The Amateur in You, Part 1

What have you been pondering?

Antenna installation considerations (properties and features)

Before we install an outdoor or rooftop antenna, we do our best to think of everything necessary to optimize the benefits of perhaps our most important station component. Still, one or more antenna concerns occasionally evade us until the fix becomes more hassle than it's worth. I'm hoping this expanded checklist might provide you with some reminders during your installation, to help you avoid the mistakes I've had to learn from.

While some of these ideas apply to HTs (handheld transceivers) and mobile solutions, they're primarily focused on a fixed home installation. And since every residence is different, you might need to use your imagination or a good elmer to help you tailor some of them to your own living quarters.

Domestic support

Before committing to any sort of amateur radio antenna installation, be sure to secure the approval of your spouse or significant other who shares your living space. Maintaining a good family relationship is more important than any hobby concern, and failure to prioritize your spouse over your craft will often result in a less-than-pleasant outcome.

Some amateurs face the prospect of incurring the potential wrath of their HOA (home owner association) if they install an antenna on a house within theirs. Unsure how the HOA might react, some will approach their leadership for permission or guidance to proceed, only to be met with resistance due to a supposed cosmetic violation imposed by such an addition. Often, it's simply better to use good judgment and install the antenna, then take it down only if it's discovered, because most HOAs honestly won't care about your antenna until they're forced to answer your question.

Also, being sensitive to the feelings of your neighbors about an antenna that might obstruct a picturesque view or potentially reduce their property value can go a long way toward avoiding an unpleasant confrontation. Instead of approaching them directly about it, however, simply engage your neighbor in casual conversation, then just happen to bring up the prospect of an antenna installation, while listening carefully to their responses.

Aesthetic compromise

If your spouse and neighbor seem to approve of your aerial intentions, return the favor by not going overboard with your project. Prefer to install your antenna in the rear of your house instead of facing the street. Often, a vertical antenna will appear less intrusive than a long wire. And if a vertical is in your plans, keep radials to a minimum.

If the goal is a compromise between performance and aesthetics; your effort to erect a pleasing installation might result in reduced signal output, for example, but might be the best course of action overall. This could therefore place a Yagi, a hex beam, or a cubicle quad out of the question.

Feed line

For most hams, the ***feed line*** is coaxial cable (coax), and typically ***RG-8X*** or ***LMR-400***, depending on the band(s) it needs to carry. Once you've considered what type (model, size) of feed line to install, often the biggest problem is how to route the cable into your home. I recommend against propping open a door or window for it, because temporarily that can damage the cable by repeated pinching, and permanently it can invite little creatures such as insects and rodents inside.

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Open-wire line, ladder-line, window line, and twin-lead exhibit probably the lowest loss of any feed line. Still, I encourage you to avoid those feed line types unless 1) your total anticipated feed line length is more than 150 feet and 2) you understand well how to work with those feed line types. For one thing, they cannot come near metal like coax can, due to unwanted coupling. For another, they require a special ("balanced") type of tuner. Yet another, they are much more prone to picking up noise because they lack shielding.

It's often difficult to guesstimate the length of coax you'll need just by looking, even if you're adding up tape measure stretches. One accurate way to measure your coax need is to tape actual coax in place around the actual location you plan to run it. That can get a bit time-consuming, but if accuracy is what you need, that might be your best method. Afterwards, however, be sure to add about six loops of eight inches times π, or about 12½ feet, to the length, for an RF choke.

You'll need at least two runs of coax, one from the antenna to the surge suppressor (lightning arrester) on the ground rod, and the other from the surge suppressor to your shack. Be sure the one between your antenna and the surge suppressor includes enough for the RF choke.

As you're routing the coax, be sure to avoid sharp bends, which can cause the dielectric to get pinched, resulting in impedance bumps, and therefore unwanted signal reflections. Where you need to get around corners, attack the edges at an angle, instead of straight-on. Make every effort to avoid nicking or scratching the jacket. If possible, avoid exposing coax to animals that will chew on it. You can purchase rodent-repellant coax, whose jackets are distasteful to animals such as rodents and raccoons. If you choose to bury the coax, be sure to purchase the DB (direct-burial) type.

Feed point impedance

One of the most important antenna considerations is feed point impedance, meaning measured where the feed line meets the antenna or its matching section. The easiest way to measure the feed point impedance is by an antenna analyzer. Using one, you're looking for the lowest SWR your antenna can offer, typically under 2.0:1 or less across the band of choice.

Measure the antenna feed point impedance right where the coax meets the antenna, not back at the transceiver. If you measure the antenna impedance at the transceiver, the coax loss can make the antenna SWR seem lower than it really is. Therefore, if your coax is relatively long, the SWR reading provided by your transceiver can be unreliable.

If the SWR for your antenna is too high, you can bring it down to workable levels by a permanently installed matching section, a balun, or a tuner. A (beta, gamma, pi, etc.) matching section is more practical for VHF or UHF antennas, due to the wavelengths in question. A balun (impedance transformer) is more useful where a large impedance transformation (4:1, 9:1, 49:1, etc.) is necessary, and a tuner is more useful if the transformed impedance exhibits an SWR of around 3.0:1 or lower.

Grounding

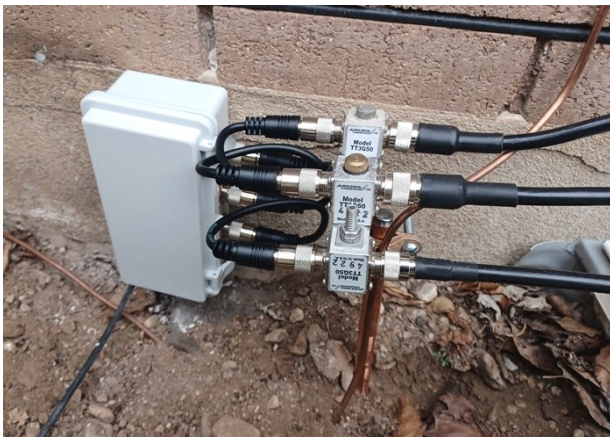
You must ground your outdoor antenna, not for performance, but for safety. If grounding your antenna seems to solve a performance issue, you've got an antenna problem that's being masked by your grounding. By ***performance*** I'm referring to feed point impedance, efficiency, pattern, noise, and bandwidth; essentially, how effectively it works.

Ground your outdoor antenna 1) from its ground conductor by ground wire to a ground rod, and 2) from its ground conductor by the coax shield to a surge suppressor.

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Once you install your ground rod in the dirt just outside your shack, install a ground clamp and a surge suppressor onto the ground rod. Connect a length of bare solid 4 AWG wire between the base of the antenna mast and a ground clamp on the ground rod, making as few bends as possible. Then, form the RF choke from the coax, connect it to your antenna on one end, and to one side of the surge suppressor on the other.



Feel free to run the 4 AWG bare ground wire from the antenna ***alongside the coax*** from the antenna, and even tie them together. A little outside the scope of this discussion, but be sure to run another length of 4 AWG solid bare wire from your ground rod to the ground of your home service box if possible.

Height

Unless you're installing a ground-mounted vertical antenna, the height of your antenna over ground is important. If your horizontal wire antenna is lower than a quarter-wavelength off the ground, your antenna pattern will likely be omnidirectional. If it's less than a half-wavelength off the ground, it's a little more directional, but meant more for NVIS (state-wide and national contacting) than DX (international).

The height of a vertical antenna is typically measured from its lowest point over ground, not its highest point. The height of a horizontal wire antenna is typically the average between its lowest point and its highest point, especially for a sloper or inverted-V.

Radials and counterpoise

Most of these height qualifications apply to vertical antennas, as long as they are counterpoised, which turns them into a vertical dipole. A counterpoise is simply the missing portion of your antenna if it was a dipole. Many good operators have reported success without using radials, for which I would say that 1) they are lucky, and 2) they might not realize what they're missing.

Radials are important for vertical antennas because they serve as a counter-balance to its vertical radiator. You'll also need to install a counterpoise wire for an end-fed HF antenna, because such an antenna acts like a vertical radiator that's laying sideways.

Conductive proximity

While for performance it doesn't really matter where you string your coax, where you mount your antenna can matter a great deal. Avoid installing it near metallic items, such as gutters, siding, stucco, or a metal shed. Keep your VHF antenna at least eighteen inches from another antenna, and keep your HF antenna at least eight feet from another antenna. Installing on a metal roof should not be a problem.

Locate your overhead power lines, and keep your antenna at least twenty feet from them, even if your power lines are insulated. And that's just for shock safety. For performance (noise, power line hum), first listen for noise using a portable HF radio and antenna near the proposed antenna location. Move your portable unit around to find sweet spots that are the least affected by the noise, then repeat that for another band.

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Terrain

If your property is a floor higher on one side than another, that sloping land will likely affect your antenna pattern by favoring a downhill direction. This means the opposite uphill direction will just as likely become compromised, possibly preventing some contacts from the uphill direction. Although by no means certain, mounting your antenna higher or using a Yagi beam are possible ways of counteracting such a hill.

Mountains a couple of miles away are not likely to affect your performance unless the tops are greater than, say, thirty degrees above flat ground at your house.

Obstructions

Installing an antenna on a house surrounded by a forest will have little effect on most amateur radio frequencies. Being surrounded by numerous trees will affect VHF much more than they will HF, primarily due to the frequency, but also because of the takeoff angle, which for VHF is nearly horizontal. There will be alight increase in signal attenuation when the trees are wet or snow-packed, but not significantly.

Nearby buildings, large vehicles, and other obstructions will likely affect antenna performance more than trees will. Overcoming these obstacles requires *aperture*, or the amount of surface area the antenna is facing unobstructed. For example, its aperture inside a house is often limited to the window size, while for nearby structures it's limited to the space between the buildings, especially if your neighbor uses stucco.

Mounting hardware

Decide whether you plan to install a rooftop mast using an eave mount or a tripod, or maybe some other method. When installing a tripod, be sure to place roofing pads under the feet to prevent water damage to your roof. Be sure to use lag screws to secure the tripod to the roof, three to each foot. They should be long enough to penetrate the tripod foot, shingles, paper, and plywood, at least 1½˝ for most roofs.

Many people prefer using trees to mount their wire antennas, but I discourage that practice for several reasons. Trees grow, both upward and in thickness, and in time that can both strain your antenna and swallow it. The antenna can also easily work its way loose after repeated wind storms. Some operators use a set of pulleys and weights to work around tree issues, as long as you use UV-resistant rope.

Depending on its height and wind load, your vertical antenna or vertical mast might be tall enough to require guying. In other words, ropes or wires that stabilize the vertical item to prevent it from falling over and potentially damaging your house.

Weather-proofing

You can apply dielectric grease to ensure a good, waterproof connection for all coax connectors that are exposed to the weather, but be sure to also seal them with silicone self-fusing tape. I recommend against sealant paste or electrical tape, because they both can result in a gooey mess if you ever need to remove the connector (more often than most will admit), and electrical tape requires skill to prevent it from coming apart.

Keep in mind when weatherproofing by conduit or piping, that pipes invite two things, no matter how well you seal the pipe: insects and water. There are good resources that can help you seal up your pipes effectively, but be prepared to clean them out in the future anyway.

Final inspection

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You might have used a level to ensure a horizontally flat or vertical mast, mount, or other antenna part, but nothing beats a visual inspection. Does it look straight to you from a couple dozen feet away? Does it look straight to your spouse?

The three rules of amateur radio are ***test***, ***test***, and ***test***. First test is to analyze your antenna alone by connecting your antenna analyzer as close as possible to your antenna feed point. Make sure the SWR bandwidth looks acceptable for each band you want your antenna to support. This means that the entire portion of the curve on your analyzer that measures SWR 2.0:1 or less fits within the expected antenna bandwidth.

Second test is to make some contacts, first on repeaters, then by simplex for a VHF antenna, or with some distant POTA activator for an HF antenna. Request an honest signal report (please not a "radio check" because your radio will likely be working properly). Call a friend on the phone, ask him or her to get on HF and give you a report. Keep in mind that your location might not be ideal for your friend due to a number of reasons.

Third test, as required by the FCC, you must perform an emissions evaluation on your station and antenna for each band you want to support, both at the controlled and uncontrolled proximity. Record those measurements and post them on your website, your QRZ page, or other publicly available spot.

Coming full circle, be sure that your masterpiece looks pleasing, or at least acceptable, to your spouse, as mentioned at the start of this article. If it doesn't, you'll need to swallow your pride and either adjust your antenna and feed line to his or her pleasing, or take it down. Attempts at bribery, flattery, tradeoff (compromise), or other kinds of manipulation will not likely produce a favorable marital outcome, and is not supported by this author.



Summary

Wow, so many things to be aware of! On the surface, antennas seem pretty innocent, but when you set out to install one outside your house, little concerns begin to emerge. This list allows you to address potential antenna and mounting concerns before they become problems.

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