

Considerations for Amateur Radio Repeaters

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There are a number of issues that can be overlooked by one who proposes to install a "ham" repeater. This article will address a few of the notable ones from the top down.

Arguably the most important factor that determines a repeater's usefulness is the location and quality of its antenna system. While it is obvious that in most cases the antenna should be located as high as possible, be sure that the tower or mast will be able to withstand the effects of adverse weather. If your installation is done on a clear summer day, it is easy to forget that your antenna and its supporting structure must survive winter winds that may be accompanied by an inch or more of ice on the entire assembly. Most of the well-known makers of land mobile antennas offer a model suitable for amateur use, at an (unfortunately) similar price. Since the spring thunderstorm season will bring winds of sometimes-phenomenal velocity as well, masts and mounting hardware should be of a quality that will not give you second thoughts when severe weather occurs. Weatherproofing of cable connections should also be done with this in mind.

The feed line used in a repeater system plays a more critical role than that used in a simplex installation, in that it must simultaneously receive and transmit without signal degradation. Some popular brands of foil-shielded cable have been known to fail in repeater service after only a few months of operation. In most instances it is a good idea to limit feed line losses to 2 db or less, this can require relatively expensive cable and fittings on frequencies of 440 MHz and higher. It takes less than 50 feet of standard RG-8 cable to account for 2 db of signal loss at 440 MHz, while Andrew LDF-5 (7/8inch) Heliac is good for over 200 feet. Use the best feed line you can arrange for, and test it before it is installed; as few things are more irritating than finding out that your cable is defective after it has been painstakingly installed on the tower. Once again, keep the wrath of Mother Nature in mind when securing and weatherproofing feed line and any needed jumpers, you will need more here than just a roll of electrical tape. Don't forget to bring the cable down and back up before entering your repeater shelter, this drip loop will help keep water out of the structure. The feed line should be properly grounded just outside of the shelter entry point; note that lightning protection devices (Polyphasors, etc.) that may be installed just inside the shelter do not eliminate the need for this ground.

Duplexers (cavity filters) may be the most misunderstood part of a typical repeater, and are accordingly the component most often subject to needless adjustment. Once properly adjusted, duplexers should require only an occasional (perhaps yearly) inspection and only very minor adjustment, if any. When you believe that the duplexer requires a significant change in settings, closely inspect the remainder of your system before taking action. Problems such as water in the feed line or a defective antenna harness are often misdiagnosed as duplexer trouble; these already laborious repairs become even more burdensome if someone has "helped" the problem by turning all of the duplexer cans. While it is possible to adjust duplexers reasonably well with basic test equipment (signal generator, receiver, wattmeter, and dummy load) if you have plenty of time, the job is quicker and easier with a tracking generator. Use double braid or semi-flexible (Andrew Superflex) jumpers between your repeater and duplexer, this is no place for RG58 cable.

Though a typical amateur repeater sometimes seems virtually un-used for days, periodically there may be several stations conversing for an hour or longer. It is not at all difficult for three or four stations in casual conversation to key up a repeater nearly continuously, since each operator is only responsible for a portion of the total usage. Your repeater will almost certainly require a transmitter capable of continuous duty operation. Repeaters used for Skywarn or other quasi-emergency operations should unquestionably be capable of continuous operation, to prevent an untimely failure. While numerous amateur repeaters have been successfully constructed using surplus mobile equipment, you should be aware that a typical duty cycle rating for mobile equipment is 20 percent (2 minutes on, 8 minutes off) transmit operation. Use of these units will usually dictate a substantial cut from rated power output and the addition of forced air-cooling for repeater service.

Even a "commercial" repeater may have to be down-rated when used for amateur service, since commercial applications typically involve brief, two-party communications that demand somewhat less than 100 percent duty cycle. Uniden's ARU251 repeater is rated at 25 watts at 20 percent (EIA) duty cycle, with a continuous rating of 15 watts; comparable units manufactured by others have similar ratings. The two more common makes of vintage commercial equipment, Motorola and General Electric, are found as both continuous and intermittent duty stations; power ratings for some models are as low as 2 watts, while others deliver 375 watts. Be sure that you know what you have, as these units look remarkably alike to the casual observer, unless viewed side by side. Intermittent duty stations are analogous to the previously mentioned mobile units, and should be de-rated accordingly. Any transmitter intended for repeater service should be able to remain continuously keyed for a minimum of one hour without noticeable overheating of the power amplifier or station power supply.

The use of sub-audible tone squelch <a.k.a. PL or Channel Guard> can make your repeater far more pleasant to use, by limiting the receiver's response to only those signals that are actually intended for the system. A repeater that frequently keys up unnecessarily due to distant co-channel users or interference from other nearby

transmitters is an annoyance to those who use it, tone squelch greatly reduces such difficulties. This is the principal reason why commercial and public safety repeaters almost universally use tone squelch, since the small expense involved is more than offset by the benefits of reduced operator fatigue.

The use of tone squelch in amateur service doesn't mean you have a closed repeater, as many people believe; a repeater is closed only if its owner says so. If your repeater has voice ID capability, the tone frequency may be incorporated into the ID, to facilitate access by itinerant stations. Another subtle contributor to operator fatigue is the "courtesy tone" employed at the end of each user's transmission, as a reminder to listen for others who may wish to contribute to a conversation in progress. Elaborate tones sound impressive at first, but can quickly become bothersome, particularly when several repeaters are linked together.

If this is your first project, don't overlook the fact that putting up a repeater is a small job compared to the seemingly never-ending task of keeping it working and available for service. Have an adequate stock of spare parts available, particularly if your repeater is constructed from former commercial equipment. Many of the units that are now becoming available as surplus are no longer fully supported by their manufacturers; this is often the reasoning behind the replacement of otherwise flawless equipment. A complete spare repeater is worth consideration, perhaps more so for those who must rely on others for technical help or equipment. A lower powered, less-elaborate (and accordingly less expensive) unit could provide substantially the same coverage while repairs are made to the primary repeater. Before seriously considering a repeater project, be sure that you have access to adequate service and test equipment. You don't have to use a brand-new state of the art service monitor, but you should be able to measure forward and reflected power, deviation and frequency. It is not possible to properly align a repeater "by ear", and even a factory new station should be checked before it is placed into service.

Some stations have a minor characteristic sound on their signal that may be difficult if not impossible to eliminate. Anyone who has heard a GE Master Pro station can recall the distinctive sound caused by the cooling fan as it spools up. Even the most carefully constructed, well-maintained repeater will produce unusual noises from time to time. A good portion of these will eventually disappear; having been caused by some source other than the repeater itself. Resist the urge to run "up the hill" every time that you hear an unusual noise from the machine. Occasional brief but bothersome man-made noises such as the mysterious "kerchunk" or "touch-tone musician" are best ignored; these problems tend to escalate if given even the most diplomatic attention. Remember that as the custodian of a repeater you are responsible for its transmissions; shut the station off if you must to effectively limit an on-going illegal situation.

As a repeater owner, don't be too critical of your system, as there always seems to be some user who isn't quite satisfied with the repeater, in spite of your best efforts. Without fail, someone who uses a low power transceiver will tell you that your receiver needs attention, devoid of a moment's thought to his or her own miniscule transmitter. I once had a fellow express genuine concern about my 2 meter machine's lack of sensitivity; at the time he was standing some 30 miles distant from the 100 watt repeater with a tiny (300mw) portable transceiver. Likewise you will hear high power mobile stations comment about your lack of transmitter power, all the while full quieting into your receiver. If you use don't use a courtesy tone, seemingly everyone will suggest that you should have one; once it is installed, there will be a few who ask why it is too loud, too soft or otherwise wrong. These almost universally well meant "armchair quarterback" suggestions are usually made by those who have never maintained a repeater of their own, and should be regarded accordingly. Changes in propagation, caused by tropo ducting or other atmospheric conditions can temporarily affect the range of your repeater; this is a normal, though sometimes unsettling condition.

Finally, don't be surprised if you install a repeater and it seems virtually un-used after an initial brief burst of enthusiastic activity. Everyone will be anxious to try the new machine, and you will begin to get a picture of its range and quality after a few days of fever-pitched use by area hams. Then the repeater may go quiet, as everyone in range has checked in and knows what the machine will do. It takes some time for hams in a given area to adjust to a new machine, and even more time for them to realize that they are welcome to use it, particularly in those areas that are already served by one or more repeaters. Whether your system covers only part of a small town or most of the surrounding countryside, a properly installed repeater is an accomplishment that brings satisfaction to the heart of its designer, and one that any amateur can be justifiably proud of.

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