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NCJ NATIONAL CONTEST JOURNAL

March/April 2004

Volume 32 Number 2

- A Review of Contest Logging Software
- How to operate Field Day
- Contest Antennas:
  - 6 Meter Stack
  - 4-Square with 8 Directions
  - Antenna Interactions—Part 5
- Canada Explained

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Top Photo: **Jukka's** low cost 4 over 4 over 4 20 meter array at OH4A.

Bottom Photo: **Jukka's** home brew tower rotator at his home station, OH6LI. Find out how he did both and more. See "Contesting on a Budget"—this issue.

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Editorial

By Carl Luetzelschwab, K9LA

Contest Expeditions column by K2KW

Kenny, K2KW, began writing the Contest Expeditions column in the November/December 2000 issue, and over the years he has written about many interesting topics related to contesting from afar. But recently he decided to put down his pen. Thanks, Kenny, for all your effort and great information that helped many of us who contested from outside the US. I'm happy to report that Kenny will stay involved with *NCJ* by contributing articles on an occasional basis.

Our Cover for This Issue

The cover for this issue highlights an interesting topic covered by Paul, K5AF, in his Contesting on a Budget column—building items for your contest station to save money, as Jukka, OH6LI, does. We've had these types of articles in *NCJ* in the past, and I'd love to see more of them. It doesn't have to be big items like building your own antennas and rotors. Maybe you've built an accessory that our other readers would be interested in. Send me your idea, and we'll go from there.

Sweepstakes Long Ago

Back in September I received a letter from Peter, W6QEU. While cleaning out his garage, Peter found two very old SS medallions that indicated he had won SS. With no documentation to confirm this, he wondered if he really did win SS. I forwarded the letter to HQ, and Dan, N1ND, did some research in old *QST*s. He found that Peter placed fourth in 1947, first in 1948, second in 1949, and first again in 1950. Congratulations, Peter!

Contest FAQs

Check out **www.qsl.net/zs1an/contesting_faq.html** for an introduction to contesting for beginners. It is written by Andrew, ZS1AN, and covers topics from "why take part in contests?" to "should I QSL my contest QSOs?" Andrew welcomes contributions, suggestions, and other opinions at **zs1an@qsl.net**. This could be some good starting material if you're doing a presentation on contesting to non-contesters (at a local radio club meeting, for example).

Errata

We had several problems with the tables in K3NA's article Antenna Interactions Part 4 in the January/February issue. In Tables 1, 2, 3, and 5, the boldface part of the column headings didn't line up properly with the table columns. For example, in Table 1 'Non Target' should be over the word 'median.' Additionally, the captions for Table 4 and 5 were interchanged. The correct version of Part 4 (in color, too) is on the *NCJ* web (**www.ncjweb.com**) under the BONUS CONTENT.

Project Goodwill Albania

As many of you know, my wife Vicky, AE9YL, and I participated in the educational aspect of Project Goodwill Albania last November in the capital, Tirana. We had a wonderful time meeting the people of Albania, and I came away with the personal satisfaction of contributing to the licensing of 39 new ZA amateur radio operators. Now if I had only taken some *NCJ* samples with me . . .

Canada Explained

Marc Ziegler, W6ZZZ
ziegler@accesscom.com

[Reprinted, with permission, from the December 2003 NCCC newsletter *The JUG*.]

Canadian amateur radio has:

—8 RAC sections
—10 provinces and 3 territories
—13 postal codes corresponding to the 10 provinces and 3 territories.
—A province that has 2 common name areas (Newfoundland and Labrador)
—Call sign prefix VEØ for stations at sea making international voyages.

Many contests treat the Canadian multipliers differently (with as few as 8 and as many as 14 multipliers). The US shares this confusion as some contests treat the District of Columbia as part of Maryland and some treat it as a separate multiplier.

RAC Section	Call Prefixes	Province/Territory	Postal Code
Maritimes	VE1, VA1, CYØ, CY9	Nova Scotia	NS
Maritimes	VE9	New Brunswick	NB
Maritimes	VY2	Prince Edward Island	PE
Newfoundland	VO1, VO2	Newfoundland and Labrador	NL
Quebec	VE2, VA2	Quebec	QC
Ontario	VE3, VA3	Ontario	ON
Manitoba	VE4, VA4	Manitoba	MN
Saskatchewan	VE5, VA5	Saskatchewan	SK
Alberta	VE6, VA6	Alberta	AB
British Columbia	VE7, VA7	British Columbia	BC
Alberta	VE8	Northwest Territories	NT
Alberta	VYØ	Nunavut	NU
British Columbia	VY1	Yukon	YT

Sources of Information

- **www.rac.ca/**
- **www.rac.ca/fieldorg/racfoo.htm**
- **canada.gc.ca/othergov/prov_e.html**
- **strategis.ic.gc.ca/epic/internet/insmt-qst.nsf/vwGeneratedInterE/sf01862e.html**
- **strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwapj/ric9.pdf/$FILE/ric9.pdf.**

Here is how the various contest rules specify Canadian multipliers:

Many of them have some conflicting or confusing statement about Canada. Some use the word Maritime to also include the RAC section of Newfoundland, while others say province but have 14 multipliers. The details follow.

Eight multipliers: California QSO Party—"eight Canadian areas: Maritime (VE1, VE9, VO1, VO2 and VY2), VE2 through VE7, and Northern Territories (VYØ, VY1, VE8)."

www.cqp.org/Rules.html—dated October 8, 2003.

Eight multipliers: North American Sprint—"The eight Canadian multipliers are Maritime (VE1, VE9, VO1, VO2 and VY2), VE2 through VE7, and Yukon-NWT (VYØ, VY1 and VE8)."

www.ncjweb.com/sprintrules.php—dated December 10, 2003.

Nine Multipliers: ARRL Sweepstakes—"RAC Section plus the Canadian NT (Northern Territories—encompassing VE8 / VY1 / VYØ)."

www.arrl.org/contests/rules/2003/novss.html—dated September 8, 2003.

Thirteen multipliers: Canada Day—"Canada's 10 provinces and 3 territories, and may be counted once on each mode on each of the 8 contest bands. The multipliers, with their postal abbreviations and prefixes are: Nova Scotia, NS, (VE1, VA1, CY9, CYØ); Quebec, QC, (VE2, VA2); Ontario, ON, (VE3, VA3); Manitoba, MB, (VE4,VA4); Saskatchewan, SK, (VE5,VA5); Alberta, AB, (VE6,VA6); British Columbia, BC, (VE7,VA7); Northwest Territories, NT, (VE8); New Brunswick, NB, (VE9); Newfoundland and Labrador, NL, (VO1, VO2); Nunavut, NU, (VYØ); Yukon, YU or YT, (VY1); and Prince Edward Island, PE, (VY2)."

www.rac.ca/CANDAY.htm—date unknown.

Thirteen multipliers: Canada Winter—"Canada's 10 provinces and 3 territories, and may be counted once on each mode on each of the 8 contest bands. The multipliers, with their postal abbreviations and prefixes are: Nova Scotia, NS, (VE1, VA1, CY9, CYØ); Quebec, QC, (VE2, VA2); Ontario, ON, (VE3, VA3); Manitoba, MB, (VE4,VA4); Saskatche-wan, SK, (VE5,VA5); Alberta, AB, (VE6,VA6); British Columbia, BC, (VE7,VA7); Northwest Territories, NT, (VE8); New Brunswick, NB, (VE9); Newfoundland and Labrador, NL, (VO1, VO2); Nunavut, NU, (VYØ); Yukon, YU or YT, (VY1); and Prince Edward Island, PE, (VY2)."

www.rac.ca/downloads/racwinterrules3.pdf—date unknown.

Thirteen multipliers: North American QSO Party - "Canadian provinces/territories (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, PEI, Newfoundland/Labrador, Yukon, NWT and Nunavut)."

www.ncjweb.com/naqprules.php—dated November 24, 2003.

Fourteen multipliers: ARRL 10 Meter Contest—"Canada; NB (VE1, 9), NS (VE1), QC (VE2), ON (VE3), MB (VE4), SK (VE5), AB (VE6), BC (VE7), NWT (VE8), NF, (VO1), LB (VO2)], YT (VY1), PEI (VY2) NU (VYØ)."

www.arrl.org/contests/rules/2003/10-meters.html—dated December 17, 2003.

Fourteen multipliers: ARRL RTTY Round-Up—"Canadian provinces/territories: NB (VE1, 9), NS (VE1), QC (VE2), ON (VE3), MB (VE4), SK (VE5), AB (VE6), BC (VE7), NWT (VE8), NF (VO1), LB (VO2), NU (VYØ), YT (VY1), PEI (VY2)"

www.arrl.org/contests/rules/2004/rtty.html—dated November 13, 2003.

NCJ

Maximum-Gain Radial Ground Systems for Vertical Antennas

Al Christman, K3LC

Abstract

This article compares the peak gain generated by quarter-wave vertical-monopole antennas when they are installed over a variety of ground systems. All of these ground systems utilize symmetrically-placed radials that are buried to a shallow depth in the soil. Computer analysis indicates that, for a given total length of wire, some configurations yield more gain than others.

Overview

Vertically-polarized antennas are widely used on the lower amateur bands, and the question often arises concerning how to achieve the best performance when a specific amount of wire is available for use as ground radials. Recently, N4UU published a fascinating article[1] that addressed this question from the perspective of minimizing the amount of antenna input power that is dissipated in the soil. I decided to tackle the same issue, but chose instead to maximize the gain of the antenna, since most amateurs are accustomed to comparing antenna performance based upon this parameter. Presumably, both of these methods should yield similar results, and will be discussed later. All three of the low bands (40, 80, and 160 meters) will be investigated, using three different types of soil on each band.

I have access to *EZNEC4*[2], which enables me to analyze ground systems using buried radials. For simplicity, all computer simulations were performed using #12 AWG copper wire for the vertical element, and #16 AWG copper wire (which is available from several sources at a reasonable price) for the radials. The lower end of the vertical element touches the surface of the earth (at z = 0), and its total height is exactly 0.25 wavelengths. No attempt was made to shorten the element in order to achieve resonance. The buried radials all begin at the base of the vertical element (zero height) and the inner segment of each radial slopes downward so that its outer end is at the "final" burial depth of three inches. The wire segment-lengths for the vertical element and the radials are all tapered in accordance with the most conservative *EZNEC* guidelines. The shortest segments, such as the one containing the feed-point at the base of the vertical element, and the inner segment of each radial, have a length of about six inches.

[1]Notes appear on page 10.

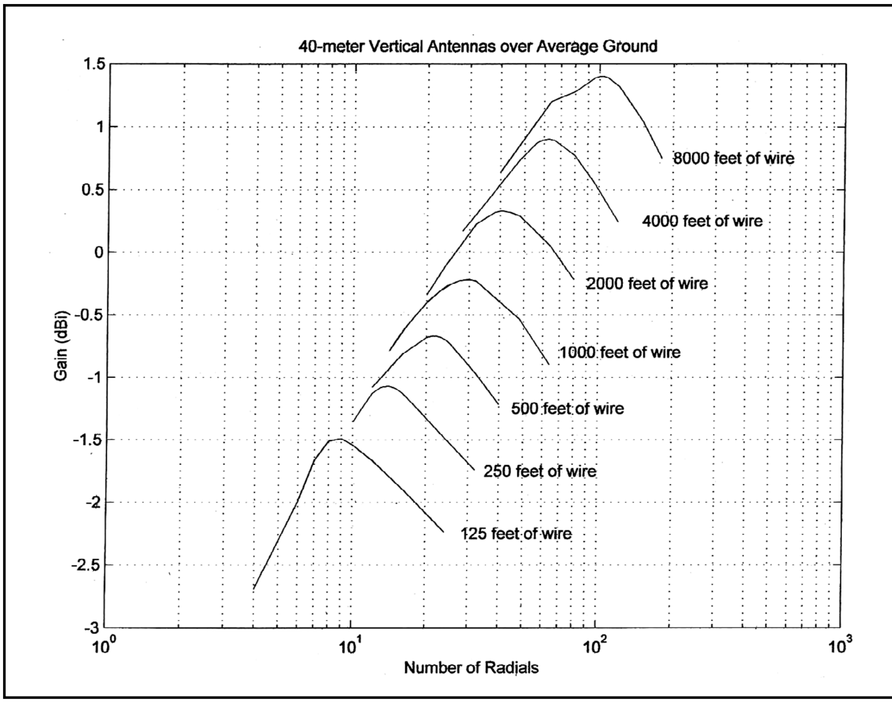

Figure 1—Gain of a quarter-wave 40 meters vertical antenna over average soil, as the number of buried radials is varied, for seven different total lengths of wire.

Table I

Optimum number and length of radials for a vertical antenna on 40 meters (7.15 MHz) operating over average soil (conductivity = 0.005 Siemens/meter and relative permittivity = 13).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
125	9	13.89	-1.49
250	14	17.86	-1.07
500	21 – 22	23.81 – 22.73	-0.67
1000	28 – 31	35.71 – 32.26	-0.22
2000	39 – 43	51.28 – 46.51	0.33
4000	62 – 63	64.52 – 63.49	0.90
8000	100 – 104	80.00 – 76.92	1.40

Table II

Optimum number and length of radials for a vertical antenna on 40 meters (7.15 MHz) operating over very poor soil (conductivity = 0.001 Siemens/meter and relative permittivity = 5).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
125	6	20.83	-2.93
250	10	25.00	-2.21
500	16	31.25	-1.48
1000	25	40.00	-0.74
2000	34 – 36	58.82 – 55.56	0.11
4000	56 – 58	71.43 – 68.97	1.02
8000	96 – 100	83.33 – 80.00	1.68

Results on 40 Meters

A frequency of 7.15 MHz was selected for the analysis on 40 meters, leading to a height of about 34.39 feet for the vertical element. Seven different total wire-lengths were utilized, ranging from 125 feet (just less than one wavelength of wire) to 8000 feet (more than 58 WL). In each case, the number of radials was varied in an effort to maximize the gain of the antenna. Figure 1 displays the results graphically, for the situation where the radials are buried in "average soil" with a conductivity of 0.005 Siemens/meter and a dielectric constant of 13. Notice that the optimum number of radials climbs steadily as the total length of available wire increases. A logarithmic scale was utilized for N (the number of radials) on the x-axis, because this parameter ranges over several orders of magnitude. Unfortunately, the log scale makes it difficult to discern the exact value of N that yields maximum gain.

Table I presents the same information in a different format, and only the optimal values of N are listed. EZNEC supplies the gain data to the nearest 0.01 dBi, so it's possible that two (or more) radial configurations will sometimes yield exactly the same peak gain. For example, with a total of 8000 feet of wire in the ground system, the "best" number of radials is anywhere from 100 (each 80 feet long) to 104 (each 76.92 feet long). In this case there are five different "best" combinations of radial length and number of radials, all of which will generate a peak gain of 1.40 dBi. The ham with plenty of land could install 100 of the 80-foot radials, while the operator who is more cramped for space might prefer to use 104 of the shorter 76.92-foot radials. For the sake of simplicity, N = 102 (which is the average value) could be selected.

Table II shows the results for the same quarter-wave 40-meter vertical when the soil is "very poor," with a conductivity of 0.001 Siemens/meter and a dielectric constant of 5. If the soil is "very good," (conductivity = 0.0303 Siemens/meter and dielectric constant = 20), then the outcome will be as listed in Table III. Typically, for a given total length of wire, fewer (but longer) radials are needed in poor soil, while more (but shorter) radials provide the highest gain in good soil. This agrees with N4UU's findings. As he stated, "more closely spaced radials are needed to coax the ground current out of more highly conductive soil and into the radial system[3]."

Results for 80 Meters

On 80 meters a frequency of 3.75 MHz was utilized, so the height of the vertical element is about 65.57 feet. Again, seven different total wire-lengths were utilized, this time ranging from 250 feet (just less than one wavelength of wire) to 16,000 feet (more than 61 WL). As before, the number of radials was varied in an effort to maximize the gain of the antenna. When the radials are buried in average soil, the results are as shown in Figure 2.

Table IV summarizes this data in numerical form, listing only the "best" values for N. Again we see that in many instances it is possible to achieve maximum gain (for a particular total wire length) from several different combinations of radial length and number of radials. Tables V and VI list the outcomes for very poor soil and very good soil, respectively.

Results on 160 Meters

A frequency of 1.835 MHz was selected for the computer simulation on top band, requiring a height of 134 feet for the quarter-wave vertical element. Here the seven different total wire-lengths spanned the range from 500 feet (just less than one wavelength of wire) to 32,000 feet (almost 60 WL). As usual,

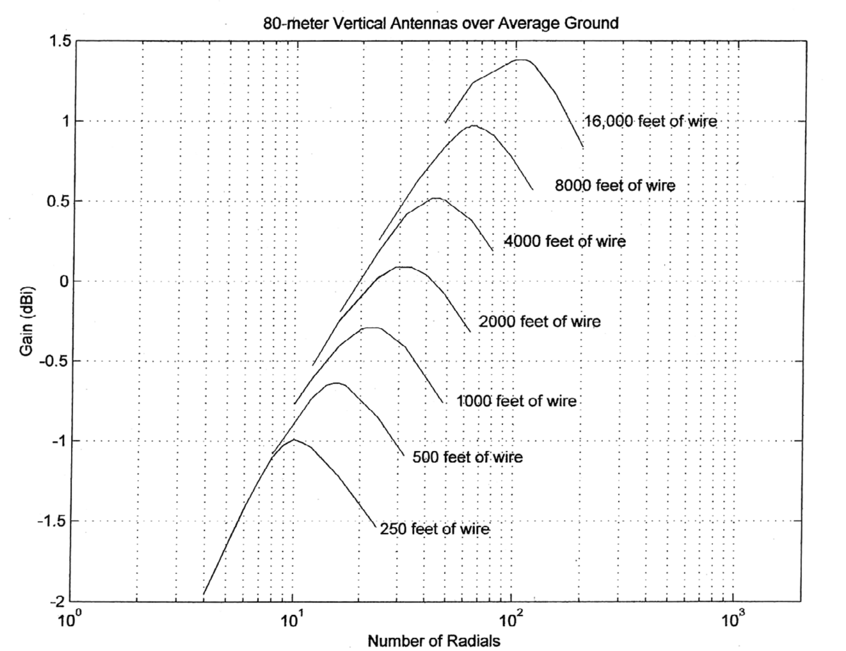

Figure 2 —Gain of a quarter-wave 80 meters vertical antenna over average soil, as the number of buried radials is varied, for seven different total lengths of wire.

Table III

Optimum number and length of radials for a vertical antenna on 40 meters (7.15 MHz) operating over very good soil (conductivity = 0.0303 Siemens/meter and relative permittivity = 20).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
125	12	10.42	0.85
250	17 – 20	14.71 – 12.50	1.04
500	24 – 28	20.83 – 17.86	1.24
1000	37	27.03	1.45
2000	48 – 58	41.67 – 34.48	1.66
4000	68 – 85	58.82 – 47.06	1.88
8000	102 – 127	78.43 – 62.99	2.10

Table IV

Optimum number and length of radials for a vertical antenna on 80 meters (3.75 MHz) operating over average soil (conductivity = 0.005 Siemens/meter and relative permittivity = 13).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
250	10	25.00	-0.99
500	15 – 16	33.33 – 31.25	-0.64
1000	21 – 24	47.62 – 41.67	-0.29
2000	29 - 34	68.97 – 58.82	0.09
4000	42 – 46	95.24 – 86.96	0.52
8000	63 – 67	126.98 – 119.40	0.97
16,000	99 – 111	161.62 – 144.14	1.38

Table V

Optimum number and length of radials for a vertical antenna on 80 meters (3.75 MHz) operating over very poor soil (conductivity = 0.001 Siemens/meter and relative permittivity = 5).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
250	7	35.71	-3.48
500	11	45.45	-2.72
1000	17	58.82	-2.00
2000	24 – 26	83.33 – 76.92	-1.23
4000	35 – 36	114.29 – 111.11	-0.30
8000	57 – 59	140.35 – 135.59	0.59
16,000	98 – 104	163.26 – 153.85	1.29

Table VI

Optimum number and length of radials for a vertical antenna on 80 meters (3.75 MHz) operating over very good soil (conductivity = 0.0303 Siemens/meter and relative permittivity = 20).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
250	14 – 16	17.86 – 15.62	1.70
500	19 – 25	26.32 – 20.00	1.84
1000	29 – 32	34.48 – 31.25	1.99
2000	39 – 50	51.28 – 40.00	2.13
4000	56 – 70	71.43 – 57.14	2.28
8000	80 - 103	100.00 – 77.67	2.43
16,000	119 – 152	134.45 – 105.26	2.58

Table VII

Optimum number and length of radials for a vertical antenna on 160 meters (1.835 MHz) operating over average soil (conductivity = 0.005 Siemens/meter and relative permittivity = 13).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
500	11 – 12	45.45 – 41.67	0.11
1000	17 – 18	58.82 – 55.56	0.38
2000	23 – 28	86.96 – 71.43	0.63
4000	32 – 40	125.00 – 100.00	0.89
8000	45 – 55	177.78 – 145.45	1.17
16,000	76	210.53	1.48
32,000	99 – 122	323.23 – 262.30	1.75

Table VIII

Optimum number and length of radials for a vertical antenna on 160 meters (1.835 MHz) operating over very poor soil (conductivity = 0.001 Siemens/meter and relative permittivity = 5).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
500	7 – 8	71.43 – 62.50	-3.13
1000	12	83.33	-2.47
2000	18	111.11	-1.87
4000	25 – 26	160.00 – 153.85	-1.24
8000	35 – 36	228.57 – 222.22	-0.49
16,000	55 – 59	290.91 – 271.19	0.27
32,000	96 – 100	333.33 – 320.00	0.93

the number of radials was varied in an effort to maximize the gain of the antenna. Figure 3 displays the results when the radials are buried in average soil.

Table VII summarizes the same information. As we have come to expect, there is often more than one "best" number of radials to achieve maximum gain, when the total length of wire is fixed. Interestingly, when the total length of wire is 16,000 feet, N = 76, so there is only one "optimum" number of radials in this case. Tables VIII and IX give the results for top-band verticals used in environments with very poor soil and very good soil, respectively.

Comparing All Three Bands

Table X lists the "best" number of radials to maximize the gain, for each specific total wire length, on all three bands, in average soil. For a given total length of wire, fewer (but longer) radials are needed as we go lower in frequency. Since the wavelength is greater at lower frequencies, the physical height of the quarter-wave vertical-monopole (radiator) also increases as we switch from 40 to 80 to 160 meters. As a result, the displacement currents leaving the vertical element intersect the earth farther from the base of the antenna, and longer radials are needed in order to collect this current. Figure 4 displays the same data in graphical form. Whenever the computer analysis showed that several different values of N would provide the same peak gain, I calculated the average value and used that number for the plot.

The results for very poor soil are displayed in Table XI and Figure 5, while Table XII and Figure 6 illustrate the outcome for very good soil. Figures 4 to 6 may be helpful for those who want to determine the best number of radials to install in those

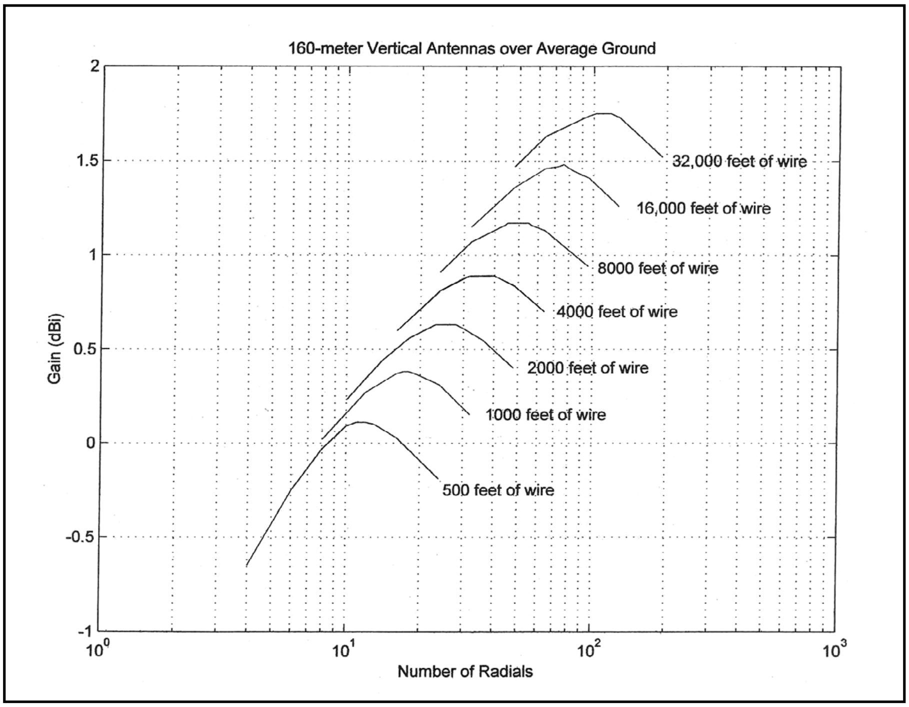

Figure 3—Gain of a quarter-wave 160 meters vertical antenna over average soil, as the number of buried radials is varied, for seven different total lengths of wire.

Table IX

Optimum number and length of radials for a vertical antenna on 160 meters (1.835 MHz) operating over very good soil (conductivity = 0.0303 Siemens/meter and relative permittivity = 20).

Total Wire Length (ft)	*Optimum Number of Radials*	*Optimum Length of Radials (ft)*	*Peak Gain (dBi)*
500	17 – 21	29.41 – 23.81	2.53
1000	23 – 30	43.48 – 33.33	2.63
2000	33 – 42	60.61 – 47.62	2.73
4000	47 – 59	85.11 – 67.80	2.83
8000	67 – 83	119.40 – 96.39	2.93
16,000	93 – 122	172.04 – 131.15	3.03
32,000	136 – 181	235.29 – 176.80	3.13

Table X

Optimum number of radials versus total wire length, for all three bands, in average soil.

Total Wire	*Optimum number of radials for each band*		
Length (ft)	*40 meters*	*80 meters*	*160 meters*
125	9		
250	14	10	
500	21 – 22	15 – 16	11 - 12
1000	28 – 31	21 – 24	17 - 18
2000	39 - 43	29 – 34	23 - 28
4000	62 – 63	42 – 46	32 - 40
8000	100 - 104	63 – 67	45 - 55
16,000		99 – 111	76
32,000			99 - 122

Table XI

Optimum number of radials versus total wire length, for all three bands, in very poor soil.

Total Wire	*Optimum number of radials for each band*		
Length (ft)	*40 meters*	*80 meters*	*160 meters*
125	6		
250	10	7	
500	16	11	7 - 8
1000	25	17	12
2000	34 – 36	24 – 26	18
4000	56 – 58	35 – 36	25 – 26
8000	96 – 100	57 – 59	35 – 36
16,000		98 – 104	55 – 59
32,000			96 – 100

Table XII

Optimum number of radials versus total wire length, for all three bands, in very good soil.

Total Wire	*Optimum number of radials for each band*		
Length (ft)	*40 meters*	*80 meters*	*160 meters*
125	12		
250	17 – 20	14 – 16	
500	24 – 28	19 – 25	17 – 21
1000	37	29 – 32	23 – 30
2000	48 – 58	39 – 50	33 – 42
4000	68 – 85	56 – 70	47 – 59
8000	102 – 127	80 – 103	67 – 83
16,000		119 – 152	93 – 122
32,000			136 – 181

cases where the total length of available wire is different from the seven choices I selected. A cubic spline interpolation was used when plotting these three figures, to make the curves as smooth as possible, and to improve their accuracy between the calculated data points.

A Surprise

An AM-broadcast station typically utilizes a ground-system composed of 120 quarter-wave radials per tower, or a total wire length of 30 WL for a single element. In other words, we assume that N = 120 is optimum when the total wire length is 30 WL. Let's examine our results and see if this same strategy is effective on the amateur bands. On 40 meters (7.15 MHz), 30 WL is about 4100 feet of wire, so we can use the 4000-foot data in Tables I through III, with only a small amount of error. For a total wire length of 30 WL, computer analysis indicates that the optimum number of radials is about 63 for average soil, 58 for very poor soil, and 85 for very good soil. Thus, on the 7-MHz band, the best number of radials is far less than 120, when 30 wavelengths of wire are available.

On 80 meters (3.75 MHz), 30 WL is nearly 7900 feet of wire, allowing us to safely utilize the 8000-foot data from Tables IV, V, and VI with good accuracy. On this band, we find that the best number of ra-

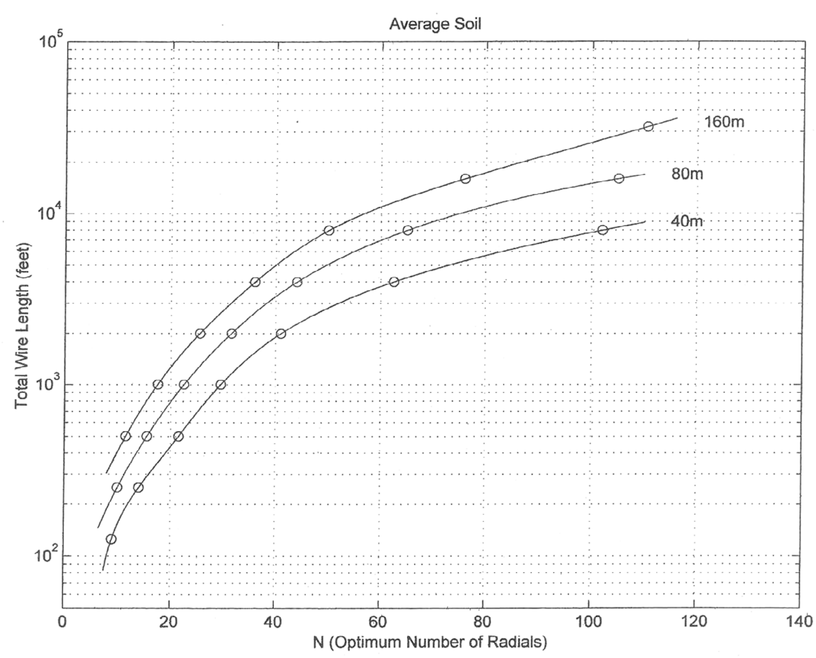

Figure 4—Optimum number of buried radials for quarter-wave vertical antennas over average soil, as the total wire length is varied, for the three "low bands" 40, 80, and 160 meters.

Table XIII

Optimum number of radials versus total wire length, for all three bands, in average soil with a conductivity of 0.005 siemens/meter. [Results using the N4UU formula are shown in brackets.]

Total Wire Length (ft)	*Optimum number of radials for each band* 7.15 MHz	*3.75 MHz*	*1.835 MHz*
125	9 [11]		
250	14 [15]	0 [13]	
500	21-22 [22]	15-16 [19]	11-12 [16]
1000	28-31 [31]	21-24 [26]	17-18 [22]
2000	39-43 [44]	29-34 [37]	23-28 [31]
4000	62-63 [62]	42-46 [53]	32-40 [44]
8000	100-104 [88]	63-67 [74]	45-55 [62]
16,000		99-111 [105]	76 [88]
32,000			99-122 [125]

Table XIV

Optimum number of radials versus total wire length, for all three bands, in very poor soil with a conductivity of 0.001 siemens/meter. [Results using the N4UU formula are shown in brackets.]

Total Wire Length (ft)	*Optimum Number of Radials for Each Band* 7.15 MHz	*3.75 MHz*	*1.835 MHz*
125	6 [7]		
250	10 [10]	7 [9]	
500	16 [15]	11 [12]	7-8 [10]
1000	25 [21]	17 [18]	12 [15]
2000	34-36 [29]	24-26 [25]	18 [21]
4000	56-58 [41]	35-36 [35]	25-26 [29]
8000	96-100 [59]	57-59 [50]	35-36 [42]
16,000		98-104 [70]	55-59 [59]
32,000			96-100 [83]

dials to install is 63 for average soil, 57 for very poor soil, and 80 for very good soil, if 30 wavelengths of wire are available.

Finally, on top band (1.835 MHz), 30 WL amounts to slightly less than 16,100 feet of wire, so the 16,000-foot data from Tables VII through IX will work nicely. Now we discover that the optimal number of radials is 76 for average soil, 59 for very poor soil, and 122 for very good soil, when 30 WL of wire are available.

We can see that, for most ham-radio applications, a ground system composed of 120 0.25-WL radials is not optimum, unless you want to operate on 160 meters and your soil conductivity is very good. If you have 30 WL of radial wire at your disposal, computer simulation reveals that, in many situations, fewer than 90 radials should be installed, with each one having a length greater than 0.25 WL, in order to maximize the gain of the antenna.

Comparison with N4UU

In his article, N4UU gives a formula that enables one to calculate the optimum number of radials for a vertical-antenna ground system, when the frequency, soil conductivity, and total length of wire are specified[4]. Tables XIII through XV compare the results obtained from this formula with those predicted by the "maximum gain" computer analysis that I performed using *EZNEC*. For average and very good soils, N4UU's formula generally yields a somewhat higher value for the optimum number of radials, while the results for very poor soil are mixed. However, the graphs show that relatively large variations in the number of radials produce changes in antenna gain of only a few tenths of a decibel, so the exact number of radials used is not critical.

Conclusions

For a single-element vertical antenna with a buried-radial ground system, the number and length of the radials can be

Table XV

Optimum number of radials versus total wire length, for all three bands, in very good soil with a conductivity of 0.0303 siemens/meter. [Results using the N4UU formula are shown in brackets.]

Total Wire Length (ft)	*Optimum Number of Radials for Each Band* 7.15 MHz	*3.75 MHz*	*1.835 MHz*
125	12 [17]		
250	17-20 [24]	14-16 [21]	
500	24-28 [34]	19-25 [29]	17-21 [24]
1000	37 [49]	29-32 [41]	23-30 [35]
2000	48-58 [69]	39-50 [58]	33-42 [49]
4000	68-85 [97]	56-70 [83]	47-59 [69]
8000	102-127 [137]	80-103 [117]	67-83 [98]
16,000		119-152 [165]	93-122 [138]
32,000			136-181 [195]

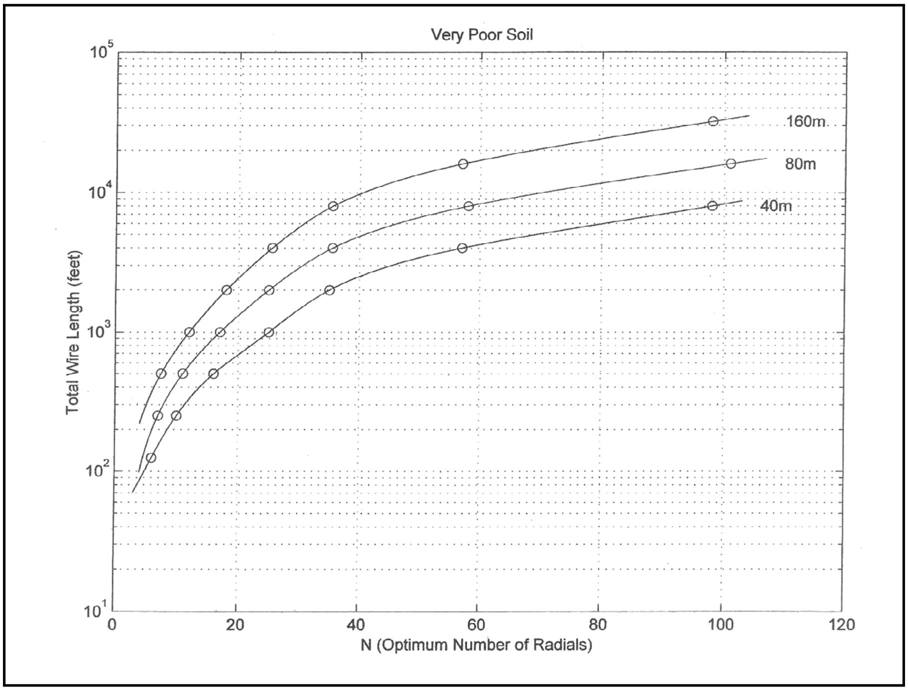

Figure 5—Optimum number of buried radials for quarter-wave vertical antennas over very poor soil, as the total wire length is varied, for the three "low bands" 40, 80, and 160 meters.

adjusted so the antenna will have the highest possible gain. The "best" number of radials depends upon the total amount of wire which can be dedicated to the ground system, and the electrical characteristics of the soil in which the radials are immersed. Contrary to what is generally used for AM-broadcast verticals, a ground system of 120 quarter-wave radials may represent a sub-optimal utilization of wire on the amateur bands from 40 through 160 meters. This article supplies tables and graphs which allow the active low-band operator to achieve maximum performance from the radial wire at his or her disposal.

Notes

[1]Robert C. Sommer, N4UU, "Optimum Radial Ground Systems," *QST*, August 2003, pages 39 - 43.

[2]Several versions of *EZNEC* antenna-modeling software are available from Roy Lewallen, W7EL, PO Box 6658, Beaverton, OR 97007.

[3]Robert C. Sommer, N4UU, "Optimum Radial Ground Systems," *QST*, August 2003, page 40.

[4]Robert C. Sommer, N4UU, "Optimum Radial Ground Systems," *QST*, August 2003, page 39.

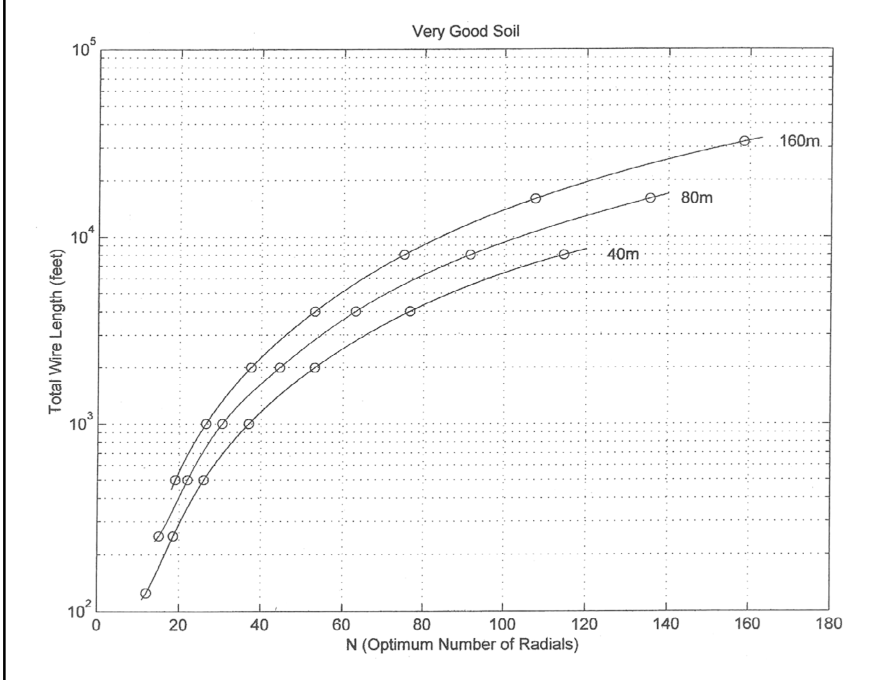

Figure 6—Optimum number of buried radials for quarter-wave vertical antennas over very good soil, as the total wire length is varied, for the three "low bands" 40, 80, and 160 meters.

How to Operate Field Day—or A Remembrance of Field Days Past

John W. Thompson MD, K3MD
Jwt105@yahoo.com

Perhaps the most (or best) organized Field Day that I participated in was my first one. The Morris Radio Club in North Jersey ran it. I was there under the auspices of my uncle, W2YTH, now W2MS. The Morris Radio Club had the ideal Field Day set up. All transmitters were homebrew. This was in the pre-transceiver age in 1964, when I was 14. There were separate setups for 10, 15, 20, 40, and 80 CW and SSB, as well as a VHF (AM) tent, with the wire antennas set up perpendicular to each other exactly at the edges of the 500-foot radius! This is exactly what you would expect from a club with a large number of scientists from Bell Labs in New Jersey.

After operating with this club for several years, using my Viking Ranger with the final stage swapped out to a 2E26 instead of a 6146 to keep the input power to 30 W (which was the low power multiplier in those days), I eventually graduated to operating from medical school with the South Jersey Radio Club, K2AA/2. These guys were really out for blood. They had a four element full sized 20 meter beam for SSB and a 3 element wire beam on push-up masts for 40 SSB with a perpendicular dipole for switching directions (one year they put it up backwards). These guys were (and are still) very sharp operators. I witnessed perhaps the biggest disappointment with this group. One year they had Philadelphia area TV coverage of the event, and the FD chairman never sent in the log. They usually win 6A.

My Field Day during my internship year was perhaps the most interesting. I was assigned 80 meters, and I cooked up a folded dipole with an RG-58 matching coil so it could easily match both the CW and SSB parts of the band. The call was W1NEM, the Hartford Area Radio Club, and everyone had a good time. At this age, around age 21, I found out that beer and coffee have exactly the same taste at 3 am.

Then I went on to Pittsburgh and my X-ray training residency. I did operate one Field Day class E with W3KWH, but only because my wife was almost due with our second kid and those were definitely the days before the availability of cell phones. The rest of the time I operated with the South Hill Brasspounders and Modulators. In this club, we started a kind of rivalry between the CW and SSB factions of the club. For one year, the CW operators made up a fixed beam that concentrated due west, with 4 elements on 20, 15, and 10. It was sort of a Force 12 antenna 30 years before the invention of Force 12. It was supported on 30 foot masts of the A-frame type. It was an FB beam, but you could only work California, Kansas and Washington on it. No W4s. So we went back to the drawing board. The next year we operated a TH3 up on an aluminum push-up ladder, with a *rotator*, and we managed to make twice the points of the two SSB stations combined. I was in charge of the satellite QSO (2 meters up, 10 meters down) and we got the 10 SSB station to shut up long enough to make the contact. The SSB boys were miffed.

Mike, N3PUR, working 20-meter SSB with his trusty MP-1000 at 2 a.m. Note that Randy, N3JPV, at the left, is still going strong. The GOTA operators are still at it in the right corner of the building, but you can't see them. On the right is a chair belonging to Jerzy, N3FIP.

John, K3MD, working 20-meter CW. Note John's key, keyer, rig, and computer. On the right are GOTA station operators Jack, W3GY, and Matt Smith.

Pittsburgh is a very provincial town. I moved 15 miles Northeast, and joined the Skyview Radio Society, K3MJW. We always operated class E and had a very good time doing it. We put up 2 element wire beams for 40 meters and 80 meters facing east, and had the very distinct advantage of computer logging, using Commodore computers. These years I finally was made the Field Day "director" (in charge of beer, eats, logs, hooking up the rigs, getting someone else to check the TH7 at 70 feet). Do you remember the days when you had to print out your log from the computer, and do the dupe sheet?

At this point I was starting to get to the disgusted stage that a nutty contester gets with Field Day operations. I operated /MM from my 24 foot boat for several years, with a Butternut vertical screwed into the trolling motor mount. Naturally, I got second place, third place, and fourth place in class 1C. I operated from a summer cabin in NH, got second place and third place in class 1B1 at 100w.

Next thing, I moved to DuBois, PA for professional reasons. Here I bought a 7 acre site on top of a hill. I set up a minibeam at 30 feet and Carolina Windom, and tried class 1B1 battery 5w and won. I know you guys say that Field Day is NOT a contest, but that is probably because you have never WON. If you happen to go to Dayton, every contester there knows who won Field Day last year in each class.

Next I went on to being Field Day director at the Quad County Amateur Radio Club in the DuBois area. We used AA3AZ and K3MD as calls, and we moved around from state parks to my hilltop location. We tried to separate the CW and SSB stations by at least 400 feet, and that really helps. Also, we run the SSB station horizontally polarized and the CW station vertically polarized. The trusty Butternut was set up in a frog pond on the north end of the property, and every time I transmitted, the toads croaked (really). We managed to make a higher score than our rival club, W3YA, who were operating one class number higher in class A than we were. There was a lot of club pride in that achievement because the other club was at least twice our size in number of members. We operated one year in class 2A, with only the entire family operating—sons N3PUR and N3NAV, daughter N3NWN, and the now late first wife N3NWM.

At the end of my stay in DuBois (10 years), I had the opportunity to operate with Mike, my son, N3PUR, class 2B2. We won. He made at least 1100 SSB QSOs. That class was not as tough as some other classes.

The next year we operated again from the cabin in NH. We were out for blood in class 2B2B, with two 30 foot push-up masts, my old generator, one TH3, and one TH3 Junior. We won 2B2B at 100 W. Not bad—2 years in a row. Attribute it to

Mike. This second year we were 200 Qs off the record.

We went back to Bloomsburg, PA, and the Columbia-Montour Radio Club. This group had and has been doing their Field Day in their own way for many years. They used several wire antennas with antenna tuners (non-resonant antennas) that were parallel and a few feet from each other. The cross talk and inter-band QRM was really difficult to believe. I tried to tell them they were doing it wrong, but I did not really get listened to until the second year. They were exposed to Mike, N3PUR, and could not figure out who in their right mind would shout into the mike on 20 SSB all night (he made 550 QSOs on night shift on 20).

So, I gave up and decided to go back to 1B1 100 W in 2003, with the trusty TH3 Junior up 25 feet and a doublet tuned with a tuner. Naturally, conditions were terrible, with the QSO rate and numbers way down.

Yes, I have missed one Field Day in the past 42 years. I was working at the Maryland shore. In those days a "portable" setup weighed around 100 pounds and did not travel well by bus.

I love field day, and hope I never miss another one. I am the guy who yells at you if you are talking too loud next to the operating position and the QSO rate starts going down. There is something about the combination of the generator running, running out of gas, getting shocked by a bad ground rod, having to go slow for some of the CW QSOs, shutting down immediately when you see lightning strikes coming toward you 3 or 4 miles away in the hills, the mosquitoes, the mosquito repellant coils, the yellow 60-W light bulbs, the moth crawling up the computer monitor screen, natural power QSOs with batteries charged with solar cells, the CW interface refusing to work at all, walking up a ladder with a Yagi duct-taped to the top, reviewing pictures of some of our operators sound asleep at the mike at 2 am, "The Flying Wallendas" (what they called my early Force 12 antenna), and the like that can not be matched by any other hamming activity.

Thanks to Bob K3QIA, Ron WN3VAW, Larry K3VX, and Mike N3PUR for their contributions to this article. NCJ

A Four-Square with Eight Directions of Fire

Al Christman, K3LC

Introduction

The four-square phased-vertical array[1] is widely used by DXers and contesters for operation on the low bands from 40 through 160 meters. It can also serve as an effective low-profile directional antenna on the upper HF bands in locations where restrictive covenants prohibit towers and beams, or on DXpeditions where compactness and low weight are important.

This article shows how to modify a conventional four-square to provide eight directions of fire instead of the normal four. The extra directions are located at points which are mid-way between the existing four, yielding a total of eight selectable beam-headings spaced 45° apart.

Antenna Description

A computer-generated drawing of an elevated four-square array for the 80 meter DX phone band is shown in Figure 1. For simplicity, all elements are composed of #12 copper wire. In the *EZNEC*[2] simulation, the array is placed at a height of 15 feet above good ground, which has soil conductivity of 5 millisiemens per meter and a relative dielectric constant of 13.

The elements are positioned so that the four directions of fire (through the diagonals of the square) are northeast, southeast, southwest, and northwest. The peak gain in these directions is 5.42 dBi at a take-off angle of 21°. When beaming northeast, the gain directly to the north (or east) is 2.80 dBi at the same take-off angle. After the four extra directions of fire are incorporated, the array can also beam north, east, south, and west. In these four "new" directions, the maximum gain is now 4.54 dBi at 21° take-off angle. Compared to the conventional array, this amounts to an improvement of 1.74 dB when beaming directly to the north, south, east, or west. Figures 2 and 3 compare the elevation and azimuthal plane radiation patterns for both configurations. A simulation was also performed over perfectly conducting earth. Here, the gain improvement achieved with the 8-direction array was 1.31 dB when firing north, south, east, or west.

Element Phasing

The conventional antenna fires outward through the corners of the square formed by the four elements, while the modified array can also fire through each of the four sides. In either case, all the elements are driven by equal amplitude base currents, but the phase angles are different to result in beams heading in the different directions.

In typical phased array fashion, the rear-most element has the leading current phase angle, with the phase lag increasing progressively as one proceeds from the rear to the front of the array. When beaming through a corner (as in

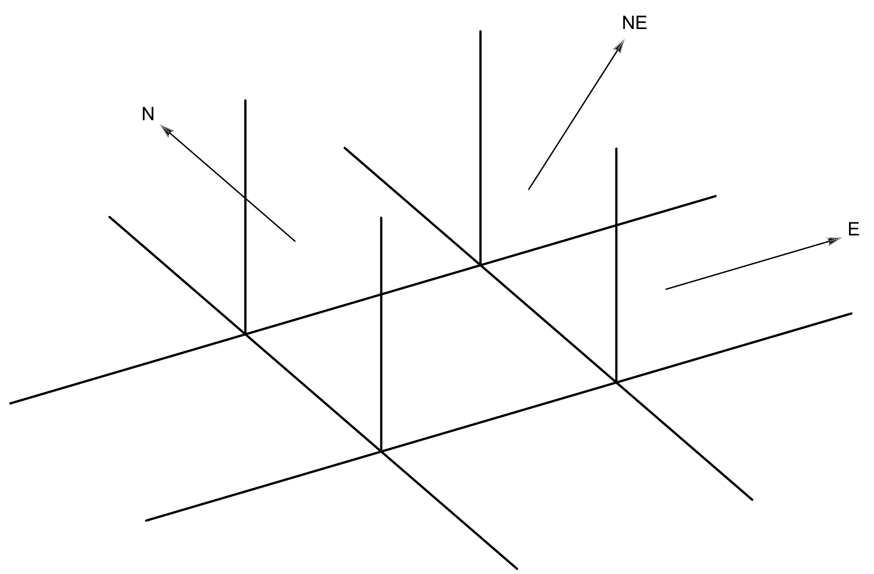

Figure 1—A computer generated drawing of the four-square array for 80 meters. Four quarter-wave elements and 12 quarter-wave radials are utilized. All conductors are #12 AWG copper wire, and the elevated feed-points are located at a height of 15 feet above the ground.

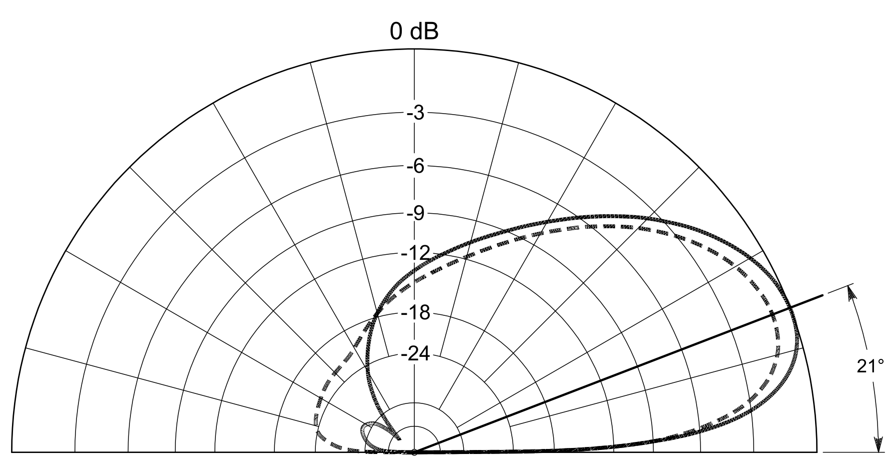

Figure 2—Elevation-plane radiation patterns for the four-square array when firing NE-SE-SW-NW through the corners of the square (solid trace), and when firing N-E-S-W through the sides of the square (dashed trace). Peak gain when firing through the corners is 5.42 dBi at a take-off angle of 21°, while maximum gain when firing through the sides is 4.54 dBi at 21° take-off angle.

[1]Notes appear on page 16.

a conventional four-square) the current in the two middle elements lags that of the rear element by 90°, while the current in the front element lags that of the rear element by 180°. When firing through the sides of the square, there are two front elements and two rear elements; now the currents in the front elements lag those of the rear elements by 90°.

A variety of strategies can be used to create the networks that are required to result in the desired base currents. One method that works well, and is widely used in Amateur Radio applications, relies upon the "current forcing"[3] concept described by Roy Lewallen, W7EL. If all of the elements in the array are fed by lossless transmission lines whose electrical length is 0.25 λ, then the output current flowing into the base of the corresponding element will have a magnitude equal to the voltage at the input end of the line divided by the characteristic impedance of the line. Further, the phase angle of the output current will lag that of the input voltage by 90°, which is the electrical length of the feeder itself. Notice that the input impedances of the various elements are not a factor; in other words, the driving point currents are not dependent upon the driving point impedances.

When applying the current-forcing technique to drive a four-square, an RF network is needed that can generate two voltages that are equal in amplitude but 90 apart in phase. One strategy, adopted by Comtek Systems[4], employs a 90° hybrid to provide the two requisite output voltages. Another method, described by W7EL, makes use of a capacitor and an inductor configured as a low-pass L-network[5].

In a typical application, the network output terminal with the lagging voltage is used to drive the two middle elements of the four-square, which will have a lagging current phase angle of 90°. At the same time, the terminal with the lead-

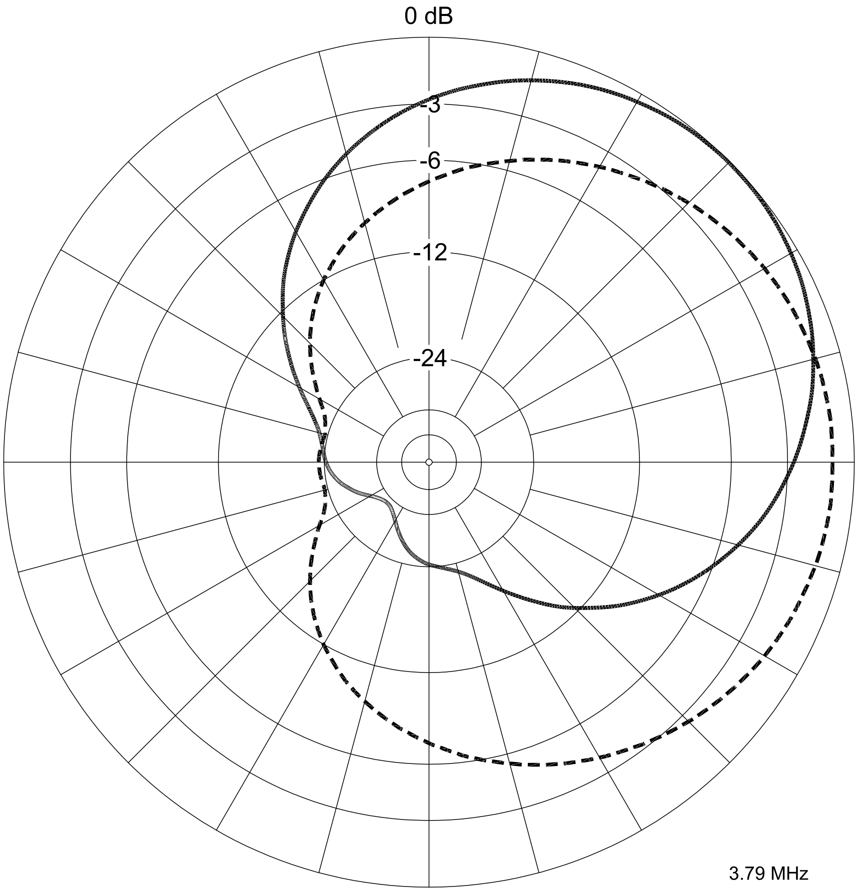

Figure 3—Azimuthal-plane radiation patterns for the four-square array when firing NE-SE-SW-NW through the corners of the square (solid trace), and when firing N-E-S-W through the sides of the square (dashed trace). Peak gain when firing through the corners is 5.42 dBi at a take-off angle of 21°, while maximum gain when firing through the sides is 4.54 dBi at 21° take-off angle.

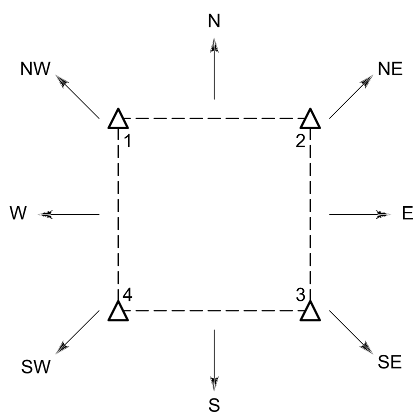

Figure 4—Plan view of the four-square vertical array. Each element is numbered, and the eight possible directions of fire are shown.

Table I

This table lists the relay control logic and the number of energized relays for each direction of fire, along with the corresponding current phase angle for each element. For the status of the six relays, "1" = on and "0" = off.

Direction of Fire	Relay States K1	K2	K3	K4	K5	K6	Number of Energized Relays	Phase Angle of Current in Element 1	2	3	4
N	1	0	0	1	0	0	2	-90	-90	0	0
NE	0	0	0	0	0	0	0	0	-90	0	+90
E	0	0	1	1	0	1	3	0	-90	-90	0
SE	1	1	1	1	1	1	6	+90	0	-90	0
S	0	1	1	0	0	1	3	0	0	-90	-90
SW	0	0	0	0	1	1	2	0	+90	0	-90
W	1	1	0	0	0	1	3	-90	0	0	-90
NW	1	1	1	1	0	0	4	-90	0	+90	0

ing voltage drives both the front (current phase angle of -180°) and rear (current phase angle of 0°) elements. Since the current in the front element actually lags that of the rear element by 180°, an additional 180° phase lag must be introduced in some manner. Comtek relies upon a 1:1 toroidal transformer configured as a broadband phase inverter, while W7EL uses an electrical half-wavelength of transmission line to accomplish the same purpose. Thus, each of the two output voltages from the RF network actually furnishes current to two of the four elements of the array.

Control Circuitry

Figure 4 is a plan view of the four array elements, showing the eight directions of fire. Figure 5 is a schematic diagram that illustrates the RF wiring for the six relays that perform all of the direction switching. Four SPDT relays (K1 through K4) and two DPDT relays (K5 and K6) are used, but eight SPDT units could be substituted. In this figure, I have chosen to use 0° as the reference phase angle for the *middle* elements of the array, when firing through the corners of the square. The front element is then at -90° and the rear at +90°. This way, the corresponding phase angles when firing through the sides of the square are 0 and -90° for the rear and front elements, respectively. Note: the terminals labeled 0°, -90°, and +90° on the RF network in Figure 5 correspond to the terminals labeled -90°, 180°, and 0° on the Comtek ACB-4 phased-array switch.

Table I gives complete information for all six relays, listing which are on and which are off for each of the eight directions of fire. In the northeastern USA, it is customary to make "NE" the default beam heading, and the relays have been wired accordingly. Even if control power is lost, the array will still beam to the northeast. The table also shows the relative phase angle of the current delivered to each of the array elements.

A method for distributing control power to the relays is given in Figure 6. If the RF relays have dc coils, then a single-pole eight-position rotary switch can be used in combination with 23 steering diodes as shown. These diodes can be common 1N4001 or similar rectifier devices. Figure 7 uses a similar switch, along with a diode matrix, to accomplish the same task. As before, 23 diodes are needed. The design of these direction control circuits utilizes a single deck switch and diode logic, instead of a more complex and expensive six-pole eight-position multi-section switch.

Conclusion

This article has discussed a technique for obtaining eight directions of fire from

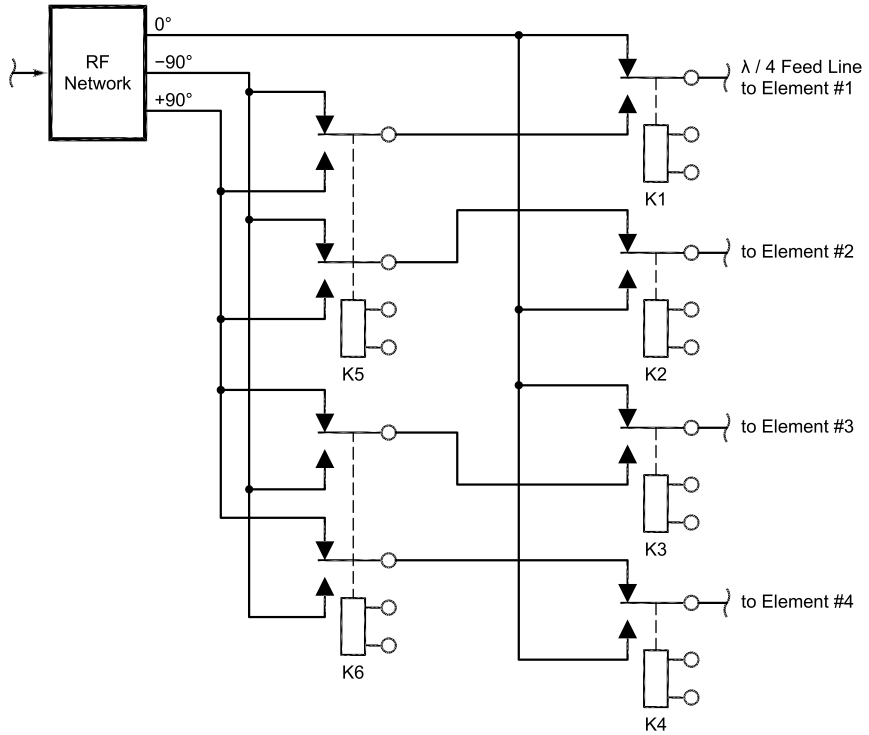

Figure 5—RF wiring for the relays that is used for direction switching. The diagram shows two DPDT relays and four SPDT relays, but eight SPDT relays could also be utilized. All relays are shown de-energized (off).

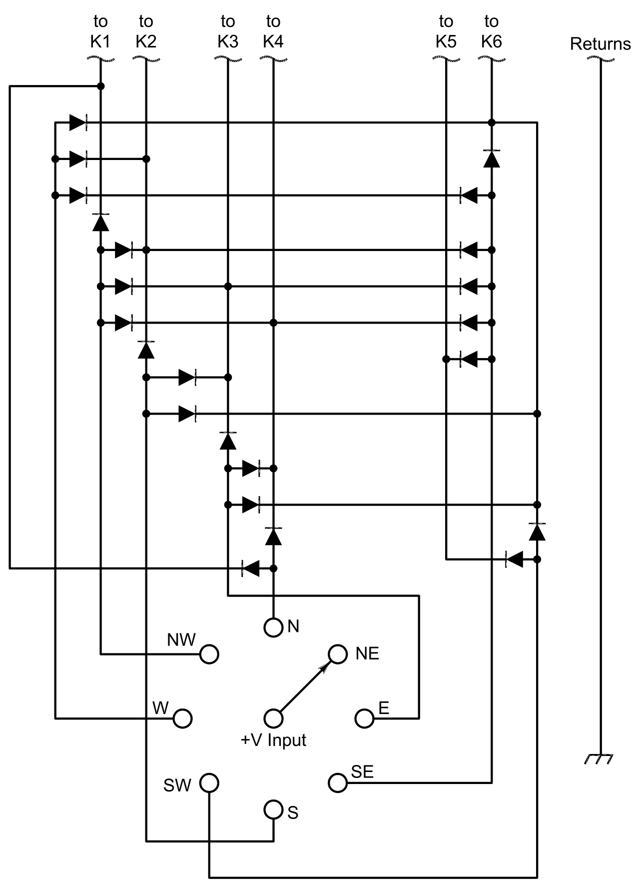

Figure 6—A direction-control switching circuit for the RF relays shown in Figure 5, assuming they have dc coils.

the well-known four-square phased vertical array. Whether these extra four azimuthal selections are important or not will depend upon the needs and desires of the operator.

For the elevated sparse-radial antenna described here, the gain improvement when firing through the sides of the square is nearly 1.75 dB, which could make a difference in a contest situation.

Notes

[1]D. Atchley, W1CF, H. Stinehelfer, ex-W2ZRS, and J. White, PhD, "360°-Steerable Vertical Phased Arrays," *QST*, Apr 1976, pp 27-30.
[2]*EZNEC* is available from Roy Lewallen, W7EL, PO Box 6658, Beaverton, OR 97007.
[3]R. Lewallen, W7EL, "A Preferred Feed Method," *The ARRL Antenna Book*, 20th Edition, American Radio Relay League, 2003, pp 8-15 and 8-16.
[4]Comtek Systems, PO Box 470565, Charlotte, NC 28247-0565.
[5]R. Lewallen, W7EL, "Feeding Elements in Quadrature," *The ARRL Antenna Book*, 20th Edition, American Radio Relay League, 2003, pp 8-16.

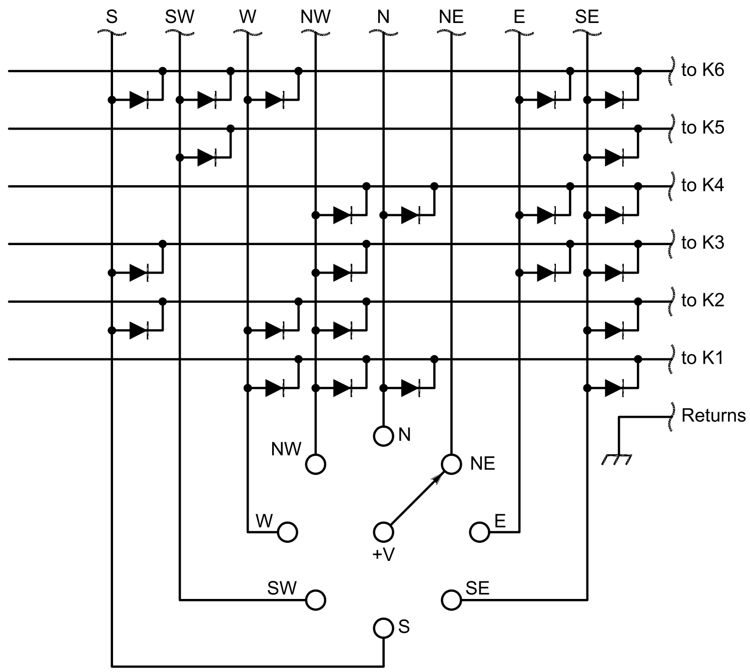

Figure 7—Another direction-control circuit for powering the RF relays shown in Figure 5. Here a diode matrix is used to feed dc to the proper relays.

A Look Back at Dayton 2003

Mark Beckwith, N5OT

At the risk of injury from patting our collective selves on the back, I wanted to share a good Dayton story about how great contesting is.

Saturday night at the Hamvention found me heading to my room, having enjoyed the midnight pizza ritual. Not only was I calling it a night, I had said my goodbyes and was heading out first thing in the morning.

Instead of following this plan, however, when I got on the elevator there were three guys, all of whom I knew a little, all of whom I'd worked a ton of times in contests, and all of whom got a kick out of my special badge which read "NOT Larry K5OT." They thought aloud that if I liked that kind of badge humor, maybe I should come back to their room and see one of their funnier badges—innocent enough.

What followed was two hours of the most memorable camaraderie. It was as if we all had known each other for *years*, but truth to tell I had met them all only in the past couple days. We talked about great DXpeditions and shared antenna secrets. They taught me the post-World-wide M&Ms-plus-Heineken ritual they picked up in St. Maarten, where Heineken is a domestic beer. We made jokes about the state of packet radio. It was great.

The makeup of the group was the most interesting of all. That night was my 45th birthday. I've been licensed since I was 13 and contesting since I was 14. But get this: Dan, K1TO, was 43 and had been at it for 31 years. Mike, N2MG, was 44 and had been licensed for 30 years. Rus, K2UA, the youngest of us all, had been licensed 22 years. By ham standards this was a room full of "young men" who had over 100 years of ham experience between them. Remarkable.

I have headed home from Dayton with new lifetime buddies, little sleep, and a memorable party that will remind me for a long time to come of just why I love what we do so much!

I hope we *never* grow up!

Preliminary Report on the January 2004 VHF Sweepstakes

Jon K. Jones, NØJK
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There was a big E_S opening for the Eastern Seaboard in the 2004 January ARRL VHF Sweepstakes. The contest also saw an E_S link to South America as well as tropo, and aurora. See the VHF-UHF Contesting column for some FAQs on sporadic E.

There was plenty of "E_S pixie dust" left for the January VHF Sweepstakes. Saturday afternoon (the 24th) there was an opening for 4 hours between Florida and the northeast states and Canada. Conditions were so good on 6 meters that N6ZE/r in Ft. Lauderdale, FL was able to work K1JT with 2 W and a whip antenna. Ed, VP9GE, had E_S to the states from about 1900 to after 2345 UTC. He reported making over 400 QSOs on 6 meters. VE3CRU/r said Ed was "5×9++" around 1900 UTC in FN13 on a wire dipole 14 feet above Lake Ontario.

An E_S link to TEP (trans-equatorial propagation) occurred towards the end of the opening and N3DB had PY1, PY2 and LUs into FM18 for 45 minutes. This makes the third January VHF Sweepstakes in a row with F2/TEP DX on 6 meters. The 2002 VHF Sweepstakes had F2 to Canada, Europe and Japan, and 2003 had KH6 to W1 plus a big E_S opening for the eastern states.

Later Saturday evening, many stations along the northern tier of states made QSOs via aurora on 6 and 2 meters. KL7NO, Fairbanks, Alaska was into Montana and Washington State on aurora at 0410 UTC on 50.125 MHz. There was an interesting spot by W7KNT at 0412 UTC for "weak JAs on 50.115!"

Early Sunday afternoon I worked WA7JTM (DM33) at 1920 UTC with 10 W and a dipole from EM18 portable on a strong 6 meter E_S opening. Late Sunday afternoon and on through the evening E_S developed over the Gulf between Texas, Florida, the Cayman Islands and Mexico. XE2HWB, XE1MEX, XE1AQX, XE1HRS and XE3PNH (EL61) worked many contestants. K6LMN/C6A/r handed out several grids in the Bahamas on 6 meter E_S to Texas ops. ZF1DC spotted the KE4SIX/b at 2321 UTC. Tropo was reported along the Gulf Coast between Texas and Florida Sunday morning. In all, there were pretty good conditions for many parts of the country for this January VHF contest.

NCJ

N3BB in the IARU HF World Championship

Jim George, N3BB

Here is the story from the recent IARU N3BB multi-single (M/S) low power effort by Jim, N3BB, and Rob, K5PI. They used the "NØAX rules" for the WRTC-style team entry. They had fun, and they did well—at least compared to the other NA stations.

Comments from Jim George, N3BB

It took a lot of time and effort to take a fairly competitive SO2R setup at N3BB and change it into an M/S arrangement with two modest antennas. The new Hy-Gain 40 and 80 meter trapped dipole installation had a hard to find intermittent that came and went before and during the contest. This caused me to make several high pressure tower climbs at 7 PM on Friday night as darkness fell. The last thing I wanted was for Diana and me to be on top of "Radio Hill" as darkness fell Friday, sweating why the new trapped dipole would not work. I finally determined that it looked normal using the MFJ 259B, and so I redid the barrel fitting, taped everything and hoped for the best. It worked OK when we got back to the radio room. However, the Radio Gods (RGs) decided it would stop working for the initial part of the contest. I was devastated when the SWR was bad again and Rob was having trouble working stations during a 40 meter opening on Friday night. Fortunately the RGs changed their mind, and it started working later while 40 was still good to Europe. We needed the HQ stations and it was crunch time to Europe and later to Asia on 40 meters, and the darned thing worked very well once it decided to be OK. I felt we "owned" 40 meters with 100 W and a dipole when the JAs came in!

Whew, all in all a terrible stress on me. I was tired when the contest started from all the extracurricular activity. On the bright side, the magic little KT34A tribander at 65 feet is a little workhorse for the HF bands, and a better friend I can't imagine (gads, I sound like Yoda now!).

K5PI is a pleasure to host, as Rob is a super operator, very FB on both modes, and a fine person. When one of us was not CQing/running (which we tried to do most of the time with our little 100 W dynamo setup) we traded off ten-minute stretches, and worked the stations we had entered in the bandmap the previous ten minutes. This seemed to work well. I was completely confident with Rob at either SSB or CW.

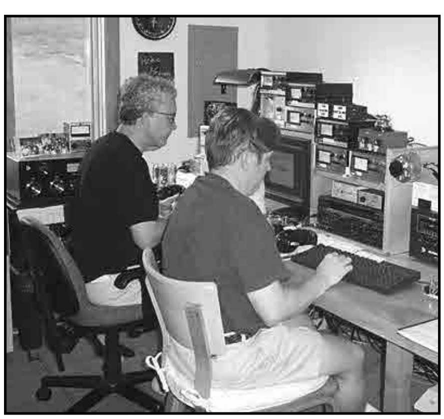
The HF bands were in pretty rugged shape, but 20 meters stayed open all night to some extent. We experienced some good 20 meter CW runs, and 40 was great the last three hours to Asia. We ran around 35 JAs, and worked HL, DU, VR2, KHØ, and the B4HQ station in Nanjing, China. After the contest, JA1NUT told me he didn't realize we were low power and not using the Yagi. Wow! I'm used to 1.5 kW and large antennas, and I have to say this was not *all* that much different from the "feeling" of a regular contest. We got nearly all the stations we called, and CQed as much as we could.

Summary:

Band	*CW Qs*	*Ph Qs*	*Mults*
160	12	0	6
80	54	0	9
40	257	30	40
20	385	163	65
15	160	102	39
10	22	16	6
Total	890	311	165

Total Score = 550,605

A break in the action—Jim, N3BB, on the left and Rob, K5PI, on the right.



Jim, N3BB, (left) and Rob, K5PI, (right) working hard during the IARU contest.

We tried and tried for a JA on 80 at the end, and moved several JA stations from 40, but weren't able to make it. We heard one JA CQing on 80, but he could not hear us, and none of our moves worked out. OK, so there is a difference with 100 W after all.

The trapped dipole loaded up well on 160 using the MP's antenna tuner, and it seemed to get out well. We worked Zones 4 (VE3), 6 (W6), 7 (W5), 8 (W3, W1AW/3), and XE2AC in Zone 10. We called VA7NT in Zone 2 but he didn't hear us. VE3DZ was running 100 W so I am proud of that QSO. We used no Beverages (not allowed) or packet (not allowed) within the special "WRTC style" rules we were using.

I took a '30 minute nap' about 4 AM, which lasted about an hour and a half. Rob was hanging tough.

Thanks to all the CTDXCCers who were active, and who worked us. If you enjoy contesting at all, then you should try the IARU contest. It offers both modes, uses ITU zones and HQ stations as multipliers (like W1AW-ARRL), it lasts 24 hours and it starts at 7 AM here on Saturday morning! Twenty meters opens up nearly all night to EU/Asia and there are good runs. This contest is very popular and there is great activity in Europe. You can work everyone, even Ws for points, so everyone works everyone in this contest. It's administered by the ARRL and has good log checking and certificate administration.

We used *NA* 10.58 for the contest software, although we noted a couple of peculiar glitches, perhaps due to RFI. It usually is solid for me, but all in all it went very well. Rob is a *TR* man, and I don't think I converted him!

All in all, it was a lot of fun, and a terrific experience. Thanks to Diana for a wonderful team breakfast at 8 AM. The morning was bubbling with beautiful sunshine and a songbird outside was warbling a magnificent tune. It was nice to be alive and to emerge from the contest shadows into the world again.

Comments from Rob Brandon, K5PI

It was beaucoup fun. We're both typically power junkies, and it was cool to see again just how much you can do with a tribander and a wire. The high points for me were a great 20 meter run of Russians and US operators on Saturday evening, a nice JA run on 40 in the wee hours of Sunday morning, operating three times as much code as SSB and some mighty fine vittles—thanks Diana! NCJ

Be Part of Something Hot —the B4HQ IARU HF 2003 Story

Michael Chen, BD5RV/4

It was a hot and exciting summer. One day in early July, Dave, BA4RF, called me on the phone: "How about contesting as a HQ station in IARU HF?" "Wow," I said. "Why not?"

Founded in 1998, the Jiangsu DX Club has become the most active DX community in China. We were known in the major contests as B4R as well as in the BI expeditions. In IARU HF, people surely need Zone 44, but a multiplier like *CRSA* would be another enticement to all the contesters around the world. A Chinese HQ station hasn't been in this contest for more than ten years. What about earlier? I don't know, as I've never heard of any story about HQ operation in this contest within the mainland of China.

So Dave's idea was really what all of us were thinking. But we didn't want to move to Beijing to operate BY1PK. Here in Nanjing we had several stations available for contest operation. Each had beam antennas and ready-for-use station equipment. Why not ask HQ to move? When telephoning Chen, BA1HAM, Secretary General of CRSA, about acting as HQ in the contest, he said "No problem."

Chen also issued the special call B4HQ to better identify ourselves. This proved to be more than useful in the pileups. We couldn't wait any more!

Overall, four stations were engaged for B4HQ. They were: BY4RSA, BA4RC, BA4RF and BA4RZ. Each site had a *Writelog*-ready computer for logging and rig controlling. Telnet-based DX clusters can be accessed. All the logs were synchronized by an Internet *Writelog* server, so a broadband Internet connection was kept in BA4RC, BA4RF and BA4RZ. For BY4RSA, we applied GPRS.

Operating conditions

Station	*Antenna*	*Equipment*
BY4RSA	CREATE714X, A3S, and Dipoles	FT-1000MP with GO2KW Amplifier (running at 1kW)
BA4RC	5 ele BA4ED monobander for 10m 4 ele BA4ED tribander	TS450S with TL922
BA4RF	4 ele BA4ED tribander for 10,15, 20 2 ele BA4ED mono-bander for 40 Dipoles for 80	FT1000MP with GO2KW amplifier (running at 1kW)
BA4RZ	4 ele BA4ED tribander for 10,15, 20	JRC245 with homebrew 1kW amplifier

We posted a message on our club's mailing list asking for operators, and soon got intense responses. Huang, BA4ED, joined us with his wife from Shanghai. Deal, BA4TB, and Wen, BD5HAG, from Wuxi and Hangzhou were both club members. Kenneth, BD4RR (VA3RRW), also a member of JSDXC, flew thousands of kilometers to operate from Canada. Besides, we had five other local operators: Chen, BA4RC, Ken, BA4RD, Dave, BA4RF, Dragon, BA4RX, and me. Team B4HQ was born.

We allocated bands and modes according to each station's working conditions and had our operators arranged. We also tested our stations before going on the air.

Station, Band/Mode, and Operator

Station	*Band & Mode*	*Operators*
BY4RSA	160 CW 160 SSB 40 CW 15 SSB	BA4TB, BD5HAG, BD5RV
BA4RC	10 CW 20 CW	BA4RC, BA4RX
BA4RF	80 SSB 80 CW 40 SSB 15 CW	BA4RF, BA4ED
BA4RZ	20 SSB 10 SSB	BA4RD, BD4RR

At 2000 local time on July 12, the contest began. The power of Amateur Radio stations heated the ionosphere from all over the world. B4HQ was warmly welcomed by pileups. People were spotting us on every running frequency. Sometimes we could raise our running rate up to more than 250 contacts per hour for short bursts. It was great fun.

We ended up with 3545 QSOs and a final claimed score of 2.86M. This was the best score we had ever achieved in this contest. I knew this wasn't much compared to the big guns in EU and NA, but it set our record for IARU HF.

Summary

Band	*CW QSO*	*CW Points*	*Phone QSO*	*Phone Points*	*Total QSO*	*Total Points*	*Mults*
160	1	1	0	0	1	1	1
80	30	76	3	11	33	87	9
40	355	1221	245	612	600	1833	52
20	590	2547	513	1934	1103	4481	74
15	637	2119	916	2973	1553	5092	77
10	123	355	132	376	255	731	21
Total	1736	6319	1809	5906	3545	12225	234

Claimed Score: 2,860,650

Thanks to Chen, BA1HAM, and the CRSA for allowing us to do a contest as B4HQ. Also thanks to all who called us in the contest. We do hope to do this again next summer. See you in the pileups!

Figure 1—Chen, BA4RC, operating B4HQ at his own station.

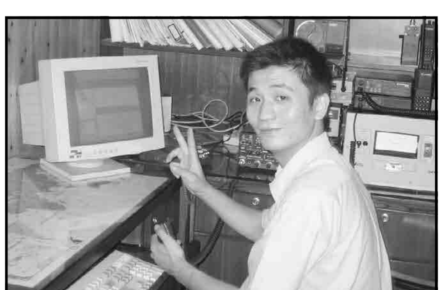


Figure 2—Ken, BA4RD, operating B4HQ SSB from BA4RZ

Figure 3—Dave, BA4RF, is busy with a CW pileup

NCJ

A Six Meter Stack with a Twist

Mike Krzystyniak, K9MK

I have enjoyed DXing and DX contesting since the early 1970s. After moving to Texas in 1980 I was reintroduced to VHF contesting. For me, the VHF arena offered a whole new world of challenges and enjoyment. In 1984 we moved from suburban Fort Worth to our country location where I have enough room to play with most any antenna. My property is situated on a ridge and I have three modest towers that support antennas from 160 meters through 23 cm. As my modest VHF station grew and morphed, I began to realize that I had hit a performance plateau defined by the limits of single Yagi antennas with 10 to 20 foot booms. In the 1990s I beefed up 2 meters with a stack and added several Yagis for 6 meters on two towers at three heights. My overall scoring increased proportionally, but now the scoring potential seemed limited by geography, the weather, and Sol.

The Competition

Throughout the years I always enjoyed the competition. When Mike Baker, W8CM, moved back to the Dallas/Ft Worth area he revamped his entire VHF antenna system. Most notable was the upgrade of his 6 meter antenna. Mike's approach used two 6 meter 7 element Yagis on a rotating tower system, rotating the top 30 feet of a 90 foot tower. Mike published his design approach in the July 2000 issue of *CQ*. His results were impressive, taking top scoring honors for NTX and the division. The competition just raised the bar and I had to come up with my own plan. You may remember the cartoon in *Mad Magazine* called Spy vs. Spy. Well, this quickly became *stack vs. stack*.

Hiatus

Don't let the fact that this project took me nearly three years to complete slow you down. Sometimes things happen in life that you have to just go deal with, and they're called family. Without compromise to my family commitments, I did what I could when I could, and here in the past year we got her done!

Design, Research and Final Selection

The goal was simple—put up more antenna on 6 meters than my nearest competitor and make it play down to the last tenth of a dB. Over the past 20 years I had nothing more than basic 3, 4, and 5 element 6 meter Yagis at various heights from 15 to 20 feet, 40 feet, 75 feet and 140 feet. Although initially not obvious to me, propagation on 6 meters is so diverse that no single antenna height would offer a dominant performance solution. The lower heights were great for sporadic E (E_s), while the medium heights helped some with tropo but E_s signals seem to have suffered. The 140 foot antenna put VK, JA and about 50 other countries in the log and it worked great on tropo, but suffered terribly on E_s. Prime time for a stack, you say?

With most of my 2 meter and higher antennas on my 70 foot tower, I decided to put this array on my 110 foot Rohn 45 tower. There is enough vertical space to put up a stack of four or even five 6 meter Yagis. My wife didn't give me carte blanche for this project so having a cost effective solution became an additional requirement.

So how do the other guys do it? I made several trips to W5KFT's ranch for the W5 DX bash, which, by the way, is usually held annually in early October and well worth the visit. There I visited with K5TR, K5IUA, W5OZI, AE5B and N5RZ (among others) and discussed the designs of their 6 meter stations. As we talked through their observations and experiences I was becoming convinced that it's possible to design a system that would be too high for effective 6 meter contesting. The W8CM stack uses two M^2 6 meter 7 element Yagis at 61 and 83 feet. Was it possible that these are too high? Considering all the inputs from the sages at the DX Bash I decided to start out by going lower but bigger.

On my 110 foot tower, the tower guys were at 30 feet, 60 feet, and 100 feet, so I decided to start a design using two Yagis. The lower antenna will mount just above the first guy at around 30 to 40 feet, and the upper will mount just above the second guy at around 60 to 70 feet. Cost, conversion effort and slower rotation times ruled out converting the tower to a rotating system. Swing arms with individual rotors didn't cover 360 degrees and were surprisingly expensive when you add it all up. So I worked a deal with Carl up at TIC General and purchased several 1022D Ring Rotors.

Antenna selection was next. Since I was going lower in height and starting with only two Yagis, I wanted something with 9 to 11 elements. Looking at my tower geometry I would be limited to booms no longer than 60 feet. The M^2 6 meter 7 element antenna was getting a lot of good press but I decided to go with its bigger brother, the 6M2WLC. This 9 element antenna is on a 40 foot boom and provides about 12 dB of gain with more than a 25 dB front to back ratio.

Assembly and Installation

The M^2 antennas and ring rotors arrived in the spring of 2001. Construction started immediately with the intent of burning in the antennas in the next VHF contest. The M^2 antennas went together easily, taking about two hours each to build. They were staged on sawhorses and the kid's trampoline. The first antenna went together with some trial and error. M^2 did a good job with the assembly directions but I chose to read them *after* I got in trouble. These precision-machined computer

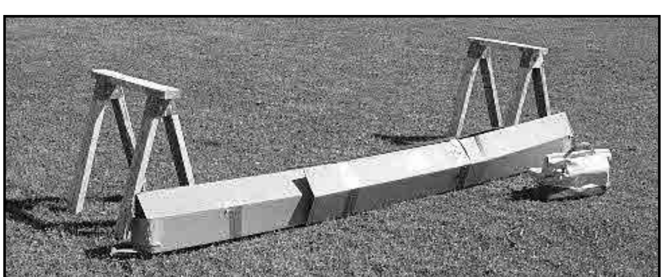


Figure 1—These antennas are big and were shipped by truck

Figure 2—Antennas were staged on sawhorses and an old trampoline.

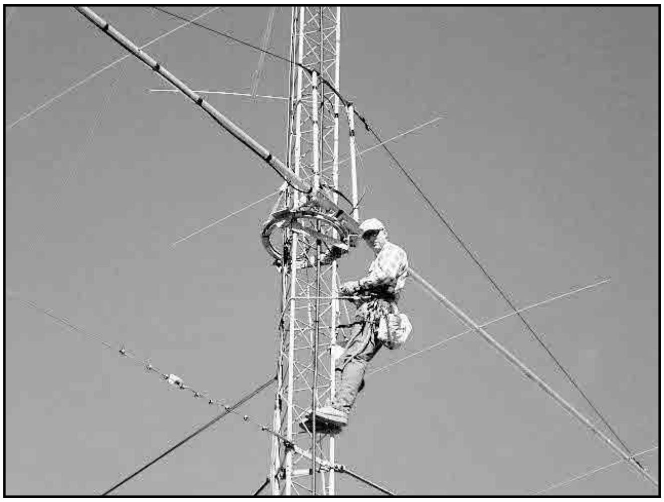


Figure 3—Rick N5DXT completing the installation of the lower 6 meter 2WLC at 36'.

Figure 4—N5DXT setting the stack azimuth North.

aided designs have some aspects to them that are not intuitive. Again, read through the directions carefully *before* you start your assembly.

These antennas are extremely well designed and they have already survived Texas ice storms, heavy hail and storm winds that were estimated at 90 to 100 MPH. The ring rotors might be considered a luxury item, but they are a surprisingly economic investment for most any application. I could have bought 5 rings for the cost of converting to a rotating tower System. I did consider swing arms but net-net the ring rotor provides 360° rotation for the same price. The rings and Yagis took about four hours each to install and plumb. Following M^2 stacking recommendations, the antennas were placed at the 36 foot and 62 foot levels on the tower. They are both fed with equal lengths of LMR-400 coax for independent selection while maintaining future flexibility toward implementing "both-in-phase/both-out-of-phase" (BIP-BOP) or diversity phasing with a Yagi on a second tower.

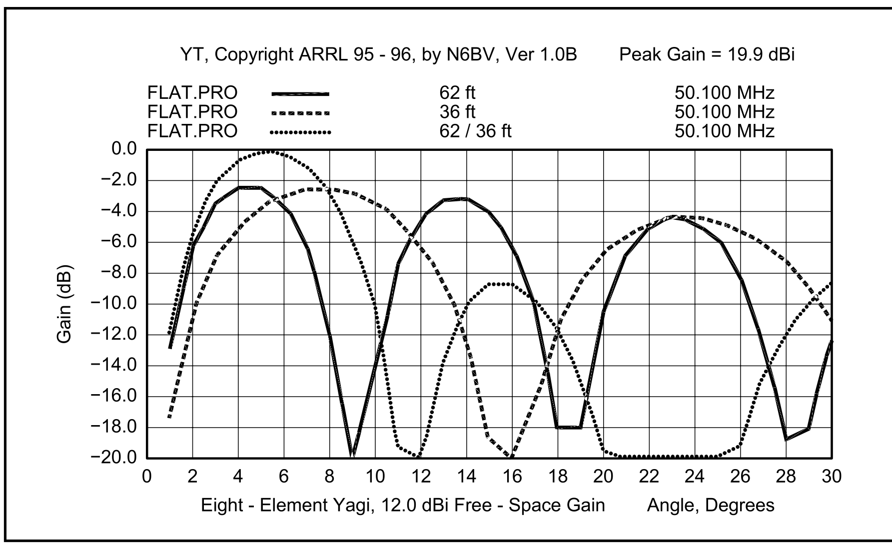


Figure 5—Theoretical stacking peaks and nulls for my installation.

Initial Performance

Hours before the June VHF contest start time, I performed the initial checks. VSWR measurements were right on the money. Then we made some RX measurements on the local beacon. Signals were 2 and 3 S units out of the noise, respectively, with a clean nose response on each antenna. This was in contrast to 1 S unit above the noise for my Hy-Gain DB-64 at 60 feet on the 70 foot tower. During the contest, for the first time ever, I was getting reports with the words "big sig" or "nice sig" included in the exchange. Stations were also easily worked on scatter, a mode that I was rarely able to exploit previously. Needless to say, I was a bit more than cautiously optimistic.

Life events continued to test my resolve in completing this project but we kept working on it when we could. At Dayton 2002 I purchased the Array Solution Stack Match for control of the 6 meter antennas. I also purchased an M^2 6 meter 5 element Yagi to replace the old Hy-Gain DB-64 on the 70 foot tower. Now the question was do I simply use this versatile Stack Match with all three antennas as is, or do we take it a step further by modifying the box for BIP-BOP.

Phasing

In anticipation of moving toward implementation of BIP-BOP in the Stack Match device, I had originally installed two equal 200 foot lengths of LMR-400. You'd think that they would be equal in electrical length. *Not* at 6 meters! My first clue was when I measured the signal strength of the local beacon with the stack match. There was *no* increase seen when the Stack Match selected both antennas—default BIP. In fact, the beacon signal dropped a couple of dB! What was causing this? I exchanged a few emails with Carl, K9LA, and he reinforced my belief that I had a phasing problem. I had no choice but to make sure that the electrical lengths of the two pieces of coax were identical.

Optimized Performance

With these two antennas at 36 feet and 62 feet there should have been about a 2 dB improvement when BIP was selected. My measurements resulted in the beacon signal being within measurement error, as predicted by theory. Now I was seeing the beacon signal strength increase when phasing the two antennas. Over several days of monitoring the strength varied somewhat, but now BIP always showed stronger signals.

Modeling

For modeling I use *EZNEC* Antenna

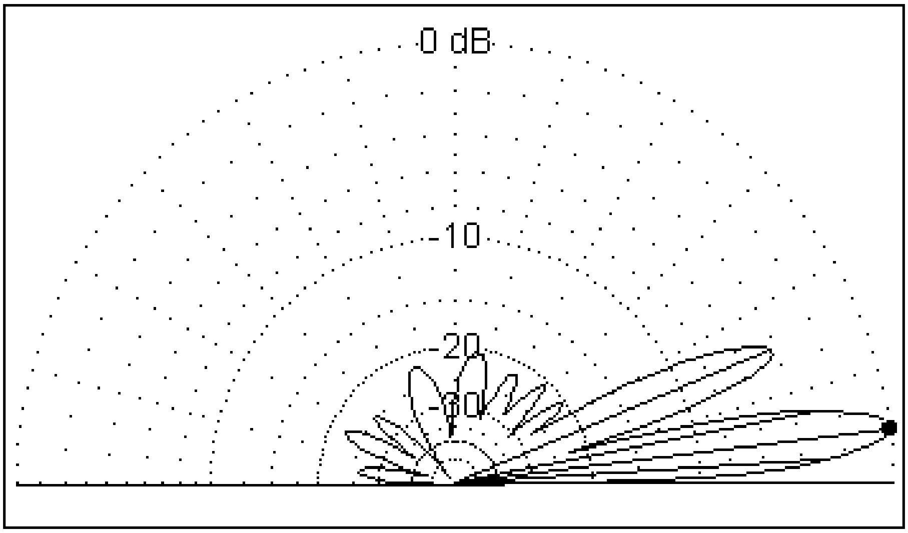


Figure 6—Lower 6M2WLC antenna at 36', real ground.

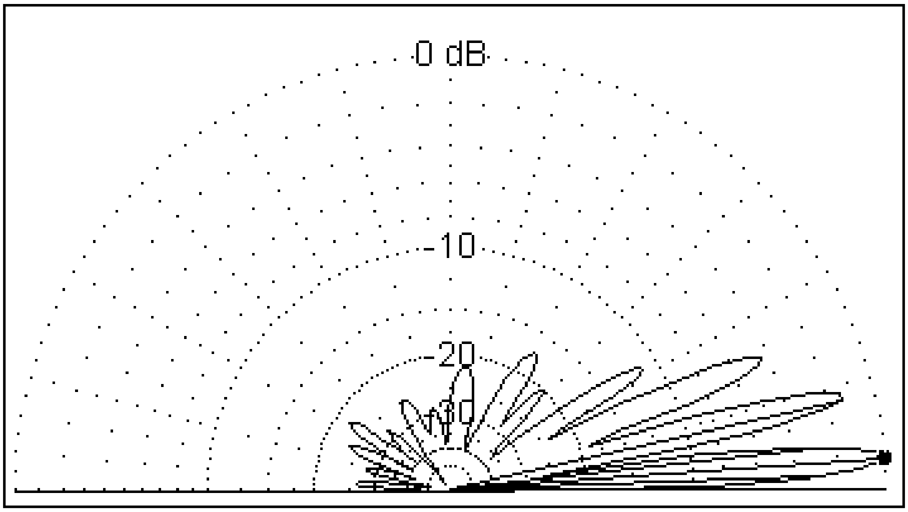


Figure 7—Upper 6M2WLC antenna at 62', real ground.

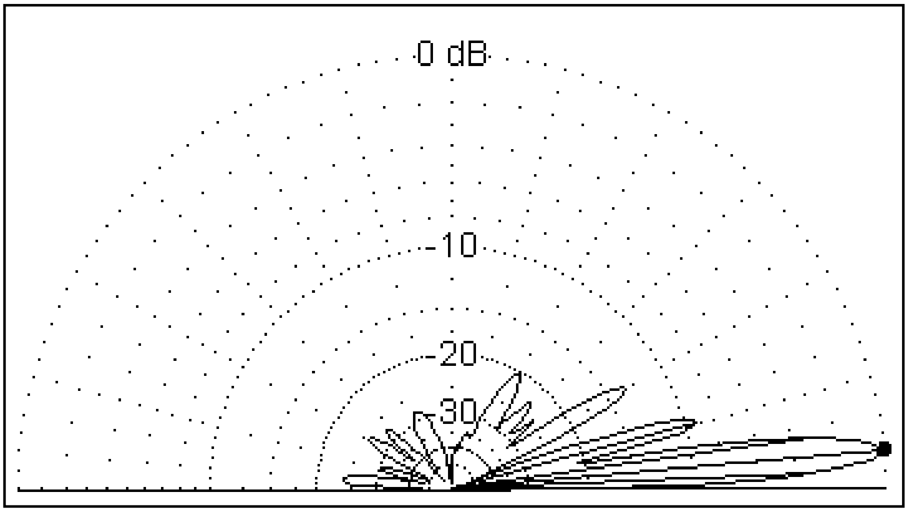


Figure 8—6M2WLC Stack in BIP Mode, real ground.

Software by W7EL. I tried to build my own model of this antenna, with poor results due to errors I introduced when building the model. Unwilling to come up the learning curve here I decided to call Mike Stahl at M². Mike provided me his 6M2WLC model data that was developed with *YO*. Translations from *YO* to *EZNEC* are not straightforward. Dean Straw, N6BV, was contacted for conversion advice and he graciously offered to do the conversion from the *YO* to the *NEC* format. Thanks again to both of you!

Figures 6, 7, 8, and 9 show the predicted performance of the antennas at their stand-alone heights and in the BIP and BOP modes. The predicted results were quite impressive. With almost 22 dBi of stacked BIP gain at 5° elevation angle, I started having thoughts of EME at moonrise or moonset.

On the Air Comparisons

During this past June 2003 VHF contest I had enough time on both days to get on and hand out a few hundred contacts. With the stack now fully optimized all I can say was *wow*. Initially the 6 meter band was dead, yet my first CQ yielded several scatter contacts within W5 while pointed east. When 6 meters did open the fun began. Late in the evening I was able to run west coast stations for several hours. The Stack Match allowed selection of either antenna in the stack, as well as the 6 meter 5 element at 70 feet on a second tower about 100 feet away. About 80 percent of the time the stack was the winner. About 10 percent of the time the lower 6M2WLC or the 6 meter 5 element out performed the upper 6M2WLC or stack. These were predominantly contacts into New Mexico and Colorado that confirmed that the higher radiation angles were needed.

There were two enhanced performance anomalies that I can't quite explain yet. The first was when I phased the 6M2WLC stack with the single 6 meter 5 element Yagi. Not always, but on some stations there was an apparent diversity gain increase of 1 to 2 S units. The other enhanced performance anomaly was seen when beaming to W6 with slightly divergent azimuths within the stack. With the 6M2WLCs pointed about 15 degrees apart in azimuth I also saw the occasional stacking gains of 1 to 2 S units over the individual antennas. If any of you have seen this on your system I would like to learn more about what was causing this phenomenon.

Conclusions

The stack is everything that I expected and maybe a little more. You can test your assumptions against theory but be prepared for the unexpected. As I burn this in over the next year I'm not sure what enhancements I will pursue next. But I have a lot of room to increase the stacking density. There might even be another dB or so of stacking gain available if I moved the lower antenna up to 43'. I have pondered that move, which would be easy enough to do. I'm also considering adding two more 6M2WLCs into one or two "four-high" combinations. The first would stack 6M2WLCs at 24 feet, 43 feet, 62 feet and 81 feet and the other at 43 feet, 62 feet, 81 feet and 100 feet. Okay, I'll save that for next year.

If you're thinking about going down a similar path by using stacks, I wholeheartedly recommend it. See you on six!

Acknowledgements

I would like to thank Carl, K9LA, for pushing me to complete this project and sharing this story. Thanks to Mike Baker, W8CM, for leading the way. Thanks to the W5 DX Bash bunch for sharing their observations and sage advice. Thanks to Mike Stahl, K6MYC, for providing the critical antenna design file and Dean Straw, N6BV, for helping me convert it to *EZNEC* modeling format.

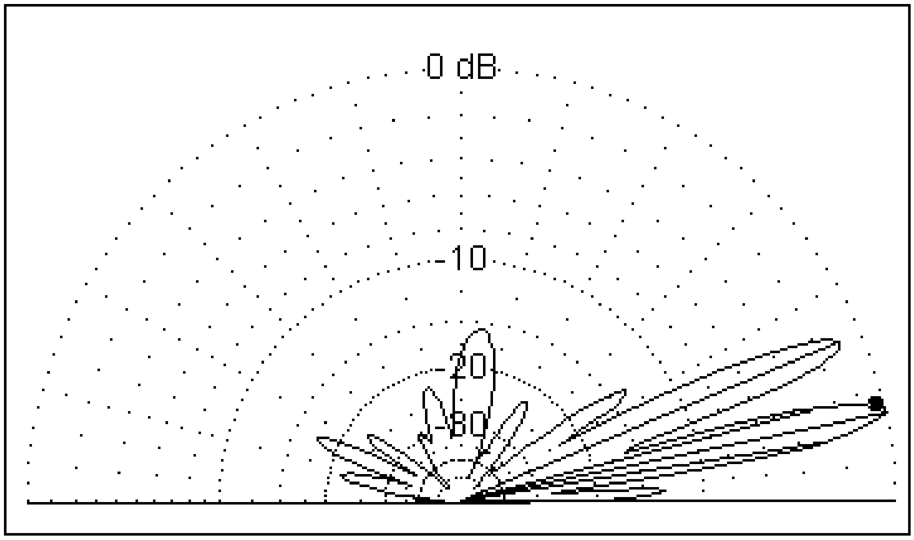


Figure 9: 6M2WLC Stack in BOP Mode, real ground.

NCJ

Antenna Interactions—Part 5
How Close is Too Close?

Eric L. Scace, K3NA[1]

Reviewing Progress to Date

Part 1 introduced meta-tools that give more comprehensive maps and statistics about antenna radiation patterns.[2]

Part 2 applied those meta-tools to twisted stacked Yagis with the antennas pointing in different directions and identified some problem situations that contesters may encounter.[3]

Part 3 examined self interactions of unused antennas within a stack, applying a new meta-tool to compare complete sky hemisphere patterns. Examples of siting problems in the design of a contesting station antenna farm were given but siting issues were not fully explored.[4]

Part 4 introduced the use of current tapering to clean up stack patterns.[5]

In this part, we return to the relationship between antenna location and pattern impairments. We begin by focusing on multiple Yagis for the same band.

Collocation on a Tower with a Tall Stack

Part 3 showed that an unused OWA Yagi placed 3/4 λ above a two Yagi stack (also with 3/4 λ spacing) shows little interaction. Essentially no pattern change to the stack occurs when one short circuits the unused OWA Yagi's feed-point and rotates the Yagi 90° to the stack's azimuth. Many contest locations in North America may exploit this result. For example, in the northeast USA a European stack points toward about 45° azimuth; South America and the Caribbean center around 155°. The station designer wants to place a Yagi fixed on South America, and on the same tower as a European stack. How close can one place the South American Yagi without unduly degrading the stack's pattern?

Table 1 shows pattern impairments to a two Yagi stack. The stack points to Europe and contains two OWA 20 meter Yagis, each with six elements on a 48 foot boom. The stack is "tall spacing", 3/4 and 1 1/2 λ heights, and current tapered feeding occurs (0.81 top; 1.00 bottom). A third Yagi of identical design, oriented toward 155°, stands at the heights specified in each row of the table. This third Yagi has a shorted feed-point. The first line of the table shows the performance characteristics of this European stack alone (no other antenna present). The remainder of the table summarizes four types of pattern impairments introduced by the South America Yagi:

Change in median gain for the Europe target zone (22-70° azimuth; 2-22° elevation).

Change in the minimum gain within the Europe target zone.

Change in median gain outside the Europe target zone.

Location and gain of the worst minor lobe.

Maximum change (both increase and decrease) in the spot gains outside the target zone.

As in previous parts, we clamp a floor of –15 dBi to all pattern gains below –15 dBi.

The South America Yagi exhibits minimal effect on the stack's main beam at most heights. Even when mounted just 1/8 λ above or below one of the stack's constituent antennas, the overall impact to the European sector's median (overall) gain is only about –1/2 dB—not op-

Table 1

Impairments caused by a single Yagi collocated on the same tower as a tall two-Yagi stack. The stack stands at 3/4 and 1 1/2 λ height. All antennas are 6 element OWA 20 meter Yagis on 48 foot booms. The single Yagi is not fed and its feed-point is shorted. The stack is fed with a 0.81 (top) 1.00 (bottom) current taper. Based on a mid-Atlantic USA location, the single Yagi points to South America, an azimuth 110° from the European stack. The top of the table gives pattern statistics for the stack without the presence of the single Yagi.

	target median gain (dBi)	*target minimum gain (dBi)*	*non-target median gain (dBi)*	*worst non-target lobe (dBi, location)*	*% sky below -15 dBi*
stack only	*13.79*	*5.49*	*-10.87*	*+1.60 az 252° el 11°*	*28.4%*

single Yagi height	*change in target median gain (dB)*	*change in target minimum gain (dB)*	*largest decrease in target gain (dB)*	*largest increase in target gain (dB)*	*change in non-target median gain (dB)*	*change in worst non-target lobe gain (dB) (location if changed)*	*largest decrease in non-target gain (dB)*	*largest incrrease in non-target gain (dB)*	*change % sky below -15 dBi*
2 1/4 λ	+0.02	-0.08	-0.08	+0.10	0.00	0.00 az 201° el 11°	-3.73	+3.95	-1.6%
2 λ	+0.03	-0.31	-0.31	+0.45	+0.07	-0.05 az 254° el 11°	-5.60	+6.46	-3.9%
1 3/4 λ	-0.08	-0.42	-0.42	+0.31	+1.47	+0.37 az 250° el 11°	-7.77	+11.00	-15.9%
1 5/8 λ	-0.50	-1.14	-1.14	+0.39	+4.12	+2.15 az 229° el 10°	-7.95	+17.75	-19.5%
1 1/2 λ			— collides with top Yagi in stack —						
1 3/8 λ	-0.54	-1.26	-1.26	+0.01	+4.70	+2.07 az 231° el 10°	-7.15	+18.15	-22.5%
1 1/4 λ	-0.14	-0.55	-0.58	+0.19	+3.49	+1.35 az 105° el 11°	-13.13	+13.50	-22.0%
1 1/6 λ	-0.08	-0.50	-0.68	+0.25	+3.19	+1.26 az 105° el 11°	-13.36	+13.70	-21.0%
1 λ	-0.13	-0.56	-0.87	+0.36	+3.69	+1.43 az 105° el 11°	-10.99	+14.13	-19.9%
7/8 λ	-0.65	-0.95	-2.05	-0.25	+5.71	+2.94 az 145° el 15°	-6.43	+19.38	-20.5%
3/4 λ			— collides with bottom Yagi in stack —						
5/8 λ	-0.63	-0.74	-1.97	-0.04	+5.78	+2.23 az 149° el 21°	-6.13	+18.76	-17.8%
1/2 λ	-0.08	-0.25	-0.70	+0.22	+3.24	+0.23 az 247° el 11°	-9.38	+11.65	-19.4%
1/4 λ	-0.01	-0.02	-0.26	+0.08	+1.31	-0.32 az 252° el 11°	-3.16	+5.87	-13.4%

erationally significant. If mounted 1/8 λ above or below the top Yagi of the stack, some spots within the European sector experience about –1 dB degradation in the worst case. When mounted 1/8 λ above or below the bottom Yagi of the stack, some spots within the European sector see degradations of –2 dB.

So, we can just stick the South America Yagi up on the tower at a convenient spot with little concern, as long as we stay at least 1/8 λ (about 8 feet on 20 meters) away from the other antennas, right? Well—maybe not.

The right side of the table reveals a much more significant impact on the stack in directions outside of the main beam—the QRM and QRN generating directions. Median gain for all directions outside of Europe rises as much as 6 dB. In some spot directions signals jump 19 dB. Where once 28% of the sky hemisphere was very quiet, with gains below –15 dBi, now the sky fills in with minor lobes.

This filling-in of the sky is not uniform. While some azimuths and elevations may see signals increase by as much as 19 dB, other spots will see a decrease in signals. The change in median gain outside of the target zone reflects the *overall* degradation of QRM rejecting ability. The column labeled "largest increase in gain" shows the worst spot degradation of pattern. The station designer can now choose what overall degradation he is willing to tolerate, in exchange for the benefit of a fixed South America Yagi on the same tower. And he also can choose the worst spot degradation that he is willing to tolerate.

For example, when the South America Yagi stands more than 1/4 λ above or below the stack, overall QRM rejecting ability degrades by 2 dB—but some particular azimuths and elevations experience much worse increases: up to 11.7 dB degradation.

By locating the South America Yagi 1/2 λ above the stack, overall QRM change is nil—some directions are quieter, and others a bit noisier. An extra 4% of the sky has gain above –15 dBi—not very much. In the worst case a specific QRM signal might increase 6 1/2 dB, just over an S-unit. This location might be a reasonable trade-off of QRM fighting ability for the convenience of a fixed antenna on South America.

Of course, such a high antenna toward South America will not have an optimal pattern as its main lobe contains a big null at important elevation angles. So perhaps collocation with a tall stack is not a good idea, if one can avoid it.

What about collocating with a short stack?

Collocation on a tower with a short stack

Table 2 shows pattern impairments introduced by a South America Yagi to a current-tapered (0.81 top; 1.00 bottom), two Yagi European stack with "short spacing": 1/2 and 1 λ heights. The Yagi designs and azimuths are identical to those discussed in the previous section. The previous part to this series showed that this stack has a far cleaner pattern than the tall stack, with 56% of the sky exhibiting gains below –15 dBi.

Similar degradations occur to this stack. Once the South America Yagi moves to within 1/2 λ of the stack's antennas, the sky starts filling up with minor lobes. But the short stack seems a bit more tolerant of the extra antenna above it. That South American Yagi can sit 3/8 λ above the stack (i.e., at 1 3/8λ total height) for about the same degradation as experienced by 1/2 λ separation above the tall stack.

A Yagi at 1 3/8 λ or even 1 1/2 λ height will be effective much of the time to South America. Take off angles on 20 meters from the mid-Atlantic region of the USA range up to 24° or so. With a pattern null centered around 20-24°, these high South American Yagis will be fine except during the 3-4% of opening hours from W3 when the higher angles are required. The current-tapered short European stack with a South American Yagi at 1 3/8 λ height above should work much better than a current-tapered tall European stack with a South American Yagi at 2 λ height.

But we've only looked at half of the story.

Impact of stack on South America Yagi

How badly does the presence of the European stack affect the pattern of the South American Yagi? Table 3 reveals a somewhat uglier result.

The table compares the South American Yagi alone to the configuration with a collocated short stack with its feedpoints shorted. The pattern statistics for the South American Yagi alone differ for each mounting height. The target zone for South America tops out at 24° eleva-

Table 2

Impairments caused by a single Yagi collocated on the same tower as a short two Yagi stack. The stack stands at 1/2 and 1 l high. Yagi design, drive currents, and orientation otherwise are identical to Table 1.

	target median gain (dBi)	*target minimum gain (dBi)*	*non-target median gain (dBi)*	*worst non-target lobe (dBi, location)*	*% sky below -15 dBi*
stack only	*13.44*	*1.38*	*-15.00*	*-0.57 AZ 252° el 11°*	*55.5%*

single Yagi height	*change in target median gain (dB)*	*change in target minimum gain (dB)*	*largest decrease in target gain (dB)*	*largest increase in target gain (dB)*	*change in non-target median gain (dB)*	*change in worst non-target lobe gain (dB) (location if changed)*	*largest decrease in non-target gain (dB)*	*largest incrrease in non-target gain (dB)*	*change % sky below -15 dBi*
1 1/2 λ	0.00	-0.18	-0.18	+0.06	0.00	+0.25 az 100° el 14°	-4.94	+4.23	-0.3%
1 3/8 λ	-0.02	-0.29	-0.29	+0.06	0.00	+0.55 az 100° el 14°	-5.94	+6.81	-3.3%
1 1/4 λ	-0.10	-0.48	-0.48	0.00	+0.78	+1.11 az 100° el 14°	-3.36	+11.73	-9.9%
1 1/8 λ	-0.74	-1.47	-1.47	-0.50	+6.48	+4.58 az 151° el 11°	-2.75	+18.29	-40.2%
1-1/16 λ	-1.88	-3.28	-3.28	-1.27	+10.92	+6.96 az 149° el 12°	-4.25	+20.82	-50.7%
1 λ			— collides with top Yagi in stack —						
7/8 λ	-0.98	-1.72	-1.72	-0.63	+7.56	+5.40 az 151° el 15°	-3.35	+18.69	-49.1%
3/4 λ	-0.43	-0.93	-1.02	-0.21	+4.70	+3.81 az 154° el 17°	-3.35	+17.37	-29.7%
5/8 λ	-0.84	-1.15	-1.76	-0.50	+8.42	+6.29 az 152° el 19°	-3.58	+18.67	-44.5%
1/2 λ			— collides with bottom Yagi in stack —						
3/8 λ	-0.68	-0.77	-1.36	-0.41	+9.19	+4.08 az 152° el 25°	-3.63	+16.24	-48.5?
1/4 λ	-0.11	-0.23	-0.34	0.00	+3.50	+0.68 az 100° el 18°	-3.22	+10.07	-23.4%

tion. But the lowest mounting heights do not yield good signals at very low take-off angles, so the target sector's lowest elevation angle is set a little higher, as indicated in the table, for the lowest mounting heights.

The stack disrupts the pattern of the single South American Yagi more than the single Yagi affected the stack. The main beam to South America is much more disturbed; even at 1/2 λ spacing the median gain declines by 0.6 dB. At 3/8 λ spacing median gain is down 1.2 dB, and 3.4 dB at 1/8 λ spacing. These gain degradations occur uniformly over the entire main beam—not just in a few spot locations. While a couple of dB may not be terribly significant except in marginal conditions, these figures greatly exceed the main beam impairment shown in the previous section's scenario. Probably the presence of more unused aluminum, cluttering up the near field of the South America Yagi, contributes to the larger impairments.

Similarly, the South America Yagi's non-target sector fills in with more minor lobes, and minor lobes with larger gains. At 3/8 λ spacing some minor lobes are up over 9 dB—and even at 1/2 λ spacing some minor lobes increase 7 dB.

When designing collocated systems, first seek to reduce impairments caused by the stack until those impairments fall below the design goal. A quick check of impairments caused by the single Yagi to the stack then can verify achievement of the design goal when the stack is fed.

Conclusions about tower collocation

Although not an exhaustive study of same-tower collocation of different antenna system, we can propose some design guidelines for the interaction of two collocated antenna systems for the same band, where one system contains a single Yagi and the other stacked Yagis:

Earlier parts of this series showed that pointing the two systems to azimuths differing by 90° reduces interactions.

At least for OWA designs, short-circuiting the feed-point of unused antennas (rather than open-circuiting the feed-point) results in somewhat less interaction. (Perhaps short-circuited feed-points also reduce interactions of traditional Yagis?)

System interactions degrade minor lobes of the non-targeted areas of the sky much more than the main beams, reducing QRM and QRN rejection.

Current-tapered short stacks (1/2 λ spacing) tolerate collocation somewhat better than tall stacks of 3/4 λ spacing.

The collocated stack impairs the single Yagi more than the single Yagi impairs the stack.

Separating the single Yagi and the stack by at least 1/2 λ keeps overall impairments to median gain relatively low, but some spot impairments of 7 dB can occur.

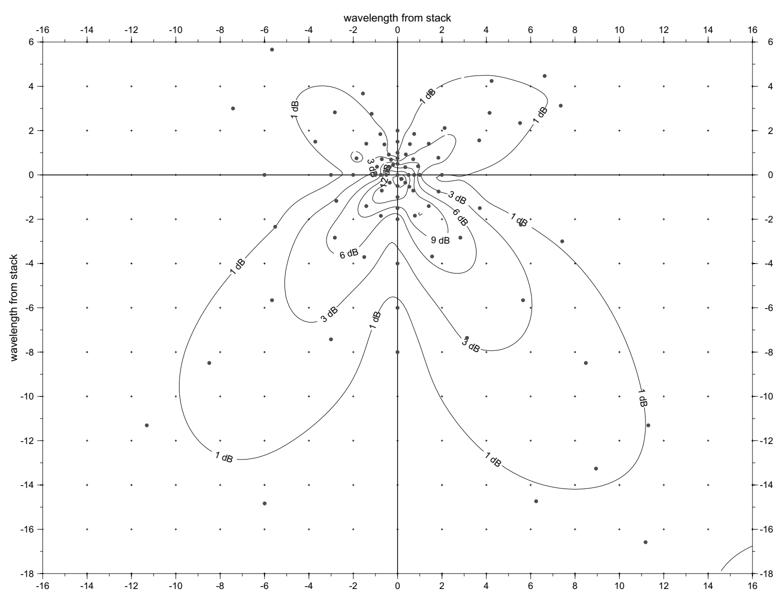
Separated systems

One may have more freedom to choose an appropriate height if the single Yagi is placed on a different tower. Those fortunate contesters with adequate space for multiple towers confront this question: "How close is too close?"

Let's begin to explore the answer by considering a stack and a single Yagi pointing toward azimuths differing by 90°. A short stack of two Yagis at 1/2 and 1 λ employs that OWA 6 element design which we have used to date in this article series. The single Yagi is of identical design.

Figure 1 maps out impairment as a function of relative antenna position. For this figure, the coordinate system originates at the stack. Since we showed in Table 3 that the single Yagi's pattern exhibits greater sensitivity to impairment from the stack, here the stack is not driven and its feed-points are shorted. The single Yagi stands 3/4 λ above ground. The single Yagi's main beam points up to the top of the map, and the stack points to the right. The models set the target zone as 50° wide in azimuth and ranging from 3 to 24° in elevation.

The tables in the previous sections summarized many views of impair-



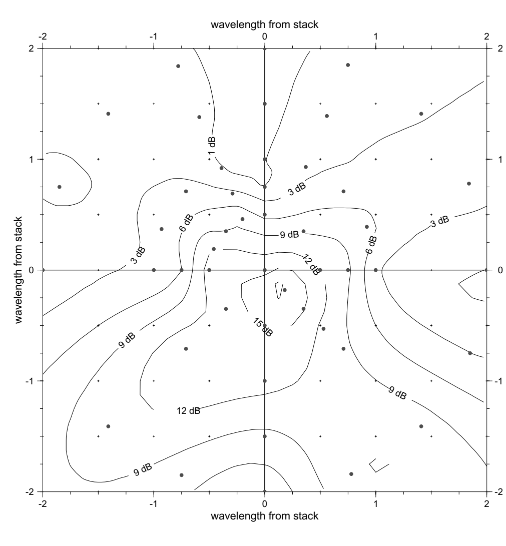


Figure 1—Map of impairment to the pattern of a single Yagi caused by a nearby two Yagi stack on the same band. The stack, two six element OWA 20 meter Yagis on 48 foot booms at heights of 1/2 and 1 λ, stands at the origin of the map and points to the right. It is not fed and has its feed-points shorted. The single Yagi (same type, mounted 3/4 λ high) points to the top of the map. The contours indicate the worst increase of gain outside the single Yagi's target zone as the location of the single Yagi relative to the stack is varied. The lower part of the figure zooms in to the locations immediately surrounding the stack.

Table 3

Impairments caused by the short stack to a single Yagi collocated on the same tower. The stack is unfed and its feed-points shorted. Yagi design and orientation otherwise are identical to Table 2. The table entries represent change in gain compared to a single Yagi at the indicated height but no stack present. The target zone for the single Yagi is 50° wide in azimuth and 2-24° elevation for heights of 3/4 λ and above. Below 3/4 λ height the elevation range narrows at the bottom to 6-24° in steps of 1° for each 1/8 λ decrease in height. Above 1 1/8 λ the elevation range narrows at the top to 2-18° in steps of 2° for each 1/8 λ.

single Yagi height	*change in target median gain (dB)*	*change in target minimum gain (dB)*	*largest decrease in target gain (dB)*	*largest increase in target gain (dB)*	*change in non-target median gain (dB)*	*change in worst non-target lobe gain (dB) (location if changed)*	*largest decrease in non-target gain (dB)*	*largest increase in non-target gain (dB)*	*change in % sky below -15 dBi*
1 1/2 λ	-0.05	-0.56	-0.56	+0.05	+0.23	+0.56 az 97° el 10°	-7.34	+6.91	-8.3%
1 3/8 λ	-0.11	-1.18	-1.18	+0.09	+0.84	+1.24 az 97° el 11°	-7.57	+9.31	-15.5%
1 1/4 λ	-0.26	-1.71	-1.80	+0.02	+3.01	+2.14 az 97° el 11°	-6.84	+14.84	-18.4%
1 1/8λ	-1.60	-3.43	-3.44	-0.99	+6.61	+7.36 az 52° el 12°	-4.34	+21.89	-20.9%
1-1/16 λ	-3.81	-5.41	-6.09	-2.57	+9.40	+9.64 az 53° el 12°	-6.78	+24.06	-24.1%
1 λ			— collides with top Yagi in stack —						
7/8 λ	-1.56	-2.81	-2.82	-1.02	+6.07	+8.02 az 51° el 12°	-6.39	+22.66	-20.7%
3/4 λ	-0.50	-1.53	-1.54	-0.09	+3.21	+3.87 az 234° el 15°	-9.01	+18.54	-14.9%
5/8 λ	-1.61	-2.75	-2.84	-0.99	+6.02	+6.74 az 52° el 23°	-4.43	+20.13	-18.0%
1/2 λ			— collides with bottom Yagi in stack —						
3/8 λ	-1.63	-2.69	-2.74	-1.06	+5.55	+7.62 az 50° el 27°	-6.87	+20.36	-15.5?
1/4 λ	-0.39	-0.96	-1.08	-0.02	+2.55	+1.52 az 97° el 35°	-6.28	+13.96	-14.0%

ments: reduction to median gain, worst minor lobes, spot increases and decreases in gain, etc. We saw that all the impairments outside the target zone varied together in a coordinated way. For this figure I have mapped the worst increase in spot gain outside the target zone as an indicator of relative impairment. Table 4, found on the *NCJ* Web site, summarizes all the impairment values at the locations indicated by a round dot on the map. I initially choose locations to develop an overall impression of the variation in impairments, and then run the models and meta-tools on additional spots needed to firm up the contours—about 80 spots in total.

The contour marked "1 dB" represents trivial impairments of no operational significance. Along the locations on this contour, the maximum increase in spot gain outside of the target zone for the single Yagi was 1 dB. Median gain, both outside the target zone and within the target zone, was unchanged. Within the target zone no disturbance of gain occurred.

Along the 3 dB contour, the pattern of the single Yagi varied slightly outside the target zone. Some spots improved by as much as 2 or 3 dB (i.e., lower gain), but these variations averaged out so that, as a whole, the entire non-targeted region saw its median gain change by 0.1 dB or less. No change in pattern occurred in the target zone. A spot increase of 3 dB in a specific direction towards QRM or QRN has almost no operational significance.

At the 6 dB contour pattern variations become more pronounced. The unused stack causes gains in the non-targeted regions to fluctuate both up and down

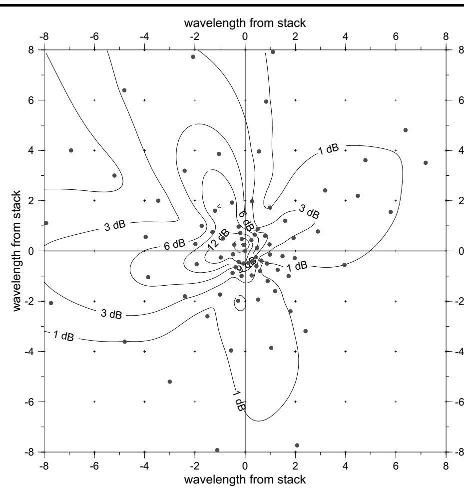
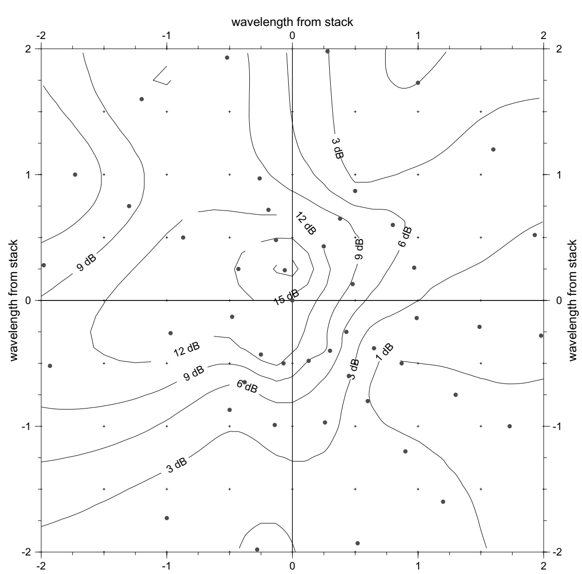


Figure 2—Same antennas as Figure 1. The stack points to 30° azimuth (Europe from the USA west coast). The single Yagi points to 120° azimuth (South America). The map shows that, when the single Yagi stands to the east-southeast of the stack, the impairment to its pattern caused by the unfed stack are minimal even at close spacings.



by 6 dB. Where the single Yagi, by itself, left 25% of the sky quiet with gains below –15 dBi, the unused stack has reduced that quiet sky to around 20%. Overall median gain in the non-target zone has started to creep up. The main beam remains unaffected; it varies an insignificant 0.1 dB in the target zone.

The 9 dB contour continues this trend. Quiet sky decreases below 20% as minor lobes fill in. Fractional dB variations in the main lobe appear at this level. The 12 dB contour encloses the region where minor lobes can reach or exceed 0 dBi. This area extends up to separations of about 1 λ. To provide greater clarity, the lower part of the figure zooms in to this region.

The irregularity of these maps initially surprised me. Depending on direction between the two antenna systems, one could be as close as 1 λ separation with no interaction. In a different direction one must go out 17 λ to eliminate interactions!

At a gross level the relative orientation of the antennas explains much of the variation. Along the $+y$ axis the single Yagi faces away from the stack, and the stack points perpendicularly away from the single Yagi. This narrow corridor allows the closest separations for a given amount of impairment. In the upper left quadrant, the stack lies behind but to the right of the single Yagi. WFigure 2—Same antennas as Figure 1. The stack points to 30° azimuth (Europe from the USA west coast). The single Yagi points to 120° azimuth (South America). The map shows that, when the single Yagi stands to the east-southeast of the stack, the impairment to its pattern caused by the unfed stack are minimal even at close spacings.

While one must go as much as 5 λ to get to the 1 dB (no interaction) contour, the 3 dB contour requires separations of just over 1 λ at worst. In contrast, the lower right quadrant places the stack forward and left of the single Yagi. The single Yagi illuminates the stack with part of its forward main beam and the stack's Yagis (which point to the right) have some parasitic receiving gain in that direction.

Note also the dimples in the pattern where the direction of separation lies exactly at right angles to one of the two antenna systems—obvious zones in which to place the single Yagi in order to minimize interaction.

At separations of less than 2 λ this gross pattern twists and fluctuates somewhat irregularly. I suspect this is a result of near field interactions between the individual 18 elements of these 3 Yagis.

I expect the values and contours will shift somewhat if one substitutes Yagis with narrower or wider main beams or changes the heights of the Yagis. But regions relatively insensitive to interactions should occur in the same areas.

Apply impairment maps

Let's now apply this impairment map to a specific station design. Assume that the station is located near the west coast of the USA, where Europe and South America lie on nearly perpendicular azimuths. Figure 2 reorients Figure 1, rotating Figure 1 so that the stack points to Europe at 30° azimuth and flipping the pattern along the boom of the stack so that the single Yagi points to South America at 150°. If permitted by the layout of the property, the single Yagi should be located east-southeast of the stack, where even small separations result in little disruption to the antennas' patterns.

But what if the stack or single Yagi rotates? In that case the antenna systems do not necessarily point at right angles. The next part will show you how to locate rotating antenna systems to minimize interactions. In the meantime you can check the *NCJ* Web site for additional interaction maps that cover other relative orientations of these antenna systems' azimuths, the corresponding tables of impairment values, and associated sky hemisphere pattern maps. We will also examine cross-band interactions at odd harmonic multiples, using 15 meters and 40 meters to illustrate problems and how to avoid them. Again, the thoughtful choice of antenna locations around the station site will minimize interactions.

Errata and miscellany

Bob, N2RM, dropped me an e-mail message describing recent work at his station. His team constructed a 3 Yagi short stack (1/2 λ spacing) on 20 meters but left their original 2 Yagi tall stack (3/4 λ) up on another tower. On the air comparisons confirm the reduction in QRM from minor lobes described in Part 4. Bob's systems do not use current tapering.

A few errors crept into the paper publication of tables and figures in Part 4. Bits and pieces of the column headings in the tables did not line up properly, and two captions were interchanged. Download Part 4 from the *NCJ* Web site to see the correct tables, captions, and full-color figures.

The Web site also updates meta-tools *NouTrim.awk* and *AEGBin.awk* to correct a bug when target zones #1 and #2 are identical. A minor improvement to *NouDifference.bat* assigns a more logical filename to the file containing the sky hemisphere difference map. You will also find there an example of a GMT batch file to generate interaction maps such as Figure 1 from a table of data points.

Notes:

[1]eric@k3na.org

[2]E. Scace, K3NA; "Antenna Interactions—Part 1: Stop Squinting! Get the Big Picture", *National Contest Journal*, 2003 Jul/Aug, pp 19-23.

[3] E. Scace, K3NA; "Antenna Interactions—Part 2: Twisting Stacks", *National Contest Journal*, 2003 Sep/Oct, pp 3-8.

[4] E. Scace, K3NA; "Antenna Interactions—Part 3: When Good Aluminum Goes Bad", *National Contest Journal*, 2003 Nov/Dec, pp 20-23.

[5] E. Scace, K3NA; "Antenna Interactions—Part 4: Cleaning Up Stacked Yagis with Current Tapers", *National Contest Journal,* 2004 Jan/Feb, pp 11-15. NCJ

Next WRTC Announced

Steve Morris, K7LXC

WRTC2006 TO BE HELD IN BRAZIL

The World Radiosport Team Championship Sanctioning Committee, LABRE (Liga de Amadores de Radio Emissão), and the GADX Araucaria DX Group are pleased to announce the next WRTC competition in 2006 in Brazil.

Following in the footsteps of previous WRTC competitions held in Seattle, San Francisco, Slovenia, and Finland, this WRTC will again showcase amateur radio competition at the highest level. The competitors are among the best operators in the world in this ham radio Olympic-type event.

The previous WRTC competitions have demonstrated the high degree of friendship in ham radio activity, together with an enormous sense of ethical competitiveness.

The competition will be in Florianopolis, capital of the Santa Catarina State in Southern Brazil in July 2006. This event is open to everyone - competitor and spectator alike. Everyone is invited to attend the WRTC2006.

Contact: Steve Morris, K7LXC

WRTC Sanctioning Committee Chairman

NCJ Snap Shot

Jerry, WB9Z, Tells a Little About His New Tower

Most of us enjoy big tower and antenna systems, so I thought you might enjoy this.

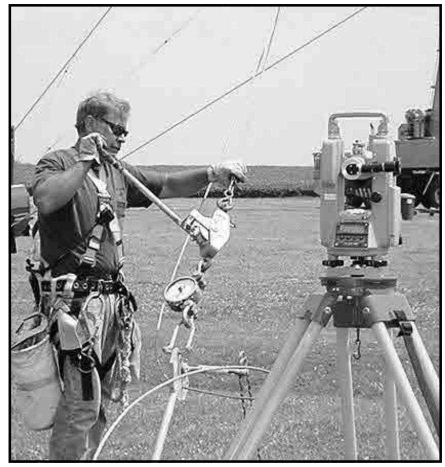
This project has been in the works for over a year now. When completed this will be my main 20 meter tower as well as the support for some fairly large antenna systems for 50, 144, 222, 432, and 1296 MHz.

I finally had the time to move further on with the erection process and I lucked out catching a 200 foot crane in the neighborhood. I have included a few photos thanks to my wife Lori.

The tower is a PiRod Model 30, which is 30 inches on a face with $1^1/_4$ inch solid steel legs. Each 20 foot section weighs in at around 400 pounds. We set 60 feet at a time, with the last 15 foot section going up separately.

The rings and base were manufactured by KØXG Rotating Tower Equipment—thanks Richard!

There is a photo of my antenna farm from a distance (minus the new tower) on the KARS Web site: **www.w9az.com**. Just scroll down on the left to the various WB9Z antenna links. Thanks to Clay, N9IO, Webmaster.



Tightening the guys.

Putting the second 60 foot section up.

Finishing the new tower.

The base.

NCJ

Announcement: New Contests

CIS DX Contest

Dates:

SSB; 1200 UTC April 10 to 1200 UTC April 11.

RTTY; 1200 UTC September 11 to 1200 UTC September 12.

CW; 1200 UTC December 4 to 1200 UTC December 5.

Objective: Everybody can work everybody for QSO and multiplier credit.

Bands: 160, 80, 40, 20, 15, and 10 meters.

Categories: SO, HP, all bands; SO, LP, all bands; SO, QRP, all bands; SO, HP, single band; SO, LP, single band; SO, QRP, single band; Multi-Op, HP, all bands, single transmitter; Multi-Op, HP, all bands, multi transmitter

For all the details see: **www.srars.org/cisdxc.htm**.

Mid-Atlantic QSO Party

Dates: 1600 UTC May 8 to 2400 UTC May 9.

Objective: To contact as many stations in the Mid-Atlantic states of Delaware, Maryland-DC, New Jersey, New York, Pennsylvania, Virginia, and West Virginia in as many counties within these states as possible. Stations in Mid-Atlantic States work any station anywhere. Stations outside Mid-Atlantic States work only stations in Mid-Atlantic States.

Bands: All MF/HF bands (except WARC bands) and 50, 144, 222, and 440 MHz.

Categories: SO QRP (up to 5w output power); SO standard power (5w - 200w output); Club/multi-Op; Mobile.

For all the details see: **www.qsl.net/maqso**.

A Review of Contest Logging Software[1]

By H. Ward Silver, NØAX

This is a survey of contest logging programs—some well known, others less so. The computer logging revolution began with the release of *CT* by Ken Wolff, K1EA, more than a decade ago. The first program to really utilize the capabilities of the IBM PC back in the *MS-DOS* days, K1EA's creation was a leader in the explosion of computer interfacing that has taken contesting to new heights. Its author received a well-deserved spot in CQ's Contesting Hall of Fame for its creation.

Along with *CT*, there are a number of other general-purpose logging programs and some specialized offerings. The general-purpose loggers are often excellent at supporting specialty contests, as well. Check out the Web sites below for complete details about features.

These are only a sample of what's out there. Most of these programs are written for the *MS-DOS* or *Windows* environment, but users of the *Linux* operating system or Macintosh aficionados can find some software for their machines by entering "contest logging" into one of the Internet search engines and sifting through the many resulting references. Let's begin.

General Contest Logging Software

CT—**www.k1ea.com**: *CT* has versions that run under *Windows 98*, *ME*, *2000* and *XP*, as well as MS-DOS. There have been several enhancements to its packet spot interface and its SO2R (single-op, two-radio) functions have been upgraded. *CT* also has a novel "partner mode" that makes multi-op a lot of fun. In the past month, Ken has decided to make *CT* a freeware program, as well.

NA—**www.datomonline.com**: Soon after *CT* was released, Dave Pruett, K8CC, released *NA* which runs under *MS-DOS* only. *NA* supports numerous contests by using templates. Fourteen templates come with the program and the user can define custom templates.

TR-LOG—**www.qth.com/tr**: Breaking with the *CT*/*NA* format, Larry Tyree, N6TR, created *TR-LOG* with an eye to minimizing keystrokes and took a giant step by integrating SO2R functions into the core of the program. Running under *MS-DOS*, *TR-LOG* supports a large number of contests "out of the box" and the use of user-settable switches in a configuration file makes it possible to customize many of the program options to support almost any contest and style of operation.

Writelog for Windows—**www.writelog.com**: Wayne Wright, W5XD, dispensed with *MS-DOS* entirely, building *Writelog* as a native Windows application. As such, it makes full use of sound cards and network resources without add-ons or TSR utilities. Along with logging features, it has excellent built-in support for RTTY and PSK31 and a full voice keyer that use the PC's sound card.

N3FJP's *Contest Loggers*—**www.n3fjp.com**: Scott Davis, N3FJP, is a very prolific author of logging software with numerous general, contest, and specialty logging programs available. Another native to *Windows*, the software has full support of LAN functions and Internet connections to packet. Each contest is supported by a separate program.

SD—**www.ei5di.com**: Paul O'Kane, EI5DI, ("Dats a Lot of Dits!") is a well-known European entry into the logging sweepstakes and supports a number of contests across the pond. *SD* also consists of separate programs for each contest and the product line offers the "officially recognized" IOTA Contest logging program. The *SD* family also includes VHF contests and SWL logging software. An update from Paul—"*SD* supports all the big international events as well as dozens of 'local' European and other events (including US QSO parties). I offer separate programs—*SDI* for the IOTA Contest (which is freeware) and *SDC* for the RSGB Commonwealth Contest, two very different contests."

N1MM Free Contest Logger—**pages.cthome.net/n1mm/**: This is an open-source program running under *Windows* with a very active users' group. RTTY and PSK31 support are built in and the program has a very nice graphical band-map feature that integrates nicely with two-radio operations and also offers two-monitor support to make extra information available on-screen.

Andy, AE6Y, has a free logging software package that was originally designed for CQP, but has been upgraded to handle the major contests and is very simple to configure. Check it out at **www.cqp.org/Software-AE6Y.html**.

VHF Contest Loggers

RoverLog—**www.2ub.org/roverlog**: Aimed specifically at the special needs of the VHF Rover entrant, Tom Mayo, N1MU, makes *RoverLog* available as freeware. It is also an open-source program. Features specific to VHF contests, such as schedule management, grid mapping and compass displays, are built in.

VHF Log by Dave Mascaro, W3KM—**www.qsl.net/w3km**: Supports all of the ARRL VHF and UHF contests and is tailored for the needs of the VHF contester. *VHF Log* is a *Windows* program. It also has band interfacing for transverter control and manages the associated frequency offsets and calibration. A voice keyer is also built in.

N3FJP's *VHF Contest Log*—See the listing above.

Specialty Loggers

RTTY by Ray Ortgeisen, WF1B—**www.rttyinfo.net/index.htm**: This has a large following in RTTY contesting circles. Running under *MS-DOS*, this has been the standard for several years. The site listed above also lists many other RTTY and digital logging/interface programs.

A collection of loggers that run on palm-top or PDA computers is listed at **www.natworld.com/ars/pages/back_issues/2002_text/0202_text/options.html**.

DXtreme Station Log-Multimedia Edition, by DXtreme Software is a new logging program in its Amateur Radio product line that has a new feature. It provides multimedia. For example, an audio facility lets you create and maintain an audio archive of your memorable contacts. It also has a QSL imaging facility, so that physical QSL cards can be scanned and electronic QSLs incorporated as they are received. *Station Log* also produces ADIF-based electronic QSLs for uploading to Web sites that specialize in the delivery of eQSLs. For more information, visit **www.dxtreme.com** or contact Bob Raymond at **bob.raymond@dxtreme.com**.

Win-EQF—Log-EQF for *Windows* by Tom Dandrea, N3EQF, tracks the whole logbook, award totals (DXCC, WAS, IOTA, counties, VUCC, WAZ, 10-10, WPX) or your QSL collection. It's been advertised in *QST* for many years and more info is available at **www.eqf-software.com**.

Lux-Log is a general-purpose logging program that tracks awards and also includes a contest logging module. It's distributed as freeware at **www.qsl.net/lx1no/llog_win.html**.

While not a logging program per se, the *BV7 QSL management and label* program by DF3CB for organizing, searching, sorting, and printing QSL la-

[1]From the Apr 23 and May 7, 2003 *ARRL Contest Rate Sheets*

bels is highly touted by many. It's a stand-alone program, which is sometimes easier to use than an integrated package. The program is available at **www.df3cb.com/bv/**.

LOGic 6 is a software package that provides complete logging and tracking of any award. It supports QSL cards and labels, contesting, rig interfacing, antenna rotor control, digital communications for all modes, packet spotting and includes a CW keyer. It offers sound card support, customizable screens and reports with user-defined fields, prints graphics and color, documentation, tech support, grayline, AZ-EQ map and callbook functionality from Web or CD. More info and demo versions are available at **www.hosenose.com**.

Wither Logging?

The future for contest logging is bright, if somewhat fractured. One intriguing possibility comes, like so many other innovations, via the Web. Recently, a Web based log-entry program (see **www.ncjweb.com/manualsprintlog.php**) developed by Bruce Horn, WA7BNM, allows a casual entrant to enter a paper log electronically, relaying to the sponsors a Cabrillo-formatted electronic log. This surely makes other possibilities spring to mind.

While too sluggish today, can a real-time logging application be far behind? And once we have a real-time logger, what's to prevent full real-time integration with a "back office" server that grabs the QSOs from contesters as they're made? Contest logging looks an awful lot like on-line credit card order processing with each QSO a transaction that requires authentication and validation. These functions are available "off the shelf" only requiring the appropriate user interface to be constructed.

Hmmm. I log on, run the application, work the contest, and in a few minutes all of the log checking is complete, the winner is announced with validated scores, and the reflectors immediately fill with post-contest analysis. It does give one ideas, doesn't it?

Adventures in Contesting

The photo in the November/December issue shows Mike, WB9NOO, checking out his vertical during the summer flooding in Fort Wayne.

This Issue:

Is *NCJ* considering branching out into the adult beverage market?

Two Contests at Christmas

Cheryl Muhr, NØWBV

When planning a DXpedition, one consideration is how rare is the location and how many people want to work it. Another consideration is whether or not it would be a good place to be during a contest.

Our trip to Christmas Island, T32, was two years in the making. One factor on timing was the CQWW CW contest. Ultimately, eight Coloradians decided to spend their Thanksgiving holiday at Christmas.

Barry, NØKV, and Bill, KØMP, had been to T32 (Eastern Kiribati) before in 1998 and wanted to go back and do a more serious effort in both contesting and DXpeditioning. The goal was to choose people with diverse talents to put up antennas, get licenses, pull their own weight (sometimes literally) and of course operate. The eight team members were: Bill, T32MP; Barry, T32KV; Greg, T32ZA; Paul, T32N; John, T32TF; Tim, T32ZM; Larry, T32WW (also our call sign in the CQWW CW and ARRL 160 meter contests); and Cheryl, T32YL.

The group decided that with only one flight to and from Christmas Island each week from Hawaii a bit of extra time to make sure the luggage arrived wasn't out of order. Everyone assembled on Oahu three days before our flight to Eastern Kiribati so that we could redistribute weight and make sure everything had arrived. Each person is allowed up to 100 pounds for the trip and overweight luggage is two dollars per pound! Unfortunately, ham radio gear is never light.

Our flight left on time at 6:30 AM on November 23, 2003, and after about three hours we arrived at our destination on November 24, 2003. Christmas Island is a day a head of the United States. Thank goodness for UTC! In fact, Christmas Island is also called Millennium Island because the first sunlight of the year 2000 reached there before any other inhabited place. The change of date proved to be interesting, especially over the Thanksgiving holiday.

Customs went smoothly and we were picked up by the transport for the Captain Cook Hotel, our home while we were there. Upon arriving at the hotel we discovered that the rooms we had been tentatively assigned were not unavailable. The night before we arrived the ocean had fallen prey to a lunar cycle and a storm that had passed through Hawaii. The waves had reached the bungalows lining the shore and they were temporarily unusable. But housing wasn't a problem. There were other bungalows available.

The Captain Cook Hotel has two types of rooms, regular hotel rooms and bungalows. Though roughly the same size, the bungalows are more separate from the other rooms. Each bungalow has two rooms forming a duplex. We felt that with all the radio gear we needed to be farther away from the other guests while we operated all night. We also needed to be near an area where we could set up our antennas. The three meals a day

Figure 1—The T32WW group after CQWW CW. Standing from left: Paul T32N, Tim T32ZM, Cheryl T32YL, John T32TF, Larry T32WW. Kneeling from left: Bill T32MP, Barry T32KV, Greg T32ZA.

Figure 2—Bill T32MP and Barry T32KV assembling antennas.

Figure 3—Bill T32MP and Tim T32ZA working 160 meters during CQWW CW.

that were provided gave us a great energy source to keep going.

We didn't even stop to unpack our bags before we started getting out the Amateur Radio equipment. We brought antennas for every band and mode from 160 meters to 10 meters on CW, SSB and RTTY. The radios were set up as our station in one of the bungalows.

The antennas were extremely straightforward to set up. Lightweight and easy to assemble, the 10 through 20 meter antennas were a combination that Bill and Barry had designed. Barry had the idea to use vertical wire antennas. Bill combined that idea with adding a second element to make a Parasitic Vertical Dipole Antenna (PVDA) after he saw pictures of the poles used in the *Microlight DXpeditions* book. As soon as the first antenna (20 meters) was set up there was an operator on the air. The rest of us went on to assemble the other antennas, including two traditional phased vertical arrays for 30 and 40 meters. Also built were two Gladiator top loaded verticals with tuned, raised radials for 160 and 80 meters. Assembling antennas took most of the rest of the day.

Three stations were chosen for a couple reasons. With eight people going and a number of requests from Europe before we even left, we could keep three stations on the air. Plus, we could run in the Multi-2 category of CQWW CW. We linked two stations' computers together and got set to run two stations for 48 hours in the contest.

The stations consisted of an ICOM 756PRO and two 756PROIIs, Alpha 76 and 78 amplifiers, ICE band pass filters, Heil headsets with microphones, laptop computers and, of course, a paddle for each. For RTTY we used two stations with a KAM TNC and MMTTY.

It was very strange with the time difference to the States. Our Thursday November 27 was very normal without a Thanksgiving turkey in sight. The next day, however, we were bombarded with Thanksgiving wishes from those in the states including family. The Thanksgiving weekend also marks another yearly event, the CQWW CW contest. This was one of the main reasons we were there. Everyone in the group got a shot at operating during the contest, which we operated as T32WW.

Everyone who came had done some form of contesting before, but for some members of the team, this was their first DXpedition. They found it mind-blowing to operate a contest while being DX. In Colorado, an operator can run around searching and pouncing until boredom sets in, but not as a DX station. Time passed quickly during all shifts and we used every band we were allowed.

This contest was amazing. When you are used to Colorado propagation where contesting can be hit or miss, it is amazing to sustain a pile up throughout the contest. It was incredible to see that we finished the contest with a rate almost as strong as that at the start! The group was very pleased with the score of just over 7800 contacts and over 10 million points.

In fact, the contesting was so much fun that the group couldn't get enough of it. The CQWW CW contest was one of the main reasons we chose the time and place to go on our trip, but in the end it was decided to enter the ARRL 160 Meter Contest on the spur of the moment. We had specifically brought the 80 and 160 meter antennas to contest with and were glad that we did for the second contest when the group managed 369 contacts in that contest as well as the numerous contacts we made during the rest of the trip. For some, gray line was the best part of the trip.

Many of the parts such as nails and rope were left behind as the last of the group left for Hawaii. It helps to leave forty pounds of nails behind when others can use them and you have a weight restriction.

As a group we made over 31,000 contacts in a two-week period, talking to 161 countries. Thanks to everyone for their help in both contests. We have updated all of our information in QRZ and Buckmaster and would love to hear from you. We hope to see you in the next contest—we just aren't sure where we will be operating from next! NCJ

RTTY Contesting

John Fleming, WA9ALS

AFSK versus FSK—The Good, the Bad, and the Ugly!

The availability of commercial AFSK (Audio Frequency Shift Keying) and FSK (Frequency Shift Keying) interfaces has unquestionably brought many new and welcome people to RTTY contesting. This is great for activity and scores in these increasingly propagation-challenged years! Although some of these interfaces are capable of operating the rig in FSK mode, many are used for AFSK, especially by beginners. In addition, some are operating AFSK RTTY by injecting their soundcard output into the microphone or patch input and using VOX to key the exciter. This presents some special challenges that are not always appreciated by those new to this mode. Operating AFSK can wreak havoc at times during contesting operations!

One fairly well known problem is that of overdriving the audio, resulting in splattering and thus interference to fellow contesters. Poor print quality often accompanies this problem. Overdrive can result from inappropriate gain set at the rig (mic input), at the soundcard (mixer setting), or at the hardware TNC. This subject is most frequently talked about with regard to over-driven PSK signals, but it happens in RTTY, too. I'm only going to briefly note this problem with AFSK. This can be solved if the operator is knowledgeable and diligent about properly adjusting the soundcard/TNC and rig gain before the contest.

My favorite subject of proper AFSK operating is operating frequency. Depending on the rig and RTTY mode, the frequency display does not show the RTTY mark frequency. Mark frequency is the general standard reference when spotting RTTY DX stations or citing net frequencies. AFSK RTTY is usually operated in LSB mode worldwide these days. It is imperative to understand how injecting audio tones of *mark* (2125 Hz) and *space* (2295 Hz) into the LSB chain affects the transmitted frequency and its relationship to the rig's displayed frequency. This is crucial to operating AFSK RTTY properly, in and out of a contest. Several reasons include: 1) Finding and spotting DX, 2) observing appropriate band and sub-band edges, and 3) proper QSY to meet another op, e.g. on another band for a multiplier.

Consider chasing a rare DX multiplier spotted at "7085 kHz". Ideally, and assuming that the DX was *correctly* spotted according to his mark frequency, you should look for him at 7085 with your rig displaying mark frequency. (Many contesters would simply click on a band map.) However, if you are operating AFSK RTTY in LSB mode, you will probably tune to 7085 and wonder why he's not there. That's because, on your LSB dial, you'll find him at 7087.125 (2.125 KHz above the spotted frequency)! Consider the relationships as shown in figure 1. With the LSB dial at 7087.125 KHz, injecting the usual mark audio tone of 2125 Hz into the microphone input results in the audio appearing at 7085 KHz (7087.125 – 2.125). To achieve the usual RTTY shift of 170 Hz, a 2295 Hz audio signal is injected, resulting in the even lower space signal. Thus injecting audio of 2295 Hz results in the space signal appearing at 7084.83 KHz (7087.125 – 2295, or 7085 – 170).

When using the common "high tones" of 2125 and 2295, it's not easy mental math to subtract 2125 kHz from your dial frequency as you QSY to another band to meet the multiplier or as you run down the band map! (Or do you run "up"?) Fortunately there are several ways to simplify your setup and skip the mental gymnastics, calculations that are especially poorly done later in the contest. Although AFSK can be indistinguishable from FSK, I believe that the best advice is to operate FSK RTTY when possible. Then you will enjoy finding spots where you expect and will always know your transmitted frequency. If you must operate AFSK, see if your rig has a menu item that allows setting a display offset. It might be possible to set a 2125 kHz display offset. (An excellent discussion of AFSK by Bill Turner, W6WRT, can be found on the OK1RR Web site at **www.qsl.net/ok1rr/rtty.html**. There are other topics as well that are great resources for those new to RTTY and RTTY contesting on Bill's site.)

Another consideration is the use of transmit-AFC when operating AFSK. Although it's possible to use transmit-AFC properly when S&Ping, beginners often use it improperly when CQing. When transmit-AFC (often called "NET") is turned on, your rig adjusts its audio tones such that your mark and space signals match that of the calling station. This is convenient in that he will hear you easily right where he is. However, let's say your first CQ is at 7085 (your LSB dial is reading 7087.125), and your first caller is 50 Hz off frequency. Your soundcard will adjust the injected audio tones to be 2175 (mark) and 2345 (space) to place your signal on his frequency. However, your dial will still be reading 7087.125! Next you call your second CQ (now 50 Hz lower than the first one) and your next caller also calls 50 Hz off frequency low. Again, your soundcard audio adjusts to keep you on frequency with your caller as before. Now your third CQ is 100 Hz lower than the first one! Soon some of your callers will be out of your receiver's (hopefully) narrow passband, and you will wonder where everyone went! (Or you will be encroaching on a frequency that some-

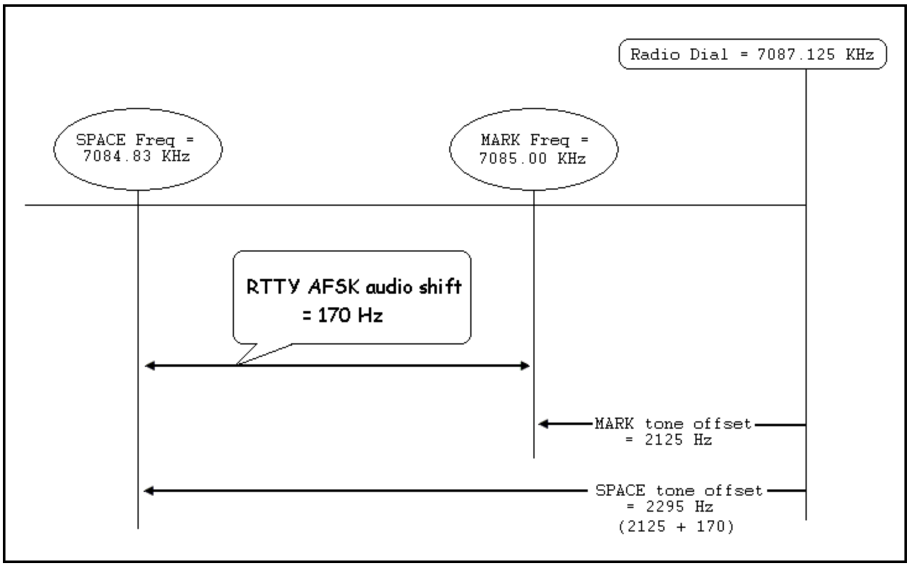


Figure 1—The frequency relationships when using AFSK based RTTY on LSB.

one else considers his for the moment!) Of course, some of your callers will be more off frequency than others, and thus you will be CQing all over the place within a few tens of Hz of your dial frequency. You quickly see the problems that can result in this "drifting" run station. The best advice is to turn transmit-AFC OFF when CQing!

2004 ARRL RTTY Roundup

This year sported lots of activity, with some notable ops posting awesome claimed scores. As examples, consider AA5AU's claimed score of 216,545 points from 1883 QSOs (24 hrs), W1ZT's 170,160 points from 1418 QSOs (24 hrs) and K3MM's 128,700 points from 1100 QSOs (11 hrs)! Ty's *average* rate of exactly 100/hr is awesome when you consider what it must've been to offset the slower times! Those on the coasts seemed to fare well with DX, but some inland US ops complained about lack of DX propagation. These times of challenging propagation are good times to maximize your antennas (first), rigs, and power capabilities.

Part of growing is being patient with those that send the exchange the first go-around instead of just their call. This really interrupts the flow for everyone. If you're new to RTTY contesting, please print the contest for a while and learn the roles of the CQing (running) station and the answering (Search and Pounce, S&P) station. It will make everyone's contest more enjoyable! WAØSXV points out that sending "5NN" is "patently ridiculous" on RTTY, to which I agreed and pointed out that it even takes longer. Sending 5NN requires an extra LTRS character (11111).

Again, welcome to all the newcomers to RTTY contesting. If you're new to RTTY, be sure to sign-up for the RTTY reflector at **www.contesting.com**! NCJ

Contest Tips, Tricks & Techniques

Gary Sutcliffe, W9XT

Time Spent on Non-Operating Contest Related Activities

Contesters are known for spending long periods of time in front of the radio, but like any competitive activity a lot of preparation goes into getting ready for the actual event. This installment of CTT&T takes a look at how contesters spend their time between the contests. Before we start, be warned that you may find what some of the respondents found out in preparing their comments that those 48 hours in the contest were just the tip of the iceberg!

The time spent between contests can be split into two categories—preparing for a specific contest, and general contest related activities such as work on the station. As far as preparing for a specific contest, the amount of time spent on preparation can vary quite a bit, even for a given operator.

Some contesters' preparation time for a particular contest will depend on how seriously they plan on operating. For non-serious efforts, preparation can be as little as starting up the computer and setting up the logging program for that contest. A serious effort can include setting up special antennas, propagation analysis and extensive band planning as well as setting of goals.

Ari, OH5DX, thinks that as contesters get older and more experienced they tend to operate fewer contests, but operate them more seriously. This would tend to skew the time ratio towards more non-operating activities. As the stations get bigger and more complex, more time is required to maintain them. This certainly holds for Ari, who has 5 towers to maintain at his home station and 13 more at his OHØZ second station.

N3BB has cut down his preparation time over the years. Jim used to spend a lot of time with propagation and sunrise charts, but feels he knows it well enough now that he does not need to spend as much time. He also used to spend a lot of time reconfiguring his station for contests, but now keeps it permanently in the SO2R configuration.

For major DX contests, K3WW figures he spends about 3 hours of actual set up. He starts preparing himself the Sunday before the major contests by getting extra sleep each night. Chas does not do anything special for the smaller contests, other than getting the computer set up a few days in advance. Chas operates these contests mostly to keep in practice and be sure the station is operating properly.

Jim, NØOCT, and Randy, K5ZD, also consider operating some contests as preparing for others. Randy operates a lot of smaller contests for the experience and for call sign recognition.

Steve, GW4BLE, thinks you should be prepared as far in advance as possible, preferably a month in advance if you are really serious about a certain contest. This lets you check out the station in realistic situations and hopefully shake out any problems.

Contest Literature

There is a lot of contest related reading material available. Besides traditional magazines, the Internet web sites and reflectors contain a wealth of current and archived information.

Randy, K5ZD, figures that reading everything on the CQ-Contest reflector takes more time than any other non-operating activity. K3WW estimates he spends about three hours per week reading about contesting.

K4TMC likes to keep up with all this in short periods of times to avoid major disruptions to family or work responsibilities. Henry even sent in his comments from a hotel room while on a business trip.

QSLs

QSLing can take a lot of time for stations that operate a lot of contests and rack up a lot of QSOs. K4JA figures he will send out about 20,000 QSLs to cover the first 3 years of his multi-op station. Besides operating a lot of contests, Paul is the only really active ham in his county. Paul says that he tries to answer the direct QSLs in one day so he can keep up.

AA4NU notes that the fall contest season is kind of a blur with a major contest nearly every weekend. Despite this, Billy tries to answer the SS QSLs right away. He really likes those stations stopping by in the next weekend to say thanks.

Several contesters noted that they only responded to bureau cards once or twice a year. Summer was listed as a common time to handle QSLs since there are not as many contests then, and it often takes months for the fall and winter cards to get through the bureau systems. They often use their computer to combine contacts on different bands and modes from several contests to generate a single label for the QSOs and generally speed the process.

A new twist on QSLing is the ARRL's new Logbook of the World. A new post contest activity will be uploading your log to that as well as to the contest sponsor. This may cut down on QSLing chores, as well as costs. AD1C says he is working on preparing all of his logs from 1995 to the present for uploading to LOTW.

I am doing a similar thing. I have consolidated the major contest logs I operated since 1999, and have a lot of smaller ones to add. I have not decided how far to go back, but I suspect that once I send them into the ARRL it will be another major time sink—sending it over my slow dial up Internet connection!

Multi-ops

Owners of multi-op stations have an even larger task of preparation. Besides all the station work for complex multi-op stations, the coordinator of these efforts also must deal with issues such as rounding up operators, scheduling them, meal shifts, etc. notes AA4NU.

KB1H echoed Billy's thoughts. Dick uses a spreadsheet to schedule operating hours, and found that it helps in keeping fresh operators at the radio. Dick also mentions scheduling antenna parties. He plans what projects to attack based on what operators are available on given weekends.

Multi-single and multi-two stations will probably need to spend some time on band planning, since they are limited to the number of band changes they can make.

Just the computers in large a multi-op station can require the efforts of the MIS department of a small company. K4JA has 7 computers networked in his station. Each one needs to have its software updated regularly. In addition, Paul also runs an AR-Cluster node. Paul says that he has a lot of help from W3BP and KE9I as well a number of contesters back from his original home area in the 9th call district.

Wrap up

This was a very popular topic with nearly 25 readers sending in their comments. I'm out of space, and have a lot more to go, so we will continue next time. One area we will cover is some actual time breakdowns sent in by readers. If you would like to jot down your estimated time breakdowns for contest related activities, send them in. I will include them in the next issue. Remember that you might find it adds up to a lot more time than you thought!

Send your tips to **w9xt@qth.com** or to 3310 Bonnie Lane, Slinger WI 53086. Also include suggestions for future topics you would like see covered. NCJ

Contesting for Fun

Brian Kassel, K7RE

Be Wary of the Scary Stew Perry

I have become a big fan of 160 meter operation. I guess this latest addiction could be blamed on several factors. I am now a proud resident of South Dakota, and a land baron with about three acres of my own antenna farm. Hey, I was raised in southeastern Pennsylvania, so anything over an acre is a township! For the first time in my 42 years of ham radio, I finally have enough space to put up some pretty respectful 160 meter antlers. In the dead of winter, here up north, and in the country, the static levels are non-existent, making 160 meter operation a real pleasure. Lastly, there is something just plain nostalgia about the band.

Having erected and perfected my 160 meter antennas, I felt that at last I had a chance to compete in the 160 meter events with some of the big guns in this Dakota Division. Maybe I could even give the national boys a run. I proceeded to get geared up for the Stew Perry contest. If there is one thing I have learned about contesting, it is to be prepared and to remove all sources of possible conflict. Check everything, twice—three times. All antennas were measured and tested to be ready. Contest software was run with a few dry tests in an effort to possibly discover and eliminate any unknown bugs. Food and drink were laid in with care. All seemed to be ready according to Hoyle. That's what I thought…

Days before the contest, I was informed that my wife's (KD7GLY) nephews and nieces were coming to visit and stay with us so that they may ski daily—for 11 days! Yep, right into and through the contest. Darn these pristine ski slopes! Now, you have to realize that we have never had any kids of our own, so we have not come close to obtaining the required level of patience, fortitude and disciplinary skills required for child rearing. I have nothing against kids at all. I am just missing the "I want a kid" gene somehow. Also realize that my wife is extremely supportive of my ham radio hobby and contesting. She never complains, in fact she assists in my antenna experiments—some of which end becoming complete Rube Goldberg extravaganzas. She plans around contest weekends, which, as we know, during the season, is almost every weekend. How in the world could I possibly object? They were to arrive the day after Christmas. Well, maybe I could just squeeze in the nightly operation that 160 meter requires, maybe they will be exhausted enough after 8 hours of hitting the slopes not to be any threat to my 160 meter operation. Yeah, right.

The weather forecast was for gale force winds, and blowing snow. Christmas day arrived, and as I checked my 160 meter antenna for the umpteenth time, I discovered that there was some sort of intermittent problem with the strong winds that had developed. My Christmas present from my wife, Joanna, was a great little airplane kit of the original Wright Flyer. Yeah, I have a weak spot in my heart for airplanes as well. She suggested that I spend the day building the kit. After many years of marriage, I know when she suggests, and when the suggestion is more like a test. I built the airplane. The antenna work would have to wait. I had the day after Christmas to locate and fix the intermittent problem, as the contest was to begin at 0800 local on December 27. If there was any hope for me to get some European multipliers in this black hole of propagation called the Midwest, I had to be on for that first hour right after sunrise.

The kids arrived as scheduled. My rural solitude was immediately shattered as they stormed into the house. Within 30 seconds I find that one of the boys has a bad head cold. As I have been completely isolated from the flu/cold germs that proliferate in the public school system I feel especially vulnerable. I envisioned the finale of the *War of the Worlds*, where the undefeated and all-powerful Martian invaders are done in by our earthly germs. Then my short mental respite is interrupted with a sneeze in my face. I am doomed.

At almost the same moment, the oldest girl arrives talking on her cell phone while carrying the tons of paraphernalia that typically accompanies young single ladies who plan on a long stay. She begins to descend on the stairs that will take her to her room. The crashing sounds of breaking glass accompanied by a screaming girl can mean only one thing. She recovers nicely, though, and I am presented with the cell phone, in three pieces. A tearful young lady requests "Can't you fix it, Uncle Brian"? Knowing full well that a cell phone is as important as air itself to her, I offer to somehow repair the device. After miraculously restoring life back into the device, using epoxy, tape and various customized phrases, my wife advises that I have to take our little mouse hunting Schnauzer mix dog for her usual 30 minute walk.

This dog is to a mouse as a cruise missile is to a target. She is 22 pounds of mouse hating fury, and nothing stands in her way. Of course, the outside soil is a quagmire of mud after the snow has begun falling. She does indeed catch a mouse, which she will not relinquish, even after bribes of doggie biscuits and human type food morsels. Yep, she is one small ball of mud after 30 minutes of romping in the mouse burrows, a ball with a wagging tail, and a mouse in her mouth. I remove my boots, carry the mass of soil into the bathroom, and hose her down. Yep, there *is* an animal under there.

I begin to gather up my tools in a clandestine effort to sneak out and fix the antenna. I almost escape to the gale force winds when I am informed that we are leaving to have dinner at a Chinese restaurant in town.

We leave the restaurant to find that the wet street is now icy, black ice. The father attempts to back out of the parking spot, no dice, wheels are spinning. I decide to pull him out with my 4WD vehicle. My wife directs traffic around us while we get the vehicles headed in the right direction. We arrive home safely. The father begins what is to become a long 12 hour stay in the bathroom. We are now down to 1 bathroom for us all until the scourge of the mushrooms subsides. No chance to fix the antenna.

The next day the kids leave early to hit those slopes. Their father is convalescing, but is well enough to drive them over. I do the first 2 hours of the contest in sort of a time-share mode. I do S&P when the intermittent problem subsides enough to make call. It is a study in precise timing. That afternoon, before the band opens I am able to make a very temporary repair to the feed line that had produced the intermittent. During that night the intermittent occasionally reappeared, but I was able to work around it to some degree.

I am happy to report that the kids returned, tired enough to go straight to bed after having their dinner. The mushroom plague totally subsided, and I did make some QSOs in the Stew Perry contest. The inevitable head cold appeared a day after the contest ended. I didn't set any new records, but then again, there were no broken bones, amazingly enough, during the 11 days of skiing. Our medicine cabinet was able to cope with the various minor injuries, but it does need to be restocked. I won't be looking to future genetic research, though, to fix my lack of the "I want a kid" gene. The CQ 160 meter contest is coming up as I write this. I just learned that the kids have purchased season tickets. NCJ

By Carl Luetzelschwab K9LA

Thanks, Old Sol, for 10 Meters During CQ WW SS

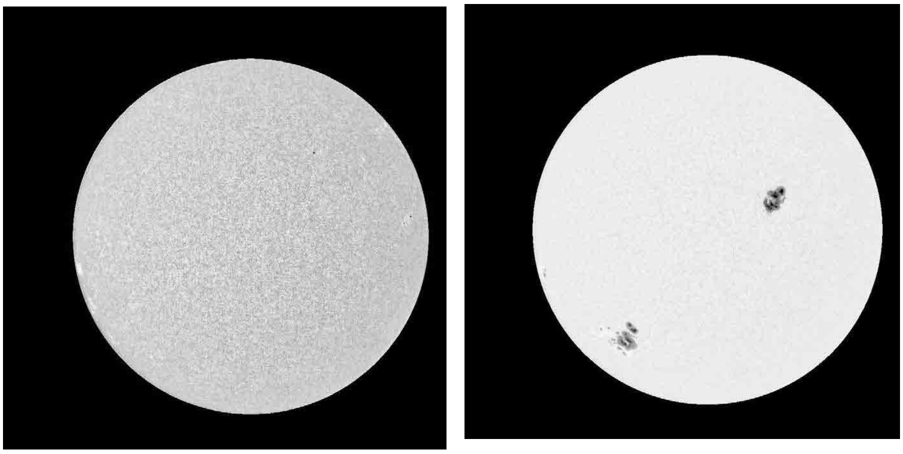


Figure 1—The Sun on October 16 (left) and on October 25 (right).
[Data used here from Mees Solar Observatory, University of Hawaii, are produced with the support of NASA grant NAG 5-4941 and NASA contract NAS 8-40801]

Based on the predicted smoothed sunspot numbers for the decline of Cycle 23 (from sec.noaa.gov/ftpdir/weekly/Predict.txt, for example), a quick run with VOACAP on the K9LA-to-HB path (a representative path from W9-land to Europe) at a smoothed sunspot number of 50 for the CQ WW SSB and CW weekends showed:

1) A best MUFday value of 0.30 at 1500 UTC – which means 10 meters was predicted to be open only 9 days of the month at that time—and there's nothing to say that any of these 9 days would fall on the desired weekends.

2) A best monthly median signal strength of –148dBW at 1500 UTC using 1 kW and 10 dBi antennas on both ends—which translates to less than S1 assuming S9 is 50 µv and an S unit is 5 dB.

But 10 meters was loaded with strong European signals here at my QTH for both contests. What happened? In a nutshell, the Sun decided to add some spice into our contesting life. The cause of 10 meter performing as well as it did was two very active sunspot regions.

Figure 1 shows the Sun on October 16 (on the left - about a week before the SSB contest weekend) and on October 25 (on the right - the Saturday of the SSB contest weekend).

The difference is quite obvious—October 25 shows two large areas of sunspots. Region 484 rotated into view on October 18 and Region 486 rotated into view on October 22. A caution for neophyte solar observers: never look directly at the Sun.

All this sunspot activity increased the amount of ultraviolet radiation impinging on our atmosphere—radiation at wavelengths that ionizes the F region and on which 10 meters heavily depends. Figure 2 is a plot of the 10.7 cm solar flux (measured at 2800 MHz) and Ap (the daily planetary A index) from the first week in September through early December.

As can be seen, the level of 10.7 cm solar flux increased spectacularly beginning in mid October when the first of the two active regions rotated into view.

But we have to watch it here. Radiation from the Sun at a wavelength of 10.7 cm is about 1,000,000 times less energetic than what's necessary to ionize any atmospheric constituents. In other words, 10.7 cm couldn't ionize its way out of a paper bag. But it is a good *general* indicator of what the Sun is doing. So based on such a large increase in 10.7 cm solar flux, we would indeed expect increased F region ionization. A best guess at what happened is that the ionosphere reacted to an increase in sunspot number from about 50 prior to the contest weekends to somewhat above 100 for the contest weekends (the contest weekends are highlighted with thick dark lines on the horizontal date axis). VOACAP now says the MUFday would be around 0.75 (significantly increasing the probability that 10 meters would be open for the contests) and the monthly median signal strength would be around S7. That certainly falls in line with the observations.

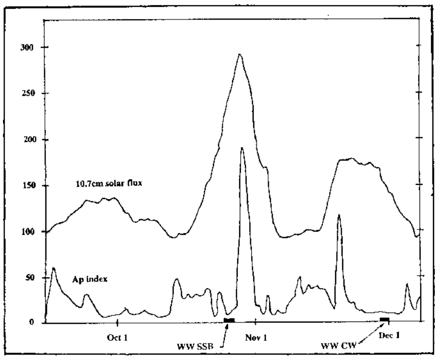


Figure 2—Solar Flux and Ap.

Unfortunately this didn't come without some bad news. There was an X1.2 flare at 1721 UTC from region 484 during the second day of the SSB contest that caused a blackout on the sunlit side of the Earth due to increased D region absorption from radiation in the 1 to 10 Angstrom range. Marty, W1MD, was the 10 meters operator at PJ2T when this flare hit, and he noted:

"I can tell you that it went very quiet but was the first to recover. I was running again within the half hour and passing Qs to 15 meters.That was the only way we were able to work guys on 15 meters for the first hour or so after the flare."

With absorption inversely proportional to the square of the frequency, 10 meters would be the last to be affected and the first to recover.

Additionally, there was an Earthward directed halo CME from region 486 that occurred on October 28. This caused the Ap index to spike up to 189 on October 29 and to 162 on October 30 (right after the SSB contest, thank you), with the resulting geomagnetic storm taking its toll on the F region ionization. The transit time for this CME was around 19 hours, making it one of the fastest on record.

Interesting, isn't it? Both contests were during periods of higher ionization, and both just missed disturbed geomagnetic field conditions causing F region problems. Whoever planned this—I want him on my side!

To summarize, Old Sol may have given 10 meters one last 'hurrah' before heading into the depths of solar minimum. I hope you participated in these contests to take advantage of it. NCJ

CONTEST CALENDAR

Compiled by Bruce Horn, WA7BNM

Here's the list of major contests of possible interest to North American contesters to help you plan your contesting activity through June, 2004. The web version of this calendar is updated more frequently and lists contests for the next 12 months. It can be found at: **www.hornucopia.com/contestcal/**.

As usual, please notify me of any corrections or additions to this calendar. I can be contacted at my callbook address or via e-mail at: **bhorn@hornucopia.com**. Good luck and have fun!

March 2004

ARS Spartan Sprint	0200Z-0400Z, Mar 2
ARRL Inter. DX Contest, SSB	0006Z, Mar 6 to 2400Z, Mar 7
DARC 10 Meter Digital Contest	1100Z-1700Z, Mar7
Pesky Texan Armadillo Chase	0200Z-0400Z, Mar 11
YL-ISSB QSO Party, SSB	0000Z, Mar 13 to 2400Z, Mar 14
RSGB Commonwealth Contest	1000Z, Mar 13 to 1000Z, Mar 14
Oklahoma QSO Party	1400Z, Mar 13 to 0200Z, Mar 1 and 0800Z-2000Z, Mar 14
SOC Marathon Sprint	1800Z-2400Z, Mar 13
North American Sprint, RTTY	0000Z-0400Z, Mar 14
UBA Spring Contest, CW	0700Z-1100Z, Mar 14
NSARA Contest	1200Z-1600Z, Mar 14 and 1800Z-2200Z, Mar 14
Wisconsin QSO Party	1800Z, Mar 14 to 0100Z, Mar 15
10-10 Int. Mobile Contest	0001Z-2359Z, Mar 20
BARTG Spring RTTY Contest	0200Z, Mar 20 to 0200Z, Mar 22
Russian DX Contest	1200Z, Mar 20 to 1200Z, Mar 21
CLARA and Family HF Contest	1700Z, Mar 20 to 1700Z, Mar 21
Virginia QSO Party	1800Z, Mar 20 to 0200Z, Mar 22
9K 15-Meter Contest	1200Z-1600Z, Mar 21
Spring QRP Homebrewer Sprint	0000Z-0400Z, Mar 22
CQ WW WPX Contest, SSB	0000Z, Mar 27 to 2359Z, Mar 28

April 2004

SARL 80m QSO Party	1700Z-2000Z, Apr 1
Kids Roundup	1400Z, Apr 3 to 2200Z, Apr 4
SP DX Contest	1500Z, Apr 3 to 1500Z, Apr 4
EA RTTY Contest	1600Z, Apr 3 to 1600Z, Apr 4
Missouri QSO Party	1800Z, Apr 3 to 0500Z, Apr 4 and 1800Z-2400Z, Apr 4
QCWA QSO Party	1800Z, Apr 3 to 1800Z, Apr 4
144 MHz Spring Sprint	1900 local – 2300 local, Apr 5
ARS Spartan Sprint	0100Z-0300Z, Apr 6
JIDX CW Contest	0700Z, Apr 10 to 0200Z, Apr 9
ARCI Spring QSO Party	1200Z, Apr 10 to 2400Z, Apr 11
EU Spring Sprint, SSB	1500Z-1859Z, Apr 10
Georgia QSO Party	1800Z, Apr 10 to 0359Z, Apr 11 and 1400Z-2359Z, Apr 11
CIS DX Contest, SSB	1900Z, Apr 10 to 1900Z, Apr 11
UBA Spring Contest, SSB	0600Z-1000Z, Apr 11
222 MHz Spring Sprint	1900 local – 2300 local, Apr 13
Holyland DX Contest	0000Z-2359Z, Apr 17
TARA Skirmish Digital Prefix Contest	0000Z-2400Z, Apr 17
ES Open HF Championship	0500Z-0859Z, Apr 17
YU DX Contest	1200Z, Apr 17 to 1200Z, Apr 18
GACW CW DX Contest	1200Z, Apr 17 to 1200Z, Apr 18
EU Spring Sprint, CW	1500Z-1859Z, Apr 17
Michigan QSO Party	1600Z, Apr 17 to 0400Z, Apr 18
Ontario QSO Party	1800Z, Apr 17 to 1800Z, Apr 18
World Amateur Radio Day Party	0000Z-2359Z, Apr 18
432 MHz Spring Sprint	1900 local – 2300 local, Apr 21
SP DX RTTY Contest	1200Z, Apr 24 to 1200Z, Apr 25
Helvetia Contest	1300Z, Apr 24 to 1300Z, Apr 25
QRP to the Field	1500Z-2400Z, Apr 24
Florida QSO Party	1600Z, Apr 24 to 0159Z, Apr 25 and 1200Z-2159Z, Apr 25
Nebraska QSO Party	1700Z, Apr 24 to 1700Z, Apr 25

May 2004

US IPARC Annual Contest, CW	0000Z-2400Z, May 1
MARAC County Hunters Contest, CW	0000Z, May 1 to 2400Z, May 2
UBA Welcome to European Union	0000Z-2400Z, May 1
10-10 Int. Spring Contest, CW	0001Z, May 1 to 2359Z, May 2
2 GHz and Up Contest	0600 local, May 1 to 2400 local, May 2
Microwave Spring Sprint	0600 local – 1300 local, May 1
Indiana QSO Party	1500Z, May 1 to 0300Z, May 2
ARI International DX Contest	2000Z, May 1 to 1959Z, May 2
New England QSO Party	2000Z, May 1 to 0500Z, May 2 and 1300Z-2400Z, May 2
US IPARC Annual Contest, SSB	0000Z-2400Z, May 2
ARS Spartan Sprint	0100Z-0300Z, May 4
VOLTA WW RTTY Contest	1200Z, May 8 to 1200Z, May 9
Oregon QSO Party	1500Z, May 8 to 0300Z, May 9
Mid-Atlantic QSO Party	1600Z, May 8 to 2400Z, May 9
FISTS Spring Sprint	1700Z-2100Z, May 8
50 MHz Spring Sprint	2300Z, May 8 to 0300Z, May 9
US Counties QSO Party, SSB	0000Z, May 15 to 2400Z, May 16
Portuguese Navy Day HF Contest	0800Z, May 15 to 2300Z, May 16
Manchester Mineira CW Contest	1500Z, May 15 to 2400Z, May 16
Anatolian RTTY WW Contest	1800Z, May 15 to 2100Z, May 16
His Maj. King of Spain Contest, CW	1800Z, May 15 to 1800Z, May 16
CW WW WPX Contest, CW	0000Z, May 29 to 2359Z, May 30
Great Lakes QSO Party	0000Z, May 29 to 2359Z, May 30
ARCI Hootowl Sprint	2000 local – 2400 local, May 30
MI QRP Memorial Day CW Sprint	2300Z, May 31 to 0300Z, Jun 1

June 2004

Major Six Club Contest	2300Z, Jun 4 to 0200Z, Jun 7
ARS Spartan Sprint	0100Z-0300Z, Jun 8
ANARTS WW RTTY Contest	0000Z, Jun 12 to 2400Z, Jun 13
Asia-Pacific Summer Sprint, SSB	1100Z-1300Z, Jun 12
ARRL June VHF QSO Party	1800Z, Jun 12 to 0300Z, Jun 13
SARL Kid's Day	0700Z—0900Z, Jun 16
All Asian DX Contest, CW	0000Z, Jun 19 to 2400Z, Jun 20
West Virginia QSO Party	1600Z, Jun 19 to 0200Z, Jun 20
Kid's Day Contest	1800Z-2400Z, Jun 19
UK DX Contest, CW	1400Z, Jun 25 to 1400Z, Jun 26
Marconi Memorial HF Contest	1400Z, Jun 26 to 1400Z, Jun 27
ARRL Field Day	1800Z, Jun 26 to 2100Z, Jun 27
ARCI Milliwatt Field Day	1800Z, Jun 26 to 2100Z, Jun 27
His Maj. King of Spain Contest, SSB	1800Z, Jun 26 to 1800Z, Jun 27

NCJ

DX Contest Activity Announcements

Bill Feidt, NG3K

CQ World-Wide 160 Meter SSB Contest (February 28-29, 2004)

Call	*Entity*	*Class*	*Operators*
D4B	Cape Verde	SO	4L5A
EA5AT	Spain	MO	EA5AT EA5JK EA5GKB
LY4A	Lithuania	SO	LY2FY

Thanks to: 4L5A, EA5AT, LY2FY

ARRL DX SSB Contest (March 6-7, 2004)

Call	*Entity*	*Class*	*Operators*
7S2E	Sweden	SOSB 40 meters	SM2DMU
4V2X	Haiti	SOAB LP	AH8DX
6Y8Z	Jamaica	M/S	WN9O WO9Z W9IU
LY4A	Lithuania	M/S	LY2FY LY2CO LY3CI LY4CW
LZ9W	Bulgaria	M/2	LZ Contest Team
P4ØA	Aruba	SOSB 20 meters	KK9A
PJ2T	Neth Antilles	M/2	NWØL AE9B WØCG K8ND WB9Z
PJ7B	Sint Maarten	M/?	K8RLM W8EB
SX1A	Greece	SOAB LP	SV1DPI
T32I	East Kiribati	M/S	KH6GMP KH6DFW
TO5A	Martinique	SOAB	NH7A
VP9/W6PH	Bermuda	SOAB LP	W6PH

Thanks to: AH8DX, F5VHJ, KH6GMP, KK9A, LY2FY, LZ2CJ, OPDX, SM2DMU, W6PH, W8EB, WB9Z, WN9O
See **www.ng3k.com/Misc/adxs2004.html** for further details

CQ WPX SSB Contest (March 27-28, 2004)

Call	*Entity*	*Class*	*Operators*
7S2E	Sweden	SOSB 40 meters	SM2DMU
D4B	Cape Verde	SOAB HP	4L5A
FM/T93M	Martinique	SOAB HP	T93M
LZ9W	Bulgaria	M/M	LZ Contest Team
P4ØA	Aruba	SOAB	KK9A
PJ4P	Neth Antilles	???	DF7ZS
SX1R	Greece	???	SV1XV
VP51V	Turks Caicos	M/S	W5AO K5CM N5KW
YUØHST	Serbia	M/?	4N1JA YU1BX 4N1LB YZ1EA YZ1MI

Thanks to: 4L5A, 4N1JA, DF7ZS, KK9A, LZ2CJ, SM2DMU, SV1XV, T93M, W5AO
See **www.ng3k.com/Misc/wpxs2004.html** for further details

Jon K. Jones, NØJK
n0jk@hotmail.com

Big coast-to-coast sporadic E opening in the 2004 January VHF Sweepstakes (but it was really one weekend early)!

Just to be sure everybody gets the word – the QST *date for the Jan VHF SS is wrong (shown as 17-19 Jan)!*—73, Ward, NØAX, *QST* Contest Corral Editor, as posted to the VHF Contesting Reflector on January 5, 2004.

Ward and others did their best to get the word out to the VHF Contest community about the correct dates for the contest. But when 1900 UTC rolled around on 17 January, some VHF contest enthusiasts were calling "CQ Contest" on the VHF bands and logging QSOs. The "one weekend early" January VHF SS was on. Mother Nature followed the contest corral announcement, too, and provided winter E_S "fireworks" to the delight of 6 meter contest operators. Most stations caught on quickly that the correct dates for the 2004 January VHF sweeps were the following weekend. But with the great E_S conditions, a number of stations decided to go into "semi-contest" mode and see how many QSOs and grids they could work in the openings.

KØGU worked double hop E_S Saturday evening January 18 UTC (kind of rare in a late winter opening) to KB5NHM (FM19), and N3DB (FM18) along with single hop stuff to 8-land. I had VE4AMU (EN19) answer my CQ on 50.125 MHz.

Sunday evening of the "contest" the 6 meter band broke wide open coast to coast. At 2342 UTC, WB5NRI found XE2TH (DM30) on 50.125. The Es quickly spread east and west; and at 0045 UTC, I had NW5E (EL98) answer me, followed by a QSO with NT6K (CN91) at 0046 UTC. The band was open to Florida and California at the same time from Kansas, just like a summer Es opening! Some big signals out of CM98 California to Kansas with W6QUV, K6YK and W6NBK "running the EM and EN grids contest style." CM98 made it all the way across the country on double hop E_S to Miami, Florida EL95 at KE4WBO's station when he heard "W6KBX CM98 blasting in" at 0212 UTC.

XE2ED, XE2TH, XE2SNG, XE2HWB/m and XE2TZP were active and provided some DX spice. XE2ED (DM10) operated on 50.300 MHz FM and was loud into Oregon at 0345 UTC in the closing minutes according to WX7R (CN85). The E_S continued right up until the end of the contest at 0400 UTC with K7OFT Seattle observing it is "a nice little winter opening into S. Cal." This was an exciting E_S opening right up to the end of the contest to wrap up the "week early" January VHF Sweepstakes.

How did some of the top scoring stations do? Bill, KØHA from EN10 in Nebraska mentioned working the following grids "in the contest" Sunday evening on 6 Meters starting at 2337 UTC:

EM83, EL98, DM54, CM98, CN85 (many), CN96, DM53, CN94, DM06, DM15, CN84, DM05 (many), DM07, CM97, CM87, DM04, DM14, DM15, DM13, DM03, DM12, XE2TH (DM30) plus XE2TZP (DM40) among others. With tongue in cheek, Bill asked, "where do I turn in my score?"

Will the ARRL will accept logs for the "week early" January VHF SS? Unlikely, but that did not stop ops from enjoying the propagation, making "contest style QSOs" while checking out their stations and having fun with the high activity on a normally placid 6 meter band in mid-winter. There had been discussion on the VHF Contesting Reflector about Ken Hawker, WM5R's, proposal of having a 6 meter single band contest similar to the ARRL 10 Meter Contest. With so many people active this particular weekend (in part due to some thinking the VHF SS was the January, 17 to 19 weekend), this could have been an opportune time to have an impromptu 6 meter contest. A fun event and a good "warm up" for the official ARRL January VHF Sweepstakes. With the Internet e-mail reflectors, prop loggers, chat boards, etc, it is possible to get the word out quickly. What do you think? Maybe on another weekend when there is a "contest date misprint", the NCJ, ARRL or perhaps another VHF organization like SMIRK can sponsor a 6 meter contest?

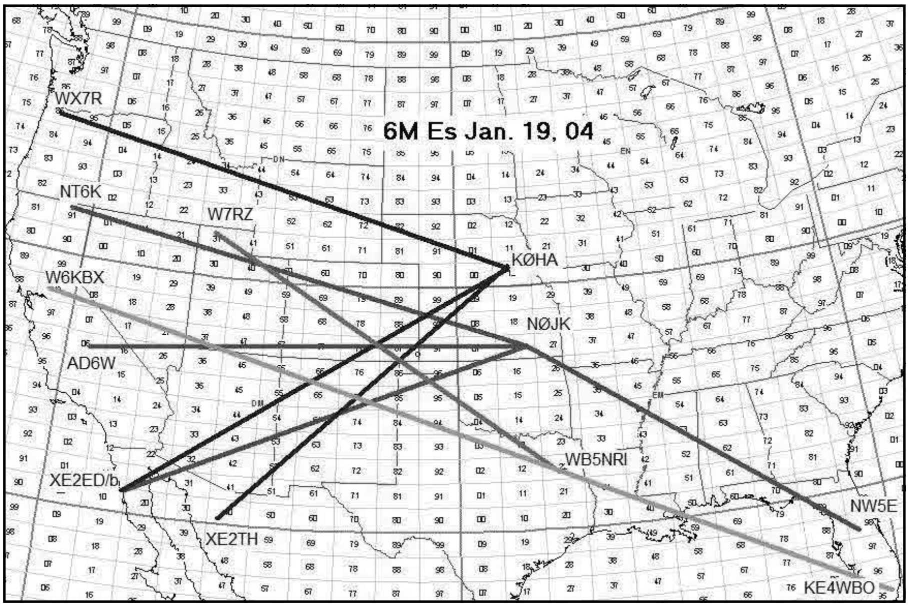
What did the "official" January VHF Sweepstakes scheduled for 24 to 26 January have in store? Let us hope that there was some "E_S pixie dust" left for the official contest!

As a long time VHF contest operator, sometimes I overlook that some readers of this column are not familiar with the various types of propagation discussed in it. Here are some FAQs and their answers:

What are E_S openings? How can I use them to improve my score?

E_S or sporadic E propagation, which was the DX mode on 6 meters mentioned in the story above, is also the primary mode of working long distance (stations over 600 km away) on 6 meters in the June VHF QSO Party. Some understanding of what E_S is and how it works can help you improve your score. Many HF operators are already probably familiar with "summertime short skip" on 10 and 15 meters. If you have operated in Field Day, the "short skip" is the contacts you work several hundred to 1000 miles away on 10 and 15.

Sporadic-E (E_S) is a kind of E-layer refraction caused by small patches (or



Representative six meter sporadic E path QSOs during the pre-contest weekend.

clouds) of unusually dense ionization. These clouds appear unpredictably, but are most common in the continental states and southern Canada during the daylight hours of spring and summer, with a “minor season” in December and January. The openings may last minutes to hours, and usually affect only limited areas at a time. The E_S clouds are 50 to 100 km in diameter, 2 to 4 km thick and at an altitude of 95 to 115 km. This gives a maximum possible refraction path distance of about 2200 km for a single hop. Signals can be very strong, and 10 W stations can be loud over 1000 mile paths.

If multiple E_S clouds form, and are located in the right places, sometimes signals can bounce off two clouds resulting in “double hop E_S.” Thus E_S QSOs can occur “coast to coast” at times. Even more rare are three and four hop E_S, which can allow the Midwest USA to work Europe, and the West Coast to work Japan on 6 meters. At times the MUF may rise above 144 MHz, allowing 2 meter E_S QSOs. E_S occurs on 144 MHz about 10% as often as on 50 MHz. In the 2003 June VHF QSO Party, the E_S MUF rose briefly above 222 MHz, with a number of E_S contest QSOs made on that band.

There are many theories as to the cause of E_S. The most widely accepted theory for mid-latitude E_S (the E_S we encounter) is the wind shear theory. This theory holds that the ions in the E layer may be concentrated into thin, dense patchy sheets by the action of high-altitude wind and the earth’s magnetic field. This theory is not much help in predicting when and where $E_S$will occur in the contest (though if the geo-magnetic field is active it tends to dampen E_S formation). But statistical studies of E_S occurrence can help. It has been found that E_S peaks in May to July in the Northern Hemisphere (good news for the ARRL June VHF QSO Party). E_S tends to form most often in mid-morning (0900 to 1200 local standard time) with a second peak in early evening (1800 to 1900 LST). These are the times to focus on 6 meters in the June contest. The most common distance for single hop contacts is 2,000 to 2200 km. Shorter distances require a higher MUF, and are less common. A contest tip—if you hear a “short E_S” station 800 to 1000 km away, call them *now*. They may be gone in a few minutes and not be heard again in the contest. And if you hear stations working short Es QSOs across the mid-point of a 2000 km path for you, check 2 meters for E_S.

What is the E_S doughnut?

If you plot out a circle around your station on a grid map at 2200 km, this is the single hop E_S range. Plot a second circle at 4400 km, and this is your range for double hop E_S. The region between 2500 to 3200 km is a zone where contacts are difficult to make, and is known as the “E_S void.” An example of an “E_S void” path are 6 meter Es QSOs from VP9 to KØAZ (EM37), KØHA (EN10) and KØETC (EM27). E_S void contacts are not common, as they usually require two high MUF E_S clouds appropriately located. E_S void contacts can also occur via “cloud to cloud” E_S. Cloud to cloud E_S is thought to account for the 2900 km 2 meter E_S QSOs reported. Contest tip—if you hear a station in the “E_S void,” do not put off working them. E_S void propagation is usually short lived and unstable. Often E_S void signals are weak, and going to CW may help. E_S void and double hop E_S contacts can sometimes occur without hearing stations at the “first hop” distance. When I worked K5AM New Mexico in the 2003 June VHF QSO Party from Bermuda on 6 meters, he was the only signal on the band.

How about $E_S$and antenna height on 6 meters

As Es is “short skip” some feel a low antenna is the best way to go on 6 meters. Low antennas do work on E_S, especially if it is very short—less than 800 km or so. But most E_S you will work will be in the 2000 to 2200 km range (as it occurs more commonly right at the MUF). With the E_S height of 105 km, this results in a radiation angle of less than 5 degrees. A high rather than a low antenna would seem to be better for most Es encountered. At WBØDRL in Salina, Kansas we found that the high (65 foot) Yagi to be better on all E_S signals than one at 30 feet except on very short E_S to Colorado. Some stations put up both a high and low antenna, and switch between the two. There is much more to E_S. A good starting place to learn about E_S is the article by Emil Pocock, W3EP. It is on the Web at: **www.uksmg.org/**

Contesting on a Budget

Paul Schaffenberger, K5AF

I received such a robust response from Jukka, OH6LI, for a previous column that I asked him to expand his input into a "guest column". If you think building a competitive contest station is expensive in the United States, try Scandinavia! I think you'll find that Jukka's money-saving efforts reflect both his passion for the hobby and his ingenuity. Here, in his own words, is an inspiring story of doing more with less.

Budget Contesting—the Finnish Approach

Jukka Klemola, OH6LI
Aarontie 5, 31400 SOMERO, Finland

I am Jukka Klemola, OH6LI. I am 36 years old and am married with three children: Harri, 5, Jenni, 3 and Markus, 8 months. I was first licensed in 1982, at 14 years of age, and am currently working at Nokia in Finland in R&D management. My education is an MS from Tampere University of Technology with thesis in telecommunications.

Finding how to make a low-cost but efficient station is vital if you operate with a normal salary earner's limitations but want to compete with the best.

I would like to note that the amount you save is roughly proportional to how much you spend. I saved some $1000-$2000 building my home station. Then I saved maybe $6000-$10,000 building the larger OHØV contest station. I have already saved much more building the OH4A station, and it is not even close to ready yet. I wrote a bunch of short stories of some real cost cutters that anyone can utilize.

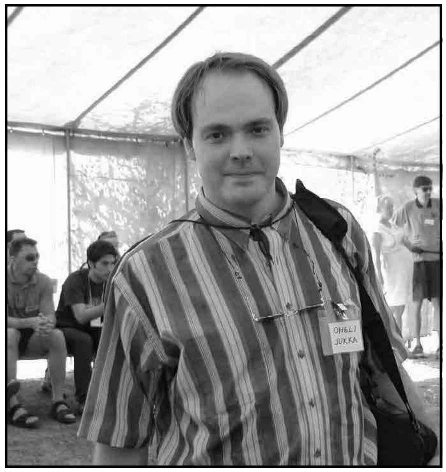


Figure 1—Jukka, OH6LI (tnx photo Bob N6TV)

To start with, I buy no new commercial antennas. The places to search for used antennas are hamfests, flea markets, and Web sites made to help people trade their used gear, like eBay and radio amateur magazines' classified ads.

Most commercial antennas have compromised something, so considering how to make them better is usually worth the effort. The commercial antennas I buy use parts that need some competence that I don't have. An example is the Cushcraft 40 meter Yagi at my home. Making shortened elements work properly is not exactly trivial.

I buy no new towers either. I find the towers in the classified ads in the Finnish Radioamatoori magazine, or in ads in domestic flea-market-type Internet sites. Sometimes the best information comes through the grapevine (friends' friends). I have also built a tower myself. I was barely 20 at the time, but now I have found I have no more time for doing that much work.

I bought a welding machine and some inexpensive tools to work with steel. I have made bases for towers and performed some other simple tower related work. I have also done equipment related work such as an amplifier power supply frame, to which I attach sheet aluminum using screws. Sheet aluminum works as the cover for the equipment.

Antenna building with mechanical details like element-boom aluminum joints with clamps and Al-plate in between, as described in ARRL handbooks, is relatively easy to do. If some precision drilling is needed, a workshop can do the more difficult parts at a reasonable price. Making more plates at one go reduces the unit cost.

I design, build and maintain my full-size antennas myself. Electrical design tools are *YO, AO* and *NEC2* based SW. Ideas for antennas come from my own needs and it has been a really big saver to notice how much the price grows with gain. My spending criteria has been that I will

Figure 2—Shown is the rotor for a small rotating tower at OH6LI's home. The 3.3 v battery operated screwdriver motor is turning an angle transmission found in a junkyard. The original use of the angle transmission was likely some paper mill equipment. The tower is in a suburban area and is 24 meters tall with a 2 element 40 meter and a five band Yagi, all of which are easily rotated with this system.

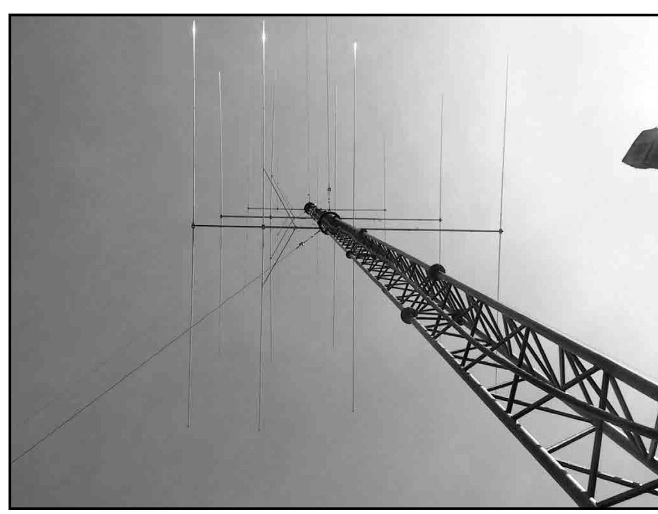


Figure 3—One of the towers Jukka, OH6LI, uses at OH4A. Antenna is a 4 over 4 over 4 for 20 meters. The antennas are home made of aluminum that costs less than $ 7 per kilo. Feed system is a delta match so the driven element construction is more robust.

invest at OH4A until I reach 200 EUR or USD per dB of gain. The largest amount of elements per boom that I use is 5 on my 10 meter Yagi at OHØV. I use 4 elements on 20 and 15 for this same cost limiting reason. 2 elements on a boom is my choice on 40 meters. Stacking creates more gain. A 40 meter 2x2 stack gives nearly a dB over a 3 element Yagi, 4x4x4 on 20 gives at least the same gain as a 5x5 and is lighter and less costly.

Yagi physical structure is described in ARRL handbooks well enough so an average ham does not really benefit much from simulation of physical properties. On the other hand, if the QTH is a windy mountaintop, or the antenna height gets over 30 meters, I suggest thinking of physical properties more closely. Dick, K5IU, has written a number of good articles on designing robust elements.

Icing can be a problem, like I saw at the QTH of Bill, N5YA. Preparing for extreme conditions is very costly but sometimes pays off. The damage I saw in Texas was such that I have never seen anything like that in Finland! My approach is to build antennas so they likely survive 160 km/h (100 mph) winds and a lot of ice. Going to extreme from that level is very expensive as diameters and wall thickness grow fast. Also, heavy antennas make for more wear on the towers and rotors.

I seldom buy new coax. Most is hard line from junkyards. CATV hard lines can be used for impedance matching, and all is practically 75 Ω. I used to have 75 Ω cables for feed lines in the 1990s when we built a station at OH3TR while we were studying at the University. These days I prefer surplus 50 Ω cables that we get from "old" cell phone systems.

If I buy hose clamps or connectors, I usually buy a larger quantity and bargain until the salesperson starts to get visibly uncomfortable. Some shops have prices so low that it does not really make sense to bargain, though. It does make buying faster, but to some it might take some fun away!

Here's one trick that may not be commonly in use. Connect a hard line to RG213 by simply soldering the cables together. There is about 3 centimeters of center lead exposed even with 7/8" hard line, and that is absolutely no problem on HF. And then I can use PL259 connectors that are low cost and easy-to-find. Remember to wrap some tape around the cables to make a strain relief. Do not forget weatherproofing, either. I use plastic juice cans for weatherproofing. Also a dash of non-metallic spray paint on the soldering prolongs the life of the connection.

I have started to use (at a minimum) silver plated connectors for high power RF use. That is the place I suggest not to use any old stuff.

To hoist a tower or an antenna up, work usually is such that it is better to have a friend or two than to work alone. Building a team that has experience and learns from mistakes is fun. Here are the negatives (-) and positives (+):

–Professionals are always expensive

–Using a random bunch of people is not the right solution

+ A small number of friends that form the core group for these occasions is good enough.

+ Guests are welcome for a day's projects, yes—but a core group of 2-3 people is really good to have

Rotators are easy to make from a budget screwdriver motor and an angle transmission from a junkyard (see picture), plus a support and bearing system. A rotator can be up on the tower or it can rotate the tower. When rotating the tower, I always have my rotors on the ground for easy maintenance.

A good source for angle transmissions is junkyards having broken car washing equipment. Yes, this is the car washing equipment we see every day at many gas stations. The large wet, fast-rotating brushes are turned by quite rugged worm gears. When insisting to overdo, I have also used gears made for some small radars. I visited Glenn, K6NA, last June. He uses prop pitch motors to turn his monster Yagis. That's a nice and cost-effective solution.

A good rule-of-thumb is the output axis diameter has to be at least 2 cm if you have a full size 40 meter Yagi or similar antenna. If more antennas are on a rotating tower, 3-4cm diameter should do.

To rotate a tower with multiple Yagis a bigger motor is needed. A power range of 200 W or 1/4 hp is sufficient for stations using almost anything but an 80 meter full sized toy.

A really quick but a bit dirty direction indicator for a tower is a simple line going once around the tower, then via a pulley at the upper edge of ham shack window and a small weight to the end of the line. Mark a point on the line by a knot. Rotate the tower and the knot moves up and down and shows the direction. Mark the directions in the dust on the window utilizing the index finger. When the markings fade out, the direction indicator should be recalibrated anyway.

I hope I have encouraged a few thoughts for you about how you can improve your stations and perform better in the coming contests. It is winter now and we practically cannot do antenna work here in Finland, so I have concentrated doing an amp and a couple of relay boxes that I might write an article about next winter.

73, Jukka, OH6LI

Topic for May-June *NCJ*:

The Cold War peace dividend—have you cashed in? Over the past several years, we've been seeing an increase in high power tubes and parts from the former Soviet Union. Have you taken advantage of the low prices to build homebrew amps and/or antenna tuners? Have you modified existing commercial gear to use the lower-cost Russian tubes? Do you have any future plans to take advantage of this parts bonanza?

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