris is knee deep in school work (he just telephoned tonight telling me about his report card—all "A"s and "B"s!), but he hasn't lost interest in DXing the SW bands in search of international broadcast stations. I stand ready to answer his questions, just like my Elmers did for me. I only hope he finds as much mystery, fun, and challenge in the radio hobby as I have over the years. When he gains experience, I plan on helping him go after MIL-COM (Military Communications) and Utility stations along with doing some "serious" DXing of the Pacific Rim and South/Central America. They are still out there, you know. All you have to do is look and listen—carefully.

VHF—The Last Frontier

Over the years, the Federal Communications Commission has worked diligently to ensure an entry-level license for amateur radio exists. Back in the 1950s, the FCC instituted the Novice class license, which allowed a newcomer to the ham radio hobby a chance to get on the HF bands using crystal-controlle transmitters and Morse code, or CW. This allowed the neophyte amateur radio operator to get on-air experience using basic equipment, thereby honing his operator skills prior to upgrading his license.

For more than 30 years the Novice class licensewas the major entry point into the amateur radio fraternity. However, in 1991 the FCC dropped the Morse code requirements for the Technician class license. As a result of this change many hams came into the hobby by way of what became known as the no-code Technician class license.

In the 2000 license restructuring the FCC stopped issuing new Novice class licenses, thereby closing that entry point into amateur radio. The FCC also lowered the Morse code requirement for the General and Extra class licenses to 5 wpm, as well as eliminated the Advanced class license.

The reduced Morse code requirement has led to an influx of General and Extra class operators. However, there remains a large number of Technician class operators who are very satisfied operating on VHF and UHF frequencies and who do not intend to upgrade their licenses in order to work HF frequencies. This is not necessarily a bad thing.

Those of us who regularly utilize the VHF bands for both localized FM communications and weak-signal DX work are quite proud of our accomplishments. It is incumbent, therefore, upon those of us who are old hands at VHF/UHF work to ensure that newcomers to the hobby are exposed to this aspect of amateur radio. In order to ensure continued growth within the hobby, we all must "Elmer" new VHF-plus operators. We must take them by the hand and help them establish good operating and engineering practices on, what I personally believe is, the last true frontier in amateur radio.

What's *Your* Excuse?

No more excuses. When you attend club meetings or proctor FCC examinations as a Volunteer Examiner, take the time to talk to the new hams and explain to them the benefits of operating VHF-plus. The no-code Technician class license is a great way to increase the number of ham radio operators within our ranks. Our job is to ensure that these new ham radio operators become active and stay active once they receive their license.

Don't stop with just strangers, either. Grab one or two of your kids or grandkids, nieces or nephews, and kindle their interest in radio. Don't beat them over the head. Just be gently persistent and explain the fun and mystery of playing radio. Show them your collection of QSL cards from some of the prominent SW broadcasters. Give them a demonstration of your VHF/UHF equipment and show them how easy it is to set up a station and enjoy the radio hobby. Don't forget to emphasize that ham radio does not need to be an expensive hobby. There is a lot of good equipment on the used market that can be had at a fraction of the original cost. Be sure they understand that VHF and UHF antennas are much smaller than their HF counterparts and therefore are much easier to erect and less of a potential problem with the neighbors. Emphasize that while radio is older technology, you can still hear first-hand about people from all over the world, all the while learning about social events that are happening every day.

Offer to loan them an old shortwave receiver if you have one, but don't forget to show them how to use it. A few minutes spent in teching them how to utilize the receiver correctly will go a long way toward their enjoying the first steps in the radio hobby. Don't worry. Once they get the hang of listening to the SW broadcast outlets, they will become interested in the *science* of radio, and once that happens, there is no turning back. Go on. You can do it. Give it a try. Take one for the hobby.

73, Rich, W3OSS

By Bob Witte,* KØNR

FM

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

2-Meter Band Plans – Many to Choose From

I subscribe to a number of e-mail lists associated with ham radio topics. On one of these lists, a pair of hams was arranging a schedule using FM just below 144.5 MHz. I poked my head in and commented that the ARRL band plan showed this frequency in the "New OSCAR Subband," 144.30–144.50 MHz. One of the hams replied that according to the Area Repeater Coordination Council (ARCC, the frequency coordination body for eastern Pennsylvania and southern New Jersey) band plan, FM simplex is allowed in the 144.310–144.370 MHz range. Sure enough, that band plan does show FM simplex in this segment of the band.

This caused me to take a look at the various 2-meter band plans around the U.S. Of course, the 2-meter ham band is the most popular VHF band and has a wide range of uses: FM repeaters, FM simplex, weak-signal SSB/CW, propagation beacons, APRS (Automatic Position Reporting System), EME (Earth-Moon-Earth), and AX.25 packet. This makes for an interesting challenge of how to share the frequency spectrum. As we'll see, how the band is allocated depends on where you are located.

Band Planning

The basic idea of band plans (also called *Frequency Utilization Plans*) is to coordinate how radio hams use the frequency spectrum. In particular, band plans designate areas for different types of modulation and communication modes, since different modes are often incompatible. For example, an FM signal can't be received correctly by an SSB receiver, so having those modes operating on the same frequency just creates confusion and frustration. Even if the modulation type is the same, there may still be incompatibility. For example, OSCAR satellites may use modulation types that are the same as terrestrial operating (FM, SSB, CW, packet, etc.). However, terrestrial contacts are incompatible with working the satellites, since it is likely that terrestrial signals would interfere with a satellite without realizing it.

In recent policy decisions, the FCC has been clear that it intends to provide a minimal amount of band planning by regulation and to allow the amateur community to manage frequency sharing. However, there are a few FCC rules that regulate how the 2-meter band is used. The FCC reserves the very low end of the 2-meter band, 144.0–144.1 MHz, for CW emissions only (FCC Part 97.305c). Also, the FCC excludes repeater operation from these frequencies on the 2-meter band: 144.0–144.5 MHz and 145.5–146.0 MHz (FCC Part 97.205b).

The ARRL Band Plan

In the U.S., the ARRL band plan provides the basic guidance on how the 2-meter band is used.

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ARRL Band Plan for 2 Meters (144–148 MHz)

(Source: http://www.arrl.org/FandES/field/regulations/bandplan.html)

144.00–144.05	EME (CW)
144.05–144.10	General CW and weak signals
144.10–144.20	EME and weak-signal SSB
144.200	National calling frequency
144.200–144.275	General SSB operation
144.275–144.300	Propagation beacons
144.30–144.50	New OSCAR subband
144.50–144.60	Linear translator inputs
144.60–144.90	FM repeater inputs
144.90–145.10	Weak-signal and FM simplex (145.01, 03, 05, 07, 09 are widely used for packet)
145.10–145.20	Linear translator outputs
145.20–145.50	FM repeater outputs
145.50–145.80	Miscellaneous and experimental modes
145.80–146.00	OSCAR subband
146.01–146.37	Repeater inputs
146.40–146.58	Simplex
146.52	National Simplex Calling Frequency
146.61–146.97	Repeater outputs
147.00–147.39	Repeater outputs
147.42–147.57	Simplex
147.60–147.99	Repeater inputs

Notes: The frequency 146.40 MHz is used in some areas as a repeater input. This band plan has been proposed by the ARRL VHF-UHF Advisory Committee.

There is a similar (but not *identical*) band plan for Canada from the Radio Amateurs of Canada (R.A.C). See the references at the end of this column for web addresses.

Regional Band Plans

Most VHF operation tends to be regional or local in nature. This may be less true of long-distance modes such as moonbounce and meteor scatter, but coordination of repeater frequencies happens on a regional basis. Visit the National Frequency Coordinators' Council (NFCC) website to find contact information for your local coordination body.

I did some web surfing on the various coordinating bodies to see how the 2-meter band plan is implemented across the country. Clearly, most of the energy expended on frequency coordination and band plans is for FM repeaters, but this must be done in the context of the other types of radio operating on the band.

FM Channel Spacing

One of the first issues that surfaces with repeater frequency coordination on the 2-meter band is the channel spacing—15 kHz or 20 kHz. FM repeaters normally are fixed in frequency, and we'd like to pack them in as tight as possible (but not too tight) to make maximum use of the spectrum. The same is true for FM simplex: We designate specific frequencies for simplex operation so that we get maximum use of the band without signals overlapping. (Compare this to HF operation, where the normal practice is to just tune to any open spot in the spectrum.)

Carson's Rule is commonly used to estimate the bandwidth of an FM signal. The rule says that the signal bandwidth is two times the sum of the peak deviation and the maximum modulation frequency.

$$BW = 2 \times (f_{dev}\ \text{peak} + f_{mod}\ \text{max})$$

For amateur radio 2-meter FM, the peak deviation is normally 5 kHz and the maximum modulating frequency is 3 kHz, resulting in a bandwidth of 2 × (5 kHz + 3 kHz) = 16 kHz.

Historically, FM operation on the ham band started out with 30-kHz spacing between channels. You may have noticed that some of the earliest FM repeaters were set up on this channel spacing: 146.76 MHz, 146.79 MHz, 146.82 MHz, 146.85 MHz, 146.88 MHz, etc. Note that the 30-kHz spacing is significantly wider than the 16-kHz bandwidth signal. As FM activity increased, available repeater frequencies were used up and there was the desire to add more repeater pairs into the spectrum.

At this point, there were basically two choices to obtain more repeater frequencies in the same spectrum. Using 15-kHz spacing essentially splits the 30-kHz channels in half and allows new channels without requiring the existing repeaters to change frequency. However, 15 kHz is a bit narrow for our nominal 16-kHz wide signals. The other choice was to realign the frequency plan using 20-kHz channel spacing. This issue was debated vigorously by repeater owners and frequency coordinators across the country. I won't go any deeper into the tradeoffs other than to say that tighter channel spacing gives you more channels, but at the expense of more potential for adjacent channel interference. One common approach is use 15-kHz channel spacing in the 146–148 MHz range, while adopting 20-kHz channels below 146 MHz.

The result is that some regions of the country adopted the 15-kHz channels while others decided to use 20-kHz spacing. This is not a big problem for day-to-day FM VHF operating (except maybe near the boundary separating a 15-kHz area and a 20-kHz area), but when traveling across the country it can get confusing. The front section of *The ARRL Repeater Directory* has a map that shows the channel spacing by state. The channel spacing for repeaters also tends to be used for the FM simplex channels. The National Simplex Calling Frequency is 146.52 MHz and is recognized nationwide. The adjacent simplex frequencies depend on the channel spacing, so the 15-kHz regions use 146.52, 146.535, 146.55, 146.565, etc., while the 20-kHz regions use 146.52, 146.54, 146.56, 146.58, etc. Putting all of this together means we have a bit of a mess in terms of inconsistent use of frequencies.

Linear Translators

The ARRL Band Plan shows 144.50– 144.60 MHz and 145.10–145.20 MHz designated as frequency pairs for linear translators (inputs and outputs). A linear translator is essentially a repeater that retransmits a portion of the frequency spectrum without demodulating it. This method is intended to allow SSB, CW, or other linear modes to be used in a repeated manner.

This concept never really took off, so most repeater coordinating bodies have reassigned these frequencies to be used for FM repeaters. (Let me know if there is a 2-meter linear translator in operation somewhere.)

More Repeater Pairs Less Simplex

In highly populated areas, there is consistent pressure to have more repeater pairs in the 2-meter band. Some repeater coordinating bodies have taken steps to squeeze in additional repeater pairs, usually at the expense of FM simplex channels. For example, the SouthEastern Repeater Association (SERA), the coordinating body for eight states in the southeast, uses fre-

Hawaii to California on 2 Meters FM

By Bob Witte, KØNR

In the previous issue of *CQ VHF*, I described the QSO that resul- ed from my mighty 2-meter FM handheld transmitting its sign across Lake Michigan to Oshkosh, Wisconsin. I am thinking th using a 1.5-watt HT to work a station 100 miles away on 2-met FM was pretty dang good. However, shortly thereafter I was liste ing to Amateur Radio Newsline™ (Report #1507) and heard abo a 2500-mile 2-meter FM contact between Hawaii and Califor Now *that* is impressive.

WH6DQ to NO6B

This contact took place on 146.52 MHz at about 5 PM Hawaii tim on June 26, 2006. Bill Cullen, WH6DQ, on The Big Island of Hawa makes it a habit to listen on 147.09 MHz, which is the transmit fr quency of the Santa Catalina Island repeater (AA6DP) off the coa of California. Bill said, "I always monitor .09 just in case tropo com in during the summer."

When the tropo came in on June 26th, there was a net running o the Catalina repeater. Bill broke in and informed the net control sta tion that the repeater was being heard in Hawaii due to the tropo ope ing. Bob Dengler, NO6B, was able to hear Bill on the repeater inpu and they switched over to 146.52 MHz for a simplex contact. Som other California stations tried to work Bill on .52, but none were su cessful, so Bill switched back over to the Catalina repeater. He quic ly had a pile-up of southern California stations wanting to wor Hawaii. Bill made about 20 contacts in 10 minutes with signal le els from the repeater peaking S7 or S8. Then the signals faded awa as the tropo propagation ended.

In an e-mail, Bob, NO6B, wrote:

> I was monitoring the swap net on the Catalina 147.090 (+) repeater with my HT in the living room when Bill broke in for a signal report. I ran to the radio room to see if I could hear him directly on the input with my Yaesu FT-8500 at 50 watts to a Comet GP9 antenna. I live on a hill in Diamond Bar and have an excellent view to the west, so I figured that once the tropo ducts to Hawaii formed, I would have a decent chance to make a direct contact. At first, though, I heard nothing. Bill chatted with net control for a minute or two, and then net control decided to continue the net and signed with him. Roughly half an hour later he showed up again on the repeater, but this time I could hear him directly on the input. I broke in and asked Bill to move to 146.52 MHz for the contact, which lasted about 3 minutes. His signal was rather weak, with about 75% of his transmissions being readable on my end. Following the contact, some other local stations tried to work him on 146.52 MHz but were unable to. He then returned to the Catalina repeater and worked several stations through the repeater, but none were able to hear him on the input. I recorded the traffic

quencies shown as FM simplex on the ARRL Band Plan for repeater pairs. Specifically, these pairs may be coordinated in some areas:

Input/Output

146.400/147.000 MHz
146.415/147.015 MHz
146.430/147.030 MHz
and so on

These pairs use the standard 600 kHz offset but with the opposite (negative) polarity. On most transceivers, you would tune to the output frequency (e.g., 147.000 MHz) and select a –600 kHz offset.

The ARCC band plan (eastern PA and southern NJ) takes a different approach, implementing repeater pairs that have a 1 MHz offset:

Input/Output

147.445/146.445 MHz
147.460/146.460 MHz
146.475/147.475 MHz
146.490/147.490 MHz

heard on 147.690 MHz and put it on my web page (http://no6b.com). Immediately before I started the recording, Bill's signal increased to 20 dB quieting for about 10–20 seconds; that was the strongest I ever heard him.

Bill, WH6DQ, says that tropo from Hawaii to the mainland is usually from The Big Island. He also notes that well-known VHFer Paul Lieb, KH6HME, has the most experience working the mainland, using SSB from his radio site on Mauna Loa.

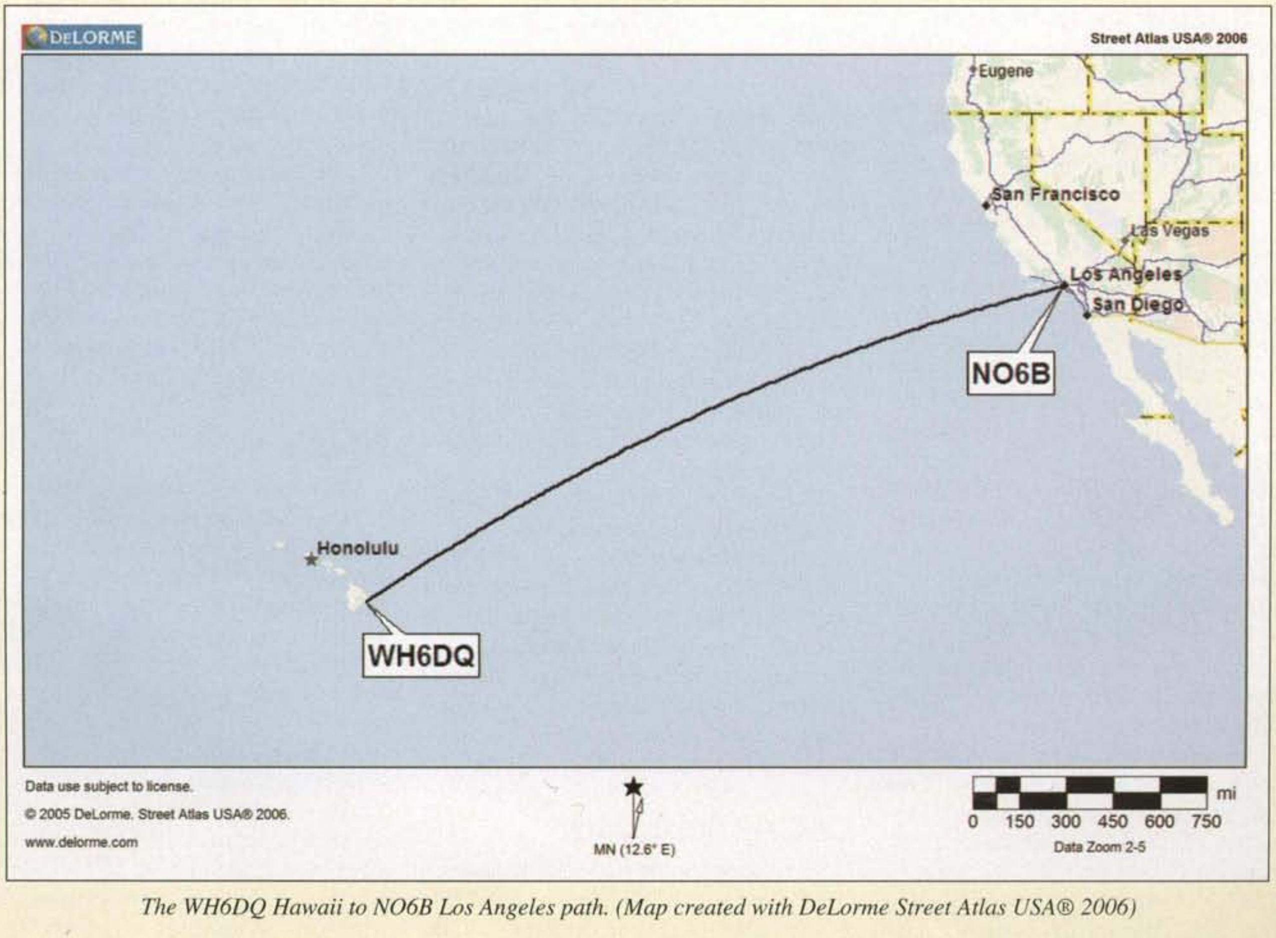
WH6DQ just listens on FM waiting for an opening and then works whomever he can. The openings are usually short, so he doesn't bother switching over to SSB. Bill's station is a Kenwood mobile 2-meter FM rig into a 160-watt Mirage amplifier, driving a vertically-polarized Cushcraft 13-element boomer antenna.

Bill says that he hasn't seen really good tropospheric ducting for quite a while, as it requires a high-pressure cell to be present all the way from The Big Island to California. The first summer he lived in Hawaii (13 years ago) was the best tropo ever, lasting for about three or four weeks. Bill worked approximately 400 mainland stations that summer on 2 meters. Sometimes the signals are so strong that hams on the mainland have a difficult time believing that his signal is really coming from Hawaii. One guy looked him up in the callbook and called him on the telephone to verify that he was really in Hawaii. Bill believes that tropo goes into Mexico more than northern locations, but there are not as many operators down there.

My thanks goes to Bill, WH6DQ, and Bob, NO6B, for providing me with information for this piece. Congratulations on an impressive 2-meter FM contact!

References

Amateur Radio Newsline: http://www.arnewsline.org
Info at NO6B web page: http://no6b.com/WH6DQ.htm
Catalina Amateur Repeater Association: http://www.cara.nu/



The WH6DQ Hawaii to NO6B Los Angeles path. (Map created with DeLorme Street Atlas USA® 2006)

To use the first pair, you tune your transceiver to 146.445 MHz and program a +1 MHz offset. Most radios default to a ±600 kHz offset, so this would require some careful programming on your part.

Shared Pairs

It seems that a lot of hams want to put their own VHF repeater on the air, so most coordinating bodies have a waiting list for individuals or clubs looking for an open pair. To ease this burden, coordinating bodies have adopted the notion of a Shared-Non-Protected (SNP) repeater pair. These pairs are intended to allow new repeaters to come on the air quickly while waiting for their permanent coordination to be approved. They also provide a proving ground for potential repeater trustees to work out the bugs in their system. Since these frequencies are shared, there is no protection against interference from other repeaters. Typically, CTCSS or other controlled-access is required to reduce the level of interference.

Some frequency coordinating bodies have a repeater pair designated for emergency and portable use. The idea is that portable repeaters can be of great service for special events, public-service activities, and emergency communications. Keeping a pair (or two) designated for such use allows builders of portable repeaters to set them up on a pair that can be used anywhere in the coordinating region without co-channel interference. The band plan for Colorado (Colorado Council of Amateur Radio Clubs) designates 146.835 and 146.865 MHz (with standard –600 kHz offset) as "Emergency/Special Event" repeater frequencies. Keeping these two pairs close together allows a repeater to be switched between the two frequencies without needing to retune the duplexer.

An interesting twist on portable repeater pairs is provided by the Two Meter Area Spectrum Management Association (TASMA) in southern California. TASMA specifies the pair of 147.585-MHz input and 144.930-MHz output for special-event/emergency portable repeaters, which results in an offset of 2.655 MHz. The wide offset allows a portable repeater to use a duplexer that is physically smaller (compared with a duplexer suitable for a 600-kHz offset), resulting in much better portability.

Frequency Coordination Practices

VHF/UHF dual-band transceivers with two independent receivers often include a crossband repeater feature. There are some legal issues with regard to identification and having a proper control point, which I won't go into in this article. This crossband operation can be useful for providing communication links into fringe areas without requiring a full-blown repeater system. Most repeater coordinating bodies do not view this as a coordination issue and don't actively address the topic. TASMA does not coordinate crossband repeaters, but does specify a frequency of 144.91 MHz for crossband use on a shared-nonprotected basis, with mandatory CTCSS or DCS. According to Bob Dengler, NO6B, designating a frequency for crossband use provides a "home" for this type of operation, rather than having crossband repeaters show up on random simplex frequencies.

The various forms of Internet linking (IRLP, EchoLink, eQSO) and simplex autopatches have frequency coordination issues similar to those of crossband repeaters. Most coordinating bodies just ignore these modes, but TASMA has specified a set of 2-meter frequencies for "fixed automatic simplex operations": 145.71, 145.725, 145.740, 145.755, 145.77, and 145.785 MHz. Again, the idea is to focus this type of activity in one area of the spectrum rather than have Internet linking show up on random simplex frequencies.

TASMA designates 146.46 MHz and 147.525 MHz for "Remote Bases." The idea here is that remote base systems that use a frequency pair on some other band (say, 440 MHz) have a designated place on the 2-meter band to form ad-hoc links between systems. This may have less usefulness given that many remote base systems are now frequency agile, but it is currently part of the TASMA band plan.

OSCAR Subband

Satellite operating is clearly one part of VHF that is global in nature. Satellites have a habit of orbiting the Earth, so the designers need to consider frequency planning on a worldwide basis. Per the ARRL Band Plan, the primary OSCAR subband is from 145.80–146.00 MHz. This portion of the band is heavily used, but you may not realize it just by casual listening. Many of the LEO (low-earth-orbit) satellites, and the International Space Station, have a downlink in this segment. However, the signals are often very weak and are only present when the satellite is overhead.

As mentioned in the opening paragraph, the ARRL Band Plan also shows an OSCAR subband for 144.30–144.50 MHz. This segment is *not* available worldwide, so satellite designers have been reluctant to deploy a transponder that uses these frequencies. I have been told that this segment may currently be used for unpublished uplinks for command and control.

Note that the nationwide APRS frequency of 144.390 MHz is also in this segment. A number of frequency coordinating bodies have indicated other uses for this segment, such as the FM simplex use specified by ARCC. SERA just shows the segment as "Multimode Operation" and lists the APRS frequency.

What's Next?

The analog FM technology that we use on the VHF ham bands has been stable for decades, but digital technology may change that. No, it probably won't happen overnight, but the new digital modulation formats, such as D-STAR or APCO 25, are likely to get adopted for amateur use over time. Both of these formats are narrower in bandwidth than conventional analog FM and could improve utilization of the spectrum. D-STAR occupies 6 kHz of bandwidth, which is better than a 2.5 times improvement over analog FM at 16 kHz. In theory, we could put 2.5 times as many repeaters or simplex channels in the same space as conventional FM.

Auxiliary Operation on the 2-meter Band

At press time, the FCC released a Report and Order which modifies Part 97 rules to allow *auxiliary operation* on the 2-meter ham band. Previously, FCC rules limited auxiliary operation to 1.25 meters (222 MHz) and higher. The new rules allow auxiliary operation anywhere on the 2-meter band, *excluding* 144.0–144.5 MHz and 145.8–146.0 MHz, which protects the weak-signal and OSCAR subbands.

There are only two little challenges: change out virtually all of the 2-meter equipment in use today and restructure the band plan to accommodate the narrower bandwidth. No, this won't happen overnight.

Implications for VHF FM Operators

We've taken a look at some of the band plans for the 2-meter band. While your local band plan may make perfect sense to you, there is quite a bit of variation in how the band is used across the U.S. It is unfortunate that we have such a patchwork quilt of 2-meter spectrum usage, but this is the reality today.

If you are a user of the 2-meter band, be sure you are familiar with the details of your local band plan. Go to the NFCC website to find your local coordinating body. Be a good citizen and good user of the radio spectrum by following that band plan. This is especially true if you plan to put a repeater on the air. Make sure you work with your frequency coordinating body to have your repeater coordinated.

Finally, expect that when you travel around the country, you will find alternative band plans. Be sure to have a current repeater directory (or other source of data) to help you figure out what frequency to use.

That's all for this issue. Let me know what you are doing with FM VHF.

73, Bob, KØNR

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Radio Amateurs of Canada (R.A.C) 2-meter band plan: http://www.rac.ca/service/2mplan.htm

Area Repeater Coordination Council (ARCC), Eastern Pennsylvania and Southern New Jersey: http://www.arcc-inc.org/

SouthEastern Repeater Association (SERA) website: http://www.sera.org/

Colorado Council of Amateur Radio Clubs (CCARC) website: http://www.ccarc.net

Two-Meter Area Spectrum Management Association, Southern California: http://www.tasma.org/

Moondata Update 2007 and Related Comments

One of the most important factors in EME communications is knowing when it is best to communicate via moonbounce. W5LUU presents a summary and table of the best and worst conditions for EME in 2007.

By Derwin King,* W5LUU

The Earth-Moon distance and the cosmic (sky) noise temperatures in the direction of the Moon are predictable, cyclical variables that set the basic day-to-day quality of Earth-Moon-Earth (EME) communications for frequencies below 1.0 GHz. The best conditions occur when: (1) the Range Factor (Earth-Moon distance) is at an absolute minimum, and (2) the Sky Temperature behind the Moon, as viewed from Earth, is the coldest along the moon path. While Range Factor is frequency independent, Sky Temperature rapidly decreases with frequency, up to ~1 GHz, and levels out. The EME signal-to-noise ratio, in dB, is usually degraded from the ideal by a factor (DGRD, see below) which varies over hourly, daily, weekly, monthly, and yearly time periods. The DGRD factors, in dB, for 144 and 432 MHz, and other pertinent EME data, are tabulated in the W5LUU Weekend Moondata for 0000 UT on each Sunday of the upcoming year and provide a general guide to the basic EME weekend conditions (see the accompanying table). Ionospheric disturbances, local noise, and polarization mismatch will increase the "apparent" DGRD.

Get active on EME by 2007. Conditions will improve over the next three years as Moon perigees are at +declinations and approach the best cold sky region (8–9 hr. RA) at ~ 2.7 hrs RA per year. These will peak in 2010 and then begin to decrease, but will still be good for approximately two more years. In 2007 two Very Good and four Good weekend days will occur in the first half of the year, and seven in the second half. Some days during the week may be rated better. Several weekends between September 2 and November 25 look good for the 2007 fall EME contests.

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The information and accompanying table are printed here in CQ VHF *on a non-exclusive basis courtesy of Derwin King, W5LUU*

Definitions

DEC (deg): Moon declination in degrees north and south (–) of the equator. This is cyclical with an average period of 27.212221 days. The maximum declination during a monthly cycle, plus and minus, ranges from 18.15 up to 28.72 degrees with a period (maximum to minimum and back to maximum) in about 19 years. *The last maximum was on 09/15/2006.*

RA (hrs): Right Ascension, in hours, gives the east-west position of the Moon against the sky background. The average period of RA cycle is 27.321662 days, but it can vary by a day or so due to the Earth and Moon motion.

144 MHz Temp (K): The 144-MHz cosmic noise in the direction of the Moon expressed as absolute temperature.

Range Factor (dBr): The additional EME path loss, in dB, due to Earth-Moon separation distance being greater than absolute minimum (348,030 km surface-to-surface). Varies from a low of 0 to 0.7 dB at perigee up to 2.33 ±0.1 dB at apogee.

DGRD (dB): The degradation in EME signal-to-noise, in dB, due to: (1) the excess sky noise temperature (in dB) at the listed position of the Moon compared to the lowest cold sky temperature and the system noise temperature (all at the frequency of interest); plus (2) the Earth–Moon range factor (dBr) for the listed time and date. The tabulated DGRD is referenced to the lowest possible sky noise temperature along the Moon path, for a system noise temperature of 80 K at 144 MHz and 60 K at 432 MHz, an antenna beam width of ~15°, and to the absolute minimum Earth-Moon (surface-to-surface) distance.

The dBr affects DGRD equally at all frequencies, but sky noise decreases rapidly as frequency increases. During a monthly lunar cycle DGRD can vary by 13 dB on 144 and 8 dB on 432. DGRD varies less with small antennas than with large ones.

Moon Phase: Shows new moon (NM) and full moon (FM) along with the number of days (d) or hours (h) before (–) or after (+) these events. At NM sun noise is a problem, while at FM the EME conditions (at night) are usually more stable.

Conditions: Summary of EME conditions as controlled by DGRD at 144 MHz and NM. Conditions may be worse, due to ionospheric disturbance, local noise, and polarity, but not better than indicated. In general, 144 MHz DGRD <1.0 dB is considered Excellent, 1.0 to 1.5 is Very Good, 1.5 to 2.5 is Good, 2.5 to 4.0 is Moderate, 4.0 to 5.5 is Poor, and over 5.5 is Very Poor. Within a day of New Moon (NM), high sun noise can make conditions Very Poor regardless of the DGRD.

W5LUU Weekend Moondata for 2007
For Sundays at 0000 UTC

2007	DEC (deg)	RA (hrs)	144 MHz Temp. (°K)	Range Factor (dBr)	DGRD (dB) 144 MHz	DGRD (dB) 432 MHz	Moon Phase	Conditions
Jan 07	14.3	10.0	**187**	1.90	2.3	1.9	**FM + 3.6d**	Moderate
14	– 22.2	15.2	426	1.94	5.1	2.7		Poor
21	– 15.1	21.6	295	0.60	2.5	1.1	**NM +1.8d**	**Good**
28	25.9	4.1	311	1.03	3.7	1.7		Moderate
Feb 04	10.7	10.5	**199**	2.02	2.6	2.1	**FM + 1.8d**	Moderate
11	–24.6	15.6	474	1.95	5.5	2.9		Very Poor
18	–11.3	22.4	251	**0.34**	1.6	0.7	**NM + 8.0h**	**Good**
25	27.8	4.8	450	1.09	4.4	2.0		Poor
Mar 4	6.8	11.0	208	2.16	2.9	2.3	**FM + 1.0h**	Moderate
11	–26.6	16.3	606	2.00	6.5	3.1		Very Poor
18	–7.6	22.9	244	**0.23**	1.4	0.5	**NM - 1.8d**	**Very Good but nr NM**
25	28.5	5.6	514	1.03	4.9	2.3		Poor
Apr 01	2.6	11.5	235	2.27	3.3	2.4	**FM – 1.7d**	Moderate
08	–27.9	16.9	843	2.00	7.7	3.6		Very Poor
15	–3.7	23.4	244	**0.28**	1.5	0.7	**NM - 2.5d**	**Very Good**
22	28.3	6.3	451	0.92	4.3	2.0		Poor
29	–1.7	12.0	263	2.30	3.8	2.6	**FM – 2.4d**	Moderate
May 06	–28.3	17.6	2266	1.92	11.7	5.5		Very Poor
13	0.7	23.9	250	**0.43**	1.7	0.5		**Good**
20	22.8	3.7	360	0.90	3.4	1.5	**NM + 3.2d**	Moderate
27	–5.9	12.5	313	2.29	4.3	2.8		Poor
Jun 03	–28.0	18.4	2364	1.75	11.7	6.1	**FM + 2.0d**	Very Poor
10	5.6	0.5	268	0.58	2.1	1.0		**Good**
17	25.7	7.5	306	0.95	2.9	1.4	**NM +2.0d**	Moderate
24	–9.9	13.0	314	2.25	4.3	2.8		Poor
July 01	–26.8	19.0	849	1.52	7.3	3.9	**FM + 10h**	Very Poor
08	10.7	1.1	286	0.67	2.4	1.1		**Good**
15	23.7	8.1	213	1.13	1.9	1.3	**NM + 12h**	**Good**
22	–13.6	13.5	322	2.24	4.4	2.7		Poor
29	–25.1	19.7	527	1.29	5.2	2.6	**FM – 1.0d**	Poor
Aug 05	15.5	1.8	311	0.64	2.7	1.1		Moderate
12	21.0	8.7	**181**	1.38	1.6	1.4	**NM – 1.0d**	**Good**
19	–17.0	14.0	349	2.27	4.7	2.8		Poor
26	–23.0	20.2	361	1.13	3.7	1.8	**FM – 2.5d**	Moderate
Sept 02	19.7	2.5	355	**0.51**	3.0	1.1		Moderate
09	17.6	9.3	**176**	1.62	1.8	1.6	**NM – 2.5d**	**Good**
16	–20.0	14.5	386	2.31	5.1	3.0		Poor
23	–20.5	20.6	334	1.05	3.3	1.6		Moderate
30	22.8	3.1	363	**0.31**	2.9	1.0	**FM + 3.2d**	Moderate
Oct 07	13.6	9.9	**186**	1.79	2.1	1.8		**Good**
14	–22.7	15.1	427	2.34	5.5	3.1	**NM + 3.0d**	Very Poor
21	–17.3	21.3	342	1.15	3.5	1.7		Moderate
28	25.0	3.4	361	**0.14**	2.7	0.8	**FM + 2.0d**	Moderate
Nov 04	9.2	10.5	**200**	1.86	2.4	2.0		**Good**
11	–24.9	15.7	485	2.33	5.9	3.3	**NM + 1.0d**	Very Poor
18	–13.4	21.4	293	1.24	3.1	1.7		Moderate
25	26.5	4.3	396	**0.10**	3.0	**0.9**	**FM + 9.0h**	Moderate
Dec 02	4.9	11.0	211	1.84	2.6	2.0		Moderate
09	–26.6	16.4	653	2.25	7.0	3.5	**NM – 18h**	Very Poor
16	–8.9	22.5	244	1.26	2.5	1.6		**Good**
23	27.6	5.0	465	**0.25**	3.7	1.2	**FM – 1.0d**	Moderate
30	0.9	11.5	236	1.78	2.9	1.9		Moderate

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

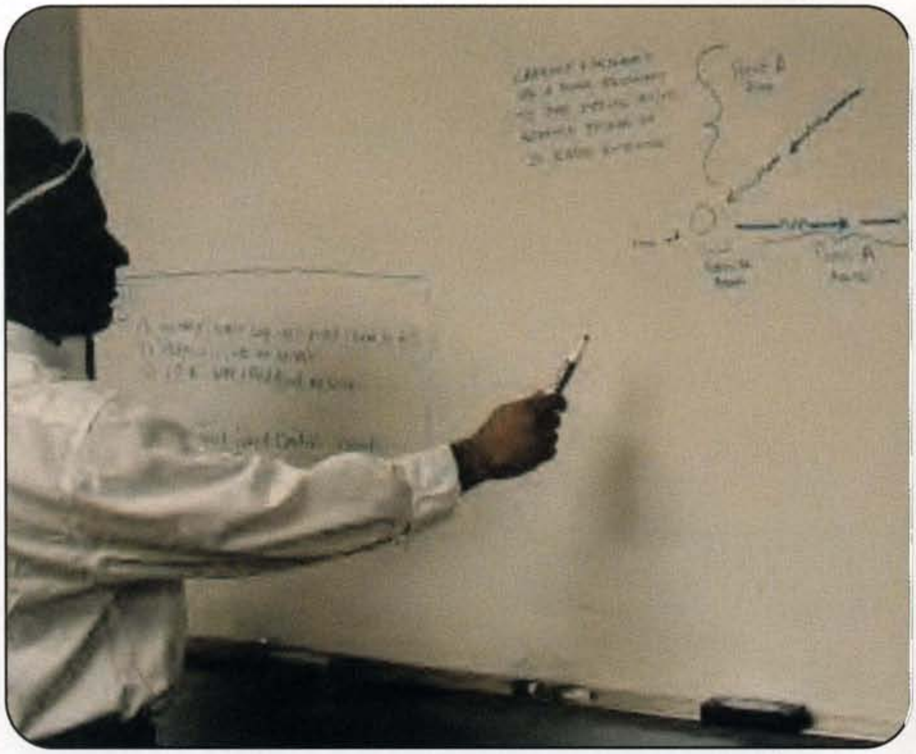
Searching For The Ultimate DX

Testing a Dubious Claim

Might extraterrestrial civilizations be so advanced that they have learned how to monitor our ham bands, or even our internet traffic? One innovative SETI experiment is betting on that premise. Through its highly publicized and widely indexed website <http://ieti.org>, *Invitation to ETI* invites contact between humanity and any beings of extraterrestrial origin finding themselves able to access it. The heart of the site is an invitation issued by 100 scholars from disparate disciplines, including a broad cross-section of the contemporary arts, physical sciences, and social sciences (and including a handful of hams). To date, the invitation has proved just as successful as traditional microwave SETI: It has yet to uncover any clear and convincing evidence of extraterrestrial intelligence!

This is not to say that we haven't heard from intelligent *terrestrials* trying to foil the system. Since the invitation was launched in 1996, it has attracted roughly 75 responses from correspondents claiming to be the beings we seek. Through simple and reliable methods, which we will not delineate here (lest we stack the deck in favor of the next prankster), we have been able quickly and conclusively to unmask those humans who have attempted to fool those issuing the invitation. There was, however, one claim that, though bizarre, was convincing and compelling enough to demand closer scrutiny before it was ultimately dismissed.

The episode in question began to unfold in October 2004, when a man left a voicemail message in which he stated that he had "what the Invitation to ETI group is looking for"—that is, evidence of extraterrestrial intelligence. The claimant (let us call him "Adam Adamson" to protect the inept) then e-mailed an assertion that although he was most assuredly a human terrestrial, he was able to communicate with extraterrestrial beings via electromagnetic means and was prepared to demonstrate this phenomenon under controlled conditions. A sustained dialog between Mr. Adamson and several amateur SETIzens convinced us that although his claims were unlikely, the individual appeared intelligent, lucid, cooperative, and sincere. Satisfied that he was probably not a raving lunatic, we proceeded to arrange for dispassionate scrutiny of his claim, which if verifiable could significantly alter our world view.



"Adam Adamson" (his face disguised to protect his privacy) explains his claim of extraterrestrial contact.

Among the members of the Invitation to ETI team is a lifelong ham who operates a successful electronics business in the U.S. His extensive commercial facilities include an electromagnetic interference (EMI) test chamber, a radiation-shielded room containing highly sensitive microwave monitoring instrumentation. The use of this facility was offered for the purposes of testing Mr. Adamson's claim. Any electromagnetic communications passing between Mr. Adamson and his alleged extraterrestrial communications partners would be clearly discernible on just such equipment. Mr. Adamson volunteered to present himself for such testing, and we readily agreed.

The tests took place in New Jersey. At noon, Adam Adamson presented and explained his claim (using a whiteboard) to the Invitation to ETI director, two microwave hams, and two journalists who were there to document the day's tests. We then gathered outside the large shielded room used for the actual tests. The subject's manner was amiable and cooperative; after all, our goal was to help Mr. Adamson prove his claim, not to make him nervous.

Mr. Adamson asserted that radio signals (somewhere in the range of 1 MHz to 1 GHz) were being emitted by a "probe" controlled by alien intelligence that was somehow associated with his person. While the claims were unusual to

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say the least, our host, an associate of the Invitation to ETI project and an active SETI League member, volunteered to conduct what tests he was able to with an open mind. He expressed concerns prior to the test that he would only be able to determine whether a signal was being emitted, and had no expertise whatsoever in determining whether it might be alien, fortuitous, fraudulent, or what. We agreed that it was worth performing the tests as a first step, in any event.

Our test subject appeared intelligent, coherent, and cooperative. He explained prior to the shield-room tests that extraterrestrial intelligence had chosen to disguise its communications signals so as to look like noise. In fact, during several different tests, nothing was observed that bore any statistical difference from thermal background plus internal equipment noise. During the alleged transmissions, nothing substantive was observed on an EMI test system or on a highly sensitive spectrum analyzer. The subject's explanation was that the transmissions did indeed look like noise, just as he had promised, which is a bit reminiscent of the old joke about the Invisible Man: "of course you can't see him. He's invisible, and that proves it!"

The subject indicated that extensive further study and testing, lasting perhaps several months, would be required to "verify and analyze the signals." Considering the cost (several hundreds of dollars per hour) of renting and operating a commercial EMI test facility, such testing is beyond the resources of most SETI organizations. We are unwilling to commit *Invitation to ETI* or SETI League resources to further testing of this claimed phenomenon. Based upon the initial null result, we do not recommend that any other organizations pursue this claim, but of course we realize this decision is up to them.

For whatever reason, an apparently intelligent and reasonably convincing individual had come to believe that he was a conduit for communications with extraterrestrial intelligence. As both serious radio amateurs and SETI scientists, it would have been easy for us to dismiss these claims out of hand. UFOlogy is generally acknowledged to be tainted by pseudoscience and the lack of sophisticated skepticism. The SETI community goes to great pains to disassociate itself from UFOlogy, in the interest of preserving the scientific credibility it has earned for itself over the past half-century. It is only because the claimant alleged electromagnetic radiation, an easily measured phenomenon with which we hams possess expertise, that we decided to test the claim at all. Given the time, effort, and expense involved in achieving this null result, I for one am unlikely to explore any further unconventional claims in the future.

The danger is that in so restricting ourselves, we risk closing our minds to contact. Like all SETI projects, we must create a scientific methodology that avoids being too open-minded—too friendly to unsubstantiated claims. However, by erring in the direction of rigor and respectability, we could be closing our eyes and our doors to a genuine manifestation of extraterrestrial intelligence. Given the likelihood that ETI will turn out to be quite different from our preconceptions, it would be foolish to dismiss the possibility that it could someday be discovered by a radio amateur, carefully checking out some anomalous phenomenon.

73, Paul, N6TX