log-periodic fixed-wire beams
for 75-meter DX

Extensive tests with overseas Amateurs have resulted in an LP antenna with excellent characteristics and performance

This article describes log-periodic antennas made of wire elements, fixed in position, for the 75-meter Amateur band. It includes test results based on contacts between W4AEO in South Carolina and an Amateur in New Zealand, ZL1BKD. During the test period (late 1975 through early 1976), performance of the 75-meter LP, in various configurations, was compared with that of other antennas including dipoles, delta loops, slopers, and verticals.

background

I first became interested in 75-meter DX while talking to Colin, ZL1BKD. Colin had read some of my articles on LP beams[1-5] and asked if I'd tested one on 75 meters. Most of the referenced articles describe the construction of LPs for 10, 15, and 20 meters, giving test results. In one or two of the articles I'd furnished dimensions for a 5-element monoband LP for 75 meters of the log-periodic dipole (LPD) type, but it was never tested. (The dimensions for the 75-meter LPD were merely scaled up from one that worked well on 40 meters.)

As a result of my on-the-air talks with ZL1BKD and an exchange of correspondence, we agreed to conduct a test program involving a 75-meter LP and several popular Amateur antennas.

reference antenna

The antenna used as a reference in the tests was a log periodic consisting of five elements about 18 meters (60 feet) high. This antenna was modified several times during the tests. It was used as an LP Yagi, then as a 5-element Yagi. Test data in the form of operating-log sheets are provided to show on-the-air results (**table 1**).

environmental test conditions

I'm fortunate to have enough space to erect several 75-meter antennas at the same time. Pine trees abound for supports, with heights of up to 21 meters (70 feet). But my location in South Carolina is subject to severe thunderstorms. Lightning took its toll in the summer of 1976: two test antennas were destroyed.

I have also found that vertical antennas don't perform well at this location. I believe this is because of poor ground conductivity in my area,[14] limited clearance between verticals and trees,[15] and an extremely high noise level.

overseas tests

Between July, 1975, and March, 1976, ZL1BKD and I compared over a dozen different antennas with

The 75-meter LP beam antenna described here requires a considerable amount of real estate as well as many high supports. The minimum area required for the 75-meter antenna suggested by W6PYK (3-element LP plus director) is about 0.3 acre (1500 square meters, or 16,131 square feet). This doesn't include space for running supporting lines between antenna elements and trees, which requires another 988 square meters (10,620 square feet). Thus the antenna isn't practical for Amateurs limited to small city lots. **Editor**

By George E. Smith, W4AEO, in collaboration with **Paul A. Scholz, W6PYK.** Mr. Smith's address is 1816 Brevard Place, Camden, South Carolina 29020. Mr. Scholz's address is 12731 Jimeno Avenue, Grenada Hills, California 91344

the 75-meter LP, which was aimed west from my location. Comparision antennas included:

1. Three 75-meter halfwave dipoles at 15, 18, and 23 meters (50, 60, and 75 feet) above ground

2. Three 75-meter delta loops

3. Several 75-meter slopers and phased slopers using various beam configurations

4. Two quarter-wave 75-meter verticals with various numbers of buried radials

5. One half-wavelength 75-meter vertical suspended from a balloon, voltage fed at the bottom with an antenna tuner

6. Two 75-meter half waves in phase (collinear horizontal dipoles) at 23 meters (75 feet) high, oriented broadside to New Zealand

7. One 2-wavelength 75-meter horizontal quad element up 23 meters (75 feet). One lobe was toward New Zealand

8. A two-element, 75-meter bobtail curtain (two phased quarter-wavelength vertical radiators with one-half wavelength spacing). An inverted groundplane was used. Antenna height was about 21 meters (70 feet). The pattern was bidirectional, broadside to New Zealand

9. One 75-meter long-wire antenna (229 meters, or 750 feet long) mounted on tree tops at about 18 meters (60 feet) high. The main lobe was oriented west.

10. A Shakespeare (commercial marine) vertical antenna, center loaded, 7 meters (24 feet) long covering the 4-MHz marine band. The antenna was tuned to 3808 kHz and mounted at 12 meters (40 feet). Four one-quarter-wavelength sloping radials were used.

a note on delta loops

Delta loops for 75 meters were popular during the time of these tests and were used by several 75-meter DXers. Of the three delta loops used in the tests, two were arranged with the horizontal section at the top and with the apex pointed toward ground (delta loops 2 and 3, **table 1**). The third delta loop (delta loop 1, **table 1**) was in the opposite configuration: apex up and horizontal section about 3 meters (10 feet) above ground.

Two deltas were first fed at bottom or center (horizontal polarization), then changed to corner feed (vertical polarization). The latter configuration was best for the U. S. — VK/ZL path.

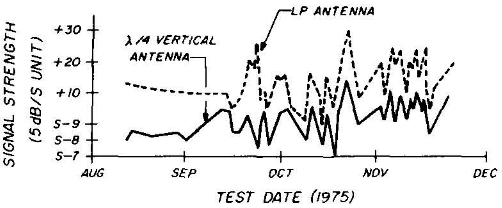

fig. 1. Data showing day-to-day differences between the LP and the quarter-wave vertical used at W4AEO during the test period (August, 1975, through November, 1975.) These data were compiled by W6PYK from reports by ZL1BKD.

Anyone considering a quad or delta loop for 75 or 40 meters is urged to read reference 16, in which the author describes his tests of deltas and quads and shows lobes, radiation angles, and other data. (A reprint of this article appears in reference 17.) Another source appears in the April, 1976, issue of *ham radio*.[18]

test results

Overseas tests began in July, 1975. A condensed reproduction of my log (**table 1**) shows representative data taken while running tests with ZL1BKD. The vertical, delta loops, and quad were first compared directly with the 5-element LP at about 18 meters (60 feet) above ground, aimed west. Note from **table 1** that the quad, erected in October, 1975, and delta loop 3, erected in November, 1975, were mounted over a pond.

The LP, LP-Yagi, and Yagi under test were the only true unidirectional antennas used during the test period. Also note that the LP had been modified several times — it was used as an LP-Yagi for a time, then later modified as a 5-element Yagi.

test note

My first 75-meter LP was completed on August 1, 1975. I made contact with New Zealand stations the following morning. Reports indicated that the LP was at least 10 dB better than the dipole or quarter-wave vertical antenna.

Colin, ZL1BKD, later added an external dB meter to his receiver, which gave more accurate readings. This method was used during the tests between August 21, 1975, and March, 1976, when the tests were completed. Contacts were made several times per week during this period.

Tests were run on 75 meters near 3808 kHz for U.S. and ZL stations, with 350 watts PEP. (VK stations operate split frequency and are received between 3690-3700 kHz.)

During some days there was little if any propagation, so no tests were run because of low signal strength. Little fading was noticed during the test periods. If there was any, it was quite slow in contrast to that on the higher-frequency bands. Signal buildup occurred just before sunrise, usually 5-10 dB. Then a gradual signal-strength decay occurred for about 30 minutes to an hour until the DX signals faded into the noise. We repeated the antenna tests at different times during the 1000-1200 GMT opening.

The unidirectional beams. From reports furnished by ZL1BKD during the 75-meter tests (**table 1**), the LP and LP-Yagi beams showed a 10-15 dB increase over the other antennas tested. This doesn't mean that the 75-meter beams had a 10-15-dB gain. Theoretically, a truncated LP of the type tested, using only three to five elements and a boom length of only 0.35 wavelength, would probably have no more gain than 5 dB over a dipole at the same height. Increasing elements to 9 or 10, and increasing boom length to about 1.3 wavelength, would probably result in a gain of about 10 dB. But the boom length would be about 103 meters (337 feet), which is impractical for most Amateurs.

I believe that the reported differences, 10-15 dB in favor of the unidirectional LP beams, were caused by the inefficiency of the other antennas tested — possibly by power wasted in lobes in undesired directions.

Comparative reports on reception at W4AEO were about the same. However, a high noise level plus heavy interference at times made direct comparison difficult on some days. (World noise charts show that ZLs and VKs generally experience much less noise than I do in my area.)

During high noise conditions I used several Beverage receiving antennas, which helped to improve reception. I am now erecting several Beverage antennas for 160, 75, and 40 meters. They are of the two-wire type with direction-reversing capability.

More on the delta loops. Table 1 shows that the quarter-wave vertical and delta loop 1 (apex up; horizontal portion near ground) were used for most test comparisons during which data were taken. Delta loop 2 (horizontal section up; apex toward ground) was tested only a few times, as it made a poorer showing than delta loop 1. Delta loop 2 was supported at about 23 meters (75 feet) over a pond. I used a 183-meter (600-foot) length of RG-8/U cable to feed this antenna. Here are some additional interesting observations.

table 1. Condensed log of W4AEO showing representative data on antenna tests with ZL1BKD during the latter half of 1975 and early 1976. Delta loop 1: apex up; delta loop 2: apex down; delta loop 3: apex down. Readings taken by ZL1BKD.

date (1975)	time (GMT)	remarks	LP or LP Yagi	quarter-wavelength vertical	delta loop 1	delta loop 2[(1)]	two-wavelength quad[(2)]	delta loop[(3)]
July		First contacts with ZL1BKD using half-wavelength dipole at 15 meters (50 feet) high						
2 Aug		ZL1BKD reports LP ≈ 10 dB better than dipole or vertical						
2 Aug later		ZL1BKD and ZL2BT report LP now ≈ 15 dB better than dipole or vertical						
21 Aug*		dipole S8	+ 10-15 dB	S8	S9-S9 + 10 dB			
25 Aug			+ 10-15 dB	S8	S9-S9 + 10 dB			
6 Sept			+ 12 dB	S8	S9 + 5 dB			
1 Oct		poor conditions	S7 (ref)	− 12 dB	− 8 dB	− 10 dB		
2 Oct			S9 (ref)	− 4 dB	− 2 dB	− 10 dB		
8 Oct	1030		+ 18 dB		+ 4 dB		+ 6 dB	
8 Oct	1200		+ 26 dB	− 8 dB	− 6 dB		− 10 dB	
11 Oct	1115	all sigs. down 10 dB today	5 dB	− 7 dB	− 7 dB		− 8 dB	
9 Nov		reworked LP	30 dB	15 dB	18 dB		12 dB	
19 Nov	1038		24 dB	8 dB	10 dB		4 dB	21 dB
31 Dec	1115		26 dB	21 dB			6-8 dB	
(1976)								
6 Jan	1125		6 dB	0	0 (ref)			4 dB
24 Jan	2120		30 dB	S9				20 dB

Notes: (1) Erected 24 Sept., 1975
(2) Erected 8 Oct., 1975
(3) Erected 29 Nov., 1975
(2) and (3): These antennas were erected over a pond 1/10 mile from shack.

*ZL1BKD improved method of taking readings, which was used for remainder of tests.

1. Delta loop 3 (horizontal part up; apex down) was erected over a swimming pool. The transmission-line length to this antenna was 76 meters (250 feet) of RG-8/U cable.

2. Delta loops 1 and 2 were tried using both end-feed and center-feed for vertical and horizontal polarization respectively. The latter was best for short distances; the former was best for DX. Delta loop 3 was used with vertical polarization only. (The ZL reports shown for the delta loops were for vertical polarization.)

3. Each delta loop had the same length of wire, which was cut by formula to resonate at 3800 kHz. However, I noted that, with vertical polarization, the antenna resonant frequency decreased to 3700 kHz. The following table shows SWR readings taken for the delta loops when fed for vertical polarization:

	standing wave ratio		
f(MHz)	DL1	DL2	DL3
3.5	2.8	2.2	2.7
3.6	2.4	2.8	3.0
3.7	2.0	2.3	2.9
3.8	1.2	2.0	2.0
3.9	1.05	1.07	1.05
4.0	1.8	1.1	1.5

notes on the vertical antenna

The quarter-wave vertical used in most of the tests was a 19-meter (61.5-foot) length of wire suspended by a nylon line between two high pine trees. The vertical was fed from a 61-meter (200-foot) length of RG-8/U coax cable buried in the ground. Ten radials were used originally; the number was later increased to thirty.

Another vertical antenna, consisting of a half-wavelength wire suspended from a balloon, was tested several times for comparison with the quarter-wavelength vertical. Little improvement was noted.

the beam antennas

The original 75-m LP beam first erected for the tests was a 4-element LP with one parasitic director in front. This antenna was later modified to an LP-Yagi using one parasitic director, three driven (LP) elements, and a parasitic reflector. Little difference was noted between these two configurations. Later the LP-Yagi was converted to a Yagi using only one driven element. (This beam was soon destroyed by lightning.)

The last beam used during the test was the Yagi. When comparing it with the quarter-wave vertical, the difference between the Yagi and the vertical was less than that in the previous reports covering the LP

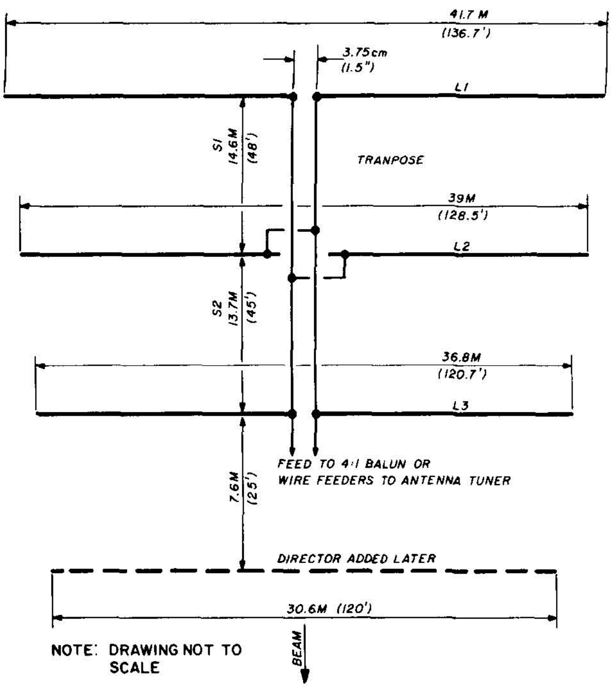

fig. 2. The 75 meter LP design suggested by W6PYK, which is for 3808 kHz. Taper factor, τ, = *0.94*; **spacing factor,** σ, = *0.175*.

or LP-Yagi. It's possible that the Yagi gain could have been improved by carefully adjusting the element lengths and spacing, since a Yagi is critical of adjustment. As the Yagi was destroyed by lightning, tests were not completed.

analysis of test results

The beam antennas gave surprisingly consistent day-to-day reports. Average reports were Q5, S9 + 10 dB average, with low readings about S9. At times readings peaked to S9 + 25 dB. These were about the same reports given on the same day to other Eastern U.S. stations running the legal power-input limit, but using only an inverted V or dipole antenna. I therefore feel that the beams did a fair job (especially at a height of 18 meters, or 60 feet). The average report on the beams was about 10 dB better than most of the conventional antennas tested at the same time at my location. I used a coaxial switch for antenna selection, so the readings taken during the tests were made within a second.

Table 1 shows differences among the same three antennas on different days. I believe that this is probably because of the differences in the vertical radiation patterns. **Fig. 1** was compiled by W6PYK from the data taken by ZL1BKD to illustrate the day-to-day difference of the LP antenna and the quarter-wave vertical. The data were taken between August and mid November, 1975. Note that the LP, the LP-Yagi,

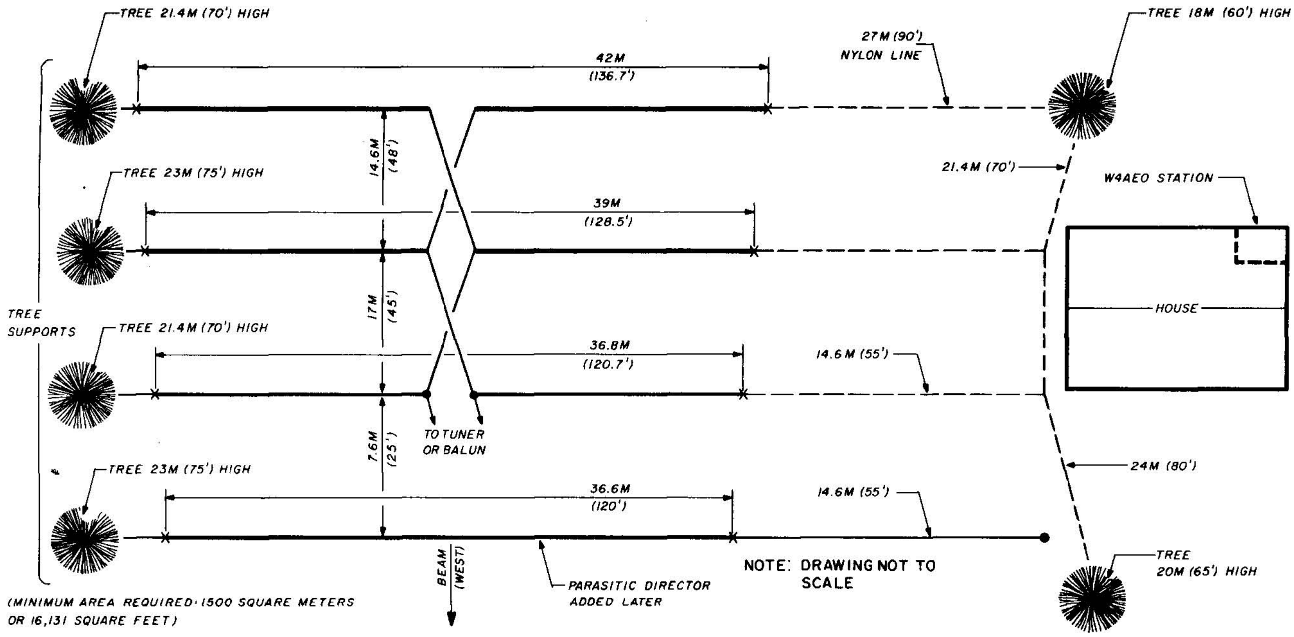

fig. 3. Plan view of the 3-element LP plus director for 3808 kHz (design suggested by W6PYK).

and the Yagi were the only *true unidirectional* beams tested.

Observations:

1. The delta loops (fed at corner's vertically polarized) have bidirectional lobes [plus the smaller high-angle center lobe (90 degrees), straight up]. Thus more than 50 per cent of the radiation is lost in unused lobe(s). Ref. 16, Fig. 10; Ref. 17, Fig. 7; or Ref. 18, Fig. 3.

2. The two-wavelength horizontal quad has four equal-spaced lobes, with only one pointing southwest.

3. The quarter- and half-wavelength verticals are omnidirectional and have maximum radiation at low angles. This may be a doubtful advantage if the antenna is located in a high-absorption environment. Interference from manmade noise was very evident.

a 3-element fixed wire beam LP for 75 meters

The 75-meter Yagi under test was destroyed by lightning in June of 1976. I wanted to replace it with another LP giving more gain, if possible. So Paul, W6PYK, suggested a 3-element, wide-spaced, truncated LP designed with a higher taper factor, τ, and spacing factor, σ. Using only three elements would limit the boom length so that it would fit into the available space previously used for the 5-element antenna.

W6PYK had observed a number of the ZL1BKD/W4AEO tests. As he is also interested in antenna design, we became acquainted on 75 meters. We also had a great deal of correspondence, comparing notes. W6PYK made a number of excellent suggestions during this period.

Paul describes his QTH as a typical California residential lot. He does not have space for a 75-meter beam, but was using a unique 40/75 roof-mounted vertical of his own design (which is quite effective considering its size — see *ham radio*, September, 1979, page 44) for working the ZLs and VKs. I agreed to construct and test some of his LP designs. He has written a number of papers on antennas, his latest being "L/P Antenna Design," which appeared in *ham radio*, December, 1979, page 34.

Paul furnished complete dimensions for the 3-element LP: element lengths and spacing (**fig. 2**)

table 2. Standing-wave ratio as a function of frequency for the beam antennas used in the test.

frequency (MHz)	standing-wave ratio 3-element LP (τ 0.94, σ 0.175)*	3-element LP plus director*	5-element LP	5-element Yagi†
3.5	1.35	1.35	1.1	2.9
3.6	1.3	1.2	1.25	2.4
3.7	1.2	1.1	1.1	2.0
3.8	1.1	1.1	1.07	1.4
3.9	1.1	1.05	1.15	1.2
4.0	1.5	1.6	1.15	2.0

*The 3-element LP and LP plus director were the last LPs tested. Design suggested by W6PYK using τ = 0.94 and σ = 0.175. This beam was tested after the tests covered by Table 1, which used the previous 4- and 5-element LPs. The improved 3-element LP was the one Bob Tanner, ZL2BT, reported the best tested here to date.

†Note that the Yagi is much sharper than the LPs.

designed to $\tau = 0.94$ and $\sigma = 0.175$. This design gives an overall array length (boom length) of 28.3 meters (93.0 feet). Paul advised that this configuration should provide good gain for the space available.

Note that the element lengths are slightly longer than those given by the formulas. Paul suggested this to allow for ground effect, since the height of the beam above ground would be limited to about 18.3 meters (60 feet), or less than a quarter wavelength. This was evidently correct from the SWR data (**table 2**), which was taken after the beam was completed. A plan view of the beam, (**fig. 3**), shows method of support — several trees.

During the tests on this new 75-meter beam, the only other antenna available at the time for comparison, was a dipole sloper. The other 75-meter antennas outlined above had been dismantled to make room for several beams needed for 20-meters. Bob Tanner, ZL2BT, reported on this new LP, the best tested to date.

acknowledgment

I especially thank W6PYK for his suggestions on LPs, Beverages, and other antennas. A number have already been tested and several more are still to be tried. I also thank Colin, ZL1BKD, for his many hours of test reports.

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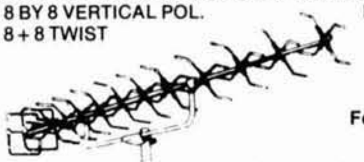

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