Good Advice From the Field:
20 Steps to Take Control of Your Wireless Transmission Line
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The cables, connectors and accessories that make up your wireless transmission line are fully exposed to harsh environments, often in difficult-to-service locations. Twenty relatively easy practices can help ensure that you get the highest performance from your wireless network, These on-site practices concern the RF transmission line that connects your antennas to your base station equipment.

1. Select cable to maximize performance.
Pick the largest cable diameter you can afford. You can use the extra safety margin in signal attenuation. Many system designers just meet their dB budget and don't consider all of the devices in the RF path and other problems that might occur in the field.

If possible, stick with one feeder-cable size for all sites. Simplification pays off in many ways. Take into account the insertion and return loss of all devices between the radio and the antenna. Make sure the cable is rated for your application, whether it be indoor (plenum, riser, CATV, etc.) or outdoor (UV protected, temperature range, harsh environments).

2. Use the largest, most rugged interface.
Use the interface with the largest diameter you can get. For cable with a ½-inch and larger diameter use a DIN interface. For ½-inch and smaller, the N style is very good. TNCs are also used in this range, but have a lower torque specification. SMAs are used for ¼-inch in-cabinet applications.

The connector must be able to handle the mechanical forces of the cable. Large-diameter cables can produce many forces on the connector and therefore on the interface. Excessive movement due to wind and vibration is also a reason to choose a large interface to withstand the environmental forces.

In addition, going from a large-diameter cable to a small-diameter connector interfaces taxes the RF return and insertion loss performance. Even if the impedances stay the same, diameter changes disrupt the electromagnetic fields. Try not to step the dimensions up and down between the radio and antenna as much as possible.

3. Use a common, simple interface scheme to keep commonality of parts and reduce confusion.
As a nice rule of thumb, feeder cables use female connectors and jumper cables use male. Of course, antennas, radios, surge arrestors and almost all other discrete RF devices are female. Using this "polarizing" scheme keeps things straight and simple, especially if a site must be visited at difficult hours of the day.

4. Carefully inspect your cable for good quality and condition.
Run your hand along the length of cable, feeling for irregularities in the jacket. It should be smooth and consistent. If you feel bumps, kinks or anything inconsistent, it is highly likely that something is wrong underneath, either mechanically or electrically.

If possible, don't use that section of cable. Once your connector is on the cable, you have committed to that cable as part of your transmission system. When in doubt, cut and move on.

5. Look for any sign of water or moisture damage before you connectorize.
Water or even moisture is the worst thing you can have near your RF signals when they travel through your cable and connector, your transmission line.

Before you put your connectors on is the best time to check for anything that might lead you to believe that the interior of the cable has been exposed to water or moisture. Cables get left exposed to the environment with ends bare.

Cable is a natural water wick with the braids, tapes, and foam dielectric. Once moisture is trapped it will migrate as far as it can.

If water is dripping out of the end of your cable then that length is permanently damaged. Don't use it.

Look for signs of corrosion on the center conductor and braid. Cut back until you see fresh undamaged metal

6. Prep with tools, not bare-handed with a knife.
A connector needs exact dimensions to work. There is too much to risk with a wrong dimension. Most manufacturers of connectors have recommended tools. Use them. It is the best way to ensure you will get good performance.

This is the one thing you can control in the field, so go ahead and control it.

Tools should be self explanatory and intuitive to use. Practice a few time to make sure it feels right and consistent

Most problems with a bad connectorization can be chased back to the original prep work. Measure twice and cut once.

7. Make clean 90-degree cuts and preps on the cable.
After you have prepped the cable give it a good look. All cuts and landings should be at 90 degrees to each other and be symmetrical 360 degrees. If it's at a slant or irregular then you will likely have a problem when you put the connector on.

If it does not look 90 degrees and consistent around then do it again. Most likely your first cut on the cable was not straight. Start over.

Make the attachment to the inner conductor, outer conductor and jacket to last for life.

8. Remove any adhesive on the center conductor.
Coaxial cables are made with an adhesive to bond the dielectric core to the center conductor. This also helps to prevent water from wicking up the end of cable and down it.

Make sure this adhesive is off the end of the center conductor before you put connector on. This is a non-conductive material and could get left on as it is typically clear and hard to see. Look for it and remove it with your fingers or something non-metallic.

9. Make sure that no damage has exposed the center conductor.
The center conductor of the cable end you have prepped is typically some type of copper-clad metal. With aluminum or steel underneath. Make sure there are no damaged or nicked sections along the short end of the prep exposing the base metal. These are dissimilar metals and can accelerate galvanic corrosion if exposed to water and electrolyte.

10. Don't use solder in the field.
Soldering and field conditions do not go well together. Soldering needs very controlled environments to go well. Too much is left to chance.

Soldering made sense a long time ago when you had to essentially build a connection from scratch. It's really only good in lab or factory conditions.

Plus connectors have come a long way in terms of captivated center pins with very high contact forces.

The other thing that is risky about soldering is that you leave the final location of the pin up to chance and then leave for doubt what the return loss will be. Especially at higher frequencies.

11. Check for high insertion forces on the center conductor.
This does not mean to leave it all up to the connector. You can do a simple check by making a "stinger" with an extra-long exposed center conductor. Check to see how hard the back of your connector grips the center conductor. You should feel the grip and release.

If the connector uses an actuating radial compression to get the connection to the center conductor, these connections are usually very strong. Check the strength of the connection by tightening the connector to itself without the cable on. See how much center seizing sizes down on itself.

Or, another trick, tighten the connector without the outer conductor of the cable, using just the center stinger. Tighten the connector all the way to itself and see how hard it is to pull the stinger out.

Either way, get a good gut feeling as to how tightly the center seizing is on the center conductor of the cable. This connection is the most critical. It is where the RF currents are the most concentrated and changes have the biggest impact on your performance.

Once you put on the connector, there is no good way to check the center attachment. The more you can understand up front the better off you will be.

12. Don’t crimp. Use another style of axial compression technology.
Crimping is an out-of-date and misapplied practice for RF coaxial connectors, especially at higher frequencies and outdoor applications.

Any RF connector you are using should employ an axial compression-and-hold mechanism. Old-style radial crimp tools distort both the electrical and mechanical dimensions. Electrically, it can change your impedance and allow for RF leakage. Mechanically, it creates gaps for water to ingress and weakens your connection.

A solid, robust, long-lasting, and electrically clean axial compression can be achieved with a compression tool technology or simply a threaded nut-and-bolt type of joint, commonly available in most medium-to-large connectors.

If you see any metallic braid ends sticking out from the back of your connector (not uncommon) after assembly, these should be eliminated. These braid ends will be a path for water ingress into the cable or connector. I recommend redoing your connection.

14. Perform a tug, pull, and twist test.
After you have installed your connector, grab it in one hand and the cable in your other; see if you can twist off the connector. If you can or if you feel uneasy, you do not have a solid connection.

Normal hand strength should not be able to overcome the mechanical strength of a medium to large diameter cable (3/8” and up). If the connector comes off or feels loose, you never had a good attachment in the first place.

15. Test for rock-solid electrical sweeps.
After you have done all the above on all of your connectors, you can be pretty sure that you will have excellent, stable return loss and insertion loss sweeps.

But test it out. After the sweep, by hand, slowly move one of the cable connector joints around. See if the trace jumps. Put a stress on the joint. If you see more than 1-2 dB of change in the plots, you probably did something wrong, a connector is bad or something else is loose. Line return loss and insertion loss should not change with a good rugged connection.

16. Check your ports for quality and cleanliness.
When all connectors are on and all cables are terminated into the transmission line, you are ready to hook everything together via your field-made transmission line: radio to surge to antenna. As a final check before you close up your system, electrically check your connector ports on all your components. Make sure they look solid and clean, with no chips or damage to the interface and with gaskets on all the male connectors. To start, make the connection finger tight.

17. Torque to the specification of the connector manufacturers.

Interfaces are designed to be set to a specified torque. Don't exceed it or you could break the connector or bow or split the inner contacts, causing damage and electrical problems.

18. Keep weather out from day one.
When moisture gets in your cable, connector, or any device for that matter, it stays in after you seal it up. Keep your cable ends dry both before you install the cable and after it is routed. Keep it dry before you put the connector on and afterwards too. Weatherproof with the technique and products that you are comfortable with.

19. Check factory-made jumpers as well.

Factory-made jumpers with pre-attached connectors should be put through the same paces. Know how the connectors were attached at the factory. Colder solder joints are always a possibility.

Do the tug/twist/pull test. Purchased jumpers should be just as solid as if you assembled them. You should be just as critical. Sweep test before installing. Check the interfaces for gaskets and cleanliness. Keep them dry with end caps before your final assembly and then be sure they are weatherproofed when you are done.

20. Install adequate grounding and hangers.
Cable runs, at a minimum, should be grounded at the antenna, at the base of the tower and before they enter the equipment area. Use standard manufacturer-recommended grounding kits and weatherproofing. Hangers should be used, even in a rooftop application, to keep cables from moving around excessively.

Finally….your bottom line.
Make sure you have been thorough and critical in the installation of your transmission line system. It's the one RF section of your network that you have some control over. If you find anything wrong or even questionable, I strongly urge you to stop, fix it, and send the suspected product back to the manufacturer with a note. Once you seal up your line, you are stuck with what you have. You deserve the best possible performance for a lifetime. This is especially critical today when frequencies are going up—data rates too—and there's more and more traffic on the line.

Taking care up front will save you many dollars over the life of your network. Taking care up front gives you a chance to directly impact the reliability and performance of your entire system.