HAM- An Elmer's Guide

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A long tradition, since the beginning of radio, has been for amateur to assist newcomers in getting thier license. Nobody knows for sure why, but the one teaching ahs always been referred to as an "Elmer".

That said, I am creating this page to assist as a study aid. Study the material I post, and take the practice tests at www.qrz.com and you should pass your tech test with ease.

Side note-

Morse code.
You will see below that in order to get privileges on HF freqs you must pass a 5wpm Morse code test. This is greatly reduced from what it was when I first go licensed, when you had a 5, 13, and 20wpm test. 5wpm is easliy learnable.

To learn code, one thing is critical, learn by LISTENING, not by looking at a chart. When you learn looking at a chart, in your mind you have to hear the sound, then convert it to an image, then to the letter. Learning by sound allows you to hear di-di-di and immediately think S. This becomes critical as your start copying long words and gain faster speed. Buy some of the code practice tapes or CD's, and spend a little time studing. I learned listening while driving.

In addition to just getting your HF privileges, there are other reasons this is advantageous. For example, CW (contentious wave), the method the code is used with, is much, much more efficient than any voice mode. When voice fails to get through, CW will if it can be done at all. CW lets you do more with less , power wise. Many hams have literally worked every state with small homebuilt rigs in Altoid tins powered by 9v batteries, power output of 300mw.

Also, it can be used in many other situations. You can literally communicate with mores with flips of the finger, winks, or taps on a table. I have several times discreetly tapped out a message on a table to a buddy with nobody else there any wiser. I once was in Poland and met a ham, but he did not know any english. Using the standard abbreviation and signals, we exchanged calls, hometowns, etc.. One ham I know was in a bad accident and when he woke up was on a ventilator. He was unable to speak do to that, and was in much more pain than the doctors though. Once a fellow ham visited, he was able to squeeze his hand and tell him what he needed the doctors to know. So it has many more uses outside radio.

Also, even if most people do hear your transmission, most will still have no idea what your saying.

Guys, what I am posting is basicly the cliffs notes for the test. The information is taken directly from what you need to know to pass the test, without much of anything else!

Here are the Lessons-

Lesson 1

T1 Commissions Rules - T1A Amateur Radio, F.C.C., License Classes, Renewal

F.C.C.
The Federal Communications Commission in Washington makes and enforces all the rules and regulations pertaining to amateur radio. They can grant or take away licenses or impose fines on amateurs if they are not following their rules.

An amateur station in definition is a station in the amateur service who is responsible for radio communications. Any licensed amateur who is responsible for the stations transmissions is called the control operator. For Example: If you allow your friend to use your radio equipment to talk, then you are responsible for his transmission because the station is yours.

Purpose of Amateur Radio
What is the purpose of amateur radio. Well, there are several purposes but I won't bore you with them. For now all you need to know for the test is the following: To increase the number of trained radio operators and electronics experts, and improve international goodwill.

Amateur Radio License
In order to operate a station in the U.S., an F.C.C Amateur Primary License is required. This license is good for a period of ten years after which it must be renewed.

How Soon Can I Operate My Station?
As soon as the FCC's computer database shows that you have been granted a license, you are authorized to operate your station if you wish.

License Classes
The F.C.C. has broken the Amateur Radio Service into 3.5 license classes. You must start as a Technician class operator and climb the ladder.(You can't skip. You must start out as a Technician and work your way up to the highest license class.) If you wish to gain more privileges than the ones you have, the F.C.C. requires that you pass an exam for you to gain the additional privileges of a higher class license.

License Class Privileges Requirements
1) Technician Class Full privileges in the VHF and UHF amateur spectrum above 30 MHz. Requires that you pass a 35 question exam.
1.5) Technician with Morse Code Limited Morse Code and Voice Privileges in the HF spectrum. Requires that you passed the previous exam with the addition of a 5wpm (words per minute) Morse Code Exam.
2) General Class Limited Access to all the HF amateur bands with Morse Code, data and voice modes.

Requires that you have already passed the Technician and Morse Code requirements with the addition of the General Class 35 Question exam.
3) Amateur Extra Full amateur radio privileges. Requires that you have passed the General Class exams with the addition of the Extra Class 50 question exam.

License Renewal
Once you get your license it is good for ten years. After the ten years are up you must renew it again for another ten years. You have up two years to renew. During this 2 year period your license has expired and your amateur radio privileges will not exist. Once you renew your license you may operate your station as usual. The F.C.C recommends that you renew your license 90 days before your license expires. This way your privileges will not disappear after the expiration date.

Summary
1.) The F.C.C.(Federal Communications Commission) enforces all amateur radio rules and regulations.
2.) An amateur station is a station in the amateur service who is responsible for radio communications
3.) Any licensed amateur who is responsible for the stations transmissions is called the control operator
4.) There are 3.5 license class: Technician, Tech with Morse Code Endorsement, General, and Amateur Extra.
5.) Your amateur radio license is good for ten years after which you have 2 years to renew it.
6.) You may operate your station as soon as the FCC's database shows that you have been granted an amateur primary license.

Lesson 2

T1 Commissions Rules - T1B Technician Frequency Privileges

VHF/UHF Bands
The F.C.C. authorizes a Technician with No Morse Code Licensee to operate on authorized frequency segments (or bands) above 30 MHz. This region is called VHF and UHF for Very High Frequency and Ultra High Frequency. Much of the activity here is local to your area. These bands are fun and you will meet many people here.

The Bands
The VHF and UHF bands are labeled by wavelength not frequency. If you are talking about a segment of frequencies it would not be wise to say: "I bought a radio that works on the 50.0 to 54.0 MHz Band." It is much easier to tell your friend that your radio works on the 6M VHF band. The number "6" for Six Meters stands for the wavelength of the radio wave in the 50 MHz region.

The Technician No Code Amateur Bands

50.0MHz_____54.0MHz 6 Meter Band VHF
144.0MHz_____148.0MHz 2 Meter Band VHF

222.0MHz_____225.0MHz 1.25 Meter Band VHF
420.0MHz_____450.0MHz 70 centimeter Band UHF
902MHz_____928MHz 33 centimeter Band UHF
1240MHz_____1300MHz 23 centimeter Band UHF
2300~2310MHz_____2390~2450MHz 13 centimeter Band UHF **
** Note: The 13cm band above is split into two segments.
One piece is from 2300 to 2310 Megahertz and the other segment is from 2390 to 2450 MegaHertz

The Technician with Morse Code HF Amateur Bands

3675kHz_____3750kHz 80 Meter Band HF
7.1MHz_____7.150MHz 40 Meter Band HF
21.100MHz_____21.200MHz 15 Meter Band HF
28.100MHz_____28.500MHz 10 Meter Band HF

The High Frequency Privileges
If you are a Tech who has not passed his 5-wpm Morse Code Exam, you will not have any HF Privileges, but you will still be required to know and understand the HF bands and the specific rules. Do not skip learning the HF frequency limits even if you never will be upgrading your license to a Tech. + Morse Code. You will be asked to know the frequencies of the HF bands on your Technician Class exam.

Summary
1.) Study and memorize the frequency limits of the VHF/UHF and HF bands above.
This is important since the test will contain questions where the frequencies may look similar but are incorrect.

Lesson 3

T1 Commissions Rules - T1C Emissions Privileges

Emission Privelages HF
As a Technician Class operator with morse Code Upgrade, you have HF privileges in the following bands: CW only on 80,40, and 15 meters, and CW and data only on 10 meters from 28.1MHz to 28.3 MHZ. Also with SSB phone and CW only from 28.3 to 28.5 MHz.
You do not have FM phone privelages on any of the HF bands. But you do have FM phone prielages on the VHF bands from 6 meters (50.1MHz and up.)

VHF Emission Privelages
Both 6 and 2 meters have a "CW only" portion for the band.
6m 50.0 - 50.1 MHz CW only
6m 50.1 - 54.0 MHz Phone emissions allowed(FM included)
2m 144.0 - 144.1 MHz CW only

2m 144.1 - 148.0 MHz Phone Emissions allowed, FM included.

Image Transmissions
Image transmissions are allowed on 2m, 1.25m, 70cm, and all other UHF bands above 70cm included. But beware! Image transmissions are not allowed within the "CW only" part of the 2m band.

What are image transmissions? Image transmissions are transmissions of either moving pictures(video) or still images. Exaples of image transmission modes are: FAX, Slow and Fast Scan Television. In other words television or FAX methods. Many hams participate in slow scan or fast scan TV, and transmit video of themselves to other hams.

Summary
1.) Tech. Class with Morse Code have priveleges in the HF bands, but no phone priveleges. They still keep their FM phone priveleges above 50.1MHz.
2.) Both 6m and 2m have a "CW only" portion of the band.
3.) Details about Emission privileges.
4.) Image transmissions allowed on 2m, 125 and 77cm and above.
5.) No image transmissions allowed in "CW only" portion of 2m band.
6.) Image emissions are instances where still or moving pictures are transmitted.

Lesson 4

T1 Commissions Rules - T1D Licensee Responsiblity

Control Operator
A station control operator is any licensed amateur who is responsible for a stations transmissions. If you are licensed and own a radio, then you are the control operator when you use the radio. The FCC requires that the control operator be at the control point when the station is transmitting. The control point of a station is the location where the control operator function is performed. The station licensee and the control operator can be two separate people. Any licensed amateur whom the station licensee chooses can be a control operator. Both the station licensee and the control operator are responsible for the station operation, but ultimately the station licensee is responsible for proper operation of the station in accordance with the FCC rules.

Terms You Should Know:
Station Licensee: The person who is licensed by the FCC to operate an amateur radio station according to FCC rules.
Control Operator: The person who is operating(using) the radio equipment.
Control Point: The control point is the point where the control operator operates his station.
Identification: The FCC requires all radio amateurs to identify their transmissions with their station callsign's.
Callsign: A short number and letter sequence issued to you by the FCC to be used for identifying your station. Examples: KG6XOR, WA1N, AC9QA, N7NA.

Identification
When you have earned your license the FCC will issue you a callsign. What kind of callsign you get depends on which country you live in and which state you live in. This callsign is your ticket to the air. Without one you cannot operate legally. The FCC requires that you identify your station every ten minutes and/or at the end of your contact with your callsign. Each station must transmit its own callsign at the end of a contact. You may always use CW to identify your station.

An Oddball Question You May See On the Exam:
If you are a Technician with a Certificate of Successful Completion of Examination for Morse Code you do not need any special form of identification.

Summary
1.) Control operator is the person at the control point.
2.) Control Point is the point where station is operated.
3.) Station licensee is responsible for station operation according to FCC rules.
4.) Station licensee can chose any licensed amateur to be the control operator.
5.) Station identification is required at the end of all transmissions.
6.) Both stations must identify after a contact even if the transmission is a little longer or shorter than 10 minutes.

Lesson 5

T1 Commissions Rules - T1E Third Party

Third Party
Third party communications is where a message is sent between two amateur stations for someone else. A "third party" is a person who is sent a message by way of two amateur stations relaying the message to them. The FCC's policy is that amateurs may never be paid for their communications third party or not."For example: Aunt Mary pays you to send a message to Uncle Bob, who is a ham radio operator." This behavior would be illegal.
If you let a third party(like a friend) use your amateur station then you must closely monitor and supervise your third party's transmission.

Third Party International
Third party messages to a foreign country may only be transmitted if the US has a third party agreement with that foreign government, or the third party is qualified to be a control operator.

When a US station is sending third party communications internationally then the US station must transmit BOTH callsigns at the end of a contact.

Terms You Should Know:

Third party communications: Communications between two amateurs intended as a message for another person who is a not a radio amateur.
Third Party: The person who receives the communications through amateur radio, but is not a radio amateur. Can also be a friend who uses your radio equipment to talk to someone, while "you" the station licensee, supervise.

Summary

1.) Third party communications is where a message is sent between two amateur stations for someone else.
2.) A "third party" is a person who is sent a message by way of two amateur stations relaying the message to them.
3.) You may never be paid for your radio communications transmissions.
4.) A third party agreement must exist between the US and foreign country's government in order for third party transmission to be legal.
5.) Each station must state both station's callsign's at the end of a third party contact to another country.

Lesson 6

T1 Commissions Rules - T1F Spectrum Use, Repeaters, Power Limits, Data Transfer

Sharing Frequency Spectrum

On many frequencies above the 70cm band, amateur radio operators are not the only users of the band. Here the FCC allows more than one radio service to use the band. In these instances amateur radio operators share the band with the other radios services as secondary users.
When amateurs are secondary users of a band, you must never interfere with the primary users of the band. If you hear another radio service using a frequency, you must leave and use another frequency which is not in use. This rule also apply's to fellow amateurs. You must not interfere (or transmit) when another amateur is using the frequency.

Repeater Coordination

If you wish to setup a repeater you must first obtain a recommendation from your local frequency coordinator. (The FCC doesn't recquire that you get a recommendation, but if there is a dispute, the FCC will side with the repeater that has received recommendation.) The Frequency Coordinator's job is to make sure your repeater will not interfere with nearby repeaters already established.

Repeater Interference

If two repeaters are causing interference to one another, and one has been recommended by a frequency coordinator, and the other not, then it is up to the licensee of the un-recommended repeater to resolve the interference.
In the case in which two repeaters are interfering and neither repeater has been recommended by a frequency coordinator, then both licensee's of the repeaters are responsible for resolving the interference.

LEGAL POWER LIMITS

The FCC limits the power levels ham radio operators can use in terms of Peak Envelope Power, or PEP for short. This is a fancy term for "The average power applied to an antenna transmission line during one RF cycle at the crest of the modulation envelope." You need to understand this term because it will be used often to describe your radio and how much power your radio transmits one the airwaves.

Power Limits
Maximum Power Output Technician for All VHF and UHF bands is 1,500 Watts PEP.
Maximum Power Output allowed to Tech. with Morse Code Endorsement Operators on the HF bands is 200 watts PEP.

NOTE: You must always use the minimum amount of power necessary to communicate. If you only need a low amount of power to reach your buddy across town, then down turn on your amplifier. It would be illegal since the extra power from the amplifier is unnecessary.

Digital Communications
Terms to Know!
Data- Telemetry, Telecommand, and computer emissions
RTTY- Narrow-band direct-printing telegraphy emissions
Maximum Symbol Rate- A term used to indicate the speed of the transfer of digital information. Most often indicated in kilobauds or kilobytes.(As in 56-kilobytes per second(56kpbs).

Maximum Symbol Rate for the VHF Bands The maximum symbol rate allowed for digital communications on the 2 meter AND 6 meter bands is 19.6 kilobauds.

Summary
1.) FCC Rule: Primary users of frequencies must not be interfered with by amateur radio operators.
2.) FCC Rule: You must never interfere with amateur radio communications. Everyone has an equal legal right to a frequency.
3.) Repeater frequencies and setup is organized through a frequency coordinator.
4.) Make sure to know the two repeater interference cases outlined above, well.
5.) PEP - Peak Envelope Power: The average power applied to an antenna transmission line during one RF cycle at the crest of the modulation envelope.
6.) Technician Class Power limits: VHF-UHF: 1,500 watts PEP.
HF: 200 watts PEP.
7.) FCC Rule: Always use the least amount of power needed for a radio contact. [Don't run more power than you really need!]
8.) Make sure you know the above vocabulary terms and understand their meaning.

Lesson 7

T1 Commissions Rules - T1G Space Communications, False Signals, Interference

Space Stations

Amateur Radio Satellite
An amateur space station is a station located 50 kilometers or more above the earth's surface. Any licensed amateur can be the licensee of an amateur space station, even a Technician. Getting your station or satellite into space is much more of a problem! Also, remember that 6 meters may not be used by earth stations for satellite communications.

False Signals
False or deceptive amateur signals may never be transmitted. You may never fake an emergency by transmitting a "MAYDAY" call on the air. This is classified as a deceptive signal because you are transmitting a call for help in an instance where there is no emergency.
Unidentified signals are illegal, except for transmissions from a space station or to control a model craft. You must always identify with your station callsign each time you transmit.
For Example: Many times ham radio operators will transmit for a brief period of time to check if they can make it into a local repeater, without giving their station identification. This is illegal and classified by the FCC as an "Unidentified Transmission".

Interference
You must always be careful to NEVER deliberately interfere with another stations communications.
For Example: If another amateur repeatedly transmits on a frequency already in use by another group of amateurs, the interference case is illegal and classified as "Harmful or Malicious Activity". Any transmission which disturbs other communications is called "Harmful Interference".

Summary
1.) An amateur space station is an amateur station located at least 50 kilometers above the earths surface.
2.) Any licensed amateur can be the licensee of an amateur space station.
3.) 6 meters may not be used by earth stations for satellite communications.
4.) You must never use the word "MAYDAY" on the air to FAKE an emergency .
5.) You must identify your transmissions every ten minutes or at the end of your transmission if it was less than 10 minutes long.
6.) Understand the terms: "False Signals", "Unidentified Signals", and "Harmful and Malicious Interference".

Lesson 8

T1 Commissions Rules - T1H - Correct Language, Beacons, Radio Control Craft

Correct Language
If you're bilingual, and you speak another language other than English, then you're in luck! The FCC allows communications on amateur bands in languages other than English So long as you send your station identification(callsign) in English. In fact there are many German, Japanese, and Latino groups who meet to

speak their language on the air.

Beacons
On various bands, there are special transmitters which operate 24 hrs as and indicator to amateurs about radio conditions and propagation. All you have to do is tune to the beacon frequency and listen for the beacon's signal. If the signal is present, then you know that a radio communication path exists between your country and the country or continent in which the beacon is located in. As a limit, beacons are limited to only 100 watts PEP. Any licensed amateur with at least a Technicians license can setup and become the licensee of a beacon or repeater.

Radio Control
To use a radio control transmitter on an amateur band, you must affix(attach) your station callsign, name, and address onto the transmitter. You may use up to 1 watt PEP of power for the tele-command(control) of your craft or vehicle. More than 1 watt would not be reasonable, because more than 1 watt would be enough to cause erratic operation of nearby radio controlled craft. Plus, 1 watt is enough power to control your craft or vehicle within mile of your location!

Summary
1.) You may communicate on amateur radio frequencies using any language as long as you identify yourself with your callsign in English
2.) Beacons are transmitters setup as indicators of worldwide radio propagation conditions.
3.) Any license class(Technician or higher) may be the licensee of a repeater or beacon.
4.) Beacons are limited in power to 100 watts PEP.
5.) Radio control transmitters are limited to 1 watt.
6.) To operate a radio control transmitter, it is required that you attach your station callsign, name and address to the transmitter.

Lesson 9

T1 Commissions Rules - T1I Emergency Communication, Indecent & Obscene Language

Emergency Communications
If you hear a distress call on the radio, you should always contact the person and get the proper authorities EVEN IF the signal is on a frequency outside your license privileges.

MAYDAY and SOS
The words "MAYDAY" and SOS are only to be used as a distress call and transmitted only in a case of life or property threatening emergency. False alarms where life or property are not threatened are illegal.

Disasters
When disaster strikes an area and severely disrupts normal communications systems [such as police, fire, and gov'mt radio, telephone and cellphone systems], the FCC may step in and declare a "Temporary State

of Communications Emergency". This results in the restriction of the types of transmissions that radio amateurs may make. Only transmissions that are necessary to meet essential communications needs to facilitate relief actions. Any special rules to be observed during the emergency are posted in the FCC Declaration of a Temporary Communications Emergency.

Broadcasting
Broadcasting is never allowed for any amateur of any license class Technician or not. It is illegal according to FCC Rules to transmit material intended for the general public.
WHY? - Because amateur radio service was not intended for broadcasting.

Words to Know
Broadcasting: Transmissions intended for reception by the general public, either direct or relayed.

Indecent and Obscene Language
You may never transmit obscene or indecent language from your amateur station because:
1.)It is offensive to some individuals.
2.)Because young children may intercept amateur communications with readily available receiving equipment.
3.)Because such language is specifically prohibited by FCC rules.

The FCC does not publish a list of prohibited words. The FCC says: "If you beleive a word is questionable, don't use it in your communications." In other words, use common sense. Most everyone knows what type of words are indecent in todays society.

Summary
1.) In an emergency situation it is legal to transmit outside your license privileges for emergency purposes,
2.) MAYDAY and SOS may only be used in an instance where life or property is threatened.
3.) During disasters the FCC may limit amateur communications to only transmissions that "Are necessary to meet essential communications needs to facilitate relief actions.
4.) FCC may post special rules for amateurs to follow in a declaration of communications emergency.
5.) It is illegal to broadcast material for the general public.
6.) It is illegal to transmit indecent and obscene language.

Lesson 10

T2 Operating Procedures - T2A Operating Rules and Procedures

Overview
This part of the test contains questions regarding basic operating rules. These are rules you should know to be able to go on the air and use a repeater or be prepared to handle emergencies. Most of these rules are not set by the FCC, but are common knowledge that every radio amateur should know in order to operate

his station properly.

Preparing to Transmit
Before transmitting ALWAYS listen to make sure others are not using the frequency. If you don't follow this rule, you won't make many friends in amateur radio, and you will make yourself look like a fool.

If you are conducting a lengthy transmitter test, or loading up procedure, it is best to use a dummy load. Dummy loads are standard equipment in a ham shack. Read the following caption for more info.

Dummy Load
A dummy load is a large resistor capable of dissipating the radio energy from your transmitter as heat into the air. This capability is necessary during the testing and repair of radio gear. When repairing the transmitter of a radio is often required to transmit for a short time in order to diagnose the problem. But instead of transmitting an unnecesary test signal live on the air, technicians connect a dummy load to the antenna jack. This allows them to transmit a test radio signal that is absorbed in the dummy load.

Emergencies
If you are in contact with another station and you hear a call for help on frequency what should you do? In this case you should stop your QSO (conversation with someone) and take the emergency call. Emergencies are always priority traffic. Just like fire engines and ambulances have the right of way in traffic on the road, emergency traffic on the radio has priority over all other traffic on the airwaves.

Basic Operating
To minimize interference on HF bands capable of long-distance communication, it is best to stick to VHF and UHF frequencies for local amateur communications.

Also, during commuter rush hours, third party repeater nets are always discouraged. During this time a lot of mobile hams will be using the repeater, and nets (which are formal gatherings on the radio) are discouraged to allow mobile hams access to the repeater.

Morse Code
You should always send your Morse code calls at a speed at which you can also receive. It is not wise to send Morse code faster than you yourself can copy.

Many hams on the air will be heard using the procedural sign "DE". This is a word which means "From" or, "This is". For example: KG7IKL de AD6XS ...means.... KG7IKL, this is AD6XS.

This is a very commonly used sign in HF conversations, especially ones using CW(Morse code). Although secret codes and ciphers are illegal, procedural signs like "DE" are not classified as a code because they are understood by most everyone and are used to make Morse code transmissions simpler to send.

Summary
1.) Before transmitting you should always listen first to make sure the frequency is clear and open to use.
2.) A dummy load is used when a an amateur desires to test or tune his radio transmitting equipment without transmitting an audible signal on the air.
3.) Emergency traffic always has priority orver all other radio traffic.
4.) IF you hear an emergency call while speaking on the air with another amateur you should always stop and assist the distressed party.
5.) HF bands should not be used for local communications. VHF-UHF bands shoudl be used instead.

6.) The morse code procedural sign "DE" is a short-cut way of saying "this is".

Lesson 11

T2 Operating Procedures - T2B Simplex; Communication modes; Q-Signals; Procedural Signs

Operating Rules

Simplex Operations
What does the term "simplex operation" mean? Simplex operation is where a station is transmitting and receiving on the same frequency. Remember, repeaters received and transmitted on different frequencies. Simplex operation should be used instead of repeaters when communication with the intended station is possible without using the repeater. This is recommended because it will reduce traffic on repeaters and prevent it from being tied up unnecessarily.

But if you are on a repeater talking with another station, how can I tell if I can communicate using simplex instead?
The answer is simple. Most radios let you switch to the frequency that your friend will be"transmitting" on. This is the frequency that is called the "input frequency" because here your friends signal is being received by the repeater.
If you listen on the "input" and you can hear your friend's voice clearly, then simplex "one on one communication is possible.

Next you can switch back to the repeater and suggest that you switch to simplex operation.

Ham Stuff
RST Reports: An RST report is a report from another station on the quality and strength of your stations radio signal. Here is what it means:
R Readability - On a scale of 1 to 5, the readability of your signal. In other words the ability of the other operator to understand what you are saying.
S Strength - On a scale of 1 to 9, indicates how strong your stations signal is.
T Tone - Used for morse code signal reports. Indicates on a scale of 1 to 9 the quality of the tone of the morse code "beeps". From a "pure tone" To an ugly "60 cycle harsh tone".
For example: a report of "599" means the following: The five mean your signal is easy to understand. The first nine means your signal registers a about nine on their signal strength meter. The second nine (only included if you are using morse code) means your CW tone has a nice pure tone.

In some cases people may tell you: your signal is five nine plus twenty dB... In this case the twenty db part indicates that your signal is so strong that it goes off the standard 1 through 9 signal strength dial by twenty decibels. This would mean that you are putting out a REALLY strong signal!

Calling CQ
Used very commonly on the HF bands, the sign "C-Q" means: calling any station.

Say "CQ" three times, followed by "this is," followed by your call sign spoken three times.

Answering a CQ call.
To answer a CQ call, say the other stations callsign once, followed by "this is", then your callsign given phonetically.

QSL Cards
A QSL card is a letter or postcard sent as proof that two amateur stations have engaged in an actual radio-chat. For example: Bob uses his station in Pennsylvania to talk to a ham in Brazil. As proof of his achievement Bob, and the Brazilian operator exchange a card describing the details of their contact(like the time, date, frequency, and power).

Full Quieting
This term is used to indicate that your signal is strong enough to over come ALL receiver noise. This term is used primarily on FM simplex and repeater use to indicate your signal strength. (RST reports are usually not used.)

Summary
1.) What is simplex operation?
2.) How can you tell if simplex operation is possible while conversing on a repeater?
3.) The RST reporting system and how it works.
4.) Understand what is meant by the following "20 dB over nine".
5.) Calling CQ, and what it is used for.
6.) What QSL cards are for.
7.) The meaning of the term "full quieting".

Lesson 12

T2 Operating Procedures - T2C Distress Calling; Emergency Drills; RACES operations

Emergencies

Distress Calls
Phone - (SSB or FM) MAYDAY several times
CW - (morse code) S-O-S, then send your callsign.
On Repeaters Say "BREAK" twice, then your callsign.

Distress calls are only to be used when there is a threat to life or property. Otherwise, a fake distress call is expressly forbidden on any frequency amateur or not.

Tactical Callsigns
During emergencies you may hear tactical callsigns like "Command Post" or "Weather Center". These are used because they are more efficient and help coordinate public-service communications.

Types of Messages During Emergencies
Only messages concerning "Health and Welfare" traffic related to the emergency are sent.

Your Emergency Station Components
Good accessory to have for a small hand-held radio in an emergency is several sets of charged batteries. A good choice for a portable HF emergency station is a dipole antenna.

RACES
RACES is an organization which is part of amateur radio emergency communications. RACES works in conjunction with law enforcement and local governments in a large scale disaster. They are trained emergency professionals who provide emergency communications when a disaster occurs. They also do all their work for no cost.

The maximum hours allowed for RACES drills is one hour. During a RACES Drill you must identify your messages as drills or test messages.

Summary
1.) Distress calls(Mayday, BREAK, and SOS.
2.) Tactical Callsigns and emergency "Health and Welfare" traffic.
3.) Critical Components of a good emergency station.
4.) Who the RACES are.
5.) The duration of RACES drills (1 hr.).
6.) Identification of RACES drill messages.

Lesson 13

T2 Operating Procedures - T2D Phonetics - Packet Terms - Remote Control - RTTY - Station Address

International Phonetics
To make your self better understood, it is always recommended to use the International Phonetics for each letter of your callsign. Here is a table listing the phonetic alphabet-

Phonetic Alphabet			
Alpha	**K**ilo	**U**niform	**0** Zero

Bravo	**L**ima	**V**ictor	**1** Wun
Charlie	**M**ike	**W**hiskey	**2** Too
Delta	**N**ovember	**X**ray	**3** Tree
Echo	**O**scar	**Y**ankee	**4** Fower
Foxtrot	**P**apa	**Z**ulu	**5** Fife
Golf	**Q**uebec		**6** Six
Hotel	**R**omeo	**.** Decimal	**7** Seven
India	**S**ierra	**.** Stop	**8** Ait
Juliet	**T**ango		**9** Niner

VOCABULARY TERMS
The terms below are to be memorized. There are questions referring to each one of them concerning their meaning or definition. Don't miss out. Learn them!

PACKET RADIO TERMS
Connected Two packet stations are connected to each other. The receiving station reply's that the information has been received correctly.
Monitoring Means a receiving station is displaying all the messages on frequency and is not replying to any message.
Digipeater A packet-radio-station that only re-transmits data that is marked to be re-transmitted.
Network A way of connecting packet-radio stations so data can be sent over long distances.

Operating a Packet Station
Packet operation is never to occur on simplex frequencies. Digital operation should be avoided on simplex voice frequencies.
Radio Tele-Type

Radio tele-type is one of the earliest types of digital transmission used on the radio. it was used to a very large extent as a message transmitting system. It is still a very commonly used way of communicating on the ham radio bands. The following will help you get familiar with questions on the exam about RTTY.
Answering a CQ

When using the RTTY mode, always use the same speed to reply to a CQ as the sending station. Remember, CQ means a call for any station. This means any amateur sending a CQ is saying in effect "I am on the air and I would like to talk to any other radio amateur that can hear my signal."
Modes of Operation for Technicians with No Code

Technicians without morse code are not allowed to operate CW or SSB on the HF bands. Only Technicians WITH morse code endorsement, General, and Extra Class operators are allowed to operate in the HF frequency spectrum.
Aircraft

You may have wondered if it is legal to operate your ham radio station aboard an aircraft. Especially a commercial airline flight. Well, you may be disappointed to hear this but, ham radio signal often interfere with the flight radio systems. This means that most airlines will not allow you to use your personal hand-talkie on the flight. The rule is you can operate on a commercial aircraft only with the pilots specific permission and not while the aircraft is operating under Flight Instrument Rules.
Operating Outside Your Station Address

You can operate your amateur radio station anywhere in the U.S. other than your the address written on your license. This means you can operate anywhere, not just from home.

Summary
1.) Distress calls(Mayday, BREAK, and SOS.
2.) Tactical Callsigns and emergency "Health and Welfare" traffic.
3.) Critical Components of a good emergency station.
4.) Who the RACES are.
5.) The duration of RACES drills (1 hr.).
6.) Identification of RACES drill messages.

Lesson 14

T2 Operating Procedures - T2 X-1 Special Repeater Tutorial

Repeaters

What Are Repeaters?
In most cases propagation on the VHF-UHF bands are line of sight. This means that VHF and UHF signals tend to travel in a straight line, and cannot travel as far as HF signals can. Amateur radio operaters in the early days found that VHF signals were easily blocked by mountains and hills, even trees could cause a significant reduction in signal levels. To help amateurs communicate on the VHF and UHF bands, ham radio operators invented a special machine called a "repeater".

A repeater consists of special radio equipment and antennae on top of a high point where it can relay weak VHF signals from far away and improve VHF-UHF communications.

How Does a Repeater Work?
A repeater works the following way:

1.) A repeater setup on a high hill or building RECEIVES a weak signal from Kevin's small low powered FM handi-talkie (a small hand held VHF transceiver) on its INPUT frequency.

2.) The repeater takes the weak signal, amplifies it and re-TRANSMITS it on a new frequency called the OUTPUT frequency, several kilohertz or megahertz above OR below the transmit frequency.

3.) Several amateurs at a nearby hobby convention receive Kevin's signal on the repeater's output and decide to respond to his call.

End Result: Kevin's weak low-power radio with only a range of a mile or two, now is able to use a mountain-top repeater which can extend the range of his radio to cover more than a hundred square miles of distance. WOW! That's what ham radio is all about!

There are several important things to note about repeaters.

OFFSET - The difference between the input and the output of a repeater is called the offset.
Example: On the Two Meter Band the standard repeater offset is 600kHz. A repeater output on the 2m frequency of 146.000MHz will have a standard offset of +600kHz this means that you should set your receiver to transmit on the input at 146.600MHz . Vise-versa, an offset of -600kHz would mean you would have to transmit at 145.200MHz.

INPUT - The frequency your transceiver is programmed to transmit on whenever you press the transmit button on your radio. (this is the frequency the repeater listens on.)

OUTPUT - This is the frequency your radio is programmed to, to recieve the repeater's signal after you release the transmit button and finish speaking. (this is the frequency the repeater simultaneously re-transmits your signal on.)

AUTOPATCH - Some repeaters also have a special ability called an autopatch. An autopatch is a device which allows radio users to access the public telephone system. If you have permission from the owner of a repeater, any ham radio operator can make a telephone call through the autopatch using special radios equipped with telephone touch tone keypads. (Most VHF transceivers come standard with this numerical key-pads)

PL-Tones - Many repeaters across the country have PL-Tones® also called a "CTCSS" Continuous Tone Coded Squelch System. A PL-Tone is a sub-audible (humans can't hear it) tone which rides along your radio signal and tells a repeater to allow or deny you access. If you have the wrong Pl-Tone programmed into your radio, or if you have no Pl-tone at all, these repeaters will reject your signal. In effect your voice will not be heard by anyone using the repeater.

Open Repeaters - Open repeaters are those which are free for use by any licensed ham. Most repeaters are this type, and are maintained and paid for by local area ham clubs. Some repeaters are closed systems. This means you must be a member of the organization which maintains the repeaters. Often these repeaters have something to offer like better coverage, or an autopatch for telephone calls, or a linked repeater system.

Time-Out Timers - Time-out timers are timers which are set on a repeater to cut short transmissions longer than the timer's limit. The timer is set off when a operator transmits a transmission longer than the timer limit. When this happens the repeater goes silent for a minute or so after which it is reset, and the repeater can be used once again. The timers are used to make sure hams shorten their transmissions to allow others to break in and use the repeater.

Courtesy Tones - A courtesy tone is a sound used to indicate when a transmission is complete. Repeaters make a special beep when you let go of a microphone key to let you know your transmission has been

completed.

Summary
1.) What a repeater is.
2.) Understand what an "offset", "Pl-tone", "courtesy tone", and "autopatch" are.
3.) Understand in detail how a repeater works.
4.) Understand what is needed to be programmed in your radio to use the repeater.(OFFSET, and PL-TONE.)

Lesson 15

T2 Operating Procedures - T2 X-2 Special Repeater Tutorial

Repeater Operation

Etiquette
Repeaters are places where there are certain accepted rules for communications. For example, don't make an autopatch** call while two ham friends are talking, using the repeater.

Here are some accepted rules you must learn for the exam:
Pause briefly between transmissions, to listen for anyone wanting to break in.
Keep your transmissions short, because a long transmission may prevent someone with an emergency from using the repeater.
The proper way to break into a conversation on a repeater is to say your call sign in between transmissions.
Make sure that you listen to the repeater before making a transmission, to prevent interrupting a conversation already taking place on the repeater.
To call another station you call another station say the stations callsign then identify with your station with your own callsign.
Input/Output Frequency Separation of Repeaters

Repeater Offsets
Two Meters 600 kHz
1.25 Meters 1.6 MHz
70 Centimeters 5.0 MHz
Because repeaters "listen" on one specified frequency and "broadcast" the information they hear on another separate frequency, a standard was set for each VHF/UHF band for the amount of frequency shift between the"input" and the"output" of the repeater.

You must memorize this repeater information, because it may possibly be on the test.

Summary
1.) Know the repeater etiquette, and guidelines.
2.) Know from memory all the repeater input/output frequency separations for each band.

Lesson 16

T3 Radio-Wave propogation - T3A Line of Sight; Reflection of VHF/UHF Signals; Ionosphere

VHF Signal propogation

Line of Sight
VHF and UHF radio signals tend to travel in straight lines going all directions out from the source. VHF and UHF signals can travel large distances as long as major obstructions are not present. But once an obstruction (like buildings or trees) gets in the way, the signals are stopped, or weakened. A problem occurs when we wish to use a VHF/UHF signal to contact someone beyond our horizon. Since VHF/UHF signals tend to travel in straight lines, and the surface of the Earth is curved, the signal will not bend around the curvature of the earth, instead it will continue in a straight line forever going out into space. Thus, the distance VHF signals can travel is severely limited, by the curvature of the Earth's surface.

VHF propogation can be described in most instances as line of sight propogation. This is because they travel as far as the human eye can see to the horizon. Because of the earth's surfaces curvature, signals leave the earth's surface beyond the horizon. In summary, VHF/UHF signals can be described as having a point to point propogation which travels outward in a straight line from the radio transmitter to the receiver in a straight line called "line of sight propogation".
Radio Signals and Metal Buildings

Although VHF/UHF signals travel in straight lines out from their source, they also tend to reflect off of metal objects. The larger the metal surface the greater the amount of reflected signal. Usually large metal objects such as aircraft and buildings reflect VHF/UHF signals the best. Sometimes this special characteristic of VHF/UHF signals is used as an advantage in large cities where many buildings can block other signals.
Ionosphere

Getting Familiar with the Ionosphere
The ionosphere [EYE-ON-OH-SFIHR] is a layer of atmosphere miles above the Earth's surface on the edge between space and life. It is a region of the Earth's upper atmosphere upon which all of High Frequency and Medium Frequency long-distance radio propogation depends. In this region high above the earth, the ionosphere reacts to the ionizing radiation of the sun's Ultraviolet rays. These ultraviolet rays strike the ionosphere and leave "charged particles" behind called ions. When the ionosphere is charged by the sun's radiation, these particles refract or "bend" radio signals back down towards Earth. These ion particles form

charged layers within the ionosphere, which are responsible for the amazing signals you can hear from distant lands on the amateur radio bands.
The Layers Within the Ionosphere

The ionopshere's charged particles form four distinct regions or layers within the earth's atmosphere. These layers can be further grouped into two additional categories. Ones which exist only while the Earth's surface is in view of the sun, and ones which exist only while the earth's surface is hidden from the sun (in darkness).

Daylight Regions Night-time Regions
F1 F Layer [F1+ F2 Combined]
F2
E
D

The two F layers, the F1 and F2 combine during darkness into one layer. The E and D layers rapidly disappear as the earth enters into darkness.

The F Layers

The "F" Layer is the layer most responsible for world wide amateur radio communications. Radio signals strike this layer and are bent back at a angle towards earth with little signal loss. During the daytime, the F layer splits into 2 layers called the F1 and F2. The F2 layer is the outermost layer, and is the one which refracts signals the most during daylight hours.
E Layer

Th E layer exists in between the F and D layers, and forms only during daylight. Some radio refraction occurs in the E-layer at very high frequencies (VHF). This phenomenon is called Sporadic-E, because of it is very sporadic in nature.
D Layer

The D layer is the closest layer to the earth's surface, and also forms only during daylight hours. This layer is a layer which instead of refracting signals to earth, absorbs them. The D layer absorbs high frequency and medium frequency radio signals. In fact, sometimes, D layer absorption can grow so great that all radio communications by way of the ionosphere are wiped out for a short period.

Summary
1.) What type of propogation does a VHF/UHF signal generally exhibit?
2.) What happens if a VHF/UHF radio wave encounters a metal building?
3.) What is the ionosphere?
4.) What type of solar radiation cause it to form?
5.) What are the four layers which make up the layer? At night? During daylight?
6.) Why is the D layer bad for radio communications?

Lesson 17

T3 Radio-Wave Propagation - T3B Tropospheric Ducting; Amateur Satellite and EME

VHF Signal Propagation

Tropospheric Ducting
Tropospheric ducting or ('tropo' for short) is a special type of radio wave propagation which occurs in the VHF and UHF frequency range. This propagation occurs up high in the atmosphere in a layer called the troposphere. This type of propagation occurs when a large temperature inversion forms. When the weather conditions are right, ham radio signals are "ducted" along trapped below a warm airmass unusually large distances. The inversion traps the radio waves (which would otherwise bleed out into space) and guides them along the surface of the earth. A temperature inversion is where warm air higher up in the atmosphere forms over a cooler airmass close the surface of the earth. They occur most often near the ocean where cool seabreezes create a temeperature inversion over the coast. A temp. inversion most often happens over large parts of the nation in the summertime when a large stable high pressure systems forms. It also occurs over the Pacific and allows signals from California to make the trip to Hawaii. Hams often take advantage of this special communication opportunity by organizing VHF "contests" where hams compete for the most number of contacts on the VHF/UHF bands.

You can generally tell "tropo" is occurring when you are operating on a VHF/UHF band and suddenly you are able to make contacts long distances away. Another important fact to consider is that signal losses or path loss through the troposphere increases as the frequency increases.

Earth Moon Earth
What is EME? EME is the term for Earth-moon-Earth. This is an amazing part of amateur radio communications where hams direct their powerful signals toward the moon and attempt to contact fellow hams across the world with their moon-echoes. This type of communication requires very sensitive receiving equipment with high powered amplifiers and large antenna systems. This is because lots of the signal is lost in the trip to the moon and back. When the echoes return to earth, they are extremely faint. This occurrence is called path loss. A good choice for an EME antenna system would be a high-gain array of yagi antennas. For a description of yagi antennas go to Section T9.

Satellite
Questions on the exam ask a few questions regarding satellites. A few of them concern power levels needed for satellite communications.
The rule to remember is:
Always use the minimum amount of power needed to use the satellite. But, when the satellite is low to the horizon it will be necessary to increase power. This is logical because when a satellite is near the horizon the satellite is the farthest from you. When the satellite is farther from earth = increase power.

How do you know if you can communicate with another station by way of a satellite?

Well, it's simple. Both your station and the other station must be in view of the satellite at the same time.

Vocabulary Terms Definition
Path Loss The signal loss occurring along the signals path to the receiving location.
Tropospheric Ducting Where a signal in the VHF/UHF range is ducted over a large distance through the troposphere.
Perigee The farthest point of a satellites orbit from the earth.

Summary
1.) What is tropospheric ducting?
2.) What causes 'tropo' to occur?
3.) In what frequency range does tropo most commonly occur?
4.) How do you know if tropo is occurring?
5.) What is path loss?
6.) What type of antenna system is recommended for an EME station?
7.) Why must you increase power when a satellite is near your horizon?

Lesson 18

T3 Radio-Wave Propagation - T3C Ionosphere; Sunspots; MUF, Skip Zone, Sky Waves

Ionosphere

Sunspots
The sun's sun spots directly correlate to the ionization of the atmosphere. The number of the sun's solar spot's are a strong indicator of the amount of solar activity on the sun's surface. When the sun spots increase, the amount of solar energy increases dramatically causing the ionosphere to become heavily charged.

The sun goes through a cycle called the Sun Spot Cycle. The sun spot cycle lasts a period of about 11 years. About every 5.5 years the sun reaches a low in sunspots where the surface of the sun has almost no spots. In another 5.5 years the sun's surface is dotted with hundreds of the dark sunspots. This is called the peak of the sunspot cycle.

When sun spot numbers are high, HF propagation becomes increasingly improved through out the world. Hams especially await with anticipation for the peak of the sunspot cycle for the experience of enhanced amateur radio propagation on the HF bands.

Maximum Usable Frequency
Why do the sun spots cause such increased propagation on the HF bands? This is a likely question someone can ask. The reason is that the sun's Ultra-Violet and other forms of radiation into the upper atmosphere increase during the peak of the sunspot cycle. Thee radiation charges the atmosphere, raising the maximum usable frequency. The maximum usable frequency is a term used to describe the highest frequency that can be bounced off of the ionosphere at a particular time. Because most High Frequency signals generally

cannot bounce off of the atmosphere, a higher maximum usable frequency means these HF frequencies on the HF bands will also be reflected. The important thing to note, is that the MUF increases with sunspot/solar activity, and it allows better ham radio communication on the HF bands.

But why is it a good thing if the "M.U.F." is higher than normal?

Because higher frequencies skip off the ionsphere at a much lower angle than lower frequency ones do. Thus, the lower angles allow the singlas to travel farther along the globe without weakening. This at the peak of the sunspot cycle incredible distances can be covered with a very small radio and poor antennas.

Skip Zones, Sky Waves, and Ground Waves
A sky wave is a signal which travels up toward the ionosphere and is reflected back down to earth many thousands of miles away. A ground wave is a signal that tends to hug the ground. It extends out from the antenna for a few miles. It is a limited signal, which allows for short distance communication. The skip zone is the gap between the two forms of radio propagation. The sky waves bounce over the skip zone, and the ground wave doesn't quite make it far enough to fill in this gap in signal coverage.

Scatter Propagation
Only one question in the Technician Class Element T-3 Section T3C concerns scatter. Scatter propagation often fills in this gap in the coverage called the skip zone. It is most often weak, faint, and distorted, coming in on a frequency very close to the maximum usable frequency.

Vocabulary Terms Definition
Sunspots- A darker spot on the sun; used as an indicator of increased solar activity and unusual radio conditions.
Sunspot Cycle- A cycle of sunspots from peak to minimum lasting about eleven years.
Sky Wave- A signal returned to Earth by the ionosphere.
Ground Wave- A signal which travels along the surface of the earth.
Scatter- A propagation type which occurs on a frequency very close to the maximum usable frequency. It produces a weak, and distorted signal.
Maximum Usable Frequency- The highest frequency signal that will reach its intended destination.

Summary
1.) How long is the solar cycle?
2.) What does an increase in solar activity mean for a radio amateur?
3.) What does the term MUF or maximum usable frequency mean?
4.) What do the terms skip zone, scatter, and ground wave respectfully mean?

Lesson 19

T4 Amateur Radio Practices - T4A Lightning Protection - Antenna Safety - Grounding

Safety

Lightning Damage
To best protect your antenna investments and prevent a disaster, you should ground your antennas when not in use.
If a storm approaches, quickly turn off all station equipment, disconnect your antenna cables, and hook them to ground.

Station Safety
Grounding - To prevent accidental electrical shock, you should ground all your station equipment.
High Voltage Power Supplies - Because high voltage power supplies contain deadly voltages inside their cabinets, manufacturers are required to place interlock switches in the power supply cabinets. The interlock switches will automatically disconnect all AC power to the supply, when you open the cabinet for repairs. *This is done for your safety to prevent accidental electrical shock.
Antenna Safety - If you are on the ground helping someone work on an antenna tower, be safe! Wear a hard hat or helmet and goggles to protect your head from something dropped from the tower.

Additional Antenna Safety
Many hams use a slingshot or bow and arrow and weight system to shoot a line over a tree for an antenna support. Because this is such a common practice, there are some exam questions concerning the safety of this procedure.

Make sure the line you are using is strong enough to withstand the shock of shooting the weight.
You must ensure that the arrow or weight has a safe flight path if the line breaks.
Make sure no one is standing in the way of the shooting arrow or weight.
Antenna's + Powerlines = Hazard

Always be sure that both your antenna and your feedline are clear of any powerlines. Use my following guideline: "If there is any possible way for the antenna or feedline to come in contact with a power line, it will happen, eventually."

Dummy Loads
Dummy loads are used in place of antennas during transmitter testing, so that no signal is radiated. This allows transmitter testing to be done off the air. For more on dummy loads see Element T2 Page A.

Dummy Loads are rated by the watts continuous. If you have a transmitter that can put out 100 watts of power, then obviously you will need a dummy load rated at 100 watts continuos. Otherwise, a dummy load rated below 100 watts will overheat when you apply 100watts to it and cause a hazard.

In the old days, old-timers used light bulbs tune up their vacuum tube rigs. This was fine for vacuum tube radios, but with today's semiconductor technology, it would be very dangerous to use a light bulb as a dummy load. The reason for this is because as soon as you apply power to the light bulb, the filament heats up, the impedance changes, resulting in an impedance mismatch and a potential problem.

Summary
1.) How can an antenna best be protected from lightning damage?
2.) Why must you ground your station equipment?
3.) What kind of safety gear should a person assisting someone on a tower wear?

4.) What does a safety interlock switch do?
5.) What is a dummy load?
6.) Why should you not use a light bulb as a dummy load?

Lesson 20

T4 Amateur Radio Practices - T4B - Electrical Wiring - Voltages - SWR Measurements - Meters

Safety

Dangerous Voltages
You may be surprised to know that as little as 30 Volts is enough to kill a human. Although such cases are rare, in the correct situation, 30 volts can be enough. This knowledge may save your life the next time you work around high voltages. Even as little as 1/10 of an Ampere of electrical current running through your body can be enough to kill you. The body part most affected by electricity is the heart. Such voltages or currents mentioned above are enough to deliver the a fatal blow to your heart.

SWR
What is SWR?
SWR is an indicator of a mismatch between an antenna and the radio. The word SWR stands for Standing Wave Ratio. When a mismatch between the radio and antenna occurs, some of the power sent to the antenna reflects back down the feedline to return to the SWR meter and radio. The ratio between the voltages sent out to the antenna and the voltages reflecting back give you an SWR reading. If there is a mismatch, it can cause problems with your radio and antenna, and somewhat degrade performance.

Understanding SWR Readings

SWR Readings are given in the following format:
1:1 - A 1 to 1 ratio is the best reading you can get. (The best impedance match has been attained.)
1.5:1 - A fairly good SWR match.
2:1 A good SWR reading.
2.5:1 - An "OK" SWR reading.
3:1 - Poor SWR reading.
4:1 - Bad SWR reading.
5:1 - Very bad SWR reading. Time to fix your antenna.

Understanding SWR Readings
SWR readings indicate the impedance match between your radio and the antenna. A bad impedance match will give you a reading of 5:1. A good impedance match will give you a reading between 2:1 and 1:1. A 1:1 is an ideal reading. It means you have a perfect impedance match between your radio and the antenna. This also means you are getting no power reflected from the antenna.

Fixing a Bad SWR Reading

A very high SWR reading means the antenna is the wrong length, or there may be an open or shorted connection somewhere along the feedline. Make sure to check that there aren't any incorrect connections or shorted components of the antenna. If there aren't any, then it is time to lengthen, or shorten the antenna. Here is the rule for tuning the antenna length for a good SWR match:

Transworld radio SWR Rule
Lengthening: The antenna is too short and must be lengthened if: the SWR reading at the low end of the amateur band is 5:1 and decreases to 2.5:1 at the high frequency end of the same band.
Shortening The antenna is too long and must be shortened if: the SWR reading at the low frequency end of the amateur band is 2.5:1 and increases to 5:1 ant the high frequency end of that same band.

Using an HF SWR Meter for VHF Readings
An HF SWR meter is not recommended for VHF use, but if it calibrates to full scale in the set position, the readings may be accurate.

Summary
1.) What does an SWR reading of 1:1 mean. How about 5:1, or 3:1?
2.) What is SWR?
3.) How can you fix your antenna if you get a bad SWR reading?
4.) What is the minimum voltage dangerous to humans? What is the minimum current dangerous to humans?
5.) What body organ is most affected by electrical current?

Lesson 21

T4 Amateur Radio Practices - T4C - Meters and their Placement in Circuits - Ratings of Fuses/Switches

Meters and Measurements

Voltmeters
Voltmeters are meters used to measure the amount of voltage in a portion of a circuit under test. To measure voltage accurately, place the voltmeter in "parallel" across the circuit. The term parallel indicates the voltmeter is placed across the circuit. One probe hits the part of the circuit you want to measure the voltage at, and the other probe touches the negative or "ground" lead, or part of the circuit.

Ammeter
Ammeters measure the amount of current in a circuit under test. Ammeters got their name from "Ampere" the unit of measurement for current. To correctly find the amount of current flowing through a wire in a circuit, it is necessary to cut a wire open and insert the ammeter in place. The ammeter is placed in "series" with the circuit. Series is a term meaning the meter is "in line", or inserted into the circuit.

RF Meter Placement
An RF Wattmeter measures the amount of RF or Radio Frequency Energy coming out of your radio. RF energy is measured in Watts. This is why it's called a Wattmeter. For an accurate reading an RF Wattmeter is placed at the transmitter output connector. Also, RF wattmeters generally operate at 50 Ohms line impedance. You will generally find that on most all ham equipment, from radio's, coax, to meters, 50 Ohms will be a standard for impedance. Remember that number!

Directional Wattmeter:
A directional wattmeter is used to measure forward and reflected power. This has more to do with SWR. When there is a mismatch between the antenna and your radio, some power gets reflected down the feedline back to the wattmeter. The wattmeter shows the amount of power going in the direction toward the antenna, and the power coming back in your direction(towards the radio).

Peak Reading Wattmeter:

A peak reading wattmeter reads the Peak Emitted Power, or PEP of your station. This type of meter is used to make sure your station is in compliance with the power output authorized for your license class.

Multimeter
A multimeter is a meter designed to give you voltage, current, and resistance readings in one single meter. These little meters are handy and can be helpful in troubleshooting problems with your ham radio gear.

DESTROYING YOUR MULTIMETER:

What Will Happen If I....
Switch the multimeter to measure Resistance while having it connected to measure voltage?
Result: This action will destroy the multimeter's circuitry.
Switch the multimeter to read microAmps and connect it into a circuit drawing 5 Amps, what might happen?
Result: DON'T DO IT! It will destroy your multimeter's circuitry.

Fuse Ratings
A fuse is a protection device. Most radios and power supplies, have a built in fuse. If an accident happens, or the equipment malfunctions and it starts to draw to much electrical current, the fuse overheats, melts and cuts off power to the circuits, thus preventing further damage or fire. When the equipment has been repaired, or the situation has been improved, the fuse can be replaced, restoring the equipment to proper operation. The rule when a fuse gets blown, always replace it with a fuse rated at the same current (Amperage) rating. Never replace it with a fuse rated at a lower rating than the previous one. For example: What would happen if a transceiver blows a 5 Amp fuse, and you replace it with a 30 Amp fuse? The transceiver can draw more than the 5 Amps it needs and a fire could occur.

If you replace a fuse with one of a lower rating, the fuse will get blown everytime you replace it. If you replace the fuse with one of a higher rating, the fuse won't blow in the case that the device malfunctions, risking fire, injury, and death.

Summary
1.) How is a voltmeter connected into a circuit under test?

2.) How is an ammeter connected into a circuit under test?
3.) What is an RF directional wattmeter?
4.) What does an RF wattmeter do?
5.) What is the standard line impedance of RF wattmeters?
6.) How can you destroy a multimeter?
7.) What is the rule on replacing a blown fuse?

Lesson 22

T4 Amateur Radio Practices - T4D - RFI and its Implications -

RFI - Radio Frequency Interference

Receiver Overload
Receiver overload occurs when someone nearby is transmitting a very strong signal. Even if you are not even listening close to the other station's transmitting signal, your receiver will be overloaded by the sheer power of the other station.

Sometimes, your amateur radiation can cause receiver overload in T.V's stereos, and telephones. In these cases, your station's signal overloads the receivers in these consumer products. Often the cause of this problem is because of poor manufacturing design in these consumer products.

Harmonic Radiation
Harmonic radiation is an unwanted type of radio radiation coming from your radio. The word harmonic means "a multiple of a given wave; an overtone." Thus harmonic radiation in the radio world is the radiation of multiples of your signal above and below your transmitting frequency.

Removing Harmonic Radiation
Often harmonic radiation occurs from a bad transmitter. The transmitter transmits copies of your signal all over the radio spectrum on frequencies which are multiples of the "fundamental" or original frequency. (The one you are really transmitting on.) The answer to this problem, is to use a filter, which prevents the harmonic radiation from bleeding into the antenna system. For harmonic radiation, you must use a "low pass filter". Low pass filters let lower frequencies "pass" through, yet block higher harmonic frequencies.

Responsibility for Interference
The first step in a neighborhood interference case, is to determine if the interference is a harmonic, or receiver overload type. If the neighbor indicates that you are interfering with his television EVERY TIME YOU OPERATE your station, then it will be a RECEIVER FRONT-END OVERLOAD case. This means regardless of what ham radio band you operate on, you are still overloading the television. Remember receiver overload occurs regardless of frequency.
Once this has been determined, the law says you are not at fault. It is the NEIGHBORS fault because he has a cheap television, which can't filter out the ham signals from its circuitry. After all, you are transmitting properly, its just his T.V. is getting overloaded.

If the neighbor indicates that he only gets interference when you operate your station on the fifteen meter HF ham band, then it is a HARMONIC INTERFERENCE case. This is because the harmonics of the frequency you are transmitting on, are appearing on the television band. What this means is that you are transmitting on the same channel as the Television Station is. Your signal happens to be stronger, so the T.V. picks up your station. Once this has been determined, the law says YOU are at fault. Because your station is transmitting out of the frequency limits of the amateur ham bands,(in the television portion) you are transmitting illegally interfering with your neighbor's television set. It will be your job to fix the problem by installing a filter, or buying a radio which doesn't have a problem with harmonic radiation.

What's The Difference Between The Two Cases?
To most people there doesn't seem to be much a difference at all. But to the FCC there is a whole lot of difference. In the first case, of receiver overload, you are operating within the law. You're transmiting within the ham bands, but your neighbor has a TV that can't handle the high power electromagnetic fields that your station is creating and is causing it to become overloaded. In the other harmonics case, your transmitter has a serious problem that is causing it to spread harmonics (or multiples) of your signal all over the frequency spectrum. This means that your transmitter is not only transmitting on the frequency shown on the dial, but on thousands of other nearby frequencies called harmonics. One of these harmonics just happens to fall onto the TV channel and your neighbor is picking it up.

Summary
1.) What is front-end receiver overload?
2.) What is harmonic radiation?
3.) How can harmonic interference be corrected?
4.) Who is responsible in a harmonic interference case? You, or the neighbor?
5.) Who is responsible in a front end overload case? You or the neighbor?

Lesson 23

T5 Electrical Principles - T5A Metric Prefixes - Current Voltage - Insulators/Conductors - Open and Short Circuits

Metric Prefixes

Units of Frequency
All frequencies are described in units of hertz. If a ham tells you that he is going to have a contact on 24.941 MHz, you should know that:
1.) This is a frequency.
2.) It is a equal to 24,941,000 Hertz.
3.) This frequency is in the 12 meter band.
4.) This frequency is in the General and Extra Class only portion of the Single Sideband Part of the 12 meter band.

Frequencies on ham bands will always be expressed in kilo(thousand Hertz), Mega(Million) Hertz, or

Giga(Billion) Hertz. To state a frequency simply in Hertz would in most cases mean reciting a six digit number. Instead of such a system, hams use metric prefixes to show that the frequency is really a much larger number.

Here is a list of common frequency prefixes:

Metric prefix Mathematically Numerically Example:
kilo thousand 1,000 7.200 kilohertz
Mega million 1,000,000 24.940 megahertz
Giga billion 1,000,000,000 1.2 gigahertz

Calculations
MATH PROBLEM:
If an ammeter is marked in amperes is used to measure a 3,000-milliampere current, what would it show?

1.) What is this problem asking me to do?

It wants you to figure out how many amperes 3,000 milliamperes is. So you have to convert 3,000-milliamperes to Amperes

2.) Conversion
The prefix "milli" means 1,000th or 1/1,000.
The mathematical formula is "milli" X 1/1000 = Amperes

3.) Set up the Problem
Insert the numbers into the equation.
"3,000 milliAmperes" X 1/1000 = 3 Amperes

4.) Solution
The solution is 3,000 milliamperes equals 3 Amperes. Units of Measurement Term Unit Measuring Instrument
Voltage Volt Voltmeter
Current Ampere Ammeter
Resistance Ohm Ohmmeter
RF Power Watt Wattmeter

The above list indicates for which electrical principle you can use what meter. To measure voltage, you use a voltmeter and make measurement in terms of volts for example.

EMF Electrical Potential
Electro-Motive Force = EMF. EMF is a term for electrical potential. In other words electrical potential is a word which is used to mean voltage. A voltmeter is used to measure EMF.

Electrical Insulators
Almost all non-metals are electrical insulators. Insulators are materials which cannot conduct electricity. If you were to replace the wiring in your flashlight with rubber string instead, the flashlight would not light. Why? because rubber would not let electricity flow from the battery to the bulb. It is an insulator.

Some Common Insulators are: Glass, air, plastic, paper, porcelain, rubber, wood, and cloth fabric. TIP: Most all non-metals are insulators. (Those materials which do not contain metals)

Conductors

Conductors are materials through which electricity passes readily. All metals are good conductors. Remember the previous flashlight example? The copper wire we removed and replaced with rubber string is a conductor. Copper is a very good conductor of electricity. That's why it is used most commonly in all electrical wiring. Some common conductors: Gold - Used in wiring, in computer chips. Plating on connectors.
Silver - Used in plating connectors.
Copper - Used in wiring
Aluminum - Used in Wiring
Steel

Short Circuits

A short circuit is the opposite of an open circuit. Since in an open circuit, there is no current flowing, the short circuit has too much current flowing. In this case all the electricity is flowing through the short circuit because it is a shorter and easier path for the electrons to travel. Thus, in the diagram, the battery would die quickly as the current rushes out of the battery though the shorter part of the circuit.

In common applications, if you short a 12-volt battery, you will see sparks fly, as large surges of current leap from the battery terminals. Short circuits are bad, generally causing radios to malfunction as the large amounts of current surging through ham radio equipment will cause electronics components inside to burn causing a bad odor.

Open Circuits

An open circuit has no current flowing in it. The path for electricity is broken. In order for electricity to flow through a circuit, there must be an un-broken path from the positive terminal to the negative terminal. Because in this case there is no complete path from the positive terminal of the battery to the negative terminal, the light bulb in the circuit cannot light.

Summary

1.) What is frequency measured in? Can you convert a frequency from kiloHertz to Hertz?
2.) Why must you ground your station equipment?
3.) What are electrical conductors? Can you name four examples?
4.) What are electrical insulators. Can you name four examples?
5.) What is an open circuit? Does current flow in an open circuit?
6.) What is a short circuit? How current flow in a short circuit?
7.) Convert milliamperes to Amperes.
8.) Know what an Ohmmeter, Voltmeter, Wattmeter, and Ammeter are and what they measure.

Lesson 24

T5 Electrical Principles - T5B Electrical Components - Practical Applications

Electrical Components and Applications

Resistance

Resistance opposes the flow of electrons. Example: Think of a household plumbing pipe. Normally water would flow quite easily through the pipe. Now what if you took a hammer and put a big dent in that pipe. All the faucets in the house after the pipe with the dent in it would barely have water flowing out of the spigot. Why? Because the dent in the pipe places a resistance to the water flow inside the pipe, thus restricting water from reaching the faucets.

A resistor works just like the dent in the water pipe does. The resistor presents resistance to the electron/current flow within the circuit, restricting current from reaching its destination.

Resistors

Resistors are used in electronic applications to control the flow of electricity for a particular voltage. The higher the resistance, the less the amount of current can flow in a circuit.

The basic unit of measurement for a resistor is the Ohm.

Definition of New Term

Ohm The resistance of a circuit in which one Ampere current flows when 1 volt is applied.

Inductors

Inductors are coils of wire wound in a spiral coil shape, which have the ability to store electrical energy in a magnetic field. They can restrict the flow of alternating current (A.C.) and R.F. (radio frequency energy) while letting DC (direct current) through freely. (Inductors are like small AC resistors. AC can't get through all the resistance the inductor creates. But DC just passes right through the inductor as if it wasn't even there!)

Capacitors

Capacitors have the ability to store electrical energy in an electrical field. They are used in electronics applications to block D.C. (direct current) while allowing AC (alternating current) to pass through. (Capacitors are like small open circuits. DC cannot jump across the tiny break in the connection. But AC can!)

Calculations

Resistance Total resistance if two resistors are in series. R1+R2 = RTotal
If two resistors are in series, their values are added together. This means their total resistance will be sum of the two resistors.

Inductance Total inductance if two inductors are in parallel. L1 + L2 / L1 + L2 = LTotal
If two equal value inductors are connected in parallel their total inductance will be half the value of one of the inductors.

Capacitance Total capacitance if two capacitors are in Series: C1 X C2 / C1 + C2= CTotal
The total value of two "equal-value" capacitors connected in series is half the value of either capacitor.

Summary

1.) Definition of resistance. Resistance restricts current flow in a circuit.
2.) Definition of Ohm: The resistance of a circuit in which one Ampere current flows when 1 volt is applied.
3.) Inductors: They can restrict the flow of alternating current (A.C.) and R.F. (radio frequency energy) while letting DC (direct current) through freely.
4.) Capacitors have the ability to store electrical energy in an electrical field. They are used in electronics applications to block D.C.
5.) If two resistors are in series, their values are added together. This means their total resistance will be sum of the two resistors.
6.) If two equal value inductors are connected in parallel their total inductance will be half the value of one of the inductors.
7.) If two equal value capacitors are connected in parallel their total inductance will be half the value of one of the inductors.