Radio Communications

General

Any ASRC member who has been on a mission probably has had occasion to curse at a radio, at someone on the other end of the radio, or about radios in general. Efficient search management, in which ASRC takes so much pride, tends to break down most commonly when the radio net malfunctions. Most radio problems can be solved by someone who knows just a little about radios and about radio communications. This chapter is designed to teach you just that little bit, plus some useful information that is usually hard to find.

The most common problem with radio communication is related to an audio transmitter and receiver - YOU. Like anything else, getting information smoothly through a radio takes some practice, but there are a few things you can do even if you don't have a radio to play with for practice. For example:

1. Keep copies of the ASRC Crib Sheets in your pack.

2. Learn the International Phonetic Alphabet and the standard ASRC prowords.

3. Know how to communicate effectively in marginal conditions. Know how to compose a succinct message, how to repeat each phrase, and how to spell and use "figures". You will seldom need to do this, but when communications are marginal, your ability to communicate effectively will be greatly appreciated by the Communications Officer. You will also find that these techniques will help you communicate more comfortably even in the best of conditions.

4. Hold the microphone properly. Keep it a couple of inches from your mouth, perhaps holding it at an angle (to reduce breath sounds), and talk in a normal to quiet voice. A load voice make weaken your radios power (RF output) with an FM radio and may cause distortion with an AM or single side band (SSB) radios. (More on the types of radios later)

Now we will detour to consider radio in general, then return to some details about radio hardware.

Characteristics

You need to know two major characteristics of radios: *mode* and *frequency*. The **mode** of a radio refers to the way your voice is encoded onto the (radio frequency or "RF") electromagnetic radio wave *carrier output*. We say the RF carrier is modulated by your voice. The two main modes in use are *frequency modulation (FM)* and *amplitude modulation (AM)*. There is also an improved version of AM known as single side-band (SSB), but you probably won't have to deal with any side-band radios. Another mode you may here about is continuous wave (CW), where an unmodulated carrier is turned on and off via a telegraph key, to produce Morse Code. The only things you need to know the different modes are:

- FM radios have less interference problems than AM, and FM gives you more "talk power" (RF output) for a given battery life. Listen to CB for a good example of AM interference and noise.

- The louder you talk into an FM radio, the louder the audio sounds at the other end, up to the point where you get distortion. But, the louder you talk, the **weaker** your RF output gets.

The effect is slight, but may be noticeable in marginal conditions. If the recipient of your message says you are breaking up, talk softly.

The other concept is of *frequency* of the RF carrier. Some radios have preset frequencies which are called "channels" - the the frequency in a particular channel depends on what crystal, or frequency reference, is plugged into the radio for that channel. Other radios tune across their frequency *bands* (range) with a dial, and some use fancy electronics to allow keyboard entry of frequencies. For instance, some amateur (Ham) 2-meter VHF-FM radios have microprocessors so that the radio will put frequencies into "memory". One may then switch between memories much as one switches channels on a crystal controlled radio. Some of these radios may even scan through the memories (or even the band) if properly set.

Frequencies are measures in Megahertz, or millions of cycles per second. The following names are applied to different bands:

15 Hz - .02 MHz..Audio Frequency (AF)

3 - 30 MHz .... High Frequency (HF)

30 - 150 MHz Low-Band, Very High Frequency (VHF) 150 - 300

MHz.... High Band, Very High Frequency (VHF) 300 -

3,000MHz...Ultra High Frequency (UHF)

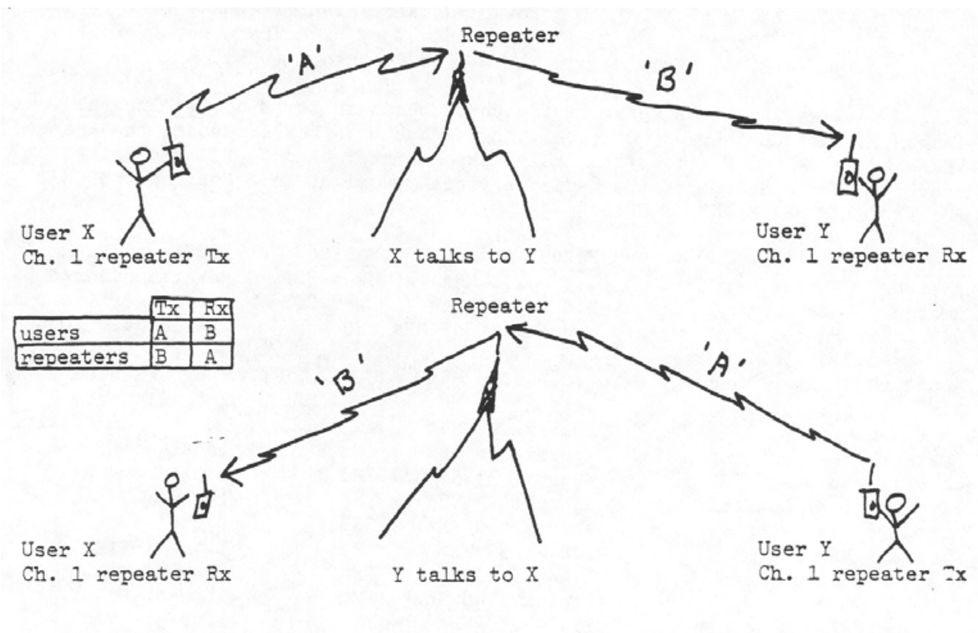
Sometimes, amateurs refer to frequency bands in terms of wavelength. Wavelength is just another way of specifying frequency. For example, the amateur VHF band 144 - 148 MHz is often called the "2-meter band". If you don't like to convert, here are some of the radio services you may have heard of.

Name	*Frequency*	*Modes*	*Notes* (useful distances)
Amateur 80-meter band	1.5 - 1.8 MHz	CW & SSB	several hundred miles
Amateur 40-meter band	3.0 - 3.5 MHz approx.	CW & SSB	" & longer (+ 3000 mi)
Civil Air Patrol HF	4.585 MHz	SSB	" & longer (+ 1000 mi)
Amateur 20-meter band	7.0 - 7.15 MHz	CW & SSB	long distance
Amateur 15-meter band	approx 14 MHz	CW & SSB	long distance
CB "11-meter" band	approx. 27 MHz	AM & SSB	local, some "skip"
Amateur 10-meter band	approx 28 MHz	CW, SSB, FM	local, some "skip"
Sheriff "Lo Band"	approx 39.5 MHz	FM	local
Fire Service "Lo Band"	approx 44MHz	FM	local
Amateur 6-meter band	approx 50 MHz	SSB, FM	local
Aircraft VHF	100 - 130 MHz	AM	line-of-sight
Amateur 2-meter band	144 - 148 MHz	FM	line-of-sight
CAP VHF	approx 148 MHz	FM	line-of-sight
Hi-Band VHF Pub. Ser.	150 - 170 MHz	FM	line-of-sigh
ASRC/MRA	155.160 MHz	FM	line-of-sigh
Amateur 70cm "220" band	220 MHz	FM	line-of-sight

Note that HF frequencies are used for long distance communications. This is because the HF waves bounce off the ionospheric layer of the atmosphere back to earth, and thus are propagated to faraway places. VHF and UHF, don't bounce, and thus are limited to line-of-sight communications. The low band VHF frequencies will bend somewhat over hills, but not as much as HF will.

You should be asking at this point, "Why don't we use HF for SAR?" The answer is in several parts. First, HF handhelds are are very difficult and expensive to make. Second, the frequencies are crowded, with the long range of HF. Third, efficient antennas must be a sizeable fraction of the wavelength. For example, a 40-meter HF quarter wave whip antenna would be about 10 meters long, a bit unwieldy to carry around in the woods.

There are several important **advantages** to VHF as well. First, VHF-FM handhelds are easy to build. Second, you don't have to worry about talking to someone in California when all you need to talk to is Base Camp. Third, good antennas are easy to handle. For instance, a quarter wave whip at 2-meters is only 18 inches long. Finally, the problem of talking around mountains and over long distances can solved by the use of *repeater stations. A* repeater is a powerful rebroadcast station, usually on a mountain or a radio tower. If you can get close to line of sight to the repeater, you can talk to someone else similarly situated, even if you do not have line of sight to them. It works like this:



Everyone transmits on "A" and listens on "B". The repeater listens on "A" and transmits on "B".

A repeater listens on frequency "A" (the *input)* and retransmits what it hears on frequency "B" (the *output)*. Repeater users transmit on "A" (the repeater input) and listen on "B" (the repeater output). This system is often called "duplex" operation, as two frequencies are used to pass traffic.

All users have the same transmit and receive frequencies, so many users may use the same repeater. Often, the channel switch is set on the radio so that Channel 1, for example, is transmit (Tx) A / Receive (Rx) B.

Since everyone is listening on "B", what if someone were to transmit on "B", the repeater output? Everyone within line of sight of this person could hear him, if the repeater did not cover him up, but he would not be going through the repeater. This could be handy for sensitive or local communications. Two people who cannot talk to each other through the repeater, yet are just 100 feet apart could talk to each other and listen to each other on the same frequency ("B"). This is called simplex operation, because everyone receives and transmits on the same frequency.

Many public service frequencies are shared by several users/agencies. A particular agency does not want to listen to everyone on the frequency, they only wants to listen to their own people. A way to do this is known as **continuous** subaudible tone **squelch, CTCSS,** "private line", but best known as "PL", has gained wide acceptance. With this system, a particular subaudible tone (below normal hearing range) is added to the audio of the transmitter by an encoder. Each receiver has a decoder attuned to that particular PL tone. When a signal is received with the proper PL tone, it turns the radio's speaker on. If a signal without the proper PL tone is detected, the radio's speaker remains off. Thus the annoyance to listen to everyone else on the frequency is overcome. It would be easy, however, to pick up the mike and interfere with others you can't hear. (This is an important point, different PL tones are not the same as different frequencies) Therefore, you should always disable the PL "tone squelch" before transmitting. This way , you will hear everyone on the frequency, and thus you won't interfere with them. Some mobile radios are provided with a mike switch, which disables the tone squelch (if it is on) when you pick the mike up from the clip. This way, if someone else is on the frequency, you will hear them when you pick up the mike.

Practical Aspects of Radio Operation

Antennas

The first and most important aspect of radio operation in the field is the *antenna.* Say you have a handheld with a "rubber duckie" antenna on it, and you have a "LOW Iw / HIGH 4w" switch for the power output. You will probably stay on the low power setting most of the time to save power, as the high power setting consumes four times as much power when transmitting. All other things being equal, going to high power gives you twice as much "talk power". (You have to increase your power by four to increase your talk power by two.) When you go from lw to 4w, you double your power twice (lw-- > 2w, 2w-- > 4w), and we say say you increase signal strength by 3 decibels (3dB) each time it doubles. Thus, going from lw to 4w is a 6dB gain. Now it turns out that a "rubber duckie" is not very good as an antenna since it sends a lot of RF energy straight up in the air, and all of this energy is wasted. It turns out that if you switch from a duckie to a quarter wave whip an 18" piece of wire), Mission Base hears you as if you had just doubled your power (the quarter wave whip concentrates its power on the horizontal plane). So, transmitting with lw with a quarter wave whip sounds like 2w with a duckie.

There are two great advantages to the quarter wave whip; you still actually put out only lw, thus saving your batteries; it also turns out that you hear Mission Base as if they had doubled their power! A quarter wave whip gives you 3 dB gain in both transmit and receive, without increasing battery drain.

It gets even better - if you use a 5/8 wave whip (48 inches of wire plus a loading coil at the bottom) your signal is even more directional, and you get 6dB gain over a duckie! So low power with a 5/8 wave whip is the same "talk power" as high power with a duckie, plus 6dB gain on receive. So if you want to carry something to make your team's radio work better, grab a couple of extra antennas.

Just a few more things about antennas. Now that you know that antennas are directional in the horizontal plane, you know to hold your antenna straight up and down (unless you're talking to an aircraft overhead). Also, antennas work best with a ground **plane** underneath; that's why a 1/4 wave antenna on a car roof works better than one in the hand. The handheld and your body provide a ground plane, but not a very good one. Setting the radio on a metallic surface, like a car roof, might improve your radio's performance. And since VHF is line of sight, a few feet of elevation may make a world of difference (when all else fails, climb a tree). Since even the wavelength of VHF (2-meters) is comparable in size to bridge struts, trees, boulders, and human bodies, many reflections may superimpose to produce "dead" spots or *good* spots. A few seconds experimentation may produce a 10dB difference in communication.

Radio Controls

Two radio controls you will use most are ***volume*** and *squelch,* and deserve some comment, even though you probably know how to use them. The volume **control** adjusts the audio amplifier feeding the speaker, but *nothing else* By changing the volume setting, you change the loudness of the sound issuing from the speaker, but the radio receiving or transmitting qualities of the radio are unaffected. When transmitting, the loudness of your outgoing signal is affected only by the loudness of your voice and how you hold the microphone. The transmit "volume" is set internally in the radio and is almost impossible to adjust in the field.

The **squelch control** is similar to the volume control in that it affects the sound issuing from the speaker, but otherwise it does not influence the operation of the radio circuitry. The squelch circuit turns the speaker off; it will turn the speaker on only under certain circumstances. For instance, the PL decoder "tone squelch" explained earlier will turn the speaker back on only when it hears the proper PL tone. The standard squelch on most radios, known as carrier **squelch,** turns the speaker back on only when it hears a strong enough signal. How strong is "strong enough"? You set that by turning the squelch control knob. The next time you have a chance to play with an ASRC, CAP, or Ham 2-meter radio, do the following:

1. Turn the squelch all the way down. You should hear the normal background noise from the speaker. At this setting, even the normal background noise is "strong enough" to cause the squelch circuit to turn the speaker on. The squelch is now *off* even though the radio is on, because the squelch is not interfering with the radio by turning the speaker off.

2. Have someone with another radio give you a test transmission, just a carrier with no modulation (don't talk). Note the way the background noise disappears when your radio picks up the carrier; this is **quieting,** and you can tell the other station he's at "full quieting" at your location, because his signal is blocking out all of the background noise.

3. You probably realize that listening to the background noise all the time could being quite annoying. That's the main reason for having the squelch control. Turn up the squelch control to the point where the noise just disappears; you have just told the squelch circuit that an incoming signal must be slightly stronger than the background noise before it should turn on the speaker. This is where you should normally set the squelch.

There are two things regarding the squelch which are probably obvious, but bear repeating. If you turn the squelch all of the way up, you will probably miss a lot of communication from the weaker stations. Also, if you have the squelch set at a normal level and still have trouble copying a weak station, sometimes it helps to turn the squelch all the way down for a minute . Turn the volume down first to avoid being "blasted" by the background noise.