HF Noise!

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So now you have finally got your new HF rig figured out. You have managed to install an antenna that is providing you with good signal reports from distant locations. The problem you have now is it seems like other stations are able to hear stations that are buried in noise in your receiver. In fact, now that you pay attention to it, the noise coming out of your radio's speaker is often not a soft hiss. It is a raspy hash that, by comparison, would make a flatulent water buffalo seem melodic.

The old saw is "If you can't hear 'em, you can't work 'em." Noise on radio receivers is a fact of life. The best we can do is minimize it. That, of course, is your next great challenge in HF operation. From the simplest perspective, there are four different kinds of things making up the noise you hear:

- **Internal receiver noise**
- **External natural noise**
- **External man-made noise**
- **Interfering transmitters**

I'll cover each in paragraphs below. As you might expect, a single presentation like this cannot provide a thorough coverage of the subject of noise. What I can do, hopefully, is to give you enough information to get started solving any noise problems you are having.

Be aware, though, that many of us live and must operate our stations in noisy residential neighborhoods. It may be impossible to obtain quiet radio conditions for HF operation at your present home location. That is a problem faced by most hams operating HF these days so you can take some comfort in knowing you are not the only one fighting it.

Internal Receiver Noise

All HF radio receivers these days have sufficient RF signal gain (amplification) that they can drive their speakers to nearly full volume with their own inherent internal noise. This noise is noticeable as a broad, smooth hiss. That a receiver can do this is not necessarily bad. It just means that you can be assured that you will most certainly hear any radio signals coming in on the antenna connection that is stronger than this internal noise.

Fortunately the receivers in our modern transceivers have sufficiently low internal noise levels that that is seldom the limiting factor in hearing weak signal below 30 MHz. You will normally hear a noticeable increase in the noise level coming from your transceiver's speaker whenever a good outside antenna is connected to it.

Why am I bothering to mention internal receiver noise if it is not a problem? A new ham might mistakenly believe that adding an external preamplifier will help receive signals buried in noise. In most cases, an external preamplifier will degrade receiver performance on the HF and MF ham bands.

External Natural Noise

There are many sources of natural external radio noise. The stars in the sky, including our sun, create a background radio hiss. All sorts of weather conditions create radio noise. Lightning is an obvious noise source. Other lower energy electrical activity such as corona and static discharge add to the natural background radio noise level.

Natural radio noise tends to be stronger at lower frequencies than at higher. The 160 meter band can be nearly useless on summer nights due to thunderstorms. On the other hand, 10 meters can be relatively free of noise under the same weather conditions.

Thunderstorms are a major pain in the butt, radio noise wise. The radio noise produced by lightning and other atmospheric sources propagates via Ionospheric reflection just as well as our own transmitted signals. Thunderstorms hundreds, and even thousands of miles away can be heard when Ionospheric conditions would allow ham transmitters to be heard from the same areas.

External Man-Made Noise

Human activities generate radio noise. In general, anything involving electric power or electronics is a potential radio noise source. Electrical motors with commutator brushes such as vacuum cleaners, and kitchen blenders and mixers are especially bad about creating radio noise. Even things we might not expect to produce radio noise, such as fish tank heaters or doorbell transformers, have occasionally been discovered producing noise that blocked radio reception for hundreds of feet around them.

Lately, a new source of man-made noise has been showing up. In an effort to reduce overall electric power consumption throughout the world, electronic equipment manufacturers are being required to change the AC power supplies in their equipment to use switching technology. Switching power supplies are prolific radio noise generators unless excellent shielding and filtering is used. It is likely that some portion of those switching power supplies, especially in cheap consumer electronic equipment, will leak RF noise.

Personal computers and their accessories are notorious radio noise generators. They typically contain switching power supplies, high-speed digital switching circuitry, and unshielded electrical cables. Noise level's generated by this equipment varies from manufacturer to manufacturer and model to model. Some equipment is nearly noise free while others of the same kind can blanket the HF radio spectrum with strong hashy noise and birdies.

Aboveground power lines are a major problem. We often have little choice but to live next to them. While some newer housing developments have their electrical supply service run underground, most of us receive our power from aboveground power distribution lines. Minimizing noise pickup from power lines requires that we install our antennas as far from them as practical. Even a few additional feet can make a difference.

Power line noise comes from two different kinds of sources. Appliances and electrical equipment at other locations generate electrical noise that is transported along the power company transmission lines. Notice the name "transmission lines". They operate as transmission lines for 60 Hz AC power in the same way that our coax and open wire transmission lines operate to carry RF energy to and from our antennas. Unfortunately, power company transmission lines are very leaky at ham RF frequencies so any electrical noise introduced onto them eventually radiates to be picked up by our antennas.

The second kind of noise conducted along and radiated by utility power lines is that created by the transmission line equipment. Loose pole top hardware is the most significant problem. In spite of ham and CB folklore, power line transformers are very seldom a significant noise source. The electrostatic fields around the high voltage power lines is sufficient to cause arcing across corrosion oxide layers between loose nuts and bolts and for that arcing to be coupled into the power lines for unwelcome delivery to your antenna. Modern power line installation hardware is designed to minimize metal-to-metal contact points and eliminate flexible joints. Even with new hardware, power line hardware generated noise is still possible. Fortunately, electric utility companies are legally responsible for eliminating power line generated radio noise.

Don't overlook the electrical wiring in your own house. Typical household electrical wiring is unshielded and runs randomly through attic and walls providing plenty of exposed length to radiate electrical noise. All those electrical and electronic appliances and gadgets we accumulate in our homes these days are noise generators.

Of course, do not forget that even if you live out in the woods, far away from power lines and other man-made noise sources, you will still receive man-made noise. As with

the case of lightning, noise from distant sources can be propagated to you via Ionospheric reflection.

Interfering Transmitters

Our last category of noise is that created by devices intentionally producing radio signals. Noise, in this case, is unintentional crap generated by other transmitters. Sometimes transmitters, through design problems or improper operation, create off frequency noise. This noise may be a broadband hiss, clicks, thumps, or voice peak splatter. Even well designed and operated transmitters produce low-level noise. No transmitter is perfect. Listening to a weak signal with a strong station on an adjacent frequency can be unpleasant.

What To Do About All This Noise?

Noise is a fact of life when operating HF radio. The trick is to recognize its source and take whatever action is necessary to minimize it or its impact. Internal receiver noise can be overcome by putting up a better antenna so more signal is being supplied to the receiver. Externally generated noise can be reduced using directional antennas and/or moving them away from potential noise sources.

Eliminating potential feedline problems should always be part of any noise elimination campaign. Loose coax shield connections will allow electrical noise from source in your house and ham shack to enter the cable and be heard on your receiver. Make sure all coax connectors are properly soldered and tightened.

There are also receiver operating techniques that can minimize the impact of noise. Internal receiver noise can sometimes be overcome to a degree by turning on a preamplifier. External low noise preamplifiers are available in case internal preamplification is inadequate. However, as mentioned above this step is very seldom needed.

Use receiver bandwidth matching the bandwidth of the signal you are attempting to hear. Wider receive bandwidth will obviously allow more noise to pass through the receiver without increasing how much of the desired signal is heard.

Reducing receiver gain by turning down the receiver's RF gain control and/or turning on its attenuators will often help minimize the impact of strong external noise. After all, you won't be able to hear signals weaker than the noise. As long as you can still hear the noise in the background, you will hear any signals that rise above the noise level. An additional benefit of reducing receiver gain is that it places noise levels further down on the receiver's automatic gain control (AGC) curve. That reduces the tendency of the AGC to try to hold both the noise and a stronger desired signal at the same audio output level.

Of course, it would be best if you can reduce the noise before it reaches your receiver. Locally generated noise can be reduced or eliminated by identifying and eliminating its source. Relocating your antenna can sometimes reduce noise from sources that cannot be silenced. Noise from distant sources can sometimes be reduced using a directional antenna.

How To Recognize Noise

How do we recognize noise and their sources? This is important if we are to figure out what to do about it. Identifying internal receiver noise in modern ham transceivers is fairly simple. It is the noise you hear when you disconnect your antenna.

Your receiver's S-Meter needle should drop to zero when you disconnect your antenna. You should, however, still be able to turn your receiver's RF gain to maximum and adjust the AF gain to hear a smooth hissing sound. That is the receiver's internal noise.

If when you reconnect an appropriate antenna to your transceiver you do not hear a significant increase in noise on any of the bands below about 20 MHz, you may have a receiver problem. Then again, you may have an antenna problem or may have encountered one of those rare times when there is very low radio noise as may occur during a large solar flare.

Above about 20 MHz, nighttime Ionospheric conditions during the bottom years of the sun spot cycle may be such that very little noise will be heard. In general, though, modern ham transceivers are sufficiently sensitive that antenna noise can be heard on any antenna that is also suitable for efficient transmission on the frequency you are listening on.

Once you determine that the noise you are hearing is arriving via your antenna feedline, the next step is to determine the source is nearby or distant. Nearby noise sources can often be reduced. Distant sources can only be reduced by making your antenna system less sensitive in the direction from which the noise is arriving. This typically means using a directional antenna.

Figuring out whether your noise source is nearby or not is usually not difficult. Check whether your S-meter drops below about S1 or S2 when the band you are listening on is supposed to be closed. That would mean daytime on 160 and 80 meters and nighttime on 20 meters and above. If the noise is still strong when a band is supposed to be quiet, your noise source is almost certainly close by.

Noise from distant sources is common on all HF bands but is especially noticeable on 160 and 80 meters. Even in very quiet rural locations where daytime noise levels on these bands is very low with the S-meter needle laying near the bottom stop all day, nighttime levels will commonly in the S5 to S7 range even without lightning storms.

Some times of the year when distant lightning storms are common, the S-meter needle may not drop below S9 unless some sort of directional antenna is used.

Noise sources can also be recognized by their individual characteristics. Lightning storms can be recognized by the crashes from lightning strokes. Power line problems will often have a strong 120Hz buzz though many nearby noise sources will have that same characteristic.

As a quick reference, consider the noise level at my rural location. My antennas are 600 feet from the nearest power line and 200 feet from any structures. Power is brought into the house and barn underground. With no lightning activity, noise level on all bands except for 160 meters leaves my receiver's S-meter at zero most of the time. It hangs at about S-1 on 160 meters during daylight hours. Nighttime, S2 to S5 readings are normal on 40, 80 and 160 meters. I have resonant dipoles for the bands below 14 MHz and a log periodic beam above. All my antennas are at about 50 feet above the ground. After 40 years of ham operation in noisy residential neighborhoods, it is a delight to operate from a quiet rural location.

Finding Nearby Noise Sources

For most ham antenna installations, the closest potential noise sources are those in the ham's house and ham shack. The simplest way to determine if the source of your noise problem is in your own home is to power your transceiver from a battery and open all the circuit breakers to your house. If the noise drops to a low level or goes away, turn breakers on one at a time until the noise returns. Find the device or appliance on that circuit and repair or replace it.

Of course, life would be easy if our noise problems always come down to locating a single faulty item and disconnecting it. What often happens with new HF station installations is that there are multiple household noise sources. These can be things such as fluorescent light fixtures, TV sets, and computer equipment. Finding and eliminating the strongest noise source will unmask the next loudest noise source, and so on.

Once you have eliminated your own household noise sources, it is time to move outside. Examine the area around your antenna. Is there a nearby power line that may be radiating noise that it has conducted from some other location? Power lines are notorious radio noise radiators.

It is often difficult to determine whether noise coming from power lines is created by the power company equipment or being introduce by equipment at a nearby customer's property. A simple method for finding the general area where a noise source is located is to carry a portable receiver through the area to find the area with the loudest noise.

If you determine that the probable noise source is at a nearby home or business, eliminating it may be difficult if you are not on friendly terms with the owner. While a home or business owner is legally responsible for eliminating radio noise that interferes with licensed radio services, knocking on a door and quoting federal law is probably not going to be well received. A better approach is to ask them if they have been experiencing radio or TV interference. They usually will be if the source is on their property. Tell them you have noticed interference so are searching for the source and noticed that the noise was loudest at their location. Explain that you are not only concerned about the noise but that there may be an appliance or other piece of equipment likely to catch fire or shock someone.

Never perform any electrical operations such as opening and closing circuit breakers on other people's home or equipment. Do not touch their electrical equipment. Most of all, do not attempt to repair anything. At most, you can offer informal advice. Touching any of their equipment could make you legally responsible for anything that goes wrong with that equipment.

Antenna Location

As mentioned above, overhead utility power lines radiate radio noise. This is an inescapable fact of life. That leads us to one important conclusion. Our antennas should be located as far away from them as practical.

Utility power line noise radiation is somewhat different from ordinary single point radio sources. RF levels from a point source decrease with the square of the distance from it. That is to say doubling the distance will decrease the level by a factor of four. It doesn't necessarily work that way with power line noise.

At HF frequencies, power lines can work like line sources. That is, the noise radiates from along the length of the power line, not from just one point along the line. The square of the distance rule does not apply to line sources. RF levels drop of in proportion to the distance. Doubling the distance from the power line may reduce noise levels by only a factor of two, not four. Distance from utility power lines is obviously important.

After utility power lines in importance comes homes and other structures containing electrical and electronic equipment. First, of course, is the problem that the electrical wiring in the house will, to a degree, radiate RF noise conducted in from the utility power distribution lines. Second, the electronic and electrical devices connected to the power lines can radiate RF noise directly or by conduction via their power cords to the AC wiring.

How far do you need to place your antenna from power lines and structures? That of course depends upon how noisy they are to start with. For typical situations where no exceptional noise sources are operating, 100 yards from overhead power lines and 100 feet from other structures is probably plenty. Greater distances will probably make no noticeable difference. Most of us get by just fine with much shorter distances.

Antenna height can be another important factor. Higher antennas can be farther away from household wiring and electronics than lower antennas. Higher antennas will sometimes provide stronger signal levels on desired signals than lower antennas.

Those of us who live in neighborhoods with underground utilities and newer homes usually experience relatively few noise problems. There are obviously no overhead power lines to radiate RF noise. Newer homes tend to have newer, quieter electrically, appliances and electronics. It is yet to be seen though what the impact of "wall-wart" switching power supplies will have though.

Antenna Type

What type of antenna you use can make a difference. Vertical antennas tend to be more sensitive to local man-made noise. Man-made noise, like other RF, will conduct along the surface of the ground via vertically polarized ground-wave propagation. Vertical antennas also tend to be omni-directional, able to receive noise from all directions.

Horizontally polarized antennas tend to be quieter than vertical antennas as they are cross-polarized to vertically polarized ground-wave propagated radio noise. They are also typically mounted higher above the ground than HF vertical antennas thus potentially locating them further away from noise sources.

The issue of noise pickup on vertical versus horizontal antennas is not cut and dried. Vertical antennas typically have an overhead null in their radiation patterns. Lightning storm noise from storms within a few hundred miles arrives at high angles above the horizon. Lightning noise from nearby storms can sometimes be significantly lower on a vertical antenna. Also, horizontal antennas are not cross-polarized to noise radiated by nearby utility power lines.

Whether horizontally or vertically polarized, directional antennas can have an advantage over non-directional antennas. A directional antenna aimed in such a way as to favor a desired signal over a noise source can provide an improved signal-to-noise ratio.

There are many types of directional antennas, of both vertical and horizontal polarization. Most HF directional and beam antennas have very wide forward gain beam widths. They usually have narrow and deep side or back nulls that may be aimed to reduce interfering noise level without badly reducing a desired signal level.

It's A Fact Of Life

As you may have realized as you read the above paragraphs, finding and eliminating radio noise sources can be difficult. Do not hesitate to request help from other hams. Specialized equipment and techniques are sometimes needed. There are no magic bullets for curing HF radio noise problems.

For most of us, tracking down and silencing noise sources is an on-going effort. Don't get too discouraged though. Many of us are able to set up stations and operate from new locations with only minor noise problems. Even when we encounter a serious noise problem at a new location, a few days of investigation will usually turn up the source of the problem, allowing it to be eliminated. After the initial noise elimination effort, new noise sources may be noticed but are usually infrequent enough that our enjoyment of ham radio is not seriously impacted.

Those of us living in residential neighborhoods will never experience a complete absence of locally generated RF noise. That has not prevented to successful HF radio operation except in a very few unique cases. Of course, there are those who are fortunate and live in rural locations with very little local man-made noise.

Even with no local man-made noise sources, radio noise is never completely eliminated. Distant man-made noise sources are still received. Think of it as the sound of millions of bar blenders mixing Margaritas plus millions of vacuum cleaners running, each radiating RF noise.

The combination of local and distant man-made radio noise and local and distant natural radio noise is what we fight when we are trying to communicate with each other on the ham bands. The trick is to eliminate as much of it as we can. The rest we simply must live with.