

# **Radio Communications**



## **A Study Guide for the Amateur Radio Technician Exam**

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**Based on the FCC Exam Question Pool Valid 7/1/06**

## **2006 Technician Class (Element 2) Master syllabus**

### **35 Exam questions**

#### **SUBELEMENT T1 – FCC Rules, station license responsibilities - 4 exam questions – 4 groups**

**T1A - Basis and purpose of the Amateur Radio Service, penalties for unlicensed operation, other penalties, examinations**

**T1B - ITU regions, international regulations, US call sign structure, special event calls, vanity call signs**

**T1C – Authorized frequencies (Technician), reciprocal licensing, operation near band edges, spectrum sharing**

**T1D - The station license, correct name and address on file, license term, renewals, grace period**

#### **SUBELEMENT T2 - Control operator duties – 4 exam questions – 4 groups**

**T2A - Prohibited communications: music, broadcasting, codes and ciphers, business use, permissible communications, bulletins, code practice, incidental music**

**T2B - Basic identification requirements, repeater ID standards, identification for non-voice modes, identification requirements for mobile and portable operation**

**T2C – Definition of control operator, location of control operator, automatic and remote control, auxiliary stations**

**T2D - Operating another person's station, guest operators at your station, third party communications, autopatch, incidental business use, compensation of operators, club stations, station security, station inspection, protection against unauthorized transmissions**

#### **SUBELEMENT T3 – Operating practices – 4 exam questions – 4 groups**

**T3A - Choosing an operating frequency, calling CQ, calling another station, test transmissions**

**T3B - Use of minimum power, band plans, repeater coordination, mode restricted sub-bands**

**T3C - Courtesy and respect for others, sensitive subject areas, obscene and indecent language**

**T3D - Interference to and from consumer devices, public relations, intentional and unintentional interference**

#### **SUBELEMENT T4 – Radio and electronic fundamentals – 5 exam questions – 5 groups**

T4A – Names of electrical units, DC and AC, what is a radio signal, conductors and insulators, electrical components

T4B – relationship between frequency and wavelength, identification of bands, names of frequency ranges, types of waves

T4C - How radio works: receivers, transmitters, transceivers, amplifiers, power supplies, types of batteries, service life

T4D – Ohms law relationships

T4E - Power calculations, units, kilo, mega, milli, micro

#### **SUBELEMENT T5 – Station setup and operation - 4 exam questions – 4 groups**

T5A - Station hookup – microphone, speaker, headphones, filters, power source, connecting a computer

T5B - Operating controls

T5C – Repeaters; repeater and simplex operating techniques, offsets, selective squelch, open and closed repeaters, linked repeaters

T5D – Recognition and correction of problems, symptoms of overload and overdrive, distortion, over and under modulation, RF feedback, off frequency signals, fading and noise, problems with digital communications links

#### **SUBELEMENT T6 – Communications modes and methods – 3 exam questions - 3 groups**

T6A - Modulation modes, descriptions and bandwidth (AM, FM, SSB)

T6B - Voice communications, EchoLink and IRLP

T6C – Non-voice communications - image communications, data, CW, packet, PSK31, Morse code techniques, Q signals

#### **SUBELEMENT T7 – Special operations – 2 exam questions – 2 groups**

T7A – Operating in the field, radio direction finding, radio control, contests, special event stations

T7B – Satellite operation, Doppler shift, satellite sub bands, LEO, orbit calculation, split frequency operation, operating protocols, AMSAT, ISS communications

**SUBELEMENT T8 – Emergency and Public Service Communications – 3 exam questions – 3 groups**

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T8B - Preparation for emergency operations, RACES/ARES, safety of life and property, using ham radio at civic events, compensation prohibited

T8C - Net operations, responsibilities of the net control station, message handling, interfacing with public safety officials

**SUBELEMENT T9 – Radio waves, propagation, and antennas - 3 exam questions – 3 groups**

T9A - Antenna types – vertical, horizontal, concept of gain, common portable and mobile antennas, losses with short antennas, relationships between antenna length and frequency, dummy loads

T9B – Propagation, fading, multipath distortion, reflections, radio horizon, terrain blocking, wavelength vs. penetration, antenna orientation

T9C – Feedlines types, losses vs. frequency, SWR concepts, measuring SWR, matching and power transfer, weather protection, feedline failure modes

**SUBELEMENT T0 – Electrical and RF Safety – 3 exam questions – 3 groups**

T0A – AC power circuits, hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance

T0B – Antenna installation, tower safety, overhead power lines

T0C - RF hazards, radiation exposure, RF heating hazards, proximity to antennas, recognized safe power levels, hand held safety, exposure to others

## **How to use this study guide.**

Contained within the next 20 pages is a text derived from the official exam question pool. All of the distractor answers have been removed, and the remaining questions with correct answers have been converted to simple statements of fact. Those statements have been arranged into paragraphs of related information to assist you in becoming familiar with the material required to pass the Technician level Amateur Radio examination Element 2. All of the subject material referenced in the FCC Syllabus above is covered in the study guide text. Should you desire to see the actual question pool text, it is available from the ARRL at:

<http://www.arrl.org/arrlvec/pools.html>

Be sure to get the new Technician question pool text for exams given on or after 7/1/06.

It is the expressed opinion of the author and editor of this study guide that studying the full question pool text is counterproductive in attempting to obtain your Technician License. We therefore do not recommend the link posted above for study, but only for supplemental information purposes.

This study guide is divided into 10 sections corresponding with the sub-elements listed in the syllabus shown above. Each section deals with a set of facts representing a block of the exam pool questions. The verbiage of those fact statements has been carefully presented in a way designed to make the correct answers stand out when the information is viewed in the form of a multiple choice question. During the exam you should generally go with this first impression as your selected answer.

This study guide does not represent the total of knowledge you should have as a radio operator, but only represents the beginning step required to pass the entry level Technician exam.

If you have questions and need an answer, we will reply to email at:

[jnordlund@earthlink.net](mailto:jnordlund@earthlink.net)

Be sure to put "Ham radio class question" in the subject line.

We hope your study experience is a pleasant and successful one.

73 and good luck - AD5FU, John and KD5QMD, Lynette.

Have fun!

Let's get started..

## **SUBELEMENT T1 – FCC Rules, station license responsibilities - 4 exam questions – 4 Groups**

The ITU (International Telecommunication Union) is the United Nations Agency that is responsible for the administration of international treaties and regulations of radio services. The ITU divides the world into Regions that are used to assist in the management of frequency allocations. The Continental United States is in ITU Region 2.

Under authority given by the Communications Act of 1931, the Federal Communications Commission (FCC) makes and enforces the rules for the Amateur Radio Service in the United States. Those rules are known officially as the Code of Federal Regulations 47 part 97. We refer to this set of rules for the Amateur Radio Service as Part 97.

The Federal Communications Commission is the government agency that grants your amateur radio license. Only in the Amateur Radio Service is an operator station license issued by the FCC.

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

Before you can 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.

You may transmit after passing the required examination elements for your first amateur radio license as soon as your license grant appears in the FCC's ULS database. Anyone can become an amateur licensee in the US except a representative of a foreign government. There is no minimum age requirement to hold an amateur license.

The classes of US amateur radio licenses that may currently be earned by examination are Technician, General, and Extra. License examinations are administered by Volunteer Examiners. A Volunteer Examiner is an amateur accredited by one or more VECs (Volunteer Examination Coordinators) 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. When you pass an examination element you will receive a Certificate of Success Completion of Examination or CSCE. A CSCE is valid for license upgrade purposes for 365 days.

One of the basic purposes 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. Second is the continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art. Third is the encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art. The last two of the five fundamental purposes for the Amateur Radio Service are to increase the number of trained radio operators and electronics experts, and to improve international goodwill. A US amateur operator may communicate with an amateur in a foreign country at any time unless prohibited by either government.

A US amateur license allows you to transmit from wherever the Amateur Radio Service is regulated by the FCC and where reciprocal agreements are in place. You are allowed to operate your amateur station in a foreign country when there is a reciprocal operating agreement between the countries.

An Amateur radio operator must have a correct name and mailing address on file with the FCC to receive mail delivery from the FCC by the United States Postal Service. If mail is returned to the FCC as undeliverable the FCC may revoke or suspend a license because the mailing address of the holder is not current with the FCC. The address the FCC requires to be kept up to date on the Universal Licensing System database is the station licensee's mailing address.

The normal term for an amateur station license grant is 10 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 grace period during which the FCC will renew an expired 10-year license without re-examination is 2 years.

In most cases the system the FCC uses to select new amateur radio call signs is based on the call signs being assigned in sequential order. The letters that must be used for the first letter in US amateur call signs are A, K, N and W, and the number used in US amateur call signs is a **single** digit, 0 through 9. **KB3TMJ** is an example of a valid US amateur call sign. On the exam they might offer call signs like UZ4FWD, KBL7766, or VE3TWJ. While KBL7766 does start with a K, and would be a US call sign, the call sign does not follow the format rules for Amateur Radio call signs.

The FCC call sign program you might use to obtain a call sign containing your initials is the vanity call sign program.

An amateur radio club might obtain a club station call sign by applying through a Club Station Call Sign Administrator.

Any FCC-licensed amateur is eligible to apply for temporary use of a 1-by-1 format Special Event call sign. Special event call signs expire after a 30 day period and the call sign is returned to the pool for later use.

There are some frequencies you should recognize as a Technician class radio operator. For example 52.525 Mhz is a frequency within the 6-meter band. You are using the 2 meter band when transmitting on 146.52 Mhz. 443.350 Mhz is a 70-centimeter frequency that is authorized to a Technician class license holder operating in ITU Region 2. 1296 Mhz is a 23 centimeter frequency that is authorized to a Technician class license holder operating in ITU Region 2. If you are operating on 223.50 Mhz, you are using the 1.25 meter band. While having a note card with the frequencies of band edges and sub-bands around as an operating aid is a good idea, these specific frequencies may be referenced in exam questions.

Normally amateur stations may only communicate with other amateur stations. Occasionally, when authorized by the FCC amateur stations are allowed to communicate with stations operating in other radio services. This would be for emergencies, or events like Armed Forces Day.

When the FCC rules state that an amateur frequency band is said to be available on a secondary basis amateurs may not cause harmful interference to primary users.

Types of communications that are permitted would include brief transmissions to make adjustments to the station, brief transmissions to establish two-way communications with other stations, and transmissions to assist persons learning or improving proficiency in CW. Communications on a regular basis that could reasonably be furnished alternatively through other radio services are not permitted in the Amateur Radio Service.

Your responsibility as a station licensee is to insure that your station operates in accordance with the FCC rules at all times.

### **SUBELEMENT T2 - Control operator duties – 4 exam questions – 4 groups**

Indecent and obscene language are specifically prohibited in the Amateur Radio Service. If you wouldn't say it in church, don't say it on the radio.

Using a call sign that is not yours or transmitting a distress call when there is no emergency is defined as false or deceptive signals. An amateur station may never transmit false or deceptive signals.

An amateur station is not authorized to transmit music, except as incidental to an authorized rebroadcast of space shuttle communications.

The transmission of codes or ciphers is allowed to hide the meaning of a message transmitted by an amateur station only when transmitting control commands to space stations or radio control craft.

The term broadcasting means transmissions intended for reception by the general public, either direct or relayed. Broadcasts are one-way communications intended for reception by the general public and may not be transmitted in the Amateur Radio Service. An amateur station is never authorized to transmit information to the general public.

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. It is 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.

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. Using amateur radio for conducting business is a prohibited amateur radio transmission. Calls to your employer requesting directions to a customer's office are communications that are prohibited when using a repeater autopatch. Calls to a recorded weather report, to the police reporting a traffic accident, or to a public utility reporting an outage of your telephone would be permitted uses of an autopatch system.

The longest period of time an amateur station can operate without transmitting its call sign is 10 minutes. When two amateur stations end communications identification is required and each station must transmit its own call sign.

You must transmit your call sign to identify your amateur station. An amateur station must transmit the assigned call sign every 10 minutes during communications and at the end of each communication.

A transmission that does not contain a station identification is called unidentified communications or signals. An amateur station may transmit unidentified communications only when sent from a space station or to control a model craft.

Acceptable methods of transmitting a repeater station identification would include by phone using the English language, by video image conforming to applicable standards, or by Morse code at a speed not to exceed 20 words per minute. All of these answers are correct.

When you are speaking to another amateur operator using a language other than English you must identify using the English language.

While operating using a special event call sign you must identify using your own assigned call sign once per hour.

If you are 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.

The correct way to identify when visiting a station if you hold a higher class license than that of the station licensee and you are using a frequency not authorized to his class of license is to send his call sign first, followed by your call sign.

When exercising the operating privileges earned by examination upgrade of a license you would append "/AG" to your call sign, meaning "authorized General."

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. Remember, both operators are actually responsible. An amateur station must have a control operator whenever the station is transmitting. 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. Unlicensed persons in your family are not allowed to transmit on your amateur station if you are not there because they must be licensed before they are allowed to be control operators. You might best keep unauthorized persons from using your amateur station by disconnecting the power and microphone cables when not using your equipment.

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

The three types of station control permitted and recognized by FCC rule are local, remote, and automatic control. The type of control being used on a repeater when the control operator is not present is automatic control. The type of amateur station that does not require a control operator to be at the control point is an automatically controlled station. The type of control being used when transmitting using a handheld radio is local control. Remote control is the type of control used when the control operator is not at the station location but can still make changes to a transmitter. The minimum class of amateur license must you hold to be a control operator of a repeater station is a Technician license.

The operating privileges allowed when another amateur holding a higher class license is controlling your station are all privileges allowed by the higher class license. When you are the control operator at the station of another amateur who has a higher class license than yours only the privileges allowed by your license may be used. In either situation, both of you are responsible for proper operation of the station.

At least 4 persons are required to be members of a club for a club station license to be issued by the FCC.

A person may hold only one amateur operator / primary station license.

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.

A transmission that disturbs other communications is called harmful interference.

### **SUBELEMENT T3 – Operating practices – 4 exam questions – 4 groups**

When selecting a frequency on which to transmit, listen to determine if the frequency is busy. This should always be how you start when using your radio.

To call another station on a repeater when you know the station's call sign say the station's call sign then identify your own station.

The procedural signal "CQ" means calling any station. To indicate that you are looking for any station with which to make contact say CQ followed by your call sign. In place of "CQ" to indicate that you are listening for calls on a repeater just say your call sign.

Before responding to another stations call you should make sure you are operating on a permissible frequency for your license class. When responding to a call of CQ you should transmit the other station's call sign followed by your call sign. You should avoid using cute phrases or word combinations to identify your station because they are not easily understood by some operators. You should use the International Telecommunication Union (ITU) phonetic alphabet when identifying your station because the words are internationally recognized substitutes for letters.

An illegal unidentified transmission describes a brief test transmission that does not include any station identification. When making a transmission to test equipment or antennas an amateur must properly identify the station. When making a test transmission station identification is required at least every ten minutes and at the end of every transmission.

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 transmitting station is accountable if a repeater station inadvertently retransmits communications that violate FCC rules.

While legal power levels on the amateur bands may be as high as 1500 watts PEP, an amateur must use the minimum transmitter power necessary to carry out the desired communication.

The 6-meter, 2-meter, and 1 1/4-meter bands available to Technician class licensees have mode restricted sub-bands. CW is the only emission mode permitted in the restricted sub-band at 50.0-50.1 Mhz and in the restricted sub-band at 144.0-144.1 Mhz. CW and Data are the emission modes permitted in the restricted portion of the 1 1/4-meter band.

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. Proper repeater operating practice involves three simple concepts, monitor before transmitting and keep transmissions short, identify legally, and use the minimum amount of transmitter power necessary.

If two amateur stations want to use the same frequency no frequency will be assigned for the exclusive use of any station and neither has priority.

Political discussions, jokes and stories, and religious preferences are not prohibited communications while using amateur radio. Keep in mind however that some of these topics may start a big argument.

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.

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.

Indecent and obscene language is prohibited in the Amateur Service because it is offensive to some individuals, because young children may intercept amateur communications with readily available receiving equipment, and because such language is specifically prohibited by FCC Rules. There is no official list of prohibited obscene and indecent words that should not be used in amateur radio. The rule to follow is simple. If you wouldn't say it in church, don't say it on the radio.

When circumstances are not specifically covered by FCC rules the general operating standard that must be applied to amateur station operation is good engineering and amateur practices.

If you receive a report that your transmissions are causing splatter or interference on nearby frequencies you should check the transmitter for off frequency operation or spurious emissions.

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 that the telephone was not equipped with adequate interference protection when manufactured.

The proper course of action if you unintentionally interfere with another station is to properly identify your station and move to a different frequency. You may never deliberately interfere with another station's communications.

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

The best way to reduce on the air interference when testing your transmitter is to use a dummy load when testing.

RACES and ARES are both organizations that provide communications during emergencies. FCC rules apply to your station when using amateur radio at the request of public service officials or at the scene of an emergency.

Receiver front-end overload is interference caused by strong signals from a nearby source.

When the FCC has not declared a communication emergency no station has exclusive use of any frequency.

#### **SUBELEMENT T4 – Radio and electronic fundamentals – 5 exam questions – 5 groups**

Current is the name for the flow of electrons in an electric circuit. Electrical current is measured in amperes. An Ammeter is the instrument used to measure the flow of current in an electrical circuit.

Resistance is the term used to describe opposition to current flow in ordinary conductors such as wires. The ohm is the basic unit of resistance.

Copper is a good electrical conductor. Glass is a good electrical insulator.

Direct current is the name of a current that flows only in one direction. An alternating current is the name of a current that reverses direction on a regular basis. Frequency is the term that describes the number of times that an alternating current flows back and forth per second. 60 hertz (Hz) means 60 cycles per second. The Hertz is the standard unit of frequency.

Wavelength is the name for the distance a radio wave travels during one complete cycle. A radio wave travels through space at the speed of light. The wavelength of a radio wave relates to its frequency in that the wavelength gets shorter as the frequency increases. The property of a radio wave often used to identify the different bands amateur radio operators use is the physical length of the wave. The formula for converting frequency to wavelength in meters is wavelength in meters equals 300 divided by frequency in megahertz.

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

A Voltmeter is the instrument used to measure Electromotive Force (EMF) between two points such as the poles of a battery. An automobile battery usually supplies about 12 volts.

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 transmitter is used to convert sounds from our voice into radio signals. A receiver is used to convert radio signals into sounds we can hear. In a transceiver the receiver and transmitter devices are combined into one unit.

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

The amplifier is a device used to increase the output of a 10 watt radio to 100 watts.

When choosing between Lead-acid, Alkaline, Nickel-cadmium, or Lithium-ion batteries, the Lithium Ion offers the longest life when used with a hand-held radio, assuming each battery is the same physical size.

1.2 volts is the nominal voltage per cell of a fully charged nickel-cadmium battery.

The carbon-zinc battery type is not designed to be re-charged.

To keep rechargeable batteries in good condition and ready for emergencies they must be inspected for physical damage and replaced if necessary. They should be stored in a cool and dry location and 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.

The formula used to calculate current in a circuit is current (I) equals voltage (E) divided by resistance (R).

The formula used to calculate voltage in a circuit is voltage (E) equals current (I) multiplied by resistance (R).

The formula used to calculate resistance in a circuit is resistance (R) equals voltage (E) divided by current (I).

30 ohms is the resistance of a circuit when a current of 3 amperes flows through a resistor connected to 90 volts.

8 ohms is the resistance in a circuit where the applied voltage is 12 volts and the current flow is 1.5 amperes.

1.5 amperes is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms.

1 volt is the voltage across the resistor if a current of 0.5 amperes flows through a 2 ohm resistor.

10 volts is the voltage across the resistor if a current of 1 ampere flows through a 10 ohm resistor.

20 volts is the voltage across the resistor if a current of 2 amperes flows through a 10 ohm resistor.

2 amperes is the current flowing through a 100 ohm resistor connected across 200 volts.

10 amperes is the current flowing through a 24 ohm resistor connected across 240 volts.

Electrical Power is measured in watts. The Watt is the unit used to describe electrical power. The formula used to calculate electrical power is power (P) equals voltage (E) multiplied by current (I). You can determine how many watts are being drawn by your transceiver when you are transmitting if you measure the DC voltage at the transceiver and multiply by the current drawn when you transmit.

138 watts is the power represented by a voltage of 13.8 volts and a current of 10 amperes.

300 watts is the power being used in a circuit when the voltage is 120 volts and the current is 2.5 amperes.

10 amperes are flowing in a circuit when the applied voltage is 120V and the load is 1200 watts.

1500 milliamperes is the same as 1.5 amperes.

Another way to specify the frequency of a radio signal that is oscillating at 1,500,000 Hertz is 1500 kHz.

One thousand volts is equal to one kilovolt.

One one-millionth of a volt is equal to one microvolt.

A hand-held transceiver puts out 0.5 watts if the output power is 500 milliwatts.

### **SUBELEMENT T5 – Station setup and operation - 4 exam questions – 4 groups**

A microphone connects to the transmitter in a basic amateur radio station.

A Terminal Node Controller is connected between the transceiver and computer terminal in a packet radio station. A microphone is not required for a packet radio station. A sound card can be used to connect a radio with a computer for data transmission.

The piece of station equipment that converts electrical signals to sound waves is the speaker.

Audio feedback is the term used to describe what happens when a microphone and speaker are too close to each other.

You could use a set of headphones in place of a regular speaker to help you copy signals in a noisy area.

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

There must be a filter installed at the transmitter to reduce spurious emissions.

If a transmitter is operated with the microphone gain set too high it may cause the signal to become distorted and unreadable.

The information a VHF/UHF transceiver may be capable of storing in memory might include transmit and receive operating frequency, CTCSS tone frequency, and transmit power level. A way to enable quick access to a favorite frequency on your transceiver is to store the frequency in a memory channel.

One way to select a frequency on which to operate is to use the keypad or VFO knob to enter the correct frequency.

The squelch control on a transceiver is used to quiet noise when no signal is being received.

You might turn on the noise blanker to improve the situation if the station you are listening to is hard to copy because of ignition noise interference.

The purpose of the buttons labeled "up" and "down" on many microphones is to allow easy frequency or memory selection.

RIT means Receiver Incremental Tuning.

The purpose of the "step" menu function found on many transceivers is to set the tuning rate when changing frequencies.

The purpose of the "function" or "F" key found on many transceivers is to select an alternate action for some control buttons.

The purpose of the "shift" control found on many VHF/UHF transceivers is to adjust the offset between transmit and receive frequency.

One purpose of a repeater is to extend the usable range of mobile and low-power stations. A courtesy tone is a tone used to indicate when a transmission is complete. You should pause briefly between transmissions when using a repeater to listen for anyone wanting to break in.

The terms input and output frequency when referring to repeater operations means the repeater receives on one frequency and transmits on another. The repeater input and output frequencies is the most important information to know before using a repeater. 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.

The meaning of the term simplex operation is transmitting and receiving 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.

A linked repeater system is a series of repeaters that can be connected to one another to provide users with a wider coverage.

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

A closed repeater is a repeater whose use is restricted to the members of a club or group. Access to any repeater may be limited by the repeater owner.

Fundamental overload in reference to a receiver is interference caused by very strong signals from a nearby source.

Radio frequency interference may be caused by fundamental overload, spurious emissions, or harmonics, but will not be caused by Doppler shift. It's a trick question.

If another operator reports that your SSB signal is very garbled and breaks up then RF energy may be getting into the microphone circuit and causing feedback.

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

If someone tells you that your transmissions are interfering with their TV reception you should first make sure that your station is operating properly and that it does not cause interference to your own television. A notch filter should be connected to a TV receiver as the first step in trying to prevent RF overload from a nearby 2-meter transmitter. Snap-on ferrite chokes, low-pass and high-pass filters, and notch and band-pass filters all may be useful in correcting a radio frequency interference problem. 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.

If a "Part 15" device in your neighbor's home is causing harmful interference to your amateur station, you should 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, and check your station and make sure it meets the standards of good amateur practice.

If another operator tells you he is hearing a variable high-pitched whine on the signals from your mobile transmitter then the power wiring for your radio is picking up noise from the vehicle's electrical system.

If you receive a report that your signal through the repeater is distorted or weak, your transmitter may be slightly off frequency, your batteries may be running low, or you could be in a bad location. All of these answers are correct. It might be any one or a combination of these causes.

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.

#### **SUBELEMENT T6 – Communications modes and methods – 3 exam questions - 3 groups**

Single Sideband (SSB) is a form of amplitude modulation. SSB is the type of voice modulation that is most often used for long distance and weak signal contacts on the VHF and UHF bands. Upper sideband is normally used for VHF and UHF SSB communications. The primary advantage of single sideband over FM for voice transmissions is SSB signals use much less bandwidth than FM signals. 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. FM modulation is most commonly used for VHF and UHF voice repeaters. 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. When comparing FM voice, SSB voice, CW, or Slow-scan TV, CW has the narrowest bandwidth.

Phone transmissions are voice transmissions by radio.

A gateway is the name given to an amateur radio station that is used to connect other amateur stations to the Internet. Gateway stations are used in both EchoLink and IRLP. The technology EchoLink and IRLP have in common is Voice over Internet protocol.

Stations using EchoLink transmit information between them by using the Internet. EchoLink allows computer-to-radio linking for voice transmission. Any licensed amateur radio operator may operate on the EchoLink system.

The abbreviation IRLP means 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.

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

You might find a list of active nodes using VoIP in a repeater directory or on the Internet. When using a portable transceiver you select a specific IRLP node by using the keypad to transmit the IRLP node numbers.

Packet radio is an example of a digital communications method.

The term APRS means Automatic Position Reporting System. 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 point-to-point digital message forwarding emission mode may be used by a Technician class operator in the 219 - 220 MHz frequency range.

The abbreviation PSK means Phase Shift Keying. PSK31 is a low-rate data transmission mode that works well in noisy conditions. PSK31 uses power and bandwidth so efficiently that transcontinental operation at power levels of less than 1 watt are possible.

The sending speed that is recommended 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.

## **SUBELEMENT T7 – Special operations – 2 exam questions – 2 groups**

A good thing to have when operating a hand-held transceiver away from home is one or more fully charged spare battery packs.

A 1500 watt output linear amplifier would probably not be very useful to include in an emergency response kit. You might find an external antenna and several feet of connecting cable, a cable and clips for connecting your transceiver to an external battery, and a listing of repeater frequencies and nets in your area very useful. You can make the signal from a hand-held radio stronger when operating in the field by using an external antenna instead of the rubber-duck antenna.

A good thing to have when operating from a location that includes lots of crowd noise is a combination headset and microphone.

A method used to locate sources of noise interference or jamming is radio direction finding. A directional antenna would be a most useful thing to have for a hidden transmitter hunt.

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

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

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

The maximum power allowed when transmitting telecommand signals to radio controlled models is 1 watt. The 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 class of license required to use amateur satellites is any amateur whose license allows them to transmit on the satellite uplink frequency. The power you should use to transmit when using an amateur satellite is the minimum amount of power needed to complete the contact. Something you can do when using an amateur radio satellite is talk to amateur radio operators in other countries. A satellite beacon is a signal that contains information about a satellite. You should use a satellite tracking program to determine when you can access an amateur satellite. The name of the group that coordinates the building and/or launch of the largest number of amateur radio satellites is AMSAT.

Doppler shift is a change in signal frequency caused by motion through space. Just like the change in pitch of a horn on a passing vehicle, the radio frequency of a moving transmitter will shift up or down according to the relative direction of motion.

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 tell you an amateur satellite is in a Low Earth Orbit.

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

### **SUBELEMENT T8 – Emergency and Public Service Communications – 3 exam questions – 3 groups**

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

The conditions amateur stations are allowed to communicate with stations operating in other radio services are when specially authorized by the FCC, or in an actual emergency.

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. If you hear someone reporting an emergency you should assume the emergency is real and act accordingly. You may use your amateur station to transmit a "SOS" or "MAYDAY" signal 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.

Keep in mind that there are penalties for making a false emergency call. You could have your license revoked. You could be fined a large sum of money. You could be sent to prison. Any or all of these penalties may apply.

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.

One reason for using tactical call signs such as "command post" or "weather center" during an emergency is they are more efficient and help coordinate public-service communications.

To be prepared for an emergency situation where your assistance might be needed you should 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, and participate in drills that test your ability to set up and operate in the field.

The primary function of RACES in relation to emergency activities is 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. The primary function of ARES in relation to emergency activities is ARES supports agencies like the Red Cross, Salvation Army, and National Weather Service. You must have an amateur radio license before you can join an ARES group.

As an alternate source of power to operate radio equipment during emergencies consider using the battery in a car or truck, a bicycle generator, or a portable solar panel. All of these will work.

Can you use non-amateur frequencies or equipment to call for help in a situation involving immediate danger to life or property?

Yes in a genuine emergency you may use any means at your disposal to call for help on any frequency. Remember, you most likely will be required to explain your reasons for doing so to the authorities after the action is over.

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.

A modified amateur radio transceiver may not be used to transmit on the local fire department frequency except in a genuine emergency when you may use any means at your disposal to call for help on any frequency.

Messages of personal information concerning victims should not be transmitted over amateur radio frequencies during emergencies. 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.

A strong and clear signal is of primary importance for a net control station. 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.

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.

One thing that must be included when passing emergency messages is the name of the person originating the message.

Emergency traffic has the highest priority. If someone breaks in with emergency traffic the net control station should stop all net activity until the emergency has been handled.

The preamble of a message is the information needed to track the message as it passes through the amateur radio traffic handling system.

The term "check" in reference to a message is a count of the number of words in the message.

25 words is the recommended guideline for the maximum number of words to be included in the text of an emergency message.

Casual conversation between stations during a public service event should be avoided because idle chatter may interfere with important traffic.

## **SUBELEMENT T9 – Radio waves, propagation, and antennas - 3 exam questions – 3 groups**

A beam antenna is an antenna that concentrates signals in one direction. Examples of directional or beam antennas are the quad, Yagi, and dish antennas. A vertical antenna is an antenna that consists of a single element mounted perpendicular to the Earth's surface. A horizontal antenna is a simple dipole mounted so the elements are parallel to the Earth's surface.

A disadvantage of the "rubber duck" antenna supplied with most hand held radio transceivers is 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 signals can be 10 to 20 times weaker than when you are outside of the vehicle. 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 should try moving a few feet; random reflections may be causing multi-path distortion.

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

The physical size of half-wave dipole antenna becomes shorter as the frequency increases. 19 inches is the approximate length, in inches, of a quarter-wavelength vertical antenna for 146 Mhz. 112 inches is the approximate length, in inches, of a 6-meter 1/2 wavelength wire dipole antenna.

VHF and UHF signals are usually not reflected by the ionosphere and so are not normally heard over long distances. When we hear VHF signals from long distances it may be sporadic E reflection from a layer in the ionosphere.

UHF signals often work better inside of 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 the signals could be as much as 100 times weaker.

The advantage of 5/8 wavelength over 1/4 wavelength vertical antennas is their radiation pattern concentrates energy at lower angles.

A way to reach a distant repeater if buildings or obstructions are blocking the direct line of sight path might be to try using a directional antenna to find a path that reflects signals to the repeater.

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

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 point where radio signals between two points are blocked by the curvature of the Earth is the radio horizon.

Standing wave ratio (SWR) is a measure of how well a load is matched to a transmitter. A 1 to 1 reading on a SWR meter indicates a perfect impedance match between the antenna and the feed line. A loose connection in your antenna or feedline might be indicated by erratic changes in SWR readings. A 2 to 1 SWR value is where the protection circuits in most solid-state transmitters begin to reduce transmitter power.

Other than a SWR meter you could use a directional wattmeter to determine if your feedline and antenna are properly matched.

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. 50 Ohms is the impedance of the most commonly used coaxial cable in typical amateur radio installations. The outer sheath of most coaxial cables is black in color because black provides protection against ultraviolet damage. The most common reason for failure of coaxial cables is moisture contamination. In older coaxial cables that are exposed to weather and sunlight for several years, losses can increase dramatically. It is important to have a low SWR in an antenna system that uses coaxial cable feedline to allow the efficient transfer of power and reduce losses. The power lost in a feed line is converted into heat by losses in the line.

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 primary purpose of a dummy load is that it does not radiate interfering signals when making tests.

### **SUBELEMENT TO – Electrical and RF Safety – 3 exam questions – 3 groups**

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

What is connected to the green wire in a three-wire electrical plug or circuit is reserved as the Ground connection.

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 the excessive current could cause a fire.

To guard against electrical shock at your station you should use 3-wire cords and plugs for all AC powered equipment, connect all AC powered station equipment to a common ground, and 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 everyone should know where it is and how to use it.

When a lightning storm is expected you should disconnect the antenna cables from your station and move them away from your radio equipment, unplug all power cords from AC outlets, and stop using your radio equipment and move to another room until the storm passes.

**All of these answers are correct and can save your life!**

One way to recharge a 12-volt battery if the commercial power is out is to connect the battery to a car's battery and run the engine. Keep in mind that the kind of hazards that are presented by a conventional 12-volt storage battery include the fact that it contains dangerous acid that can spill and cause injury, short circuits can damage wiring and possibly cause a fire, and explosive gas can collect if not properly vented. If a storage battery is charged or discharged too quickly the battery could overheat and give off dangerous gas or explode.

Fire prevention is the most important reason to have a lightning protection system for your amateur radio station.

Be aware of the hazard that might exist in a power supply when it is turned off and disconnected. You might receive an electric shock from stored charge in large capacitors.

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 arrange for a helper or observer, inspect the tower for damage or loose hardware, and make sure there are no electrical storms nearby.

**All of these answers are correct and can save your life!**

The maximum allowed height with regard to nearby airports must be considered when erecting an antenna near an airport.

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.

An important consideration when putting up an antenna is to 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.

The guy wires for an antenna tower should be installed in accordance with the tower manufacturer's instructions.

The minimum safe distance from a power line to allow when installing an antenna would be a location where if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power wires.

The most important safety rule to remember when using a crank-up tower is it 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.

Separate 8 foot long ground rods for each tower leg, bonded to the tower and each other are considered to be an adequate ground for a tower.

VHF and UHF radio signals are non-ionizing radiation. Radio waves cause injury to the human body only if the combination of signal strength and frequency cause excessive power to be absorbed.

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

The factors that affect the RF exposure of people near an amateur transmitter are the frequency and power level of the RF field, the distance from the antenna to a person, and the radiation pattern of the antenna. 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.

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 at others. The unit of measurement used to measure RF radiation exposure is milliwatts per square centimeter.

To determine that your station complies with FCC RF exposure regulations you could use calculations based on FCC OET Bulletin 65, calculations based on computer modeling, or measurement of field strength using calibrated equipment.

To prevent exposure to RF radiation in excess of FCC supplied limits amateur operators might alter antenna patterns, relocate antennas, and/or change station parameters such as frequency or power.

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.

## **About the Exam.**

Now you are ready for the fun part. First, relax! Be sure to take a rest break. Once you begin the exam you may not leave the room. Be sure to turn off cell phones, pagers, watches that make noise, and any two way radio equipment you may have with you. Place books and study materials on the floor or out of sight.

The Exam is a simple 35 question multiple choice test, and you have been studying all the correct answers. You know this stuff. You are ready!

Please follow the instructions of the Volunteer examiners carefully!

First there is a little paperwork that needs to be done. The Volunteer Examiners will assist you in filling out the necessary application form NVEC-610. When this form is completed, they will ask to see your photo ID. This is required to verify that you are in fact the person you claim to be on the application form. If you have copies of CSCE documents or licenses to be counted as credit for exam elements, be sure to inform the VE that checks your ID. They will now take your money. The exam processing fee on July 1 of 2006 is \$14.00. This payment is to defray the actual costs of processing your application from the exam all the way to the FCC ULS Database.

Now you will receive the actual exam materials, and you may begin taking your exam.

When you are finished, return your exam materials including scratch pages you used for calculations to the examiners. They will grade your exam while you wait. **IMPORTANT!!!** Do not leave the session until your exam has been graded. Before you leave you should receive a CSCE document for any exam elements you have passed in this session. This is your only proof of passing this exam should the paperwork be lost in handling. Keep this CSCE in a safe place. If you take and pass the Morse Code test, the CSCE is the only proof you will ever receive that you are qualified to operate in the Novice – Technician sub-bands on the HF frequencies, and you will need to have it for upgrade credit to get your General license.

If you pass the exam, you will be given an opportunity to take the written exam for the General class license. There is no additional charge for taking another exam element so long as you pass each previous element. If you need to re-take an exam element, there will be a new \$14.00 fee required.

If you desire to take the Morse Code test, it is usually given after the written tests are completed, so as to not disturb persons taking written exams.

If you have passed elements that qualify for a license, you will be able to see your call sign in the ULS system typically in 5-7 days.

A hardcopy document from the FCC will follow via US Mail to the address given on your application.

To search in the ULS for your new call sign, visit:

<http://www.arrl.org/fcc/fcclook.php3>

And enter your name in the name-search box just as you entered it onto the application form.