Antenna Airborne Research©

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**Spec Review** utilizes publicly available manufacturer's specifications ("spec") on the product, usually referred to as the "User Manual" or "User Guide." This can include photos and drawings of the product, a product description of the complete product, its components and connection materials. Many User Manuals also include tuning instructions accompanied with VSWR data, such as charts; however, it is important to know if the VSWR data is from a computer model, or actual testing utilizing reliable measurement devices. Tuning instructions sometimes can indicate if the product is simple or difficult to tune, the sensitivity to tuning settings to nearby objects and height above ground. User Manuals might also include instructions on how to match the particular product (antenna) to a recommended feed line, such as 50-ohm coax, plus placement of the feed line and additional suggestions for entry into a radio room (i.e. house).

A Spec Review includes comments on:

__The materials specified that are used to build the components;

__The ergonomics of the product ("user friendly")

__Installation suggestions for the product(s)

__Assembly/building instructions

__Specifications on efficiency, gain, pattern, power rating, environmental survival

__VSWR charts, tuning directions

__Warranty

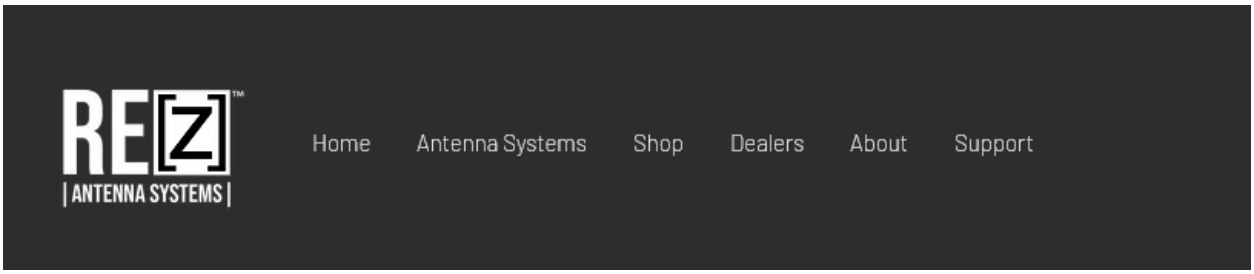
**Field Review** is a hands-on assembly and testing of the physical antenna/product, with measurements using appropriate devices (i.e. VSWR meter, VNA) and power handling

**Flight Review** includes the above Field Review and adds actual field signal measurements using static signal sources and/or drones through the antenna pattern(s)

**AMATEUR RADIO ANTENNA PRODUCT**

**SPEC REVIEW**

using screenshots from the company website and product Manual




# Recon 40 – loading coil

(…and short Spec Review of the Recon 80)

## First Look

__The website describes this product as, “The Recon 40 from REZ Antenna Systems is a high-performance HF antenna coil capable of tuning 10-40 meters when paired with the [Z]-17 17-foot telescoping whip.”

__Transmit power rating is 500watts SSB, 300watts CW and 200 watts digital (50% duty cycle).

__Changing bands is accomplished by selecting the entire coil, or bypassing the coil via the integrated toggle switch. All tuning, with or without the coil, is accomplished by adjusting the length of the telescoping whip (maximum height is 17’).

__The 50-ohm coax feed line (user supplied) screws onto the provided female UHF connector (SO-239).

__The Recon-40 also has an attachment for eight (8) wire radials at the bottom of the unit. This is called the radial “puck” and accepts 4mm banana plugs. There is also a radial kit of four (4) wires (33’ long, 18ga wire) with matching banana plugs for the puck.

__ Price point, advertised at $299.00USD

__Optional products (either by REZ, or other) are required to install this unit.

# Looking Deeper

__The User Manual is a full eight (8) pages and provides sufficient information and instructions to deploy and tune a vertical antenna using the Recon 40 coil as the base component. The manual lists additional equipment that is required to do a typical installation. meters. The coil is specified as a “high-performance HF antenna coil capable of tuning 10-40 meters when paired with the [Z]-17 17-foot telescoping whip.”

__ The manual further states, “In order to complete your antenna system you will need a 17 foot telescoping antenna whip, a mounting solution, and a set of radials terminated with a 4mm banana plug. The Recon 40 is offered as a full kit, which includes all of the required accessories or you may purchase them separately.” The following are recommended products to purchase to complete an installation:

| GROUND SPIKE | |
|---|---|
| Length | 17” |
| Spike Dia. | 3/8” |
| Max Dia. | 1” |
| Material | 316 Stainless Steel |
| Thread Type | 3/8-24 |

| [Z]-17 TELESCOPING WHIP | |
|---|---|
| Length | 17’ |
| Material | Stainless Steel |
| Finish | Black Electroplate |
| Mounting Thread | 3/8-24 Thread Pitch |
| Collapsed Length | 24” |

| [Z]QD RADIAL KIT | |
|---|---|
| Wire Length | 33’ (Set of 4) |
| Wire | 18ga Stranded Copper |
| Termination | 4mm Banana Plug |
| Wire Management | Silicone wire ties (set of 4) |

| [Z]-POD | |
|---|---|
| Height | 12 Inches |
| Footprint | Approx. 30 Inches |
| Leg Length | 18 Inches |
| Thread Type | 3/8-24 Thread |

These products are priced at:
Ground Spike $55.00 (Z) Telescoping Whip $70.00 (Z)QD Radial Kit $40.00 (Z) Pod $75.00
These items, plus the Recon 40 coil will total: $299 + 55 + 70 + 40 + 75 = $539
The manual states there is a full Recon kit (presumably less cost), but it was not found on their website Shop.

__There are no VSWR charts, as often found in antenna manuals; however, the manual states, “With the [Z]-17 17’ telescoping whip, the Recon 40 is capable of tuning from 7.0 MHz to 29.7 MHz while maintaining an SWR of less than 2:1. A coax choke is not required but may be used based on personal preference or if you find you have RFI issues.”

__There is an in-line balun (aka “coax choke” above) available from their SHOP. It consists of a short length of coaxial cable with connectors and seven (7) ferrite beads on the cable, making a common mode choke.

# Detailed Spec Review of the User Guide

The Recon 40 is a component for a vertical antenna system. By itself, it is a nicely made, fixed inductance coil. It has a female UHF connector at the bottom (an SO-239 connecting to the coil and to a metal ring for radial wires), a threaded connection for a tripod (also at the bottom), a toggle switch that can short out the coil and a threaded top portion to accept various vertical antennas, primarily telescoping, stainless models. The Recon 40 and the additional, required components will compose a base-loaded vertical antenna system.

The screenshot of the Recon 40 notes that the core material of the coil (what the wire is wound on) is Delrin. from suggeste4d vertical is their 17', telescoping stainless steel whip. The telescoping capability of this whip is the main tuning mechanism. Taller telescoping models (i.e. 25') could also be used, although without the ability to vary the value of the coil to correctly load the taller vertical for 40 meters, the added height would not be useful.

The manual offers information not often found in user guides. One short paragraph is relating to ground and radials, which says, "Note: Different soils, radial configurations, and mounting options will affect the ground system of the Recon 40. Depending on these factors, you may notice a difference in the SWR and resonant point of the system. This is normal and well documented behavior of any vertical antenna system. We recommend using the included insulating mount to ensure the mount itself does not change the characteristics of the ground system. For further information we recommend reading Rudy Severns' (N6LF) work on radial ground systems here: antennasbyn6lf.com/2009/12/series-of-qex-articles-on-ground-system-experiments.html"

There are several QEX articles by N6LF and all are work reading. Empirical (real time) testing has also been done by others, including this writer (N6BT), with data published in the NCJ and Array of Light (4th Edition), as well as presentations at Antenna Forums and Seminars on radials and other counterpoise / current return systems. It should be noted that the more recent testing tracks with that by N6LF.

The instructions from the manual are as follows:

"1. Connect the coax to the coil base and antenna analyzer.

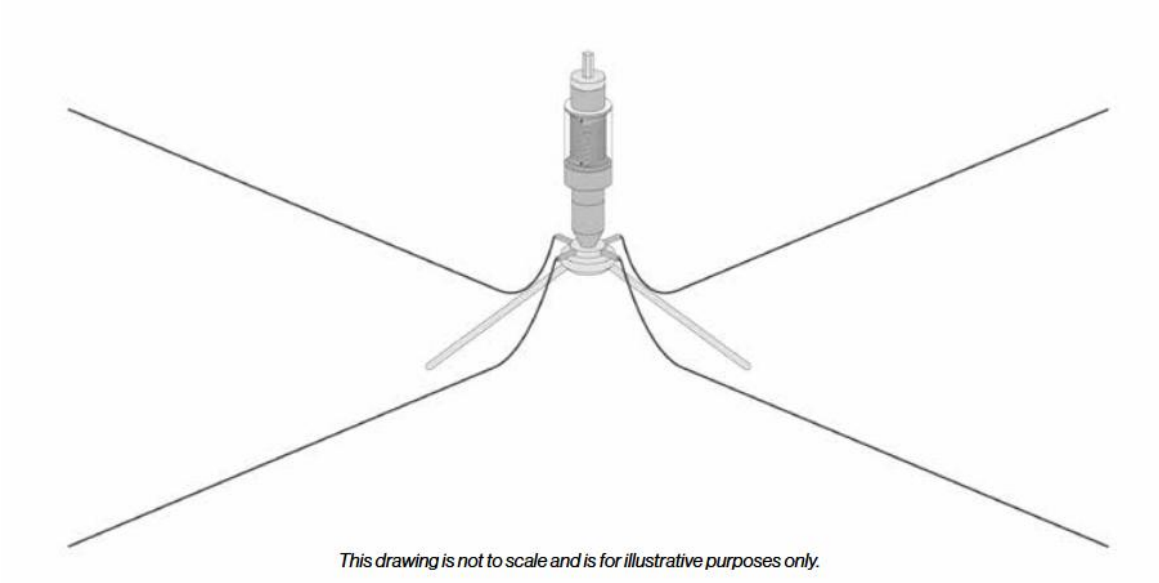
2. To operate the antenna on the 40 meter band, ensure the loading coil switch is set to "ON" (SEE FIG. 1). This activates the coil and sets the system into a loaded state. To operate on the 20 meter band and above set the loading coil switch to "OFF" (SEE FIG. 2)

3. Stand at least 10 feet from the antenna and run a sweep of the desired band. If you stand too close, your body will detune the antenna and throw off your measurements.

4. Note where the resonant frequency is on the antenna analyzer and adjust the telescoping whip accordingly. Increasing the length of the whip will lower the resonant frequency while shortening it will have the opposite effect (SEE FIG. 3). Make small adjustments on the whip. A little goes a long way.

5. Repeat steps 3-4 and adjust the whip accordingly until the desired tune is achieved. (SEE FIG. 4)."

In addition, the Recon 40 manual illustrates two, basic ways to install the radial wires for the vertical. "The vertical" means the Recon 40 coil, the telescoping vertical (17') and the radials (varying quantity). One method, which is most common, is to lay the wires on the ground as shown in this drawing from the manual:

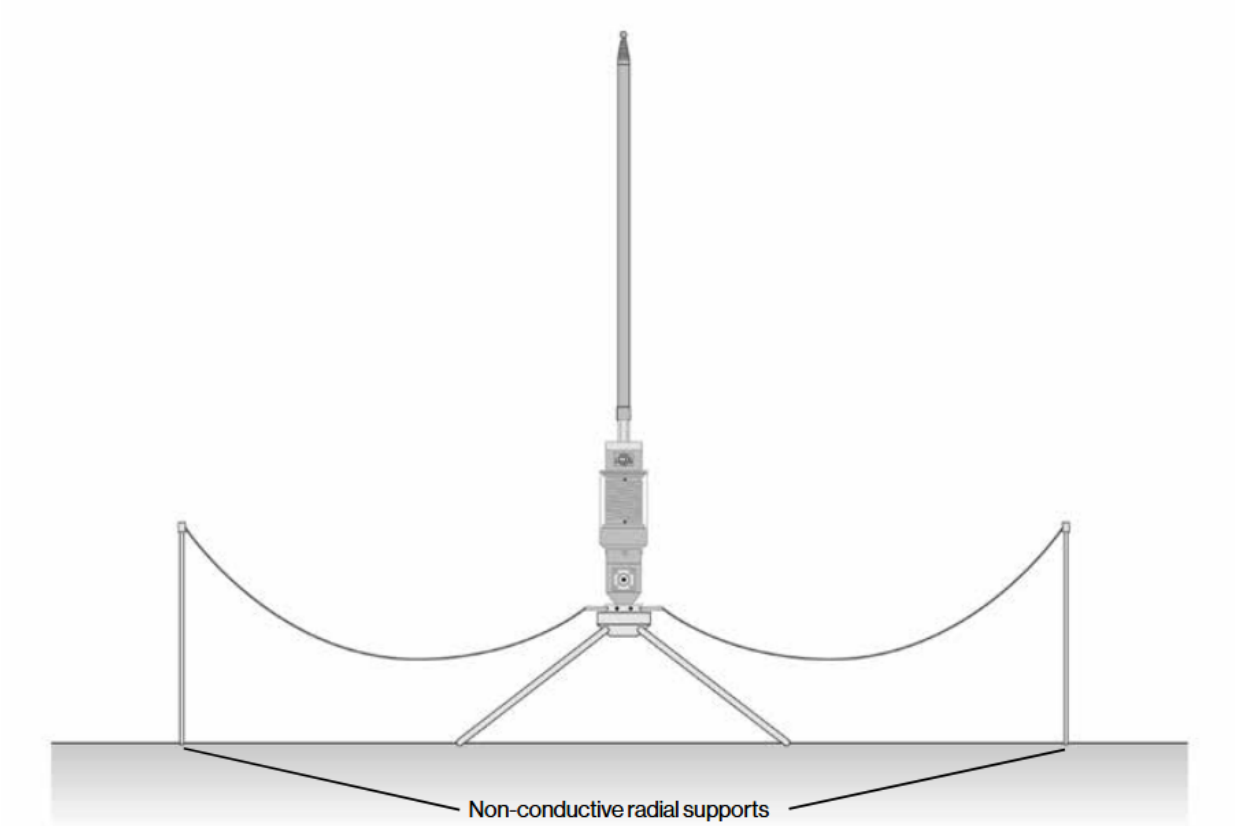


*This drawing is not to scale and is for illustrative purposes only.*

The manual notes that adding more radials, going from 4 to 16, will offer an increase of about 1.5dB. This is actually not the same as gain when you add a parasitic element to a horizontal dipole and achieve gain over the dipole (which is due to re-distributing the energy emitted by the dipole). The noted 1.5dB is from reducing the ground loss through adding more radials.

The second radial installation method is to raise them above the ground, while leaving the base of the vertical at the same height as before, such as atop the ground spike and insulator. As shown in this drawing from the manual:

**Elevated Radials**

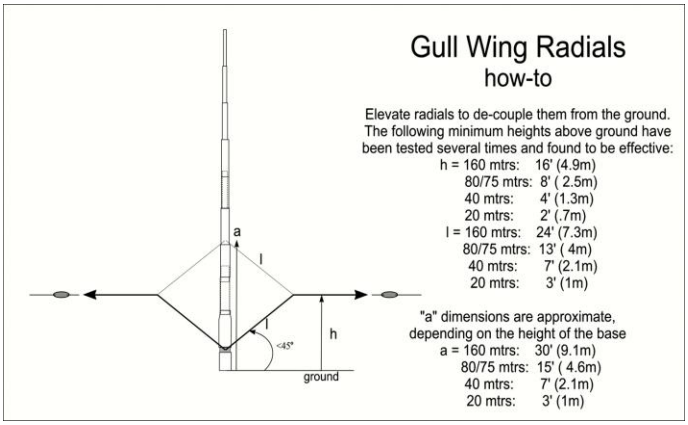


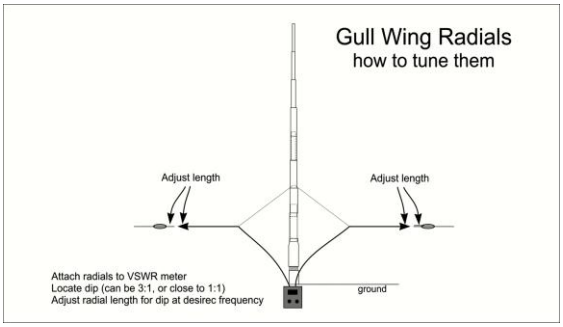

*This drawing is not to scale and is for illustrative purposes only.*

The manual further details, “The above diagram shows a ‘gull wing’ style deployment using the [Z] Pod and 3 foot radial supports. In this configuration, the radials are suspended by non-conductive supports at the end of each radial. When compared to the ground radial configuration, this configuration requires more effort to deploy, but achieves higher performance with less radials. Just 2 elevated radials can perform the same as 16 ground radials. For this deployment method we recommend using two 1/4-wave elevated radials tuned for each band. These radials can be deployed simultaneously for a multi-band radial configuration.”

As a point of history, the term, “gull wing” regarding radials was first used by Dean Straw, N6BV (former Senior Tech Editor for A.R.R.L.) back in 1997. He was operating with Team Vertical on the island of Jamaica and came up with a particular method for elevating radials while leaving the vertical base as ground level (DXpeditions have limitations). He also noted that the radials needed to be tuned to the desired operating frequency for proper operation. A useful chart developed

and later published by Team Vertical also shows the recommended height above ground for the HF bands:




The reason radials should be raised is that the ground is a big capacitor. If radials are cut to the "classic" ¼ wavelength, when they are placed on or in the ground, they will be 20-30% too long (depending on the ground). This means that if you have a correct length vertical, say, on 20-meters and connect it to 2 or 4 ¼ wavelength radials on the ground, the resonance will not show anything near 14MHz. Instead, it will more likely show 12MHz or even lower. The current distribution, which is very important, will have the maximum current in the ground. In typical fashion, if we see the "dip" at 12MHz, we will shorten the vertical to move it up to 14MHz. Unfortunately, this makes the situation worse, as the maximum current is now moved farther into the ground, as what we should do is shorten the radials (as noted, for example, in N6LF's work). The better solution is to get the radials off the ground and tune them for the band in use. An improvement of 6-7dB for changing from ground radials to elevated is fairly easy to validate doing your own testing. Back to the Recon 40.

Overall, the Recon 40 is a reasonable solution for a base-loaded 40-mtr vertical antenna. The short coming is using the stainless steel, telescoping whip, which is only 17' tall. This is about ½ size. What should the feed point for a ½ size vertical be, equipped with a pair of tuned, elevated radials? First, a full size ¼ vertical with proper current return (radials) will be in the low 30-ohm range, with a resulting VSWR of 1.5:1 to 1.7:1 (in this range). A ½ size vertical (like using the 17' telescoping vertical), with the same, full-length radials will be about 8-9 ohms, for a VSWR of a bit under 6:1. The question becomes that the manual says the VSWR 2:1 or less on all bands. How can this be?

One way to show less than 2:1 when the feed point is looking at 8-9 ohms and a VSWR of 6:1 is to install an impedance step-up (transformation) device, such as a hairpin. Unfortunately, there

is no impedance transformation device on this system. The way to get to 2:1 or less is by having loss in the antenna system. This is not coax loss, but in the components of the antenna system itself. Knowing that the expected feed point for this ½ size vertical is 8-9 ohms, we would need to raise this to 25 ohms in order to achieve a 2:1 VSWR. If we take 25 and subtract 9, we get 16 ohms of loss. If we want to get closer to a 1.5:1 VSWR, then we need to have 25 ohms of loss to have the feed point back up to 34 ohms. Overall, the calculated loss is on the order of -5dB, presuming that the radials are elevated and not on the ground (in which case, there would be more loss). Where can we look for loss in this Recon 40 system?

Overall, the 40-mtr coil, itself, is probably not the source, as the wire is copper and the core is a reasonable Delrin. The radials are also copper. This leaves the stainless steel whip and possibly some other electrical/mechanical connections at the base, but mainly the whip.

Operating on the higher bands, the coil is shorted using the toggle switch and the whip adjusted for best VSWR. Using radials on the ground is a common method of having a current return for a multi-band vertical, although there can be substantial loss due to the untuned radials being on the ground. Raising them and tuning for the band in use is the best choice, although the stainless steel whip is still in play.

An additional comment regarding the Recon 80 meter coil follows the Recon 40 conclusions.

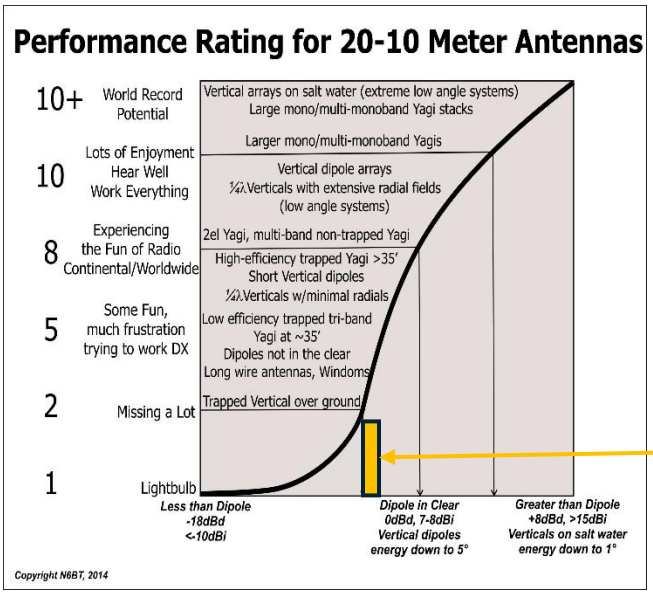
# REVIEW CONCLUSIONS

**Marketing focus:** easy set-up for 40-meters and higher bands, plus low VSWR of <2:1 on each band, with minimal tuning time

**Overall impression:** materials are good, simple assembly and several optional components to suit a customer's needs

**Probable performance:** certainly can make contacts with this antenna on all the bands and the installation should be straightforward and repeatable. The system has components that can be improved for better, overall performance. The easiest is elevating the radials, which will make a notable improvement; however, the most likely loss component is the vertical radiator (the telescoping, stainless steel 17' whip).

We rated the Recon 40 on our chart of antenna vs. enjoyment of radio at a 5, presuming the installation used elevated radials.




**Ways to improve this product:**

__connect a copper wire at the top of the coil and run it up, alongside the stainless steel whip to provide a copper radiator. This will use the whip as a support.

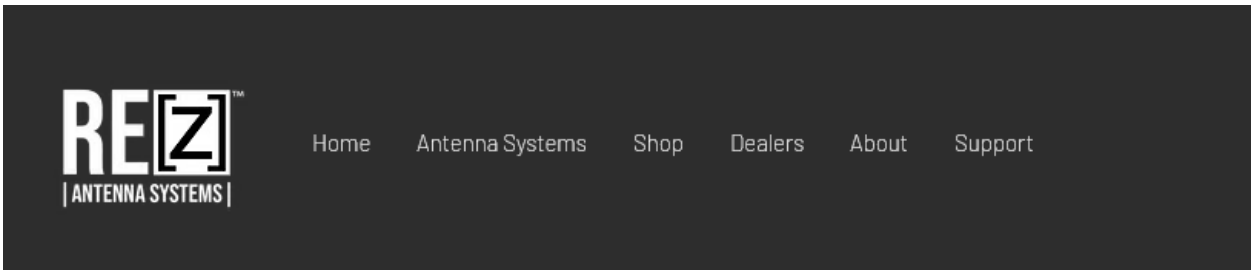
__as mentioned above, use elevated, tuned radials.

…end **Recon 40** loading coil Spec Review, 80 coil follows

**AMATEUR RADIO ANTENNA PRODUCT**

**SPEC REVIEW**

using screenshots from the company website and product Manual




# Recon 80 – loading coil


Another loading coil from this manufacturer is their Recon 80-meter coil. The construction is similar to the Recon 40 reviewed above, but with a major change in the wire used in the coil: the Recon 40 is wound using copper wire; however, the 80-meter coil is wound with stainless steel wire. As noted in the Recon 40 review, the 40 coil is certainly a reasonably good product, but using

stainless steel wire on the 80-meter coil will likely create a coil with substantial loss. How can be know? The User Manual will provide some useful information. The 80-meter coil is the main component in the 80-meter kit.

## REZ Antenna Systems™ Ranger 80™

**Kit Contents:**

(1) Ranger 80 Loading Coil Base
(1) 9.3' Military Whip
(1) [Z]QD-RP Radial Puck
(4) 33' 18ga Radials
(1) Mounting Spike
(1) Backpack

Thank you for purchasing your REZ Antenna Systems Ranger 80! This manual will familiarize you with how to set up, tune, and perform basic maintenance on your antenna. We take great pride in the build quality of our products, but should you have any issues or questions, please email us at support@rezantenna.com.

We hope you enjoy your new antenna for many years to come!

### Specifications

| COIL BASE | |
|---|---|
| Length | 21" |
| Max Dia. | 2.25" |
| Material | Delrin & 6061 Aluminum |
| Hardware | Stainless Steel |
| Coax Connector | SO-239 |
| Power Limits | 200 Watts SSB, 100 Watts Digital (50% Duty Cycle) |

| RADIAL SYSTEM | |
|---|---|
| Wire Length | 33' (Set of 4) |
| Wire | 18ga Stranded Copper |
| Termination | 4mm Banana Plug |
| Radial Puck | 3/8-24 Thread Pitch, (8) 4mm Banana Jacks |

| MOUNTING SPIKE | |
|---|---|
| Length | 17" |
| Spike Dia. | 3/8" |
| Max Dia. | 1" |
| Material | 316 Stainless Steel |
| Thread Pitch | 3/8-24 |

| HEAVY DUTY MILITARY WHIP | |
|---|---|
| Length | 9.3' |
| Material | Stainless Steel/Brass |
| Finish | Black |
| Mounting Thread | 3/8-24 Thread Pitch |
| Collapsed Length | 17" |

The antenna portion of the package is the coil, the (4) radials and the military whip. The whip is stainless/brass construction, which is typical of many telescoping devices used as antennas. The key to this whip the stainless thickness (relates to RF skin depth at the frequency of operation). The stainless is over the brass core that is a fairly good conductor.

The manual has good instructions for installation and includes similar writing found in the Recon 40 User Manual. The first portion of this manual states the expected frequency range and VSWR:

## Tuning

With the included whip, the Ranger 80 is capable of tuning from 3.5 MHz to 21.45 MHz with an SWR of less than 2:1. The Ranger 80 is also capable of higher frequencies when paired with a telescopic whip such as our Light Duty Telescopic whip. **Use one of the following methods to get the antenna tuned:**

***Note:*** *Different soils, radial configurations, and mounting options will affect the ground system of the Ranger 80. Depending on these factors, you may notice a difference in the SWR and resonant point of the system. This is normal and well documented behavior of any vertical antenna system. For further information we reccomend reading Rudy Severns' (N6LF) work on radial ground systems here: antennasbyn6lf.com/2009/12/series-of-qex-articles-on-ground-system-experiments.html*

What does this mean? It tells the user that using the 9.3' whip as the vertical radiator, coupled with the coil and (4) 33' ground radials, we can tune from 80 to the 15-meter band with a VSWR of less than 2:1. This is a frequency range of 3.5MHz to 21.45MHz, which is 2 ½ octaves. An octave is doubling or halving a frequency range (3.5 x2 = 7, 7x2 = 14, 14 x 1.5 = 21). The feed point impedance will significantly change throughout this stated coverage range. What can we expect for a feed point with the 9.3' whip on each band (80, 40, 20, 15)?

On 15-meters, a full size ¼ wave vertical and (2), all elevated 2' above ground would be approximately 36 ohms. A similar 20-meter vertical also 2' above ground will be about 38 ohms. On 40, maintaining the 2' above ground, the feed impedance will be about 39 ohms and on 80, it would be also about 39 ohms. All these verticals are full size, they are all significantly taller than the 9.3' tall military whip. If we substitute 9.3' as a fixed height vertical radiator into each full-size model while *maintaining the full-length radials* and the 2' above ground, then add inductance to achieve resonance on each band, the feed point values are the following:

15mtrs = add .65 µH coil, feed impedance is 19.5 ohms at 21.200MHz, VSWR 2.5:1

20mtrs = add 2.5 µH coil, feed impedance is 7.8 ohms at 14.150MHz, VSWR 6.4:1

40mtrs = add 10 µH coil, feed impedance is 2.5 ohms at 7.150MHz, VSWR 20:1

80mtrs = add 31 µH coil, feed impedance is 1.4 ohms at 3.800MHz, VSWR 35:1

How is it possible to achieve a 2:1 or less VSWR on these bands? An obvious method is to employ a matching network at the feed point; however, there is none on this product. This leaves to have loss in the system. This is often from radials on the ground and lossy components, such as stainless steel for a conductor and a coil form that is loss. In this case, the most obvious are the stainless

steel wire in the coil and the 9.3’ radiator.  How much loss would you need to get to 2:1 as a minimum VSWR on each band?

On 15mtrs, 6 ohms will give you 2:1; 20mtrs 17 ohms for 2:1; 40mtrs 24ohms for 2:1; 80mtrs 27ohms for 2:1.

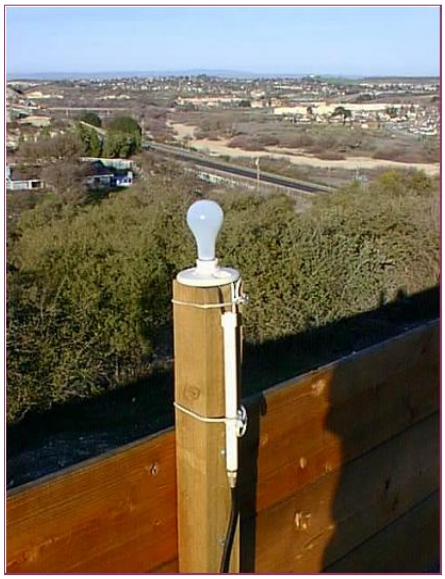
An estimate of the radiated signal loss with a 2:1 VSWR from component loss:

-17dB on 80mtrs, -12dB on 40, -5.5dB on 20 and -1.5 on 15mtrs. If the VSWR turns out to be lower than 2:1, due to more loss than anticipated, then the radiated signal loss will be even more.

How to improve this efficiency? Reduce the loss by using improved components.

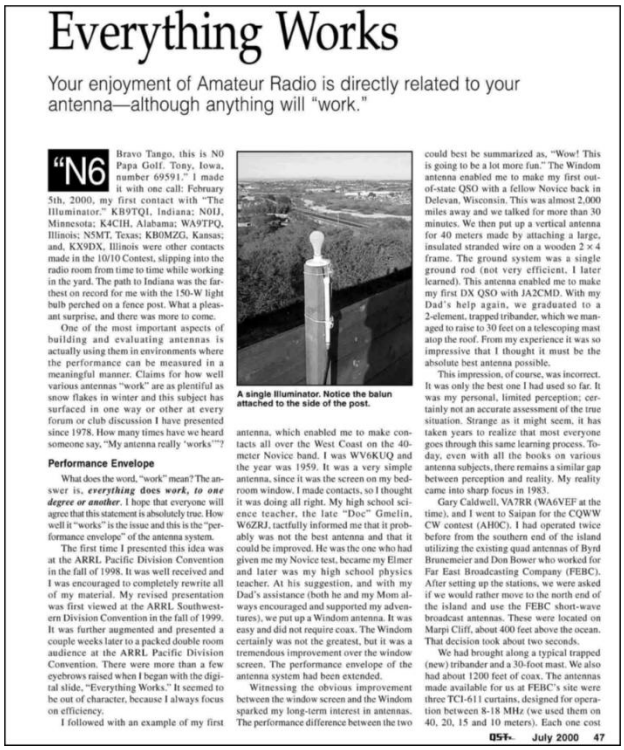
General summary -- It is certainly possible to make contacts on these bands, as the other station is the one making up the difference in the signal path. A single, copper wire would likely be an improvement.

**Remember: Everything Works – the key is, "Compared to what?"**



This lightbulb was used in the A.R.R.L. International DX Contest with 120 watts; worked 28 countries and all continents.

The write-up is found back in QST, July, 2000



# Everything Works

Your enjoyment of Amateur Radio is directly related to your antenna—although anything will "work."

"N6 Bravo Tango, this is N0 Papa Golf. Tony, Iowa, number 69591." I made it with one call: February 5th, 2000, my first contact with "The Illuminator." KB9TQI, Indiana; N0IJ, Minnesota; K4CIH, Alabama; WA9TPQ, Illinois; N5MT, Texas; KB0MZG, Kansas; and, KX9DX, Illinois were other contacts made in the 10/10 Contest, slipping into the radio room from time to time while working in the yard. The path to Indiana was the farthest on record for me with the 150-W light bulb perched on a fence post. What a pleasant surprise, and there was more to come.

One of the most important aspects of building and evaluating antennas is actually using them in environments where the performance can be measured in a meaningful manner. Claims for how well various antennas "work" are as plentiful as snow flakes in winter and this subject has surfaced in one way or other at every forum or club discussion I have presented since 1978. How many times have we heard someone say, "My antenna really 'works'"?

## Performance Envelope

What does the word, "work" mean? The answer is, ***everything does work, to one degree or another***. I hope that everyone will agree that this statement is absolutely true. How well it "works" is the issue and this is the "performance envelope" of the antenna system.

The first time I presented this idea was at the ARRL Pacific Division Convention in the fall of 1998. It was well received and I was encouraged to completely rewrite all of my material. My revised presentation was first viewed at the ARRL Southwestern Division Convention in the fall of 1999. It was further augmented and presented a couple weeks later to a packed double room audience at the ARRL Pacific Division Convention. There were more than a few eyebrows raised when I began with the digital slide, "Everything Works." It seemed to be out of character, because I always focus on efficiency.

I followed with an example of my first antenna, which enabled me to make contacts all over the West Coast on the 40-meter Novice band. I was WV6KUQ and the year was 1959. It was a very simple antenna, since it was the screen on my bedroom window. I made contacts, so I thought it was doing all right. My high school science teacher, the late "Doc" Gmelin, W6ZRJ, tactfully informed me that it probably was not the best antenna and that it could be improved. He was the one who had given me my Novice test, became my Elmer and later was my high school physics teacher. At his suggestion, and with my Dad's assistance (both he and my Mom always encouraged and supported my adventures), we put up a Windom antenna. It was easy and did not require coax. The Windom certainly was not the greatest, but it was a tremendous improvement over the window screen. The performance envelope of the antenna system had been extended.

Witnessing the obvious improvement between the window screen and the Windom sparked my long-term interest in antennas. The performance difference between the two could best be summarized as, "Wow! This is going to be a lot more fun." The Windom antenna enabled me to make my first out-of-state QSO with a fellow Novice back in Delevan, Wisconsin. This was almost 2,000 miles away and we talked for more than 30 minutes. We then put up a vertical antenna for 40 meters made by attaching a large, insulated stranded wire on a wooden 2 × 4 frame. The ground system was a single ground rod (not very efficient, I later learned). This antenna enabled me to make my first DX QSO with JA2CMD. With my Dad's help again, we graduated to a 2-element, trapped tribander, which we managed to raise to 30 feet on a telescoping mast atop the roof. From my experience it was so impressive that I thought it must be the absolute best antenna possible.

A single Illuminator. Notice the balun attached to the side of the post.

This impression, of course, was incorrect. It was only the best one I had used so far. It was my personal, limited perception; certainly not an accurate assessment of the true situation. Strange as it might seem, it has taken years to realize that most everyone goes through this same learning process. Today, even with all the books on various antenna subjects, there remains a similar gap between perception and reality. My reality came into sharp focus in 1983.

Gary Caldwell, VA7RR (WA6VEF at the time), and I went to Saipan for the CQWW CW contest (AH0C). I had operated twice before from the southern end of the island utilizing the existing quad antennas of Byrd Brunemeier and Don Bower who worked for Far East Broadcasting Company (FEBC). After setting up the stations, we were asked if we would rather move to the north end of the island and use the FEBC short-wave broadcast antennas. These were located on Marpi Cliff, about 400 feet above the ocean. That decision took about two seconds.

We had brought along a typical trapped (new) tribander and a 30-foot mast. We also had about 1200 feet of coax. The antennas made available for us at FEBC's site were three TC1-611 curtains, designed for operation between 8-18 MHz (we used them on 40, 20, 15 and 10 meters). Each one cost



NOTE: All those 28 countries were worked because the other station had a far better antenna system – it made up the difference of the very poor lightbulb "antenna."

…end