Chapter 1

# What is Amateur (Ham) Radio?

You are reading this book because you are an interesting person whose curiosity is piqued by unusual things. Or you enjoy talking to other people, or you want to understand a little about electronics — our world is full of electronic tools. You may want to know enough about electronics to tackle building your own electronics project. You may be a user of a personal radio station, purely for noncommercial purposes, with other radio hobbyists. We call that ham radio or Amateur Radio. We call ourselves Amateur Radio operators, ham radio operators or just plain "hams."

You know that ham radio operators communicate with other hams — on a distant continent or around the block — or from an orbiting space station! Some talk

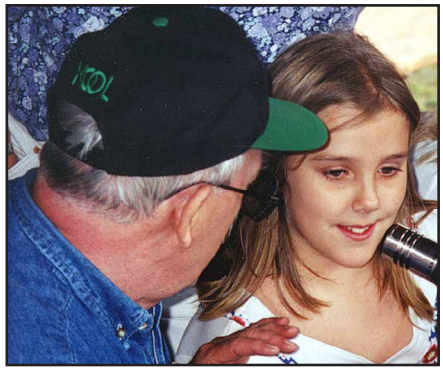


**Fig 1.1 — Hams are always willing to help others who are excited about becoming ham radio operators. You will find more information in this chapter about how to locate ham radio operators in your local area.**

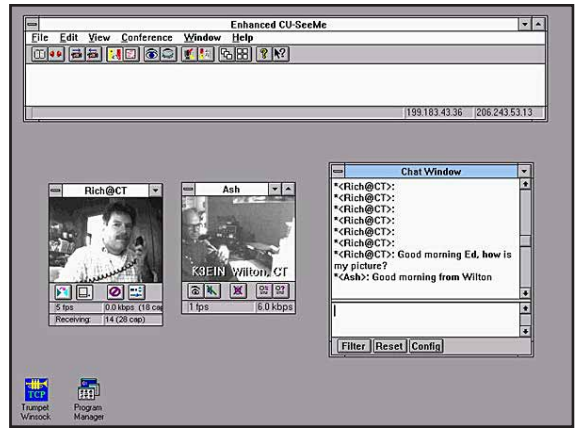



**Fig 1.2 — Computers are an integral part of ham radio, and the Internet plays a large role. Rich Roznoy, K1OF and Ed Ashway, K3EIN, use their PCs to hold a video conference. Audio transmission was by way of their VHF transmitters.** ***(Photo courtesy of Rich Roznoy, K1OF)***

**Fig 1.3 — Brian Wood, WØDZ, like many hams, enjoys restoring antique radios.**

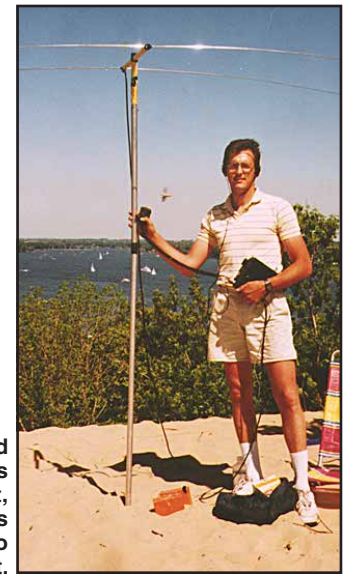


**Fig 1.4 — Ham radio, sun and fun. Peter Venlet, N8YEL, enjoys hilltop operating. Lightweight, portable rigs and small batteries give you many opportunities to pick your operating spot.**

via computers and ham radio; others prefer to use regular voice communication. Still others enjoy using one of the oldest forms of radio communication — Morse code — even though it is not a requirement to know Morse in order to earn a ham license. Some hams help save people's lives by handling emergency communication following a natural disaster or other emergency. Some become close friends with the people they talk to on the other side of the globe — then make it a point to travel and meet one or more of them in person. Some can take a bag full of electrical parts and turn it into a radio.

This chapter, by Rosalie White, K1STO, covers the basics — what hams do, and how they do it.

## HOBBY OF DIVERSITIES

If you wrote down a list of all of the unusual, interesting things you can do as an Amateur Radio operator, you would fill a few pages. What types of people will you meet as a ham? If you walk down a city street, you'll pass men and women, girls and boys, and people of all ages, ethnic backgrounds and physical abilities. Any of them might be a ham you will meet tonight on your radio. They're office workers and students, nurses and mail carriers, engineers and truck drivers, housewives and bankers.

If you drive your car on the interstate this weekend, you'll see people on their way to a state park, a Scout camp, a convention, an airport or a computer show. The young couple going to the park to hike for the day have their hand-held ham radio transceivers in their backpacks. When they stop on a scenic hilltop for a rest, they'll pull out their radios and see how far away they can communicate with the radio's 3 watts of power. And, the radios will be handy just in case they break down on the road or lose the hiking trail.

The father and son on their way to Scout camp will soon be canoeing with their Scout troop. After setting up camp, they'll get out a portable radio, throw a wire antenna over a branch, and get on the air. Aside from the enjoyment of talking with other hams from their campsite, their radios give them the security of having reliable communication with the outside world, in case of emergency.

The family driving to the ham radio convention will spend the day talking with their ham friends, including two they've never met but know quite well from talking to them on the air every week. They will also look at new and used radio equipment, listen to a speaker talk about the latest ways computers can be used to operate on the Amateur Radio bands, and enjoy a banquet talk by a NASA astronaut who is also a ham radio operator.

The couple on the way to the airport to take a pleasure flight in their small plane has their hand-held radios in their flight bags. Once they're airborne, they'll contact hams on the ground all along their flight path. Up at 5,000 feet, they can receive and transmit over much greater distances than they can from the ground. Hams enjoy the novelty of talking to other hams in a plane. The radios are an ideal means of backup communication, too.

The two friends on their way to the computer show are discussing the best interface to use between their computers and their radios for several of the operating modes that use computers. They're looking forward to seeing a number of their ham friends who are into computers.

What other exciting things will you do on the Amateur Radio bands? You might catch yourself excitedly calling (along with 50 other hams) a Russian cosmonaut in space or a sailor on the Coast Guard's tall ship *Eagle*. You could be linked via packet radio with an Alaskan sled-dog driver, a rock star, a US legislator, a major league baseball player, a ham operating the Amateur Radio station aboard the ocean liner *Queen Mary,* an active-duty soldier, a king or someone who is building the same power supply that you are from a design in this *ARRL Handbook*.

On the other hand, a relaxing evening at


**Fig 1.5 — A ham's operating area is called *the shack*. It may be a corner of a room, a basement area or in this case part of a former battleship. The Mobile (AL) Amateur Radio Club installed a temporary station, W4IAX, on this imposing structure.**

### All Types of Physical Abilities

People who aren't as mobile as they'd like find the world of Amateur Radio a rewarding place to make friends — around the block or the globe. Many hams with and without certain physical abilities belong to Courage Handi-Hams, an international organization of radio amateurs. Courage Handi-Ham members live in all states and many countries, and they are ready to help however they can. The Handi-Ham System provides members with study materials and aids for physical disabilities. Local Handi-Hams will assist you with studies. Once you receive your license, the Handi-Ham System may lend you basic radio equipment to get you on the air.

handihams

home could find you in a friendly radio conversation with a ham in Frankfort, Kentucky, or Frankfurt, Germany. Unlike any other hobby, Amateur Radio knows no country boundaries and brings the world together as good friends.

Although talking with astronauts isn't exactly an everyday ham radio occurrence, more and more hams are doing just that, as many NASA astronauts are ham radio operators.

## YOUR LICENSE

You must have a license granted by the FCC to operate an Amateur Radio Station in the United States, in any of its territories and possessions, or from any vessel or aircraft registered in the United States. The FCC sets no minimum or maximum age requirement for obtaining a license, nor does it require that an applicant be a US citizen. However, US citizens are required to pass an FCC license exam to obtain a US Amateur Radio license.

An Amateur Radio license incorporates two kinds of authorization. For the individual, the license grants operator privileges in one class. The class of license the operator has earned determines these privileges. The license also authorizes the licensee to operate transmitting equipment physically present at the licensed station location. Therefore, the full license includes a class-specific *Operator license* and a *Station license*.

### The Technician License: Your Path to Amateur Radio Fun!

Most people start in Amateur Radio with a Technician Class license. They hold that license for a while to learn the ways of the hobby. Then they move to the next class of ham license. The Technician license presents an excellent way for beginners to start enjoying the fun and excitement of Amateur Radio. The only requirement for the Technician license is that you pass a single 35-question written exam. The exam covers Federal Communications Commission (FCC) rules and regulations that govern the airways, courteous operating procedures and techniques, and some basic electronics. There is no Morse code requirement for a Technician license.

Technician license frequency privileges begin at 50 MHz and extend through the very high frequency (VHF) and ultra high frequency (UHF) ranges, and into the microwave region. All of these frequency bands give Technicians plenty of room to explore. They aren't restricted to only certain operating modes, either. They can use any communication methods allowed to hams.


**Fig 1.6 — Bill Carter, KG4FXG, helps young Andrea Hartlage, KG4IUM, work her way through her first CW contact.**

**Fig 1.7 — The gang's all here. Who said ham radio is a solo activity? Standing are KC9XT, N9LVL, KB9ATR, WZ9M, N9IOX and N9LBT. Seated are Chris Kratzer, W9XD and KB9GRP. *(Photo courtesy of Mike McCauley, KB9GNU)***

Most new hams will operate first on the popular 2-meter band. With plenty of *repeaters* across the country, the FM voice signals from their low-power hand-held and mobile radios reach many other hams. Technicians also communicate through *satellites* and *packet radio* networks. They use *single-sideband (SSB)* voice and *Morse code (CW)*.

Technician licensees can gain additional operating privileges on the amateur high frequency (HF) bands by passing a 5-wpm Morse code test. Passing another 35-question written exam completes the upgrade to a General class license. Generals enjoy worldwide communication using SSB and CW as well as *slow-scan television (SSTV)* and a variety of *digital communication* modes.

One more written exam, this one containing 50 questions, will take you to the top of the Amateur Radio license ladder — the Amateur Extra class license. Amateur Extra class licensees enjoy full amateur privileges on all bands. The exam may be challenging, but many hams find it to be well worth the effort!

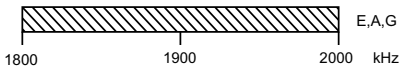
## WHAT'S IN A CALLSIGN?

When you earn your Amateur Radio license, you receive a unique *call sign.* Many hams are known by their call signs more than by their names! All US hams get a call sign, a set of letters and numbers, assigned to them by the Federal Communications Commission (FCC). No one else *owns* your call sign — it's unique. Your Amateur Radio license with your unique call sign gives you permission to operate your Amateur Radio station on the air. US call signs begin with W, K, N or A, with some combination of letters and numbers that follow. When a US call sign begins with A there are always two letters for the

# US Amateur Bands

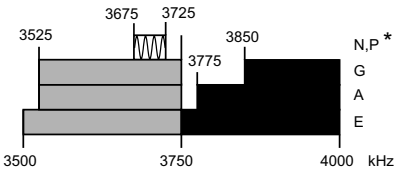
**ARRL** *The national association for AMATEUR RADIO*

## 160 METERS




Amateur stations operating at 1900-2000 kHz must not cause harmful interference to the radiolocation service and are afforded no protection from radiolocation operations.

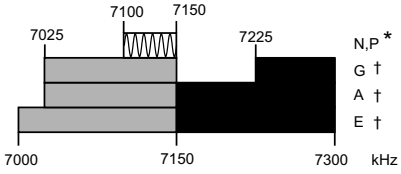
## 80 METERS




## 60 METERS

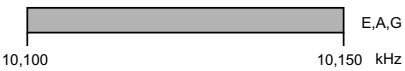
General, Advanced, and Amateur Extra licensees may use the following five channels on a secondary basis with a maximum effective radiated power of 50 W PEP relative to a half wave dipole. Only upper sideband suppressed carrier voice transmissions may be used. The frequencies are 5330.5, 5346.5, 5366.5, 5371.5 and 5403.5 kHz. The occupied bandwidth is limited to 2.8 kHz centered on 5332, 5348, 5368, 5373, and 5405 kHz respectively.

## 40 METERS



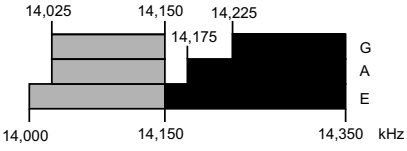

† Phone and Image modes are permitted between 7075 and 7100 kHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11). Novice and Technician Plus licensees outside ITU Region 2 may use CW only between 7050 and 7075 kHz. See Section 97.301(e). These exemptions do not apply to stations in the continental US.

## 30 METERS

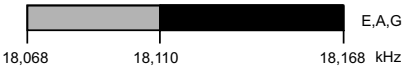



Maximum power on 30 meters is 200 watts PEP output. Amateurs must avoid interference to the fixed service outside the US.

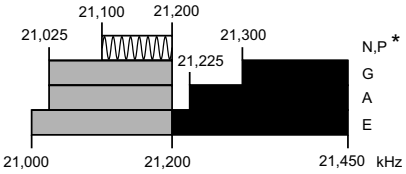
## 20 METERS




## 17 METERS



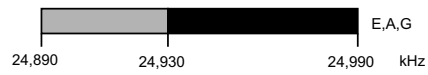

## 15 METERS



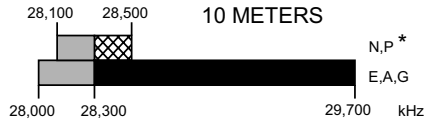

## Novice, Advanced and Technician Plus Allocations

*New* Novice, Advanced and Technician Plus licenses are no longer being issued, but *existing* Novice, Technician Plus and Advanced class licenses are unchanged. Amateurs can continue to renew these licenses. Technicians who pass the 5 wpm Morse code exam *after* that date have Technician Plus privileges, although their license says Technician. They must retain the 5 wpm Certificate of Successful Completion of Examination (CSCE) as proof. The CSCE is valid indefinitely for operating authorization, but is valid only for 365 days for upgrade credit.

## 12 METERS

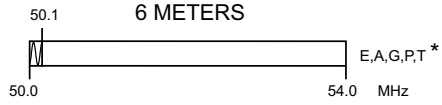



## 10 METERS




Novices and Technician Plus Licensees are limited to 200 watts PEP output on 10 meters.

## 6 METERS

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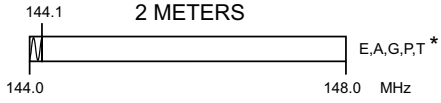


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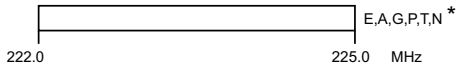
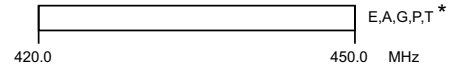
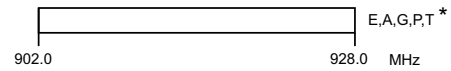



Novices are limited to 25 watts PEP output from 222 to 225 MHz.

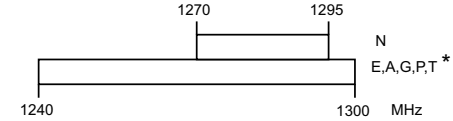
## 70 CENTIMETERS **




## 33 CENTIMETERS **




## 23 CENTIMETERS **




Novices are limited to 5 watts PEP output from 1270 to 1295 MHz.

### US AMATEUR POWER LIMITS

At all times, transmitter power should be kept down to that necessary to carry out the desired communications. Power is rated in watts PEP output. Unless otherwise stated, the maximum power output is 1500 W. Power for all license classes is limited to 200 W in the 10,100-10,150 kHz band and in all Novice subbands below 28,100 kHz. Novices and Technicians are restricted to 200 W in the 28,100-28,500 kHz subbands. In addition, Novices are restricted to 25 W in the 222-225 MHz band and 5 W in the 1270-1295 MHz subband.

### KEY

- = CW, RTTY and data
- = CW, RTTY, data, MCW, test, phone and image
- = CW, phone and image
- = CW and SSB phone
- = CW, RTTY, data, phone, and image
- = CW only

**E** = AMATEUR EXTRA
**A** = ADVANCED
**G** = GENERAL
**P** = TECHNICIAN PLUS
**T** = TECHNICIAN
**N** = NOVICE

* Technicians who have passed the 5 wpm Morse code exam are indicated as "P".

** Geographical and power restrictions apply to all bands with frequencies above 420 MHz. See *The ARRL FCC Rule Book* for more information about your area.

*** 219-220 MHz allocated to amateurs on a secondary basis for fixed digital message forwarding systems only and can be operated by all licensees except Novices.

All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz
2390-2450 MHz
3300-3500 MHz
5650-5925 MHz
10.0-10.5 GHz
24.0-24.25 GHz
47.0-47.2 GHz
75.5-76.0, 77.0-81.0 GHz
119.98-120.02 GHz
142-149 GHz
241-250 GHz
All above 300 GHz



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## Field Day: Ham Radio Alfresco

Most hams enjoy operating during Field Day. On the fourth full weekend in June, US and Canadian amateurs plus some in other parts of the world, take their radios into the great outdoors to operate away from power mains. They test how to set up efficient temporary stations to operate under emergency conditions and contact as many other stations as possible. But Field Day is, above all, fun! Hams enjoy working with a group to compete against perhaps 100,000 other hams who are also out in the elements!

**Many different Field Days are possible — from a camper, cabin or tent, maybe a view of the mountains, which is what the W7AV team did.**

prefix — AA through AL. The number in the middle of the call sign indicates the station location within the country when the license was first issued. In the US, call signs that contain a 9 indicate that the ham lived in the Midwest when the license was issued, and call signs with the number 1 indicate a New England location. However, with the creation of the FCC's vanity callsign program, which permits certain FCC licensees to select their own callsign from a list of unassigned call signs based on the license class of the holder, one can no longer assume that a specific number in a US amateur call sign denotes that licensee's actual physical location. You can tell what country issued a ham's call sign by the prefix — the letters before the number.

### HAM RADIO ACTION

Amateur Radio and public service go together. On a warm early-summer weekend, hams can be found directing radio communication in the aftermath of a train derailment — a simulated one, that is — to prepare for a real emergency. Others provide radio communication for a walk-a-thon. Still others hone their communication skills by setting up a station outdoors, away from electrical power. This largest public-service-related ham activity is called *Field Day*.

### Biking and Cruising

Hams even operate their radios while riding on bicycle treks. They easily carry their lightweight hand-held radios in their packs, and can pull them out quickly, if needed. Or they might pull along a small trailer with sleeping bag, food and water and a small ham radio transceiver and wire antenna that they can set up in the evenings.

**Fig 1.8 — A radio set up can be simple or complex.**

Other hams enjoy going to far-flung, exotic parts of the world. They get to go to new places, operate the radios, and meet new friends. Hams call these trips *DXpeditions*. Many hams enjoy operating from a sparsley populated country to provide rare ham contacts for their excited fellow hams around the world.

### Nets: Scheduled Get-Togethers

If you'd enjoy finding other hams with interests like yours (such as chess, gardening, rock climbing, railroads, computer programming or teaching), you'll soon learn about *nets*. A net forms when hams with similar interests get together on the air on a regular schedule. You can find your special interest — from the Armenian Amateur Radio and Traffic Net to ARES nets — listed in *The ARRL Net Directory* on the *ARRLWeb*.

### Awards and Contests: Competitive Fun

If you're competitive by nature, you'll want to explore ham radio awards and contests. These activities recognize your ability to contact many hams under specific guidelines. In the ARRL DX Contest, for example, you'll try to contact as many DX (foreign) stations as possible over a weekend. During such a weekend, experienced hams with top-notch stations easily contact more than 100 different countries!

Awards you can earn include *Worked All States*, earned by communicating with a ham in every US state, *Worked All VE*, earned by contacting hams in every Canadian province, and *DX Century Club*, for working stations in 100 or more different countries.

In an outdoor orienteering competition, "fox-hunters" track and locate hidden transmitters by car or on foot. This activity, also called direction finding, has a serious side: Skills learned in tracking the fox are useful when there's a suspected pirate (unlicensed ham station) in the area.

### QRP: Talk to the World with 5 Watts of Power

For a new challenge, try operating *QRP* — using low power. Some hams enjoy operating with only 1 watt or less. It's a challenge, but with decent antennas and skillful operating, QRP enthusiasts are heard around the world. The best reason for operating QRP is that equipment is lightweight, inexpensive and easy to build. Some hams use nothing but "homebrew" equipment.

### Computers and Ham Radio

If computers are your favorite aspect of today's technology, you'll soon discover that you can connect your computer to Amateur Radio equipment and operate using such digital modes as *packet radio*, RTTY, *PSK31* and High-Speed Multimedia (*HSMM*). HSMM is a popular multimedia mode used on the ultra-high-

**Fig 1.9 — Ham radio operators are well-known for providing emergency communication. Famous newscaster Walter Cronkite, KB2GSD, honored hams by narrating a show on hams saving the day with communications when all else failed.**

frequency (UHF) bands for the simultaneous transmission of voice, video, text and data. With packet, you can leave messages that other packet enthusiasts will pick up and answer later. PSK31 is a popular digital mode used on the amateur high-frequency (HF) bands. It is used with common computers and sound cards, allowing you to talk great distances with a modest ham station. Computers can help you practice taking amateur license examinations or improve your Morse code abilities. ARRL, and others, offer software especially designed to help you pass amateur radio exams. You'll discover software for many ham applications, from keeping track of the stations you've contacted to designing a great antenna. See also the chapter on **Web, Wi-Fi, Wireless and PC Technology** in this *Handbook* for additional information.

**Fig 1.10 — John Tallon, N6OMB (standing) and Randy Hammock, KC6HUR, discuss operation of the APRS net in the LA Police Department command center during the 1998 LA Marathon. *(KN6F Photo)***

### Enhancing Radio Signals

Radio signals normally travel in straight lines, which limits their range. But hams have found some ingenious ways of extending the distance and improving the quality of the signals they transmit. High-frequency (HF) radio waves can be refracted or bent by a layer of the atmosphere called the ionosphere. Signals are returned to Earth, often after several "hops." This *ionospheric propagation* of radio signals allows worldwide communication on the HF bands. Hams have also learned how to bounce signals off the moon, airplanes and even meteor trails! Repeaters, located on hilltops or tall buildings, strengthen signals and retransmit them. This provides communication over distances much farther than would be possible without repeaters.

### Helping out in Emergencies

When commercial communication services are disrupted by power failures or during natural disasters such as earthquakes and hurricanes, Amateur Radio operators are often first at the scene. Battery-powered equipment allows hams to provide essential communication even when power is knocked out. If need be, hams can make and install antennas on the spot from whatever materials and supports they find available. Many hams join their local Amateur Radio Emergency Service (ARES)® group sponsored by ARRL, and regularly practice their emergency communication skills.

Working with emergency personnel such as police and fire departments, the Red Cross and medical personnel, ham volunteers provide communication. Hams can handle communication between agencies whose normal radios are incompatible with one another, for example. The ability of radio amateurs to help the public in emergencies is one of the reasons Amateur Radio has prospered since the early days of the 20th century.

### Community Events

To keep their emergency-preparedness skills honed, and to help their community, hams enjoy assisting with communication to aid the public at any number of activities. Hams volunteer to provide communication for marathons, bike races, parades and other community events. In fact, it's rare to see a large community event that doesn't make use of public-spirited ham radio operators.

### Build It Yourself!

Another favorite activity hams enjoy is building their own radio equipment. Many amateurs proudly stay at the forefront of technology, continually being challenged to keep up with advances that could be applied to the hobby. They have an incessant curiosity and an eagerness to try new techniques. They try to find ways to allow the radio frequency bands to support more users, since some portions of the

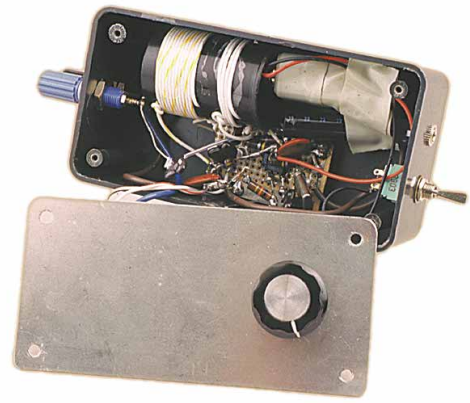

**Fig 1.11 — The art of *homebrewing*, or building your own equipment, is thriving. This small receiver contains two transistors and one integrated circuit. It is assembled without special tools in one or two evenings. The thrill of operating a radio you built lasts a long time! See Chapters 14 and 15 for some receivers and transceivers you can build.**

## Hams at the Forefront

Over the years, the military and the electronics industry have often drawn on ham ingenuity to improve designs or solve problems. Hams provided the keystone for the development of modern military communication equipment, for example. In the 1950s, the Air Force needed to convert its long-range communication from Morse code to voice — and jet bombers had no room for skilled radio operators. At the time, hams communicated by voice at great distance with both home-built and commercial single-sideband (SSB) equipment. Air Force Generals LeMay and Griswold, both radio amateurs, hatched an experiment that used ham equipment at the Strategic Air Command headquarters and an airplane flying around the world. They found that the equipment would need only slight modification to meet Air Force needs. By using ham radio technology, two generals saved the government millions of dollars in research costs.

## OSCARs: The Ham Satellites

You will be thrilled hearing your own radio signal returned from space by an orbiting "repeater in the sky" — a ham radio satellite. Hams regularly use Amateur Radio satellites, called OSCARs (for *O*rbiting *S*atellites *C*arrying *A*mateur *R*adio). Your VHF and UHF ham signals normally won't travel much beyond the horizon. But if you route signals through a satellite, you can make global radio contacts on VHF and UHF. OSCAR-16 was built and launched in the '90s. It allows messages from Earth to be stored and forwarded back down to Earth when the spacecraft is within range of the designated station. Hams from around the globe worked together to design, build and test OSCAR 40, launched in 2000. It provided hams with communication on several radio frequencies up through the microwave bands.

OSCAR-E — the "Echo Project" — was built and launched in June 2004. The satellite has two UHF transmitters for running simultaneous operation, four VHF receivers and a multiband, multimode receiver for the 10-m, 2-m, 70-cm and 23-cm bands. Hams can use FM voice and various digital modes — including PSK31 on a 10-meter SSB uplink. Does this sound beyond your skills? It shouldn't. All it takes is a Technician license to enjoy satellites.


**Fig 1.12 — Amateur Radio operators on the International Space Station (ISS) enjoy using its on-board ham station during their off-duty hours. They talk to friends, school students and hams around the world by voice and packet radio. Many astronauts are ham radio operators now that they are assigned long-duration ISS stints.**

**Fig 1.13 — Most communication with unmanned satellites uses VHF, UHF or microwave frequencies, and many hams build their own antennas for this pursuit.**

**Fig 1.14 — Astronaut Susan Helms, KC7NHZ, made several dozen Field Day contacts operating from the ISS as NA1SS. *(NASA Photo)***

ham bands are very popular and can be crowded.

The projects you'll find in this book provide a wide variety of equipment and accessories that make ham radio more convenient and enjoyable. Many manufacturers provide parts kits and etched circuit boards to make building even easier.

### Hams in Space

In 1983, the first ham/astronaut made history by communicating from the space shuttle *Columbia* with ground-based hams. On that mission, NASA Payload Specialist Owen Garriott, whose Amateur Radio call sign is W5LFL, took along a hand-held amateur transceiver and placed a specially designed antenna in an orbiter window. It was the first time ham radio operators throughout the world were to experience the thrill of working an astronaut aboard an orbiting spacecraft. In 1985, Mission Specialist Tony England, WØORE, transmitted slow-scan television via Amateur Radio while orbiting the Earth in the shuttle *Challenger*. He named the payload *SAREX*, for *S*huttle *A*mateur *R*adio *EX*periment.

From then on, NASA routinely scheduled SAREX missions. In 1991, all five members of mission STS-37 had earned a ham radio license! NASA promotes ham activity because of its proven educational and PR value. It could be used for backup communication. In 1995, five shuttle crews requested that NASA install the SAREX payload on their flights. A ham station was one of the first "extra" items installed in the International Space Station (ISS).

Plans began in 1996 to have Amateur Radio on the ISS, in a program called ARISS. During crew members' on-board leisure time, the ham astronauts sometimes talk to hams, school students and friends. Because ISS missions are long-duration stints, many astronauts have decided to earn their ham licenses.

### GETTING STARTED

Now that you know some things hams do, you may be asking, "Okay, how do I get started?" The first step is to earn a license.

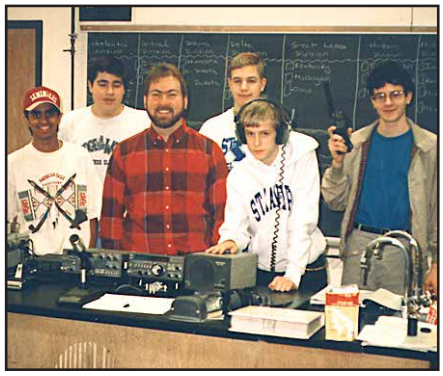

**Fig 1.15 — The St Xavier High School Amateur Radio Club assembled for this photo just before a big weekend contest. Their enthusiastic efforts led them to a high score for their type of station.**

**Fig 1.16 — There were no computers, satellites or TV when Clarice, W7FTX, was first licensed in 1935. One thing has not changed — the friendship of her fellow hams.**

Most people start with the Technician license, which has a 35-question written exam. Exams are given by local ham Volunteer Examiners (VEs). Many clubs sponsor exam sessions regularly, so you shouldn't have to travel far. Exams are given on weekends or evenings. Exam questions are taken from a large pool of questions for each license class. The complete question pools for the three licenses are published in study guides or can be found on the Internet. (See the URL for *ARRLWeb* in the Resources section at the end of this chapter.)

### Study Guides

You can prepare for the exams in a class or on your own. Help is available at every step. The ARRL publishes study materials for all classes of licenses. Contact ARRL's New Ham Desk (the phone number and address are at the end of this chapter) for more information on getting started: nearby ham clubs, instructors who have registered with ARRL, and local VEs. You'll find a lot of information on the ARRL Web site, such as frequencies hams can use, popular operating activities and the latest versions of ARRL study guides.

ARRL's beginner manual, *Now You're Talking!*, includes the complete, up-to-date question pool with the correct answers and clear explanations. You'll also find tips for how to choose your equipment and put together your ham radio station, simple and inexpensive antennas and much more.

*Now You're Talking!* assumes no prior electronics background. Children as young as five years old have passed ham radio exams! You could choose *ARRL's Tech Q & A manual,* instead, if you already have some electronics background or just want brief explanations to help you understand the correct answers. Every question in the Technician question pool is included to help you prepare.

When you are ready to upgrade to a General class license, *The ARRL General Class License Manual* or *ARRL's General Q & A* will help you prepare. *The ARRL Extra Class License Manual* will guide your study efforts for the Amateur Extra class license. ARRL's *Your Introduction to Morse Code* will teach you the Morse code and prepare you for the 5-wpm exam. *ARRL's Technician Video Course* and *ARRL's General Video Course* can bring our expert instructors to your TV. Even newer is ARRL's online Technician license course—learn what you need to know to earn your license by studying at your computer when it's convenient for you!

### Mentors, Sometimes Called Elmers

Ham radio operators often learn how to get on the air from a mentor. An experienced ham, called an "Elmer," teaches newcomers about Amateur Radio on a one-to-one basis. Many ham clubs have special mentor programs. Elmering was first documented in ARRL's monthly magazine, *QST*, in a story meant to be a public thank you from an appreciative student whose mentor's name was Elmer. Elmers are there for you as you study, buy your first radio and set up your station. They are proud to help you with your first on-the-air contacts.

### Putting Together a Station

As with any other hobby, you can enjoy ham radio no matter how small or large your budget. You can start with a handheld transceiver that fits in your pocket or purse, and take it along when you hike, canoe or aviate. Or you can fill your "radio shack" with the latest and fanciest radios technology offers and money can buy, and talk to people in all corners of the world. You can put up a simple, inexpensive wire antenna between two trees in your backyard, or install a tower with antennas on top. Either way you'll talk to the world.

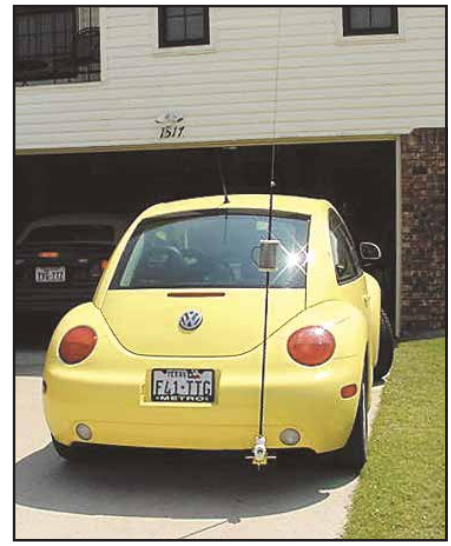

**Fig 1.17 — Many hams operate radios while on the road.**

Accessories and equipment for your ham radio station come in all price ranges. *QST* contains display advertisements for new ham gear plus classified ads for previously owned items.

#### *Used Versus New*

Hams are continually upgrading their stations, so you can always find a ready supply of good previously-owned Amateur Radio gear. You can find new handheld transceivers and used HF radios for less than $300. Many hams start with a radio that costs between $300 and $600. Antennas and other gear can add appreciably to the cost, but less-expensive alternatives, such as putting together your own antenna or low-power transceiver, are available.

## HAMS AS WORLD CITIZENS

When you become an Amateur Radio operator, you become a "world citizen" — you join people who have earned the privilege of talking to other hams around the corner or around the world. Hams have a long tradition of spreading international goodwill. One way hams do this is to assist with getting needed medical advice or

medicine to developing countries. Another is by learning about the lives and cultures of those they contact. But you should avoid talking about sensitive political or ethical issues.

Although English is the standard language on the ham bands, English-speakers will make a good impression on hams in foreign countries if they can speak a little of the other person's language — even if it's as simple as *danke* or *sayonara*.

### International Amateur Radio

Hams in other countries have formed national organizations, just as US hams organized the ARRL — the national association for Amateur Radio. These sister societies work to have a united voice in international radio affairs, such as when governments together decide how radio frequencies will be divided among users. The International Amateur Radio Union (IARU), composed of about 160 national Amateur Radio societies, works to help protect the amateur frequencies.

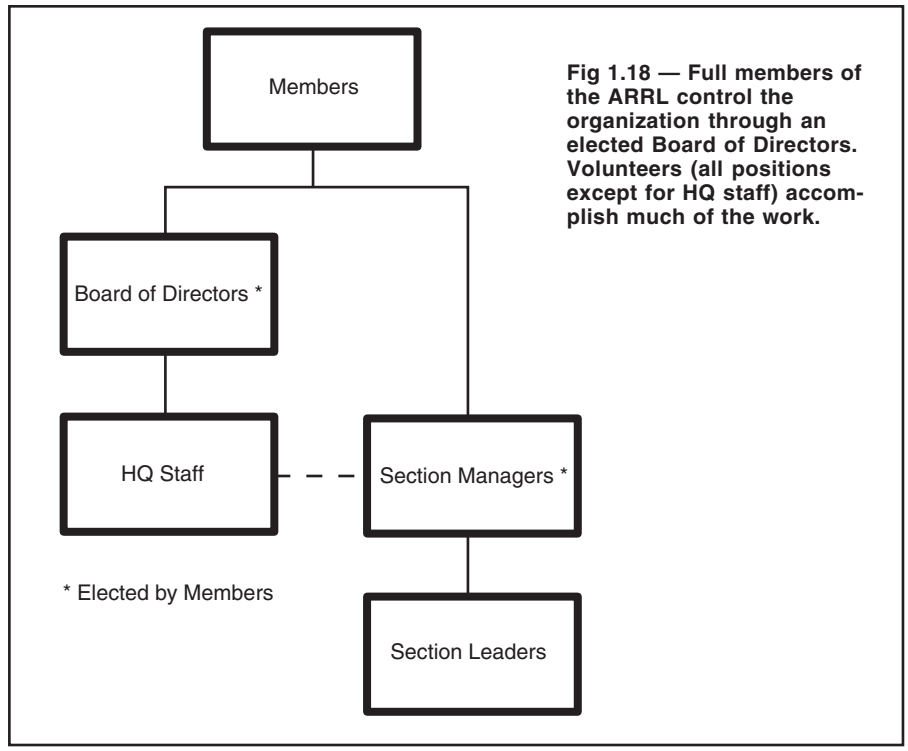


**Fig 1.18 — Full members of the ARRL control the organization through an elected Board of Directors. Volunteers (all positions except for HQ staff) accomplish much of the work.**

## THE ADMINISTRATORS: ITU AND FCC

Our world has a limited spectrum of radio frequencies. These frequencies must be shared by many competing radio services: aeronautical, marine, land mobile, to name a few.

The International Telecommunication Union (ITU), an agency of the United Nations, allocates frequencies among the services. With its long tradition of public service and technological savvy, ham radio enjoys the use of many different frequency bands.

In the US, a government agency, the Federal Communications Commission (FCC), regulates the radio services, including Amateur Radio. The section of the FCC Rules that deals with Amateur Radio is Part 97. Hams are expected to know the important sections of Part 97, as serious violations (such as causing malicious interference or operating without the appropriate license) can lead to fines and even imprisonment! Aside from writing and enforcing the rules governing Amateur Radio, the FCC also assigns call signs and issues licenses.

## THE ARRL

Since it was founded in 1914, the ARRL — the national association for Amateur Radio — has grown and evolved along with Amateur Radio. The ARRL Headquarters building and Maxim Memorial Station, W1AW, are in Newington, Connecticut, near Hartford. Through its dedicated volunteers and a professional staff, the ARRL promotes the advancement of the amateur service in the US and around the world.

The ARRL is a nonprofit, educational and scientific organization dedicated to the promotion and protection of the many privileges that ham radio operators enjoy. Of, by and for the radio amateur, ARRL numbers 150,000 members — the vast majority of active amateurs in North America. Licensed hams become Full Members, while unlicensed persons become Associate Members with all membership privileges except for voting in ARRL elections. Anyone with a good interest in Amateur Radio belongs in the ARRL.

The ARRL volunteer corps is called the Field Organization. Working at the state and local level, these volunteers work on ARRL goals to further Amateur Radio. They organize emergency communication in times of disaster and work with agencies such as Red Cross and Citizen Corps. Other

**Fig 1.19 — W1AW, the station operated by the ARRL in Newington, Connecticut, is known around the world as the home of ham radio. W1AW memorializes Hiram Percy Maxim, one of the founders of the ARRL. Visitors are welcome and often operate the station. *(Photo courtesy of W2ABE)***

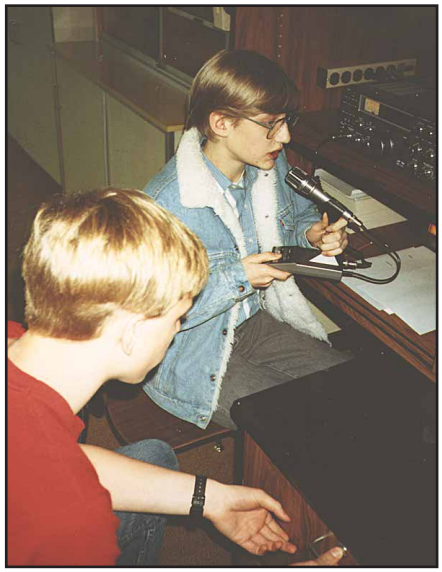

**Fig 1.20 — Many hams enjoy talking to far away stations, and learn geography in the process. Here Bill, KB7JAH, and William, KB7JAG, chat with a ham in Kiribati. Don't know where Kiribati is? (Hint: Part of the island is the first in the world to greet each new day.)**

**Fig 1.21 — All-ham families are not unusual. Class instructor Robert Lavin, K6BOB, and VE Jonathan Fleischer, AC6GW, handed graduation certificates to the Harrises: Wesley, KG6QHT, age 7; Desiree Domingo Foraste, KD6LEW; Wesley's twin Ryan, KG6QHU, and David, KD6LET.**

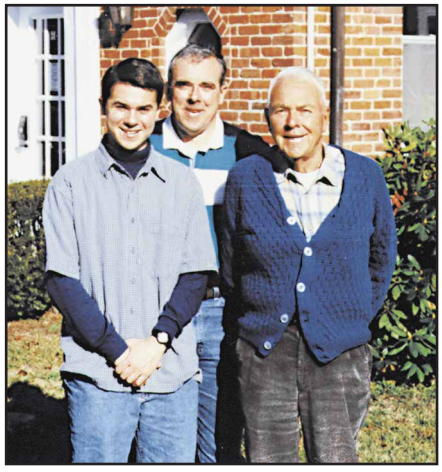

**Fig 1.22 — Three generations of Andrew Maroneys visit W1AW. From left to right, Andrew IV, W2AJM, Andrew III, WA2QAX, and Andrew Jr, W2SON. While at Headquarters, Andrew Jr turned in QSL cards for his DXCC Honor Roll verification, bringing his total to 325.**

volunteers keep state and local government officials abreast of the good that hams do at the state and local level.

### Membership Services

When you join ARRL, you add your voice to those who are most involved with ham radio. The most prominent benefit of ARRL membership is *QST*, the premiere Amateur Radio magazine. *QST* has stories you'll want to read, articles on projects to build, announcements on upcoming activities, equipment reviews, reports on the role hams play in emergencies, and much more.

But being an ARRL member is far more than a subscription to *QST*. The ARRL represents your interests to the FCC and Congress, sponsors operating events, and offers membership services at a personal level. A few are:

- Low-cost equipment insurance
- the Volunteer Examiner program
- the Technical Information Service (which gets you answers to questions about any technical subject in Amateur Radio)
- the QSL bureau (which lets you exchange postcards with hams in foreign countries as a confirmation of your contacts with them)

### Schoolteachers and Volunteer Instructors

ARRL Field & Educational Services (F&ES) provides teachers with aids for using Amateur Radio in schools, and even has equipment grants. Hundreds of teachers have found Amateur Radio an ideal way to provide hands-on, intercurricular learning, while enticing students to become interested in science and technology. F&ES also has materials, such as online newsletters and lesson plans for hams that wish to teach Amateur Radio licensing classes.

### WELCOME!

For answers to any questions you may have about Amateur Radio, write or call ARRL Headquarters. See Resources, at the end of this chapter, for information.

# Governing Regulations

International and national radio regulations govern the operational and technical standards of all radio stations. The International Telecommunication Union (ITU) governs telecommunication on the international level and broadly defines radio services through the international Radio Regulations. In the United States, the agency responsible for nongovernmental and nonmilitary stations is the Federal Communications Commission (FCC). Title 47 of the *US Code of Federal Regulations* governs telecommunication. Different rule Parts of Title 47 govern the various radio services in the US. The Amateur Radio Service is governed by Part 97. Some other Parts are described in the sidebar "Other FCC Rule 'Parts'." *The ARRL RFI Book* contains a detailed chapter on these FCC Rule parts, which affect Amateur Radio directly and indirectly.

Experimentation has been the backbone of Amateur Radio for almost a century and the amateur rules provide a framework within which amateurs have wide latitude to experiment in accordance with the basis and purpose of the service. The rules should be viewed as vehicles to promote healthy activity and growth, not as constraints that lead to stagnation. A brief overview of Amateur Radio regulations follows with special emphasis on technical standards.

## Other FCC Rule "Parts"

Part 97 is just a small piece of the overall regulatory picture. An up-to-date copy of Part 97 can be found on the Web at **www.arrl.org/FandES/field/regulations/news/part97** and in *The ARRL FCC Rule Book*, which also contains hundreds of pages of interpretive materials. The *US Code of Federal Regulations*, Title 47, consists of telecommunication rules numbered as Parts 0 through 300. These Parts contain specific rules for the many telecommunication services the FCC administers. Individuals may purchase or obtain from the Web (**wireless.fcc.gov/rules.html**) a specific rule Part for a particular service from the Superintendent of Documents, US Government Printing Office. Here is a list of FCC Parts amateurs may find of interest:

| *Part* | |
|---|---|
| 0 | Commission organization |
| 1 | Practice and procedure |
| 2 | Frequency allocation and radio treaty matters; general rules and regulations. |
| 15 | Low-power radio-frequency transmitting devices |
| 17 | Construction, marking and lighting of antenna structures |
| 18 | Industrial, scientific and medical equipment |
| 73 | Radio broadcast services |
| 76 | Cable Television Service |
| 90 | Private Land Mobile Radio Service |
| 95 | Personal radio services, including CB and GMRS |
| 97 | Amateur Radio Service |

### BASIS AND PURPOSE OF THE AMATEUR RADIO SERVICE

There's much more in the regulatory scheme than Part 97. The basis for the FCC regulations is found in treaties, international agreements and statutes that provide for the allocation of frequencies and place conditions on how the frequencies are to be used. For example, Article 25 of the international *Radio Regulations* limits the types of international communication amateur stations may transmit and mandates that the technical qualifications of amateur operators be verified.

It's the FCC's responsibility to see that amateurs are able to operate their stations in a manner consistent with the basis and purpose of the amateur rules. The FCC must also ensure that amateurs have the knowledge and ability to operate powerful and potentially dangerous equipment safely without causing harmful interference to others. A review of each of the five basic purposes of the Amateur Radio Service, as they appear in Part 97, follows:

***Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communication*** [97.1(a)].

Probably the best known aspect of Amateur Radio to the general public is its ability to provide emergency communication, such as following the World Trade Center attack by terrorists in 2001. One of the most important aspects of the service is its noncommercial nature. Amateurs are prohibited from receiving any form of payment for operating their stations.

***Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art*** [97.1(b)].

For nearly a century, hams have carried on a tradition of learning by doing, and since the beginning have remained at the forefront of technology. Through experimenting and building, hams have pioneered advances, such as techniques for single-sideband transmissions, and are currently engaged in the development of new digital schemes which continue to improve the efficiency of such communication. Hams' practical experience has led to technical refinements and cost reductions beneficial to the commercial radio industry. In addition, amateurs have designed and built a series of sophisticated satellites at a fraction of the cost of their commercial equivalents.

***Encouragement and improvement of the Amateur Radio Service through rules which provide for advancing skills in both the communication and technical phases of the art [97.1(c)].***

Amateurs have always been experimenters and that's what sets the Amateur Service apart from other services. The cost to the government for licensing and enforcement is minimal when compared to the benefit the public receives. Hams have contributed greatly to the development of computer communication techniques. The FCC and industry have also credited the amateur community with the development of Low-Earth-Orbit (LEO) satellite technology. The same can be said for a number of digital modes that have arrived on the scene in the 1990s, such as PacTOR, CLOVER and PSK31.

***Expansion of the existing reservoir within the Amateur Radio Service of trained operators, technicians and electronic experts*** [97.1(d)].

Amateurs learn by doing. While all amateurs may not be able to troubleshoot and repair a transceiver, all amateurs have some degree of technical competence.

***Continuation and extension of the amateur's unique ability to enhance international goodwill*** [97.1(e)].

Amateur Radio is one of the few truly international hobbies. It is up to amateurs to maintain high standards and to represent the US as its ambassadors, because, in a sense, all US amateurs serve that function.

## A QUICK JOURNEY THROUGH PART 97

The Amateur Radio Service rules, Part 97, are organized in six major subparts: General Provisions, Station Operation Standards, Special Operations, Technical Standards, Providing Emergency Communication and Qualifying Examination Systems. A brief discussion of the highlights of each subpart follows:

### General Provisions

Subpart A covers the basics that apply to all facets of Amateur Radio. The "Basis and Purpose" of Amateur Radio, discussed above, is found at the beginning of Part 97 [97.1]. Definitions of key terms used throughout Part 97 form the foundation of Part 97 [97.3].

The remainder of the subpart is devoted to Federal restrictions on amateur installations, which include a mention of FCC standards for RF exposure. The ARRL publication *RF Exposure and You* details these RF exposure requirements.

### Station Operation Standards

Subpart B, "Station Operation Standards," concerns the basic operating practices that apply to all types of operation. Amateurs must operate their stations in accordance with good engineering and amateur practice [97.101(a)]. Part 97 doesn't always tell amateurs specifically how to operate their stations, particularly concerning technical issues, but the FCC provides broad guidelines. The use of good engineering and amateur practice means, for example, that amateurs shouldn't operate a station with a distorted signal and that amateurs shouldn't operate on a busy band like 20 m just to talk to a ham across town. Also, amateurs must share the frequencies with others — no one ham or group has any special claim to any frequency [97.101(b)]. The station licensee is always responsible for the proper operation of an amateur station, except where the control operator is someone other than the station licensee, in which case both share responsibility equally [97.103(a)]. This subpart also contains regulations for the reciprocal operating authority.

The requirements for control operators, station control and reciprocal operating authority are also addressed in Subpart B. Each station must have a control point [97.109(a)]. A control operator must always be at the control point, except in a few cases where the transmitter is controlled automatically [97.109(b), (c), (d) and (e)]. The purpose of the Amateur Radio Service is to communicate with other amateurs [97.111]. Certain one-way transmissions are allowed. Amateurs can send a one-way transmission to:

- make adjustments to equipment for test purposes
- call CQ
- remotely control devices
- communicate information in emergencies
- send code practice and information bulletins of interest to amateurs [97.111(b)]

Broadcasting to the public is strictly prohibited [97.113(b)]. The section on prohibited transmissions states that amateurs cannot: be paid for operating a station, make transmissions on behalf of an employer, transmit music (unless otherwise allowed in the rules), transmit obscenity, use amateur stations for news-gathering purposes or transmit false signals and ciphers. The FCC has relaxed the previously restrictive business rules to encourage public service and personal communication [97.113].

Station identification is addressed in this subpart. The purpose of station identification is to make the source of its transmissions known to those receiving them, including FCC monitors. The rules cover identification requirements for the various operating modes. Section 97.119 details the station-identification requirements. Amateurs must transmit their call sign at the end of the communication and every 10 minutes during communication. CW and phone may be used to identify an amateur station. RTTY and data (using a specified digital code) may be used when all or part of the communication are transmitted using such an emission. Images (Amateur Television, for example) may be used to identify when all or part of the transmission is in that mode. A final section addresses restricted operation and sets forth the conditions that must exist in an interference case involving a neighbor's TV or radio before the Commission can impose "quiet hours" — hours of the day when a particular amateur may not operate an amateur transmitter [97.121(a)]. Imposition of quiet hours by the FCC is rare, however.

### Special Operations

Subpart C, "Special Operations," addresses specialized activities of Amateur Radio including the various types of stations an amateur may operate. This subpart gives specific guidelines concerning repeaters, beacons, space stations, Earth stations, message forwarding systems, and telecommand (remote control) stations. These rules are of particular interest to the technically minded amateur. An amateur may send ancillary functions (user functions) of a repeater on the input of the repeater — to turn on and off an autopatch, for example. However, the primary control links used to turn the repeater on and off, for example, may be transmitted only above 222.150 MHz since such one-way transmissions are auxiliary transmissions. Every repeater trustee/licensee and user should understand the rules for repeaters and auxiliary links. An important regulatory approach to solving interference problems between repeaters is addressed in that section: Repeater station licensees are equally responsible for resolving an interference problem, unless one of the repeaters has been approved for operation by the recognized repeater coordinator for the area and the other has not. In that case, the owner of the uncoordinated repeater has primary responsibility to resolve the problem [97.205(c)]. The control operator of a repeater that inadvertently retransmits communication in violation of the rules is not held accountable [97.205(g)]. The originator and first forwarding station of a message transmitted through a message forwarding system are held accountable for any violations of Part 97. Other forwarding stations are not held accountable [97.219]. For a detailed explanation, see *The ARRL FCC Rule Book*.

### Technical Standards

The word *standard* means consistency and order — and this is what the technical standards in Subpart D are all about. The FCC outlines the specific frequency bands available to US amateurs [97.301] as well as the sharing agreements [97.303]. (This chapter includes a table of frequencies allocated to the Amateur Radio Service.) The Commission made these standards a basic framework so all types of amateur operation may peacefully coexist with other radio occupants in the spectrum neighborhood. Emission standards for RTTY, data and spread spectrum are discussed, as are standards for the Certification of RF power amplifiers. FCC Certification is not needed for most amateur equipment. This gives amateurs the freedom to experiment without being bound by specific equipment standards.

### Providing Emergency Communication

Subpart E, "Providing Emergency Communication," addresses disaster communication, stations in distress, communication for the safety of life and protection of property and the Radio Amateur Civil Emergency Service (RACES).

### Qualifying Examination Systems

The final subpart of the rules, Subpart F, deals with the examination system and covers exam requirements and elements and standards. In 1983, the Commission dele-

gated much of the exam administration program to amateurs themselves. The rules provide for checks and balances on volunteer examiners (VEs), who administer exams at the local and regional levels. These checks and balances protect against fraud and provide integrity for the exam process.

The classes of Amateur Radio license are Novice, Technician, Technician Plus, General, Advanced, and Amateur Extra. Since April 15, 2000, the FCC has issued only *new* Technician, General and Amateur Extra licenses. (A Technician with credit for 5 wpm has the same privileges as the "old Technician Plus.") Those who hold any of the six classes of license may have their license renewed at the same license class, however.

## EMISSION STANDARDS, BANDWIDTH, POWER AND EXTERNAL POWER AMPLIFIERS

Like most of Part 97, the technical standards exist to promote operating techniques that make efficient use of the spectrum and minimize interference. The standards in Part 97 identify problems that must be solved. Section 97.307 spells out the standards FCC expects amateur signals to meet. It states, in part: "No amateur station transmission shall occupy more bandwidth than necessary for the information rate and emission type being transmitted, in accordance with good amateur practice" [97.307(a)]. Simply stated, don't transmit a wide signal when a narrow one will do. Specific bandwidth limits are given for RTTY and data emissions. Specific bandwidth limits are not given for other modes of operation, but amateurs must still observe good engineering and operator practice.

The rules state: "Emissions resulting from modulation must be confined to the band or segment available to the control operator" [97.307(b)]. Every modulated signal produces sidebands. Amateurs must not operate so close to the band edge that the sidebands extend out of the subband, even if the frequency readout says that the carrier is inside the band. Further: "Emissions outside the necessary bandwidth must not cause splatter or key-click interference to operations on adjacent frequencies" [97.307(b)]. The rules simply codify good operating practice. Key clicks or over-processed voice signals shouldn't cause interference up and down the band.

### Spurious emissions

Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but do not include splatter [97.307(c)]. Definitions for *necessary bandwidth* and *out-of-band emission* appear in the **Glossary** at the end of this chapter. Also see **Fig 1.23**.

### Emission standards

The FCC is very specific concerning spurious emission standards for emissions below 30 MHz and emissions from 30-225 MHz. The following requirements apply only to amateur transmitters or external HF amplifiers **below 30 MHz** [97.307(d)]:

If the amateur transmitter was installed (FCC terminology for put into operation) ***after* January 1, 2003**, the mean power of any spurious emission from the station transmitter or external RF power amplifier on a frequency below 30 MHz must be **at least 43 dB below the mean power of the fundamental emission.** This applies to *all* power levels, including QRP transmitters.

For transmitters installed ***on or before* January 1, 2003**, the mean power of any spurious emission from a station transmitter or external RF power amplifier transmitting on a frequency below 30 MHz must **not exceed 50 mW** and must be **at least 40 dB below the mean power of the fundamental emission**. For a transmitter of mean ***power less than 5 W*** installed ***on or before* January 1, 2003**, the attenuation must be ***at least 30 dB***. A transmitter built before April 15, 1977, or first marketed before January 1, 1978, is exempt from this requirement.

The following spurious emission standards apply **between 30 and 225 MHz** [97.307(e)]:

- In transmitters with **25 W or less mean output power**, spurs must be **at least 40 dB below the mean power of the fundamental** emission and never greater than 25 μW (microwatts), but need not be reduced further than 10 μW. This means that the spurs from a 25-W transmitter must be at least 60 dB down to meet the 25-μW restriction.
- In transmitters with more than 25 W mean output power, spurious emissions must be at least 60 dB below the mean power of the fundamental emission.

The situation for transmitters operating between 30 and 225 MHz is more complex. The combination of the requirement that spurious emissions be less than 25 μW and the stipulation that they don't need to be reduced below 10 μW makes the requirements vary significantly with power level. This ranges from 0 dB suppression required for a transmitter whose power is 10 μW to 60 dB of suppression required for power levels above 25 W. The requirements for transmitter operation between 30 and 225 MHz are shown graphically in **Fig 1.24**. There are no absolute limits for

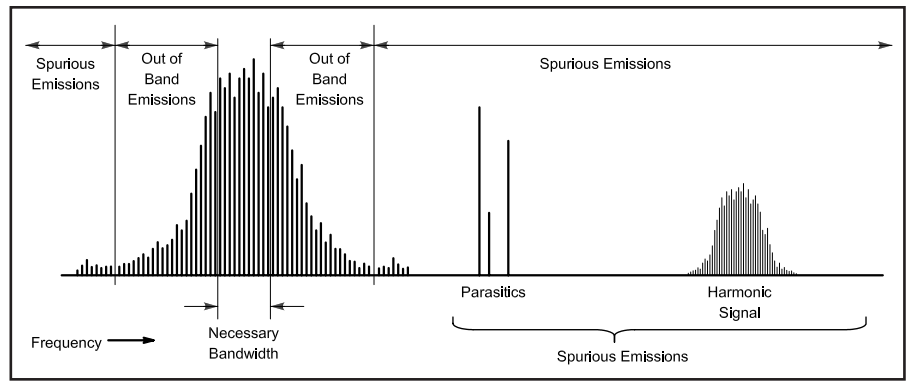


**Fig 1.23 — Some of the modulation products are outside the necessary bandwidth. These are out-of-band emissions, but they are not considered spurious emissions. On the other hand, these out-of-band emissions must not interfere with other stations [97.307(b)]. The harmonics and parasitics shown in this figure are spurious emissions, and they must be reduced to the levels specified in Part 97. The FCC states that all spurious emissions must be reduced "to the greatest extent practicable" [97.307(c)]. Further, if any spurious emission, including chassis or power-line radiation, causes harmful interference to the reception of another radio station, the licensee of the interfering amateur station is required to take steps to eliminate the interference.**

### Emission Designators

ITU system of designating emission, modulation and transmission characteristics employed appears in the International Radio Regulations at **life.itu.int/radioclub/rr/aps01.htm**. The same text appears in FCC rules. The cite is 47 CFR, Section 2.201 — Emission, modulation and transmission characteristics.

transmitters operating above 225 MHz, although the requirements for good engineering practice would still apply.

### Transmitter Power Standards

Amateurs shall not use more power than necessary to carry out the desired communication [97.313(a)]. Don't use 700 W when 10 m is wide open, for example. No station may use more than 1.5 kW peak envelope power [97.313(b)] and no station may use more than 200 W in the 30-m band. Novices and Technicians with 5 WPM credit are limited to 200 W in their HF segments [97.313(c)]. Amateurs may use no more than 50 W in the 70-cm band near certain military installations [97.313(f) and (g)].

The FCC has chosen and published the following standards of measurement: (1) Read an in-line peak-reading RF wattmeter that is properly matched; and (2) calculate the power using the peak RF voltage as indicated by an oscilloscope or other peak-reading device. Multiply the peak RF voltage by 0.707, square the result and divide by the load resistance. The SWR must be 1:1 for calculation accuracy.

The FCC requires that you meet the power output regulations, but does not require that you make such measurements or possess measurement equipment. The methods listed simply indicate how the Commission would measure your transmitter's output during a station inspection.

As a practical matter, most hams don't have to worry about special equipment to check their transmitter's output because they never approach the 1500-W PEP output limit. Many common amplifiers aren't capable of generating this much power. However, if you do have a capable amplifier and do operate close to the limit, you should be prepared to measure your output along the lines detailed above.

### External RF Power Amplifiers: Certification and Standards

In 1978, the FCC banned the manufacture and marketing of any external RF power amplifier or amplifier kit capable of operation on any frequency below 144 MHz, unless the FCC has issued a grant of type acceptance (now called FCC Certification) for that model amplifier. The FCC also banned the manufacture and marketing of HF amplifiers that were capable of operation on 10 m to stem the flow of amplifiers being distributed for illegal use in and around frequencies used by CB operators.

Amateurs may still use amplifiers capable of operation on 10 m. While the rules may make it difficult to buy a new amplifier capable of operation on 10 m, the FCC allows amateurs to modify an amplifier to restore or include 10-m capability. An amateur may modify no more than one unit of the same model amplifier in any year without FCC Certification [97.315(a)].

Of course, amateurs are permitted to build amplifiers, convert equipment from any other radio service for this use or to buy used amplifiers. When converting equipment from other services, it must meet all technical standards outlined in Part 97, and it can no longer be used in the service for which it was intended since the Certification would have been voided. Non-amateurs are specifically prohibited from building or modifying amplifiers capable of operation below 144 MHz without FCC Certification [97.315(a)]. All external amplifiers and amplifier kits capable of operation below 144 MHz must be FCC Certificated in order to be marketed [97.315(b)]. A number of amplifiers, manufactured prior to the April 28, 1978 cutoff were issued a waiver of the new regulations [97.315(b)(2)]. Amateurs may buy or sell an amplifier that has either been FCC Certificated, granted a waiver or modified so that the Certification is no longer valid. There are restrictions that would be valid regardless of whether the amplifier was capable of operation below 144 MHz. Some amplifiers marketed before April 28, 1978, are covered under the waiver if they are the same model that was granted a waiver [97.315(b)(2)]. An individual amateur may sell his amplifier regardless of grants or waivers, provided that he sells it only to another amateur operator [97.315(b)(4)]. Amateurs may also sell a

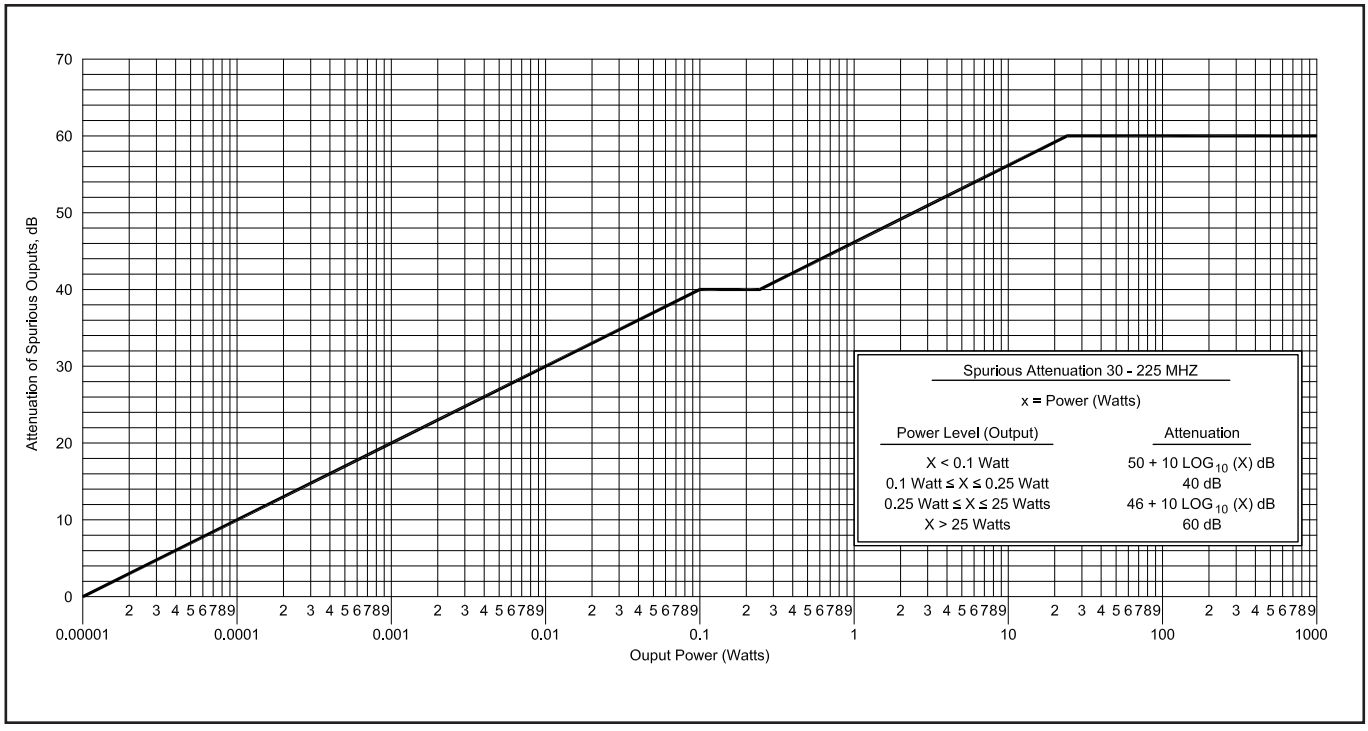


**Fig 1.24 — Required attenuation of spurious outputs, 30-225 MHz.**

used amplifier to a *bona fide* amateur equipment dealer. The dealer could sell those amplifiers only to other hams [97.315(b)(5)].

In some cases, the FCC will deny Certification. Some features that may cause a denial are (1) any accessible wiring which, when altered, would permit operation in a manner contrary to FCC rules; (2) circuit boards or similar circuitry to facilitate the addition of components to change the amplifier's operation characteristics in a manner contrary to FCC rules; (3) for operation or modification of the amplifier in a manner contrary to FCC rules; (4) any internal or external controls or adjustments to facilitate operation of the amplifier in a manner contrary to FCC rules; (5) any internal RF sensing circuitry or any external switch, the purpose of which is to place the amplifier in the transmit mode; (6) the incorporation of more gain than is necessary to operate in the amateur service.

## CONCLUSION

A common thread in Amateur Radio's history has been a dynamic regulatory environment that has nurtured technological growth and diversity. This thread continues to sew together the elements of Amateur Radio today and prepare it for tomorrow's challenges.

## RESOURCES

**ARRL — the national association for Amateur Radio**
225 Main St
Newington, CT 06111-1494
860-594-0200
Fax: 860-594-0259
e-mail: hq@arrl.org
Prospective hams call 1-800-32 NEW HAM (1-800-326-3942)
*ARRLWeb:* **www.arrl.org**
Membership organization of US ham radio operators and those interested in ham radio. Publishes study guides for all Amateur Radio license classes, a monthly journal, *QST*, and many books on Amateur Radio and electronics.

**AMSAT NA (The Radio Amateur Satellite Corporation, Inc)**
PO Box 27
Washington, DC 20044
301-589-6062
**www.amsat.org**
Membership organization for those interested in Amateur Radio satellites. Publishes *The AMSAT Journal*, monthly.

***Courage Handi-Ham System***
3915 Golden Valley Rd
Golden Valley, MN 55422
763-520-0511
**www.handiham.org**
Provides assistance to persons with disabilities who want to earn a ham radio license or set up a station.

***Now You're Talking! All You Need for Your First Amateur Radio License***
(Newington, CT: ARRL)
**www.arrl.org/catalog/**
Complete introduction to ham radio, including the exam question pool, complete explanations of the subjects on the exams. Tips on buying equipment, setting up a station and more.

***The ARRL's Tech Q & A***
(Newington, CT: ARRL)
**www.arrl.org/catalog/**
All the questions on the Technician exam, with correct answers highlighted and explained in plain English. Many helpful diagrams.

***Your Introduction to Morse Code***
(Newington, CT: ARRL)
**www.arrl.org/catalog/**
A set of audio CDs (or cassette tapes) that make learning Morse code fun. Teaches all letters, numbers and other required characters, and provides practice text.

***Ham University***
(Available from ARRL)
**www.arrl.org/catalog/**
Windows-based PC software. Learn Morse code to pass your 5 words-per-minute exam. Ham University includes the questions for all written exams so you can quiz yourself.

# Glossary

*Note:* Words in ***boldface italics*** have separate entries in the Glossary.

**ADV (Amateur digital video)** — A mode of operation in which ***Amateur Radio*** operators exchange video motion images using their personal computers.

**AM (Amplitude modulation)** — The oldest voice operating mode still found on the amateur bands. The more common voice mode, ***SSB***, is actually a narrower-bandwidth variation of AM.

**Amateur Radio** — A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest. (*Pecuniary* means payment of any type, whether money or goods.) Also called ***ham radio***.

**Amateur Radio operator** — A person holding a license to operate a ham radio station.

**Amateur Radio station** — A station licensed in the amateur service, including necessary equipment.

**Amateur Service** — A radio communication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

**AMSAT (Radio Amateur Satellite Corporation)** — An international membership organization that designs, builds and promotes the use of Amateur Radio satellites.

**ARES®** — An ARRL program specializing in emergency communication.

**ARISS** — An acronym for Amateur Radio on the International Space Station.

**ARRL** — The membership organization for Amateur Radio operators in the US.

**ATV (Amateur television)** — A mode of operation that amateur radio operators use to exchange pictures from their ham stations.

**Auxiliary station** — An amateur station, other than in a message-forwarding system, transmitting communication point-to-point within a system of cooperating amateur stations.

**Band** — A range of frequencies. Hams are authorized to transmit on many different bands.

**Bandwidth** — The width of a frequency band outside of which the mean power of the transmitted signal is attenuated at least 26 dB below the mean power of the transmitted signal within the band.

**Beacon** — An amateur station transmitting communication for the purposes of observation of propagation and reception or other related experimental activities.

**Beam antenna** — A type of ham radio antenna that can be pointed in any direction.

**Broadcasting** — Transmissions intended for reception by the general public, either direct or relayed.

**Call sign** — A series of unique letters and numbers assigned to a person who has earned an Amateur Radio license.

**Carrier power** — The average power supplied to the antenna transmission line by a transmitter during one RF cycle taken under the condition of no modulation.

**Certification** — An equipment authorization granted by the FCC. It is used to ensure that equipment will function properly in the service for which it has been accepted. Most amateur equipment does not require FCC Certification, although HF power amplifiers and amplifier kits do. Part 15 Rules require FCC Certification for all receivers operating anywhere between 30 and 960 MHz. Amateur transmitters may not be legally used in any other service that requires FCC equipment authorization. For example, it is illegal to use a modified amateur transmitter in the police, fire or business radio services.

**Contact** — A two-way communication between Amateur Radio operators.

**Contest** — An Amateur Radio activity in which hams and their stations compete to contact the most stations within a designated time period.

**Control operator** — An amateur operator designated by the licensee of a station to be responsible for the transmissions from that station to assure compliance with the FCC Rules.

**Control point** — The location at which the control operator function is performed.

**Courage Handi-Ham System** — Membership organization for ham radio enthusiasts with various physical disabilities and abilities.

**CW** — Abbreviation for *continuous wave;* another name for ***Morse code*** telegraphy by radio. Also, International Morse code telegraphy emissions having designators with A, C, H, J or R as the first symbol; 1 as the second symbol; A or B as the third symbol; and emissions J2A and J2B.

**Data** — Telemetry, telecommand and computer communication emissions having designators with A, C, D, F, G, H, J or R as the first symbol; 1 as the second symbol; D as the third symbol; and emission J2D. Only a digital code of a type specifically authorized in this Part may be transmitted.

**Digital communication** — Computer-based communication modes such as PSK31, ***packet radio*** and ***HSMM***.

**Dipole antenna** — A wire antenna often used on the high-frequency amateur bands.

**DSP (Digital signal processing)** — A newer technology that allows software to replace electronic circuitry.

**DX** — A ham radio abbreviation for *distance* or *foreign countries*.

**DXCC** — A popular ARRL award earned for contacting Amateur Radio operators in 100 different countries.

**DX PacketCluster** — A method of informing hams, via their computers, about the activities of stations operating from unusual locations.

**DXpedition** — A trip to an unusual location, such as an uninhabited island or other geographical or political entity which has few, if any, Amateur Radio operators, where hams operate while visiting. DXpeditions provide sought-after contacts for hams who are anxious to have a radio contact with someone in a rare location.

**Elmer** — A traditional term for someone who enjoys helping newcomers get started in ham radio. A mentor.

**Emergency communication** — Amateur Radio communication that take place during a situation where there is danger to lives or property.

**External RF power amplifier** — A device capable of increasing power output when used in conjunction with, but not an integral part of, a transmitter.

**External RF power amplifier kit** — A number of electronic parts, which, when assembled, is an external RF power amplifier, even if additional parts are required to complete assembly.

**FCC (Federal Communications Commission)** — The government agency that regulates Amateur Radio in the US.

**Field & Educational Services (F&ES)** — Staff at ARRL Headquarters that helps newcomers get started in ham radio and supports hams who help newcomers.

**Field Day** — A popular Amateur Radio activity during which hams set up radio stations outdoors and away from electrical service to simulate emergencies.

**Field Organization** — A cadre of ARRL volunteers who perform various ser-

vices for the Amateur Radio community at the local and state level.

**FM (Frequency modulation)** — An operating ***mode*** commonly used on ham radio ***repeaters***.

**Fox hunt** — A competitive Amateur Radio activity in which hams track down a transmitted signal.

**Frequency coordinator** — An entity, recognized in a local or regional area by amateur operators whose stations are eligible to be auxiliary or repeater stations, that recommends transmit/receive channels and associated operating and technical parameters for such stations in order to avoid or minimize potential interference.

**FSTV (Fast-scan television)** — A mode of operation that Amateur Radio operators can use to exchange live TV images from their stations.

**Ham band** — A range of frequencies on which ham communication are authorized.

**Ham radio** — Another name for ***Amateur Radio***.

**Ham radio operator** — An ***Amateur Radio operator*** holding a written authorization to operate a ham station.

**Harmful interference** — Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service — including ham radio — operating in accordance with the international Radio Regulations.

**HF (High frequency)** — The radio frequencies from 3 to 30 MHz.

**HSMM (High Speed Multimedia)** — A digital radio communication technique using spread spectrum modes primarily on UHF to simultaneously send and receive video, voice, text, and data.

**IARU (International Amateur Radio Union)** — The international organization made up of national Amateur Radio organizations such as the ARRL.

**Image** — Facsimile and television emissions having designators with A, C, D, F, G, H, J or R as the first symbol; 1, 2 or 3 as the second symbol; C or F as the third symbol; and emissions having B as the first symbol; 7, 8 or 9 as the second symbol; W as the third symbol.

**Information bulletin** — A message directed only to amateur operators consisting solely of subject matter of direct interest to the amateur service.

**International Morse code** — A dot-dash code as defined in International Telegraph and Telephone Consultative Committee (CCITT) Recommendation F.1 (1984), Division B, I. Morse Code.

**ITU (International Telecommunication Union)** — An agency of the United Nations that allocates the radio spectrum among the various radio services.

**Key clicks** — Undesired switching transients beyond the necessary bandwidth of a Morse code transmission caused by improperly shaped modulation envelopes.

**Mean power** — The average power supplied to an antenna transmission line during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions.

**Mode** — A type of ham radio communication; examples are ***frequency modulation (FM voice), slow-scan television (SSTV)*** *and* ***SSB (single sideband voice).***

**Morse code** — A popular communication mode transmitted by on/off keying of a radio-frequency signal. Hams use the *international Morse code*.

**Necessary bandwidth** — The width of the transmitted frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

**Net** — An on-the-air meeting of hams at a set time, day and radio frequency.

**Network** — A system of interconnected radios to allow more than one station access to shared resources.

**Out-of-band emission** (splatter) — An emission on a frequency immediately outside the necessary bandwidth caused by overmodulation on peaks (excluding spurious emissions).

**Packet radio** — A computer-to-computer radio communication mode in which information is broken into short bursts. The bursts (packets) contain addressing and error-detection information.

**PEP (peak envelope power)** — The average power supplied to the antenna transmission line by a transmitter during one RF cycle at the crest of the modulation envelope taken under normal operating conditions.

**Phone** — Emissions carrying speech or other sound information having designators with A, C, D, F, G, H, J or R as the first symbol; 1, 2 or 3 as the second symbol; E as the third symbol. Also speech emissions having B as the first symbol; 7, 8 or 9 as the second symbol; E as the third symbol.

**Power** — Power is expressed in three ways: (1) Peak envelope power (PEP); (2) Mean power; and (3) Carrier power.

**Public service** — Activities involving Amateur Radio that hams perform to benefit their communities.

**Pulse** — Emissions having designators with K, L, M, P, Q, V or W as the first symbol; 0, 1, 2, 3, 7, 8, 9 or X as the second symbol; A, B, C, D, E, F, N, W or X as the third symbol.

**QRP** — An abbreviation for low power.

**QSL bureau** — A system for sending ***QSL cards*** to and from ham radio operators.

**QSL cards** — Cards that serve to confirm communication between two hams.

***QST*** — The premiere ham radio monthly magazine, published by the ***ARRL***. *QST* means "calling all radio amateurs."

**RACES (Radio Amateur Civil Emergency Service)** — A radio service that uses amateur stations for civil defense communication during periods of local, regional or national civil emergencies.

**Radio Regulations** — The latest ITU *Radio Regulations*.

**RF (Radio frequencies)** — The range of frequencies that can travel through space in the form of electromagnetic radiation.

**RIC (Radio interface card)** — A PCMCIA device with an antenna port used in ***HSMM*** radio to allow a personal computer to control a radio transceiver.

**RLAN (Radio Local Area Network)** — This is similar to a wireless LAN, except that hams replace the small antennas with larger outdoor antennas and use the equipment to cover several miles or more.

**RMAN (Radio Metropolitan Area Network)** — This is an ***HSMM*** radio technique, usually longer range or higher data rates, to interconnect amateur radio RLANs.

**Radio (*or* Ham) shack** — The room where Amateur Radio operators keep their station.

**Radiotelegraphy** — See ***Morse code***.

**Receiver** — A device that converts radio signals into a form that can be heard.

**Remote control** — The use of a control operator who indirectly manipulates the operating adjustments in the station through a control link to achieve compliance with the FCC Rules.

**Repeater** — An amateur station, usually located on a mountaintop, hilltop or tall building, that receives and simultaneously retransmits the signals of other stations on a different channel or channels for greater range.

**RTTY** — Narrow-band direct-printing telegraphy emissions having designators with A, C, D, F, G, H, J or R as the first symbol; 1 as the second symbol; B as the third symbol; and emission J2B.

**SAREX (*S*pace *A*mateur *R*adio *Ex*periment)** — Amateur Radio equipment

flown in space and operated by astronauts who are licensed Amateur Radio operators.

**Space station** — An amateur station located more than 50 km above the Earth's surface.

**Splatter** — See ***Out-of-band emission***.

**Spread Spectrum** — A technology, originated during World War II, which distributes or spreads a radio signal over a broad frequency range. This spreading prevents narrow band signals and noise sources from interfering with the spread spectrum signal. The spread spectrum signal is heard as noise to the traditional narrow band receiver. Also, emissions using bandwidth-expansion modulation emissions having designators with A, C, D, F, G, H, J or R as the first symbol; X as the second symbol; X as the third symbol.

**Spurious emission** — An emission, on frequencies outside the necessary bandwidth of a transmission, the level of which may be reduced without affecting the information being transmitted. They include harmonic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

**SSB (Single sideband)** — A common ***mode*** of voice operation on the amateur bands.

**SSTV (Slow-scan television)** — A ***mode*** of operation in which ham radio operators exchange still pictures from their stations.

**SWL (Shortwave listener)** — A person who enjoys listening to shortwave radio broadcasts or Amateur Radio conversations.

**Telecommand** — A one-way transmission to initiate, modify, or terminate functions of a device at a distance.

**Telecommand station** — An amateur station that transmits communication to initiate, modify, or terminate functions of a space station.

**Telemetry** — A one-way transmission of measurements at a distance from the measuring instrument.

**Test** — Emissions containing no information having the designators with N as the third symbol. Test does not include pulse emissions with no information or modulation unless pulse emissions are also authorized in the frequency band.

**TIS (Technical Information Service)** — A service of the ***ARRL*** that helps hams solve technical problems.

**Transceiver** — A radio transmitter and receiver combined in one unit.

**Transmitter** — A device that produces radio-frequency signals.

**UHF (Ultra-high frequencies)** — The radio frequencies from 300 to 3000 MHz.

**VE (Volunteer Examiners)** — Amateur Radio operators who give Amateur Radio licensing examinations.

**VHF (Very-high frequencies)** — The radio frequencies from 30 to 300 MHz.

**WAS (Worked All States)** — An ***ARRL*** award that is earned when an Amateur Radio operator talks to and exchanges QSL cards with a ham in each of the 50 states in the US.

**WAVE (Worked All VE)** — An award that is earned when a ham talks to and exchanges QSL cards with a ham in each Canadian province.

**Wavelength** — A means of designating a frequency ***band,*** such as the 80-meter band.

**Work** — To contact another ham.