No. 39: Frequently Asked Questions

L. B. Cebik, W4RNL

In our column for the last issue, we covered some fundamentals of the material side of beam construction. That exercise brought to mind a number of more general questions that folks have posed from time to time about antennas. So, let's try to give some succinct answer to these questions.

1. *With a wire antenna, does insulation make a difference in performance?*

This question is actually two questions in one. First, once we get the antenna set correctly, insulation makes no difference in how well the antenna performs. The gain will be virtually the same, whether the wire is bare or covered with any of the standard insulating materials.

Second, insulation will make a difference in how long a wire must be to be resonant. If a bare wire is resonant on 10 meters (actually some specific frequency on 10 meters) at a length of 200", then an insulated wire will be resonant at the same frequency at a length from about 190" to about 198". Insulation creates a velocity factor (VF) so that the required physical length is always shorter than the required electrical length. If we set the VF of bare wire to 1.0, then the VF of insulated wire will be from 0.95 to 0.99.

The nature of the insulation and its thickness determine the VF of insulated wire. The higher the dielectric constant of the material and the thicker the insulation, the lower the VF value. Unfortunately, there is no handy chart that you can consult when you buy insulated wire to tell you what the precise VF is. For dipoles, you simply prune to resonance.

If you are thinking about a wire beam, where the elements are not resonant on the design frequency, then the best policy is to use the exact wire specified in the article or handbook from which you draw the design. There are techniques for handling insulated wire in these cases, but they generally require efforts or instruments that the average backyard antenna builder does not have.

2. *Does the feedpoint gap make a difference in the antenna element length?*

If a design that you are copying calls for an element length of 200", then this length remains constant, regardless of how large you make the feedpoint gap--within reason, of course. The gap can range (at 10 meters) from 1/4" to a couple of inches without disturbing the overall length of the antenna element. The leads from the feedline to the inner edges of the gap make up the missing element section.

Remember that the feedline is in series with the antenna element. The feedline itself begins where the line is at its proper form to create currents of equal magnitude and opposite phase. When you turn the wires of a parallel feedline at right angles to the line to make the antenna connection, those

wires are part of the antenna. When you separate the coax braid and center conductor to make the same kind of connection, those leads are parts of the antenna element. Even if not identical in diameter to the antenna element itself, the length is short enough at HF not to make any difference in the way the element performs.

3. *I have a multi-band doublet (or loop, etc.) that I use for all or most of the HF region. Can I connect a 4:1 balun at the antenna terminals and use coax to the antenna tuner in the shack?*

The answer to this question is yes, but there are better ways to handle the situation. The impedance presented by the antenna varies from one band to the next, ranging from very high to very low. If your coax run is long--perhaps 100' or so, your losses will climb according to the SWR on the line and the frequency. Higher frequencies and SWRs multiply natural coax losses.

Let's look at alternatives to this system. The most efficient system is to run parallel transmission line from the antenna to the antenna tuner. Parallel transmission line naturally has much lower loss than coaxial cables (except for the very low-loss hard lines used at UHF and microwave frequencies). Hence, the multiplier that comes with high SWR values on the line tends to increase the loss by only a very little. Hence, in most cases, the losses in a high SWR parallel line system will be less than the losses in a perfectly matched 10-meter coax system.

The installation rules for parallel line--whether it is 300-Ohm TV line, windowed vinyl 450-Ohm line, or open wire 600-Ohm line--differ from the rules that apply to coax. Keep the line free and clear of everything by several times the width of the line. Conductive materials--even wet wooden posts or trees--can disrupt the balance in the line and reduce its effective operation as a transmission line.

4. *If I run parallel into the house/shack, I get RF pick-up by the X (where X may equal the telephone, the TV, the rig, etc.). How can I have my parallel line and no interference?*

The losses of coax increase with line length. Hence, a short piece of coax--something less than about 20' at 10 meters--will not create significant losses. Even at a 10:1 SWR, 20' of RG-213 will have less than a 1 dB loss. Now lets assume that we can place the antenna tuner within 20' of where the coax would pass though the wall/window/etc. to reach the outside world.

We can install our parallel line from the antenna to this same wall/window--keeping it free and clear of unbalancing forces in the outdoor run. At the entry point, we can install a 1:1 bead balun. From the coax end of the balun, we run our short length of coax to the antenna tuner.

a. I specified a 1:1 balun, not a 4:1 balun. Sometimes the 4:1 balun will do the job--sometimes it will not. Since the antenna shows a different impedance on every band, it is rarely matched to the feedline headed toward the shack. At every point along the line, the impedance is transformed to a new value--and some of these values will be very low. Further transforming the impedance to a still lower value by a 4:1 ratio is likely to yield such a low impedance that the tuner may not be able to handle it. Hence, a 1:1 balun is the better choice.

b. I tend to prefer bead baluns for this transition, although other 1:1 balun types may work. Bead baluns--originated by Walt Maxwell, W2DU--are compact and inexpensive (from such sources as the Wireman in South Carolina). No balun will be lossless in this application, but the losses will be modest at moderate power levels.

c. At the coax end of the balun, run a short, heavy ground lead from the coax braid to a good ground rod. This measure helps prevent significant levels of RF from being on the outside of the

coax braid and thus helps reduce coupling into conductors inside the shack.

This system is not perfect, but it is effective for using an all-band antenna with parallel feedline while suppressing unwanted RF coupling to systems other than the amateur radio equipment.

5. *I have followed all of the recommendations and my all-band antenna will still not load up properly on 1 or more bands. What should I do?*

Let's assume that your system is flawless--good connections, not opens or shorts, etc. In this case, the most likely cause of a failure of the antenna to load is the length of transmission line.

Earlier, I noted that when the antenna feedpoint impedance does not match the impedance of the feedline, the impedance is continually changing along the line. It is possible to calculate the impedance at the shack end of the line, but only if we know the impedance at the antenna feedpoint. In most cases, we do not know the impedance at the shack end of the line.

The impedance may be a complex combination of a resistive value and a reactive value. Your antenna tuner has limits to the maximum and minimum resistive value that it will accept and transform. The reactive part of the impedance is the more likely culprit, since most tuner designs will compensate for only limited reactance. Depending on tuner design, the compensation range will be better for one type of reactance (capacitive or inductive) than for the other type. In most cases of a failure to provide a good match to the 50-Ohm requirement of the rig, the culprit an impedance at the tuner terminals that is outside the matching range of the tuner.

Wait--do not throw away the tuner. Instead, change the length of the line to obtain a different combination of resistance and reactance at the tuner terminals. You can splice in a section (4 to 10 feet) of parallel line, either permanently or with knife switches. Just keep these added sections from folding over each other or coiling up. In other words, they should be free and clear like the rest of the line.

Sometimes, you can find a single length of line that allows you to tune all bands with your multi-band wire antenna. In that case, you can make the connections permanent. In other cases, you can find two line lengths that between them allow you to handle all bands. A simple knife-switching system makes quick work of changing the connections.

6. *I have the ground line at the shack entry point. Is my system safe from lightning?*

Not especially. The safest system for an amateur station that does not need to operate during a thunderstorm is one that disconnects the antenna line from the shack lead and reconnects it directly to a ground rod. Then any charges that accumulate on the antenna go to ground and not to the equipment.

In addition, set up your station so that you can do a complete disconnect in preparation for a thunderstorm. Disconnect--pulling the plug is best--the AC lines. Also disconnect the equipment from the outside ground line. Now the equipment is disconnected from every source of electrical surge.

Sensitive solid state devices do not care if the supply line has a high surge or whether the ground side of the device has a high surge. In either case, the voltage across them is destructively high. Hence, isolating the equipment from both the supply voltage and the grounding lines is necessary to prevent surge damage. Surge protectors help, but when the storm is near, nothing succeeds like

isolation.

You can design your station to make all of these disconnects easy--easy enough to apply whenever you shut down after an operating session. The only step that requires a trip outdoors is changing the antenna lead from shack lead-in to ground rod. If you disconnect the antenna routinely along with the other indoor disconnects, you can save the trip outdoors for an impending storm and still be relatively safe. Of course, if you travel out-of-town, set up the station as if you will have a thunderstorm every day that you are gone.

7. *I have a beam on a tower. The base of the tower is strapped to ground rods. My coax from the antenna enters the shack, and I can change it from the rig to a second connector that goes to a ground rod outdoors. Am I safe?*

Maybe--maybe not. Experts suggests that most of the current in a lightning strike is in the coax braid. This current is very high, capable of destructively melting the insulation and arcing to other conductors. It is best if this current never enters the house at all. Hence, having an outdoor grounding system so that the coax never gets indoors during a thunderstorm is best.

There is a second move that you can make. Since your have well-grounded the tower, and since the bulk of destructive lightning-induced current is in the braid, consider this measure. Near the top of the tower, clamp a small plate to a tower leg. On the plate, install a coax bulkhead connector--a double female connector with mounting hardware. Now run the antenna lead from the antenna to the connector and a second length of coax from the connector to the outdoor disconnect near ground level. The coax braid is now at the same potential as the tower leg and connected to the ground system serving the tower. You can add a second plate and connector at the tower base for added safety.

If you maintain this system so that the connectors make excellent contact with the plates and the plates make excellent contact with the tower legs, you shunt currents on the outside of the braid to ground. However, this measure does not remove the need to disconnect the coax from the shack lead-in before it enters the shack. It just adds to the overall protection.

There are more questions on my FAQ list. But these are enough for one column.