

# AHØA Technician Class

## Exam Study Notes

### Version A - 7/3/2008

## T1 - FCC Rules, Station License Responsibilities

The **Federal Communications Commission** (FCC) is the government agency that grants amateur radio licenses. It issues operator station licenses for the Amateur Radio Service that have a normal term license grant of **10 years**. The **grace period** during which the FCC will renew an expired 10-year license without re-examination is **2 years**. If you forget to renew your amateur license and it expires, transmitting is **not allowed** until the license is renewed and appears on the **FCC ULS database**.

The **Federal Communications Commission** makes and enforces the rules for the Amateur Radio Service in the United States. As a station licensee you have the responsibility to **operate your station in accordance with FCC rules**.

An amateur operator as defined in Part 97 is a person named in an amateur operator/primary license grant in the **FCC ULS database**. The definition of an amateur radio station is a station operating in the Amateur Radio Service consisting of the apparatus **necessary for carrying on radio communications**.

A basic purpose of the Amateur Radio Service as defined in Part 97 is to provide a **voluntary noncommercial** communications service to the public, **particularly in times of emergency**. Two more of the five fundamental purposes for the Amateur Radio Service are to increase the number of **trained radio operators** and electronics experts, and **improve international goodwill**.

A transmission that disturbs other communications is called **harmful interference**. Under FCC rules, when an amateur frequency band is said to be available on a **secondary basis** this means amateurs may **not cause harmful interference** to the primary users.

**Anyone except a representative of a foreign government** can become an amateur licensee in the US. There is **no minimum age** requirement to hold an amateur license. After passing the required examination elements for your first amateur radio license, may you transmit as soon as your license grant **appears in the FCC's ULS database**. To be the control an amateur station in the US you must be **named in the FCC amateur license database**, or be an **alien with reciprocal operating authorization**.

The FCC requires the station licensee mailing address be **kept up to date** on the **Universal Licensing System (ULS) database**. If the mailing address of the holder is not current with the FCC and **mail is returned** to the FCC as undeliverable, the FCC may **revoke or suspend a license**.

A US amateur license allows you to transmit from wherever the *Amateur Radio Service* is **regulated by the FCC** or where **reciprocal agreements are in place**. Communications on a regular basis that **could reasonably be furnished alternatively** through other radio services are **not permitted in the Amateur Radio Service**. A US amateur operator may communicate with an amateur in a foreign country **at any time unless prohibited by either government**.

**Only when authorized by the FCC** are amateur stations allowed to communicate with stations operating in other radio services. When there is a **reciprocal operating agreement** between countries you are allowed to operate your amateur station in that foreign country.

The three US amateur radio licenses that may currently be earned by examination are **Technician, General, and Extra**.

A **Volunteer Examiner** is an amateur **accredited by one or more VECs** who volunteers to administer amateur license exams. **Three Examiners holding a General Class license or higher** are required to administer an Element 2 Technician written exam.

A CSCE (Certificate of Successful Completion) is valid for **365 days** for license upgrade purposes.

The ITU is the **International Telecommunication Union**. The purpose of the three ITU Regions is to assist in the **management of frequency allocations**. The U.S. is in Region 2.

The FCC assigns new amateur radio call signs in **sequential order**. The letters **A, K, N and W** must be used for the first letter in US amateur call signs. A **single digit, 0 through 9** is used in US amateur call signs, for example **KB3TMJ** is a valid US amateur call.

The FCC **vanity call sign program** might be used to obtain a call sign containing your initials. By applying through a **Club Station Call Sign Administrator** you can obtain an amateur radio club station call sign. **Any FCC-licensed amateur** is eligible to apply for the temporary use of a 1-by-1 format Special Event call sign.

Each band, defined by the **approximate wave length** of the electromagnetic waves, has FCC frequencies allocations for ITU Region 2 given in Part 97. The wavelength measured in meters or centimeters (hundredths of a meter) is simply 300 divided by the frequency in MHz. The table below shows the relationships between frequencies and the main amateur bands allocated to Technician class license holders operating in ITU Region 2.

Frequency	300 ÷ Frequency	Amateur Band
52.525 MHz	5.7115	6 meter band
223.500 MHz	1.3423	1.25 meter band
443.350 MHz	0.6767	70-centimeter band
1296 MHz	0.2315	23-centimeter band

## T2 - Control operator duties

Broadcasting is a term used to describe **one-way transmissions intended for reception by the general public, either direct or relayed**. An amateur station is **never** authorized to transmit information to the general public.

**Indecent and obscene language** is specifically prohibited in the Amateur Radio Service. An amateur station can **never** transmit false or deceptive signals. An amateur station can transmit unidentified communications **only when sent from a space station or to control a model craft**. The transmission of codes or ciphers to hide the meaning of a message transmitted by an amateur station is allowed **only when transmitting control commands to space stations or radio control craft**.

**Using amateur radio for conducting business** is a prohibited amateur radio transmission. The FCC allows an amateur radio station to be used as a method of communication for hire or material compensation **only when in accordance with part 97 rules**. You may use your station to tell people about equipment you have for sale **when you are offering amateur radio equipment for sale or trade on an occasional basis**. An example of a type of communication prohibited when using a repeater autopatch is **a call to your employer requesting directions to a customer's office**.

You must transmit **your call sign** to identify your amateur station. A transmission that does not contain a station identification is called an **unidentified communication or signal**. An amateur station must transmit its assigned call sign **every 10 minutes during communications and at the end of each communication**. **Ten (10) minutes** is the longest period of time an amateur station can operate without transmitting its call sign. When two amateur stations end communications, **each station must transmit its own call sign** as identification. When operating using a special event call sign you must also identify using your assigned call sign **once per hour**. When you are speaking to another amateur operator using a language other than English **you must identify your station using the English language**.

There are many acceptable methods of transmitting a repeater station identification. All of the following are acceptable methods,

- **by phone (voice) using the English language**
- **by video image conforming to applicable standards**
- **by Morse code at a speed not to exceed 20 words per minute**

When exercising the operating privileges earned by examination upgrade of a license you can use the indicator "/AG", **(Authorized General)** until the ULS database has been updated by the FCC. When using one or more self-assigned indicators with your assigned call sign, **the indicator must not conflict with an indicator specified by FCC rules or with a prefix assigned to another country**

One person may hold **only one** amateur operator / primary station licenses.

The definition of a control operator of an amateur station is **an operator designated by the licensee to be responsible for the station's transmissions to assure compliance with FCC rules**. When transmitting, every amateur station must have **a control operator**. The **control operator** is responsible for the transmissions from an amateur station. The control point of an amateur station is **the location at which the control operator function is performed**.

It is only permissible for the control operator of a club station to accept compensation for sending information bulletins or Morse code practice **when the station makes those transmissions for at least 40 hours per week**.

The three types of station control permitted and recognized by FCC rules are **local, remote and automatic control**.

- When transmitting using a handheld radio you are using **local control**.
- If the control operator is not present when a repeater is being used, the repeater is operating in **automatic control** mode. The minimum class of amateur license you must hold to be a control operator of a repeater station is **Technician**.
- When the control operator is not at the station location but can still make changes to a transmitter, the station is operating in **remote control**. **An automatically controlled station** is the only type of amateur station that does not require a control operator to be at the control point.

If you transmit from another amateur's station, **both you and the station licensee** are responsible for proper operation. Unlicensed persons in your family are not allowed to transmit on your amateur station if you are not there. **They must be licensed before they are allowed to be control operators**. A good way to keep unauthorized persons from using your amateur station would be to **disconnect the power and microphone cables when not using your equipment**.

When another amateur holding a higher class license is controlling your station, he is **allowed all privileges of his higher class license**. When you are controlling a station of licensee who has a higher class license than yours, you are **allowed only the privileges of your license**. If you hold a higher class license than the station licensee you are visiting and you are using a frequency not authorized to his class of license, you must identify by sending **his call sign first, followed by your call sign**.

The definition of third-party communications is any **message sent between two amateur stations for someone else (a third party)**.

For a club station license to be issued by the FCC, **at least 4 persons** are required to be members of the club.

You may operate your amateur station aboard an aircraft **only with the approval of the pilot in command and not using the aircraft's radio equipment**.

The FCC is allowed to inspect your station equipment and station records **at any time upon request**.

## T3 - Operating practices

The procedural signal "CQ" means **calling any station**. You indicate you are looking for any station with which to make contact by calling **CQ followed by your callsign**. When responding to a call of CQ you should transmit **the other station's callsign followed by your callsign**. Before responding to another stations call, **you should make sure you are operating on a permissible frequency for your license class**.

When selecting a frequency on which to transmit, **listen to determine if the frequency is busy**. The proper way to break into a conversation between two stations that are using the frequency is to **say your call sign between their transmissions**.

Just **saying your call sign** is often used in place of "CQ" to indicate that you are listening for calls on a repeater. If you know the station's call sign, you call another station on a repeater by simply **saying the station's call sign then identify your own station**.

You should use the International Telecommunication Union (ITU) phonetic alphabet when identifying your station because **the words are internationally recognized substitutes for letters**. You should avoid using cute phrases or word combinations to identify your station because **they are not easily understood by some operators**.

A band plan is a **voluntary guideline, beyond the divisions established by the FCC for using different operating modes within an amateur band**. Band plans are **voluntary guidelines for efficient use of the radio spectrum**. The **amateur community** developed the band plans used by amateur radio operators. **The recognized frequency coordination body** is in charge of the repeater frequency band plan in your local area. The main purpose of repeater coordination is **to reduce interference and promote proper use of spectrum**.

**The 6-meter, 2-meter, and 1 1/4-meter bands**, which are available to Technician class licensees, have mode restricted sub-bands. **Only CW** is permitted in the restricted sub-bands 50.0-50.1 MHz and 144.0-144.1 MHz.

**An amateur must use the minimum transmitter power necessary to carry out the desired communication** on the amateur bands. Proper repeater operating practice include all of the following,

- Monitoring before transmitting and keep transmissions short
- Identifying legally
- Using the minimum amount of transmitter power necessary

Amateur radio operators should avoid the use of racial or ethnic slurs when talking to other stations because **it is offensive to some people and reflects a poor public image on all amateur radio operators**. There is no official list of prohibited obscene and indecent words that should not be used in amateur radio. Indecent and obscene language is prohibited in the Amateur Service for all of the following reasons,

- It is offensive to some individuals
- Young children may intercept amateur communications with readily available receiving equipment
- Such language is specifically prohibited by FCC Rules

The types of subjects are **not** prohibited communications while using amateur radio include,

- Political discussions
- Jokes and stories
- Religious preferences

The best way to reduce on the air interference when testing your transmitter is to **use a dummy load when testing**. The term that best describes a brief test transmission that does not include any station identification is **an illegal unidentified transmission**. An amateur must **properly identify the station** when making a transmission to test equipment or antennas. When making a test transmission, **station identification is required at least every ten minutes and at the end of every transmission**.

Receiver front-end overload is the term used to describe **interference caused by strong signals from a nearby source**. If signals from your transmitter are causing front end overload in your neighbor's television receiver, **the owner of the television receiver** is responsible for taking care of the interference. The major cause of telephone interference is **a telephone not equipped with adequate interference protection when it was manufactured**.

**No station has exclusive use of any frequency** when the FCC has not declared a communication emergency. If you unintentionally interfere with another station, **properly identify your station and move to a different frequency**. If two amateur stations want to use the same frequency the rule that applies is **no frequency is assigned for the exclusive use of any station and neither has priority**.

You may **never** deliberately interfere with another station's communications. If you receive a report that your transmissions are causing splatter or interference on nearby frequencies you should **check transmitter for off frequency operation or spurious emissions**.

The effect of a break in a cable television transmission line can have significant effects on amateur communications. **TV interference may result when the amateur station is transmitting, or interference may occur to the amateur receiver.**

FCC rules apply to your station when using amateur radio at the request of public service officials or at the scene of an emergency. When circumstances are not specifically covered by FCC rules, the general operating standard that should be applied to amateur station operation is "**good engineering and amateur practices**". If you hear a newly licensed operator that is having trouble with their station, you should **contact them and offer to help with the problem**.

RACES and ARES are two **organizations that provide communications during emergencies**.

## T4 - Radio and Electronic Fundamentals

The name for the flow of electrons in an electric circuit is **current**. Electrical current is measured in **amperes**. The name of a current that flows only in one direction is **direct current**. The name of a current that reverses direction on a regular basis is an **alternating current**. The instrument used to measure the flow of current in an electrical circuit is an **ammeter**.

The term used to describe opposition to current flow in ordinary conductors such as wires is called **resistance**. The basic unit of resistance is the **ohm**. **Copper** is a good electrical conductor. **Glass** is a good electrical insulator.

The instrument used to measure Electromotive Force (EMF) between two points such as the poles of a battery is a **voltmeter**.

The formulas to compute voltage, current and resistance in a circuit are variants of Ohms law,

- Voltage in a circuit is **Voltage (E)** equals current (I) multiplied by resistance (R) [ $E=I \times R$ ].
- Current in a circuit is **Current (I)** equals voltage (E) divided by resistance (R) [ $I=E \div R$ ].
- Resistance in a circuit is **Resistance (R)** equals voltage (E) divided by current (I) [ $R=E \div I$ ].

The problems in the Technician questions pool that can be solved with these equations are summarized in the following table,

Voltage $E=I \times R$	Current $I=E \div R$	Resistance $R=E \div I$
1 Volt	0.5 amperes	2 ohms
10 Volts	1 ampere	10 ohms
20 Volts	2 amperes	10 ohms
120 Volts	1.5 amperes	80 ohms
200 Volts	2 amperes	100 ohms
240 Volts	10 amperes	24 ohms
90 Volts	3 amperes	30 ohms
12 Volts	1.5 amperes	8 ohms

The **watt** is the unit used to describe electrical power. You determine how many watts are being drawn by your transceiver when you are transmitting by **measuring the DC voltage at the transceiver and multiplying it by the current drawn when you transmit**. Electrical Power is measured in **watts**. The formula used to calculate electrical power in a DC circuit is **Power (P) equals voltage (E) multiplied by current (I)** [ $P=E \times I$ ].

The power represented by a voltage of 13.8 volts DC and a current of 10 amperes is **138 watts**. The power being used in a circuit when the voltage is 120 volts DC and the current is 2.5 amperes is **300 watts**. The amperes flowing in a circuit when the applied voltage is 120 volts DC and the load is 1200 watts is **10 amperes**.

The standard unit of frequency is the **Hertz**. The term that describes the number of times that an alternating current flows back and forth per second is **frequency**. The term for the distance a radio wave travels during one complete cycle is **wavelength**. Sixty (60) hertz (Hz) means **60 cycles per second**.

Sound waves in the range between 300 and 3000 Hertz are called **voice frequencies**. Electromagnetic waves that oscillate more than 20,000 times per second as they travel through space are generally referred to **radio waves**.

A radio wave travel travels through space at **the speed of light**.

The wavelength of a radio wave relates inversely to its frequency - **the wavelength gets shorter as the frequency increases**. The formula for converting frequency to wavelength in meters is **wavelength in meters equals 300 divided by frequency in megahertz**.

**The physical length of the wave** (wavelength) of a radio wave is often used to identify the different bands amateur radio operators use.

- The frequency range of the 2 meter band in the United States is **144 to 148 MHz**.
- The frequency range of the 6 meter band in the United States is **50 to 54 MHz**.
- The frequency range of the 70 centimeter band in the United States is **420 to 450 MHz**.

A **receiver** is used to convert radio signals into sounds we can hear. A **transmitter** is used to convert sounds from our voice into radio signals. A **receiver and transmitter** combined into one unit is called a **transceiver**. An **amplifier** can be used to increase the output of a 10 watt radio to 100 watts.

A **power supply** is used to convert the alternating current from a wall outlet into low-voltage direct current.

An automobile battery usually supplies **about 12 volts**. A **lithium-ion** battery offers the longest life when used with a hand-held radio. The nominal voltage per cell of a fully charged nickel-cadmium battery is **1.2 volts**. A **carbon-zinc battery** is a type that **not** designed to be re-charged.

To keep rechargeable batteries in good condition and ready for emergencies **all** of the following apply,

- They must be inspected for physical damage and replaced if necessary
- They should be stored in a cool and dry location
- They must be given a maintenance recharge at least every 6 months

The best way to get the most amount of energy from a battery is to **draw current from the battery at the slowest rate needed**.

Equivalent units of measurement included in the Technician pool tests are,

- A current of 1.5 amperes is the same as **1500 milliamperes**.
- Another way to specify the frequency of a radio signal that is oscillating at 1,500,000 Hertz is as **1500 kHz**.
- One kilovolt is equivalent to **one thousand volts**.
- One microvolt is equivalent to **one-millionth of a volt**.
- If a hand-held transceiver puts out **0.5 watts** the output power is 500 milliwatts.

## T5 - Station Setup and Operation

### Transceiver Frequency Controls

- RIT means **Receiver Incremental Tuning**
- One way to select a frequency on which to operate is to **use the keypad or VFO knob to enter the correct frequency**
- A quick way to enable access to a favorite frequency on your transceiver is to **store the frequency in a memory channel**. All of the following are kinds of information that a VHF/UHF transceiver may be capable of storing in its memory,
  - Transmit and receive operating frequency
  - CTCSS tone frequency
  - Transmit power level
- The purpose of the "step" menu function found on many transceivers is to **set the tuning rate when changing frequencies**
- The purpose of the buttons labeled "up" and "down" on many microphones is **to allow easy frequency or memory selection**
- The purpose of the "shift" control found on many VHF/UHF transceivers is to **adjust the offset between transmit and receive frequency**

### Other Transceiver Controls

- The purpose of the squelch control on a transceiver is to **quiet noise when no signal is being received**
- The purpose of the "function" or "F" key found on many transceivers is to **select an alternate action for some control buttons**
- If the station you are listening to is hard to copy because of ignition noise interference you might **turn on the noise blanker** to improve the situation

A microphone connects to **the transmitter** in a basic amateur radio station. The piece of station equipment that converts electrical signals to sound waves is the **speaker**. The term used to describe what happens when a microphone and speaker are too close to each other is **audio feedback**. You could use a set of **headphones** in place of a regular speaker to help copy signals in a noisy area.

A **Terminal Node Controller (TNC)** is connected between the transceiver and computer terminal in a packet radio station. One of the items **not** required for a packet radio station is a **microphone**.

A **sound card** can be used to connect a radio with a computer for data transmission. One of the reasons to use digital signals instead of analog signals to communicate with another station is that **many digital systems can automatically correct errors caused by noise and interference**.

What is a good reason for using a regulated power supply for communications equipment is **to protect equipment from voltage fluctuations**.

If another operator tells you he is hearing a variable high-pitched whine on the signals from your mobile transmitter it may be that **the power wiring for your radio is picking up noise from the vehicle's electrical system**. If another operator reports that your SSB signal is very garbled and breaks up it may be that **RF energy may be getting into the microphone circuit and causing feedback**. If a transmitter is operated with the microphone gain set too high, **it may cause the signal to become distorted and unreadable**.

The proper course of action to take when a neighbor reports that your radio signals are interfering with something in his home is to **check your station and make sure it meets the standards of good amateur practice**. **Doppler shift** is **NOT** a cause of radio frequency interference. All of the following may be useful in correcting a radio frequency interference problem,

- Snap-on ferrite chokes
- Low-pass and high-pass filters
- Notch and band-pass filters

If someone tells you that your transmissions are interfering with their TV reception a first step would to **make sure that your station is operating properly and that it does not cause interference to your own television**. To prevent RF overload from a nearby 2-meter transmitter a **notch filter** should be connected to a TV receiver. To reduce spurious emissions a filter should be installed **at the transmitter**. In reference to a receiver, the term fundamental overload means **interference caused by very strong signals from a nearby source**.

The most likely cause of telephone interference from a nearby transmitter is that **the transmitter's signals are causing the telephone to act like a radio receiver**. A first logical step when attempting to cure a radio frequency interference problem in a nearby telephone is to **install an RF filter at the telephone**.

If a "Part 15" device in your neighbor's home is causing harmful interference to your amateur station **all** of the following are possible actions,

- Work with your neighbor to identify the offending device
- Politely inform your neighbor about the rules that require him to stop using the device if it causes interference
- Check your station and make sure it meets the standards of good amateur practice

One purpose of a repeater is **to extend the usable range of mobile and low-power stations**. The term for a series of repeaters that can be connected to one another to provide users with a wider coverage is a **linked repeater system**.

The most important information to know before using a repeater is **the repeater input and output frequencies**. When referring to repeater operations, the terms input and output frequency indicates **the repeater receives on one frequency and transmits on another**. The most common input/output frequency offset for repeaters in the 2-meter band is **0.6 MHz**. The most common input/output frequency offset for repeaters in the 70-centimeter band is **5.0 MHz**.

You should pause briefly between transmissions when using a repeater **to listen for anyone wanting to break in**. A repeater courtesy tone is **a tone used to indicate when a transmission is complete**.

If you receive a report that your signal through a repeater is distorted or weak, **all** of the following might be the reason,

- Your transmitter may be slightly off frequency
- Your batteries may be running low
- You could be in a bad location

The term simplex operation is used to indicate that **transmitting and receiving occurs on the same frequency**. A reason to use simplex instead of a repeater is **to avoid tying up the repeater when direct contact is possible**. You might find out if you could communicate with a station using simplex instead of a repeater by **checking the repeater input frequency to see if you can hear the other station**.

The main reason repeaters should be approved by the local frequency coordinator before being installed is because **coordination minimizes interference between repeaters and makes the most efficient use of available frequencies**.

It is true that **access to any repeater may be limited by the repeater owner**. The term used to describe a repeater when use is restricted to the members of a club or group is a **closed repeater**.

## T6 - Communications Modes and Methods

Phone transmissions are **voice transmissions by radio**. One form of amplitude modulation for voice transmissions is **Single SideBand (SSB)**. The sideband normally used for VHF and UHF SSB communications is the **upper sideband**.

The type of voice modulation most often used for long distance and weak signal contacts on the VHF and UHF bands is **SSB**. The primary advantage of single sideband over FM for voice transmissions is that **SSB signals use much less bandwidth than FM signals**. The type of modulation most commonly used for VHF and UHF voice repeaters is **FM**.

The emission type which has the narrowest bandwidth is **CW**. The approximate bandwidth of a single-sideband voice signal is **between 2 and 3 kHz**. The approximate bandwidth of a frequency-modulated voice signal is **between 5 and 15 kHz**. The normal bandwidth required for a conventional fast-scan TV transmission using combined video and audio on the 70-centimeter band is **about 6 MHz**.

The name given to an amateur radio station that is used to connect other amateur stations to the Internet is **a gateway**.

The abbreviation IRLP stands for **Internet Radio Linking Project**. The term IRLP describes **a method of linking between two or more amateur stations using the Internet**. The method used to transfer data by IRLP is **Voice over Internet Protocol (VoIP)**. When using a portable transceiver you select a specific IRLP node by using **the keypad to transmit the IRLP node numbers**. The technology that EchoLink and IRLP have in common is **Voice over Internet Protocol (VoIP)**.

EchoLink allows computer-to-radio linking for voice transmission. **Any licensed amateur radio operator** may operate on the Echolink system.

If you hear a brief tone and then a station from Russia calling CQ on a 2-meter repeater you are probably listening to **an Internet linked DX station**.

You might find a list of active nodes using VoIP in **a repeater directory or the Internet**.

**Packet radio** is an example of a digital communications method.

The term APRS means **Automatic Position Reporting System (APRS)**. A **global positioning system receiver** is required along with your normal radio for sending automatic location reports.

The type of transmission indicated by the term NTSC is **a standard fast scan color television signal**.

The emission mode that may be used by a Technician class operator in the 219 - 220 MHz frequency range is **point-to-point digital message forwarding**.

The abbreviation PSK means **Phase Shift Keying**. PSK31 is **a low-rate data transmission mode that works well in noisy conditions**.

The recommended sending speed when using Morse code is **any speed at which you can reliably receive**. A practical reason for being able to copy CW when using repeaters is to **recognize a repeater ID sent in Morse code**.

The "Q" signal used to indicate that you are receiving interference from other stations is **QRM**. The "Q" signal used to indicate that you are changing frequency is **QSY**.

## T7 - Special Operations

A good thing to have when operating a hand-held transceiver away from home is **one or more fully charged spare battery packs**. A good thing to have when operating from a location that includes lots of crowd noise is **a combination headset and microphone**. Items that would probably **not** be very useful to include in an emergency response kit is **a 1500 watt output linear amplifier**.

One way you make the signal from a hand-held radio stronger when operating in the field is to **use an external antenna instead of the rubber-duck antenna**. **Radio direction finding** is a method that could be used to locate sources of noise interference or jamming. An item that would be the most useful for a hidden transmitter hunt is a **directional antenna**.

A grid locator is a **letter-number designator assigned to a geographic location**.

A popular operating activity that involves contacting as many stations as possible during a specified period of time is called **contesting**.

A special event station is a **temporary station that operates in conjunction with an activity of special significance**.

The only station identification requirement when sending commands to a radio control model using amateur frequencies is a **label indicating the licensee's call sign and address must be affixed to the transmitter**. The maximum power allowed when transmitting telecommand signals to radio controlled models is **1 watt**.

The name of the group that coordinates the building and/or launch of the largest number of amateur radio satellites is **AMSAT**.

**Any amateur whose license allows them to transmit on the satellite uplink frequency** may use amateur satellites. When using an amateur radio satellite you can **talk to amateur radio operators in other countries**. You should use **the minimum amount of power needed to complete the contact** when using an amateur satellite.

**Any amateur with a Technician or higher class license** may make contact with an astronaut on the International Space Station using amateur radio frequencies.

A satellite beacon is a **signal that contains information about a satellite**. To determine when you can access an amateur satellite you should use **a satellite tracking program**. Doppler shift is a **change in signal frequency caused by motion through space**.

A satellite sub-band is a **portion of a band where satellite operations are permitted**. The satellite sub-band on 70-CM is **435 to 438 MHz**.

The initials **LEO** associated with an amateur satellite that tells you that **the satellite is in a Low Earth Orbit**.

## T8 - Emergency and Public Service Communications

The information included in an FCC declaration of a temporary state of communication emergency is **any special conditions and rules to be observed during the emergency**. An FCC declaration of a communications emergency is legally required to restrict a frequency to emergency-only communication. Restrictions on amateur radio communications after the FCC has declared a communications emergency require **you to avoid those frequencies dedicated to supporting the emergency unless you are participating in the relief effort**. If the FCC has not declared a communication emergency **no station has exclusive use of a frequency**.

**Emergency communications** has priority at all times in the Amateur Radio Service. Priority must be given to stations providing emergency communications **at all times and on all frequencies**. If you hear someone reporting an emergency you should **assume the emergency is real and act accordingly**. If you are in contact with another station and an emergency call is heard you should **stop your contact immediately and take the emergency call**.

The penalties for making a false emergency call include **all** of the following,

- You could have your license revoked
- You could be fined a large sum of money
- You could be sent to prison

You may use your amateur station to transmit a "SOS" or "MAYDAY" signal only **when there is immediate threat to human life or property**. An appropriate way to initiate an emergency call on amateur radio is to say "**Mayday, Mayday, Mayday**" followed by "**any station come in please**" and **identify your station**.

Amateur stations are allowed to communicate with stations operating in other radio services only **when specially authorized by the FCC, or in an actual emergency**. In a genuine emergency you may use any means at your disposal to call for help on any frequency. You can use non-amateur frequencies or equipment to call for help in a situation involving immediate danger to life or property. You use a modified amateur radio transceiver to transmit on the local fire department frequency.

During emergencies messages involving **personal information concerning victims** should not be transmitted over amateur radio frequencies. One way to reduce the chances of casual listeners overhearing sensitive emergency traffic is to **pass messages using a non-voice mode such as packet radio or Morse code**.

If a large scale emergency has just occurred and no net control station is available you should **open the emergency net immediately and ask for check-ins**.

**Emergency traffic** is the highest priority traffic. If someone breaks in with emergency traffic, a net control station should **stop all net activity until the emergency has been handled**. To minimize disruptions to an emergency traffic net once you have checked in **do not transmit on the net frequency until asked to do so by the net control station**.

**A strong and clear signal** is of primary importance for a net control station. Casual conversation between stations during a public service event should be avoided because **idle chatter may interfere with important traffic**. One reason for using tactical call signs such as "command post" or "weather center" during an emergency is that **they are more efficient and help coordinate public-service communications**.

The preamble of a message includes **the information needed to track the message as it passes through the amateur radio traffic handling system**. When passing emergency messages the one thing that must be included is **the name of the person originating the message**.

The term "check" in reference to a message is **a count of the number of words in the message**. The recommended guideline for the maximum number of words to be included in the text of an emergency message is **25 words**.

In relation to emergency activities **RACES organizations are restricted to serving local, state, and federal government emergency management agencies**. You must register with the responsible civil defense organization before you can participate in RACES activities.

In relation to emergency activities **ARES supports agencies like the Red Cross, Salvation Army, and National Weather Service**. Before you can join an ARES group you must have an amateur radio license.

If a reporter asks to use your amateur radio transceiver to make a news report you should **advise them that the FCC prohibits such use**.

You can do **all** of the following to be prepared for an emergency situation where your assistance might be needed,

- Check at least twice a year to make sure you have all of your emergency response equipment and know where it is
- Make sure you have a way to run your equipment if there is a power failure in your area
- Participate in drills that test your ability to set up and operate in the field

As an alternate source of power to operate radio equipment during emergencies **all** of the following could be used,

- The battery in a car or truck
- A bicycle generator
- A portable solar panel

## T9 - Radio waves, Propagation, and Antennas

A beam antenna is an antenna that concentrates signals in one direction. The Quad, Yagi, and Dish antennas are all directional or beam antennas.

An antenna that consists of a single element mounted perpendicular to the Earth's surface is a **vertical antenna**. The advantage of a 5/8 wavelength over 1/4 wavelength vertical antennas is that **their radiation pattern concentrates energy at lower angles**.

A simple dipole antenna mounted so the elements are parallel to the Earth's surface is a **horizontal antenna**. The physical size of half-wave dipole antenna **becomes shorter as the frequency increases**.

The disadvantage of the "rubber duck" antenna supplied with most hand held radio transceivers is that **it does not transmit or receive as effectively as a full sized antenna**. A good reason not to use a "rubber duck" antenna inside your car is that **signals can be 10 to 20 times weaker than when you are outside of the vehicle**.

One type of antenna that offers good efficiency when operating mobile and can be easily installed or removed is a **magnet mount vertical antenna**.

A primary purpose of a dummy load is to insure **it does not radiate interfering signals when making tests**.

The *approximate length*, in inches, of a quarter-wavelength vertical antenna for 146 MHz is **19 inches (95% of  $\frac{1}{4} \times 2M$  × 39.37 in. = 18.7 in.)**, and of a 6-meter half-wavelength wire dipole antenna it is **112 inches (95% of  $\frac{1}{2} \times 6M$  × 39.37 in. = 112 in.)**.

VHF/UHF signals are not normally heard over long distances because **VHF and UHF signals are usually not reflected by the ionosphere**. When we hear a VHF signal from long distances a possible cause is **sporadic E reflection from a layer in the ionosphere**.

The most likely cause of sudden bursts of tones or fragments of different conversations that interfere with VHF or UHF signals is **strong signals are overloading the receiver and causing undesired signals to be heard**.

The radio horizon is **the point where radio signals between two points are blocked by the curvature of the Earth**. UHF signals often work better inside buildings than VHF signals because **the shorter wavelength of UHF signals allows them to more easily penetrate urban areas and buildings**.

If the antennas at opposite ends of a VHF or UHF line of sight radio link are not using the same polarization, **signals could be as much as 100 times weaker**.

A way to reach a distant repeater if buildings or obstructions are blocking the direct line of sight path would be to **try using a directional antenna to find a path that reflects signals to the repeater**. A good thing to remember when using your hand-held VHF or UHF radio to reach a distant repeater is to **keep the antenna as close to vertical as you can**. If a station reports that your signals were strong just a moment ago, but now they are weak or distorted you can **try moving a few feet; random reflections may be causing multi-path distortion**.

The term commonly used to describe the rapid fluttering sound sometimes heard from mobile stations that are moving while transmitting is **picket fencing**.

VHF and UHF Radio signals usually travel about a third farther than the visual line of sight distance between 2 stations because **the Earth seems less curved to radio waves than to light**.

The standing wave ratio (SWR) is a **measure of how well a load is matched to a transmitter**. The reading on a SWR meter that indicates a perfect impedance match between the antenna and the feed line is **1 to 1**. The SWR value where the protection circuits in most solid-state transmitters begin to reduce transmitter power is **2 to 1**. A loose connection in your antenna or feedline might be indicated by erratic changes in SWR readings. An instrument other than a SWR meter that you could use to determine if your feedline and antenna are properly matched is a **directional wattmeter**.

The most common reason for failure of coaxial cables is **moisture contamination**. If older coaxial cables are exposed to weather and sunlight for several years, **losses can increase dramatically**. The outer sheath of most coaxial cables is black because **black provides protection against ultraviolet damage**.

It's important to have a low SWR antenna system that uses coaxial cable feedline to **allow efficient transfer of power and reduce losses**. The power lost in a feed line is **converted into heat by losses in the line**. Coaxial cable is used more often than any other feed line for amateur radio antenna systems because **it is easy to use and requires few special installation considerations**. The impedance of the most commonly used coaxial cable in typical amateur radio installations is **50 Ohms**.

## T0 - Electrical and RF Safety

The commonly accepted value for the lowest voltage that can cause a dangerous electric shock is **30 volts**. The lowest amount of electrical current flowing through the human body that is likely to cause death is **100 milliamperes**.

The green wire in a three-wire electrical plug is connected to **ground**. The purpose of a fuse in an electrical circuit is **to interrupt power in case of overload**. If you install a 20-ampere fuse in your transceiver in the place of a 5-ampere fuse it is possible that **excessive current could cause a fire**.

There is a hazard that might still exist in a power supply when it is turned off and disconnected. **You might receive an electric shock from stored charge in large capacitors**.

All of the following are good ways to guard against electrical shock at your station,

- Use 3-wire cords and plugs for all AC powered equipment
- Connect all AC powered station equipment to a common ground
- Use a ground-fault interrupter at each electrical outlet

The most important thing to consider when installing an emergency disconnect switch at your station is that **everyone should know where it is and how to use it**.

The most important reason to have a lightning protection system for your amateur radio station is **fire prevention**. All of the following are precautions you should take when a lightning storm is expected,

- Disconnect the antenna cables from your station and move them away from your radio equipment
- Unplug all power cords from AC outlets
- Stop using your radio equipment and move to another room until the storm passes

If the commercial power is out, one way to recharge a 12-volt battery is to **connect the battery to a car's battery and run the engine**. If a storage battery is charged or discharged too quickly, **the battery could overheat and give off dangerous gas or explode**. A 12-volt storage battery can present **all** of the following hazards

- It contains dangerous acid that can spill and cause injury
- Short circuits can damage wiring and possibly cause a fire
- Explosive gas can collect if not properly vented

You should wear a hard hat and safety glasses if you are on the ground helping someone work on an antenna tower **to protect your head and eyes in case something accidentally falls from the tower**. A good precaution to observe before climbing an antenna tower is to **put on your safety belt and safety glasses**. Before you climb a tower you should do **all** of the following,

- Arrange for a helper or observer
- Inspect the tower for damage or loose hardware
- Make sure there are no electrical storms nearby

An important consideration when putting up an antenna is that you **make sure people cannot accidentally come into contact with it**. If a person accidentally touched your antenna while you were transmitting **they might receive a painful RF burn injury**.

When erecting an antenna near an airport you need to consider **the maximum allowed height with regard to nearby airports**.

The most important safety precaution to observe when putting up an antenna tower is **to look for and stay clear of any overhead electrical wires**. A safe distance from a power line to allow when installing an antenna is to consider that **if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power wires**.

Guy wires for an antenna tower should be installed **in accordance with the tower manufacturer's instructions**. An adequate ground for a tower is considered to be **separate 8 foot long ground rods for each tower leg, bonded to the tower and each other**. The most important safety rule to remember when using a crank-up tower is that **a crank-up tower should never be climbed unless it is in the fully lowered position**.

Stainless steel hardware is used on many antennas instead of other metals because **stainless steel parts are much less likely to corrode**.

VHF and UHF radio signals are **non-ionizing radiation**. Radio waves can cause injury to the human body **only if the combination of signal strength and frequency cause excessive power to be absorbed**. The frequency of an RF source must be considered when evaluating RF radiation exposure because **the human body absorbs more RF energy at some frequencies than others**.

Factors that affect the RF exposure of people near an amateur transmitter include all of the following,

- Frequency and power level of the RF field
- Distance from the antenna to a person
- Radiation pattern of the antenna

The maximum power level that an amateur radio station may use at frequencies above 30 MHz before an RF exposure evaluation is required is **50 watts PEP at the antenna**.

You can make sure your station stays in compliance with RF safety regulations **by re-evaluating the station whenever an item of equipment is changed**. The duty cycle is one of the factors used to determine safe RF radiation exposure levels because **it takes into account the amount of time the transmitter is operating**. You can determine that your station complies with FCC RF exposure regulations with **all** of the following,

- By calculation based on FCC OET Bulletin 65
- By calculation based on computer modeling
- By measurement of field strength using calibrated equipment

Amateur operators might take **all** of the following to prevent exposure to RF radiation in excess of FCC supplied limits

- Alter antenna patterns
- Relocate antennas
- Change station parameters such as frequency or power

The unit of measurement for RF radiation exposure is **milliwatts per square centimeter**.