Best Practices When Installing an Antenna System

By Eugene Morgan, WB7RLX

One of the most common questions I hear from amateurs is about the performance or lack of performance of their antenna or complaints that their antenna has mysteriously stopped working or seems to work intermittently. In this article I will offer some recommendations about how to install an antenna system that will endure the test of time and the challenges of our Utah weather and hopefully result in a log book full of contacts or in the case of VHF/UHF many long QSO's. Before we start let's talk a little bit about your antenna situation.

"All antenna systems are a compromise driven by our individual constraints"

Few of us are lucky enough for our imagination to be our only constraint when it comes to selecting and installing an antenna system. Most of us are constrained by our pocket book, our property situation, our partner desires or requirements, our health and physical limitations, our knowledge, or worse of all HOA covenants. Any antenna system we build and install is always a compromise driven by our individual constraints. A free space antenna is a myth and only possible within the domain of mathematical theory or one's dreams. Also, there is no one size fits all solution when it comes to an antenna system. Given this fact it is critical that we optimize the antenna system we install regardless of the antenna we select. It may not be the biggest, the tallest, or the highest, but if it has been installed properly you will get the most out of it for years. What that means is that you optimize the whole antenna system where ever possible.

Note that I purposely used the phrase "*antenna system*". It's important that one understands that the antenna system includes everything in the hardwired RF path between the radio and the antenna. This includes patch cables, antenna switches, antenna tuner, any connectors that connect the inside of the shack to the outside of the shack, the transmission line, matching devices and finally the antenna itself.

Any antenna system is only as good as its weakest link. A failure of, or compromised performance of any one component will affect the whole system and impact your ability to transmit and receive. The components mentioned in the previous paragraph are all a part of the "Antenna System" and where possible each component should be optimized in their respective way. Sometimes these optimization are a small extra step and sometimes they can be a much larger undertaking. Regardless, these little

extras can sometimes make a big difference in your stations on air presents, especially over the long term.

Installing a New Antenna

Your new antenna has just arrived and you are all excited to get it on the air and try it out. So you open the box, glance at the instructions and with screw-driver and wrench in hand you put it together, mount it, connect the cable, maybe check the SWR and put out your first CQ or call for an antenna check. Stop, hold the phone, or rather the mic, step away from that CW key. That's not the right way to do it…

In talking to many amateurs this is exactly the process they follow and this is exactly where we need to start in optimizing the antenna system, at the beginning before the antenna actually shows up on your door step. Let's turn the clock back, rewind and start at the very beginning of the process. Let's go back to that point where you have made your decision and you are ready to order your shiny new and sometimes very expensive antenna. Or it may be you decided to put up a simple dipole or some version of a dipole. Regardless, the steps and goals are the same:

1. Prevent corrosion
2. Make sure the antenna's physical and electrical properties will not change regardless of weather or how long it's been up.
3. Maximize the energy going to and coming from the antenna.
4. Did I mention Prevent corrosion!

Here is a list of my recommendations based over years of fiddling around with antenna:

Step 1: Acquire one or more roles of silicone self-fusing electrical tape, not to be confused with black vinyl electrical tape, although you need a roll or two of that as well. The self-fusing electrical tape is noticeably thicker and is soft like rubber. There are several brands, get the one that won't breakdown in sunlight. You will use this on all exposed coaxial fittings, especially where the transmission line connects to the antenna and to the shack. This stuff doesn't fuse well when it's cold. So if your doing this in winter break out your wife's hair dryer.

Step 2: Acquire a tube of dielectric grease. I use Permatex 22058 Dielectric Tune-Up Grease. You use this inside your PL259 fittings when connecting the transmission line to the antenna. It's critical that you eliminate all air inside the connection between the PL-259 and the SO-239 which is usually the point of connection between the coax and the antenna. Where there is air there is moisture, where there is moisture there will be corrosion. The dielectric grease will fill the airspaces at the junction of the PL-259 and the SO-239. This will prevent rust and corrosion from forming inside the connector.

Figure 1: A PL259 on the left and SO239 on the Right

Step 3: If you are assembling an antenna with aluminum tubing that slides together you will also want to purchase a can of *Jet-Lube SS-30 Pure Copper Anti-Seize*. You use this on the end of the elements where they slide together. This will keep the water from corroding the elements connection points and will make it easier to disassemble the antenna in the future. This will insure a solid metal to metal connection that won't corrode. I will also overlay the joint with a layer or two of self-fusing tape, especially on verticals.

Step 4: Acquire a tube of LocTite thread locker. Use this on all bolts and screws to prevent them from coming lose over time. Antennas experience a lot of movement and vibration as well as temperature variations. All of this movement and expansion and contraction will cause nuts and screws to loosen over time. If that six element beam is sitting 120' in the air and a single bolt comes loose it can be a bit of a project to fix it, that also goes for the 3 element version at 40 feet. In extreme cases if left unattended it can weaken the antenna to the point of failure.

On a personal note I prefer to use aluminum rivets in place of bolts and screws for assembling aluminum tubing in antennas where aluminum tubing is used. I've never heard of one coming loose that was secured by rivets and if you're not sure you can pop in a couple of extra rivets to make sure the holes don't elongate or come loose over time. For aluminum tubing less than 2" in diameter I use rivets that have an 1/8 hole size and are ¼ long. For larger tubing, 2" and up, I use 3/16 rivets. I've never had an element come loose. In fairness I should mention the down side. If you ever have to disassemble the antenna you will need to drill the rivets out. Although to be honest I've never found that to be an issue.

Step Five: Anti-oxidant Compound: Some antenna are connected to the transmission line without using the conventional SO239 connector. They are instead connect directly to a modified feed line that has had lugs or terminals soldered directly to the center conductor and shield. The Butternut vertical antenna is just such an antenna. Many Yagi antenna usually have wires with soldered lugs connecting the matching section to the driven element. And if you are using a vertical there is the connection point between the radials and the antenna. These connection points are usually not protected from the weather so being proactive in preventing corrosion is critical.

I recommend the use of an anti-oxidant compound on the exposed terminals. Using the compound will help to stop the corrosion that always forms at the exposed connection points. If you take apart a connection that has been not been properly treated you will notice a white powder has formed at the connection point. That is corrosion, the same kind of corrosion you sometimes see on battery terminals in your brothers Trans-Camaro. It is also recommended that where feasible these connection points be inspected yearly for corrosion and a reapplication of anti-oxidant compound.

Now that you have required these necessary items it's time to move forward and build that antenna.

Building Antenna Systems – Some Best Practices: Use the best coaxial you can afford. If it's HF (30 mHz and below) most of the RG8 on the market today will work fine. If the cable is used or its history is unknown make sure it's healthy cable. Look over every inch of it. Is the jacket cracked from sun rot or cut or chafed? Has it been kinked? When you peal back the jacket is the copper jacket bright and shinny? If the jacket is silver is there any discoloration from corrosion? Discoloration of the copper or silver shielding indicates that water has wicked into the cable, if this is the case it's time to retire the cable. Has the PL259's been properly installed? If you're not sure, cut them off and put a new set on

yourself. The ARRL Antenna handbook has a whole section on soldering on PL-259 connectors. If you don't feel comfortable doing it yourself ask one of your ham buddies, most of us are happy to help.

Given how inexpensive Antenna analyzers have become more hams now own one. It only takes a minute to check a length of coax with an analyzer. If you don't have one ask one of your ham friends. We are always looking for an excuse to break out our analyzers.

If you're installing a VHF/UHF antenna the cable you use is a critical consideration, especially if the cable run is more than 30' or so. Line loss from using cheap cable or the wrong cable can play havoc with your ability to hear or to be heard. I strongly recommend that you not use RG8X or RG58 for runs longer than 25' or more. For runs over 30' the line loss can be a problem. Instead use RG8 or RG213. Paying a little extra for good cable is worth it in the long run, especially when it comes VHF/UHF frequencies.

Final Checks: When you assemble the antenna did you double measure? Did you read **all** of the instructions? Did you put some sort of a corrosion blocker on the elements where they slide together? When you connected the cable to the antenna or balun did you fill the connector with dielectric grease before screwing it onto the SO239? Once you attached the cable did you clean off the excess grease from the connection and then wrap the connection with self-sealing tape? Did you use thread locker on all the nuts, bolts, and screws? Did you apply anti-corrosion compound on all exposed connection points?

Figure 2: Using Dielectric grease, self-fusing tape, and anti-oxidant compound

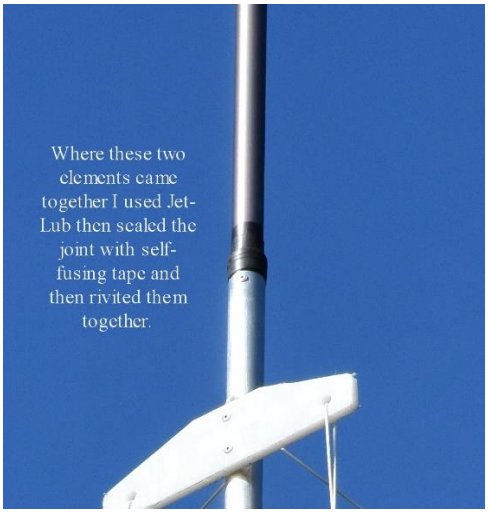

Figure 3: Joining antenna elements together

If you followed these recommendations your system should work as promised for a very long time. I have taken down antenna systems that have been up for over ten years and the connections looked as good as the day I installed the antenna.

Now that you have installed the system and optimized the installation it's now time to put your station on the air. Nearly always the first measure we take of our antenna is an SWR reading. We should take a moment and talk about that. Let me peak your interest and tell you there are a lot of misconceptions about SWR. Let me also hint at something which is one of the biggest misconceptions about SWR. Regardless of SWR, **ALL** the power that you send to the antenna, including the reflected power, is radiated except the power that is lost through heat and attenuation in the transmission line. Hopefully that has peaked your interest.

SWR?: Most hams place a lot of importance on having a low SWR, typically something under 1.5:1. They seem to equate it to antenna performance. Be careful, SWR is not a key indicator of antenna performance. For many antenna's, the G5RV for example, if you look at the SWR on the feed line between the output jack on the antenna tuner and the antenna feed point you will see the SWR can be very high, yet these antenna work well. The same can be said for long wire antenna as well as a host of end feed and OCF antenna, they all seem to work in spite of high SWR readings on the transmission line beyond the antenna tuner. Good performance with these high impedance antenna is possible due the ability of our antenna tuners to provide a conjugate match to the antenna system. You will also note that dummy loads have a very low SWR but make poor antenna.

There have been many books and articles written on the subject of SWR (aka VSWR), perhaps the best one, IMHO, is "*Reflections III Transmission Lines & Antennas*" by Walter Maxwell W2DU. I'm not going to attempt to take on the subject here. Instead I'm going to recommend you watch the following short YouTube video titled: "*SWR Explained*" https://www.youtube.com/watch?v=w1eE13UXAKs. Another much better but much longer video on SWR and related items is called "*Standing Up for Standing Waves*", https://www.youtube.com/watch?v=oejsHzurzv4. After watching either of these videos you will have a much better understanding of SWR and hopefully you will be able to put the subject of SWR

into its proper perspective. You will also have a better understanding of why using a low loss transmission line is so important. If you want a much deeper and more technical and expansive explanation I recommend you read Walter Maxwell's book. It's one of the best and most understandable books on the topic of SWR. I clears up a lot of misconceptions regarding SWR.

Summary: Our antenna systems are always a compromise of constraints and as such it's important that we optimize our installations especially if the optimization is easy and inexpensive. Taking steps to prevent corrosion is one of the little things we can do. Using good coaxial cable is another. Of course there are those optimization that take a lot more work and sometimes money. In those situations one has to ask, is the effort worth the reward? Will adding two more radials really make a difference in S-Meter reading on the far end of your signal? Will an extra 3' of elevation on that beam really make a difference in S-meter readings three states away? Sometimes the answer is easy, sometimes not so much.

I hope the information I have provided will be helpful as you contemplate your next antenna installation. Or if you are having issues with your current system perhaps this article will provide you with some specific areas to investigate. If you hear me on the air know that I'm always happy to talk about antenna, they are one of my favorite subjects.

73,

Gene (WB7RLX)