ARRL's Tech Q&A

Your Quick & Easy Path to your FIRST Ham Radio License

Fifth Edition

By Ward Silver, NØAX

Contributing Editor:
Mark Wilson, K1RO

Editorial Assistants
Maty Weinberg, KB1EIB

Production Staff:
David Pingree, N1NAS, Senior Technical Illustrator
Jodi Morin, KA1JPA, Assistant Production Supervisor: Layout
Sue Fagan, Graphic Design Supervisor: Cover Design
Michelle Bloom, WB1ENT, Production Supervisor: Layout

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Fifth Edition

This book may be used for Technician license exams given beginning July 1, 2010. *QST* and the ARRL Web site (**www.arrl.org**) will have news about any rules changes affecting the Technician license or any of the material in this book.

We strive to produce books without errors. Sometimes mistakes do occur, however. When we become aware of problems in our books (other than obvious typographical errors), we post corrections on the ARRL Web site. If you think you have found an error, please check www.arrl.org for corrections. If you don't find a correction there, please let us know, either using the Feedback Form at the back of this book or by sending e-mail to pubsfdbk@arrl.org.

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FOREWORD

Welcome to the diverse group of individuals that make up Amateur Radio! There are nearly 700,000 amateurs, or "hams," in the United States alone and 3,000,000 around the world. Hams come from all walks of life, all ages, and every continent. Hams are busily communicating without regard to the geographic and political barriers that often separate humanity. This is the power of Amateur Radio — to communicate with each other directly, without any other commercial or government systems.

Hams came to Amateur Radio from many walks of life and many interests. Perhaps you intend to provide emergency communications for yourself and your community. Technical experimentation might be your interest or you might be one of the burgeoning "do-it-yourself" community, discovering the pleasures of building, testing, using and learning. Making new friends via the radio, keeping in touch as you travel, or exploring where a wireless signal can take you — these are all valuable and valued parts of the Amateur service.

As you read this book, getting ready to pass your first ham radio licensing exam, be sure to take advantage of the additional material on the ARRL's Web site as suggested in the Introduction. That's the ARRL way of going the extra mile to help you learn about Amateur Radio. "Of, By, and For the Amateur" is the ARRL's motto. By providing this extra information, you will be better prepared to get on the air, have more fun, and be a more effective operator.

Most active radio amateurs in the United States are ARRL members. They realize that since 1914, the ARRL's training, sponsorship of activities, and representation both nationally and internationally are second to none. The book you're reading now, *ARRL's Tech Q&A* is just one of many publications for all levels and interests in Amateur Radio. You don't need a license to join the ARRL — just be interested in Amateur Radio and we are interested in you. It's as simple as that!

David Sumner, K1ZZ
Chief Executive Officer
Newington, Connecticut
March 2010

When to Expect New Books

A Question Pool Committee (QPC) consisting of representatives from the various Volunteer Examiner Coordinators (VECs) prepares the license question pools. The QPC establishes a schedule for revising and implementing new Question Pools. The current Question Pool revision schedule is as follows:

Question Pool	Current Study Guides	Valid Through
Technician (Element 2)	*The ARRL Ham Radio License Manual,* 2nd Edition *ARRL's Tech Q & A,* 5th Edition	**June 30, 2014**
General (Element 3)	*The ARRL General Class License Manual* 6th Edition *ARRL's General Q & A,* 3rd Edition	**June 30, 2011**
Amateur Extra (Element 4)	*The ARRL Extra Class License Manual,* 9th Edition *ARRL's Extra Q & A,* 2nd Edition	**June 30, 2012**

As new Question Pools are released, ARRL will produce new study materials before the effective dates of the new Pools. Until then, the current Question Pools will remain in use, and current ARRL study materials, including this book, will help you prepare for your exams.

As the new Question Pool schedules are confirmed, the information will be published in *QST* and on the ARRLWeb site at **www.arrl.org**.

Introduction

The Technician License

Earning a Technician Amateur Radio license is a good way to begin enjoying ham radio. Topics covered by the exam provide you with a good introduction to basic radio and there is no difficult math or electronics background required. You are sure to find the operating privileges available to a Technician licensee to be worth the time spent learning about Amateur Radio. After passing the exam, you will be able to operate on every frequency above 50 megahertz that is assigned to the Amateur service. With full operating privileges on those bands, you'll be ready to experience the excitement of Amateur Radio! You also gain privileges on the traditional "shortwave" 80, 40, 15 and 10 meter amateur bands.

Perhaps your interest is in Amateur Radio's long history of providing emergency communications or "emcomm" in time of need. Your experience with computer networks might lead you to explore the many digital modes and networks used in ham radio. If your eyes turn to the stars on a clear night, you might enjoy tracking the amateur satellites and using them to relay your signals to other amateurs around the world! Your whole family can enjoy Amateur Radio, taking part in outdoor activities like ARRL Field Day and mobile operating during a vacation or weekend drive.

An Overview of Amateur Radio

Earning an Amateur Radio license is a special achievement. The nearly 700,000 people in the US who call themselves Amateur Radio operators, or hams, are part of a global fraternity. Radio amateurs provide a voluntary, noncommercial, communication service. This is especially true during natural disasters or other emergencies when the normal lines of communication are out of service. In the aftermath of hurricanes Katrina, Rita, and Wilma in 2005, more than 2000 hams traveled to the stricken areas to establish communications links until normal systems were restored. Thousands more relayed information around the country. In every county and city, organized groups of amateur operators train and prepare to support their communities during disasters and emergencies of every type.

Hams have made many important contributions to the field of electronics and communications, and this tradition continues today. Amateur Radio experimentation is yet another reason many people become part of this self-disciplined group of trained operators, technicians and electronics experts — an asset to any country. Hams pursue their hobby purely for personal enrichment in technical and operating skills, without any type of payment except the personal satisfaction they feel from a job well done!

Radio signals do not know territorial boundaries, so hams have a unique ability to enhance international goodwill. Hams become ambassadors of their country every time they put their stations on the air.

Amateur Radio has been around since the early 1900s. Hams have always been at the forefront of technology. Today, hams relay signals through their own satellites, bounce signals off the moon, relay messages automatically through

computerized radio networks and use any number of other "exotic" communications techniques. Amateurs talk from hand-held transceivers through mountaintop repeater stations that can relay their signals to other hams' cars or homes or through the Internet around the world. Hams establish wireless data networks, send their own television signals, and talk with other hams around the world by voice. Keeping alive a distinctive traditional skill, they also tap out messages in Morse code.

The US government, through the Federal Communications Commission (FCC), grants all US Amateur Radio licenses. Amateurs are expected to know more about their equipment and operating techniques because of the tremendous flexibility granted to the Amateur service. Unlike other radio services, amateurs organize their own methods of communication, they are encouraged to build and repair their own equipment, perform experiments with antennas and with radio propagation, and invent their own protocols and networks. The FCC licensing process ensures that amateurs have the necessary operating skill and electronics know-how to use that flexibility wisely and not interfere with other radio services.

Who Can Be a Ham?

The FCC doesn't care how old you are or whether you're a US citizen. If you pass the examination, the Commission will issue you an amateur license. Any person (except the agent of a foreign government) may take the exam and, if successful, receive an amateur license. It's important to understand that if a citizen of a foreign country receives an amateur license in this manner, he or she is a US Amateur Radio operator. (This should not be confused with a reciprocal permit for alien amateur licensee which allows visitors from certain countries who hold valid amateur licenses in their homelands to operate their own stations in the US without having to take an FCC exam.)

License Structure

Anyone earning a new Amateur Radio license can earn one of three license classes — Technician, General and Amateur Extra. Higher-class licenses have more comprehensive examinations. In return for passing a more difficult exam you earn more frequency privileges (frequency space in the radio spectrum). The vast majority of beginners earn the most basic license, the Technician, before beginning to study for the other licenses.

Table 1 lists the amateur license classes you can earn, along with a brief description of their exam requirements and operating privileges. A Technician license gives you the freedom to develop operating and technical skills through on-the-air experience. These skills will help you upgrade to a higher class of license and obtain additional privileges.

The Technician exam, called Element 2, covers some basic radio fundamentals and knowledge of some of the rules and regulations in Part 97 of the FCC Rules. With a little study you'll soon be ready to pass the Technician exam.

Each step up the Amateur Radio license ladder requires the applicant to have passed the lower exams. So if you want to start out as a General class or even an Amateur Extra class licensee, you must first have passed the Technician written exam. Once you have a valid Amateur Radio license, you have credit for all the

Table 1
Amateur Operator Licenses

Class	*Written Exam*	*Privileges*
Technician	Basic theory and regulations (Element 2)	All above 50 MHz and limited HF privileges
General	Basic theory and regulations; General theory and regulations (Elements 2 and 3)	All except those reserved for Advanced and Amateur Extra
Amateur Extra	All lower exam elements, plus Amateur Extra theory (Elements 2, 3 and 4)	All amateur privileges

exam elements of that license when you are ready to upgrade. For example, if you hold a Technician license, you will only have to pass the Element 3 General class written exam for a General class license.

Although there are also other amateur license classes, the FCC is no longer issuing new licenses for them. The Novice license was long considered the beginner's license. Exams for this license were discontinued as of April 15, 2000. The FCC also stopped issuing new Advanced class licenses on that date. They will continue to renew previously issued licenses, however, so you will probably meet some Novice and Advanced class licensees on the air.

As a Technician, you can use a wide range of frequency bands — all amateur bands above 50 MHz, in fact. (See **Table 2** and **Figure 1**.) You'll be able to use point-to-point or repeater communications on VHF, use packet radio and other digital modes and networks, even access orbiting satellites or bounce a signal off meteor trails and the Moon! You can use your operating skills to provide public service through emergency communications and message handling.

Station Call Signs

Many years ago, by international agreement, the nations of the world decided to allocate certain call sign prefixes to each country. This means that if you hear a radio station call sign beginning with W or K, for example, you know the station is licensed by the United States. A call sign beginning with the letter G is licensed by Great Britain, and a call sign beginning with VE is from Canada. (All of the amateur call sign prefixes are listed in a table on the ARRL's Web site, **www.arrl.org**.)

The International Telecommunication Union (ITU) radio regulations outline the basic principles used in forming amateur call signs. According to these regulations, an amateur call sign must be made up of one or two characters (the first one may be a numeral) as a prefix, followed by a numeral, and then a suffix of not more than three letters. The prefixes W, K, N and A are used in the United States. When the letter A is used in a US amateur call sign, it will always be with a two-letter prefix, AA to AL. The continental US is divided into 10 Amateur Radio

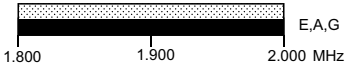
Table 2

US Amateur Bands

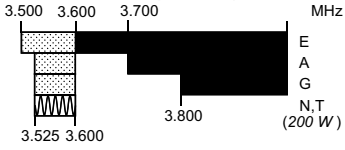
As of February 2010

160 Meters (1.8 MHz)

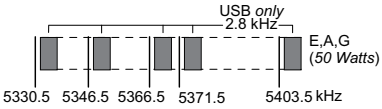
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz



80 Meters (3.5 MHz)

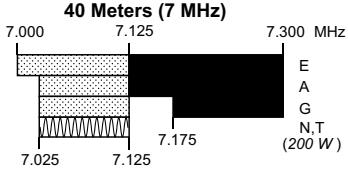


60 Meters (5.3 MHz)



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

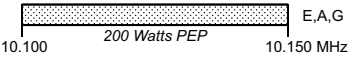
40 Meters (7 MHz)



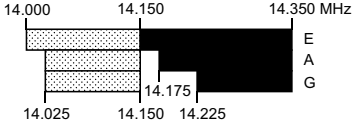
Phone and Image modes are permitted between 7.075 and 7.100 MHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11). Novice and Technician Plus licensees outside ITU Region 2 may use CW only between 7.025 and 7.075 MHz. See Section 97.301(e). These exemptions do not apply to stations in the continental US.

30 Meters (10.1 MHz)

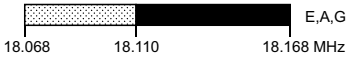
Avoid interference to fixed services outside the US.



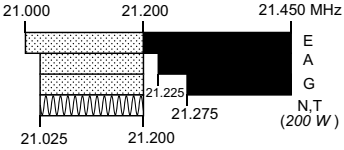
20 Meters (14 MHz)



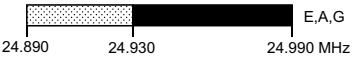
17 Meters (18 MHz)



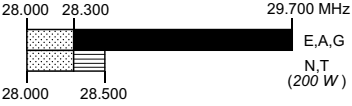
15 Meters (21 MHz)



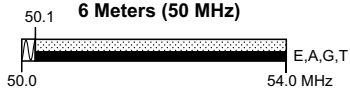
12 Meters (24 MHz)



10 Meters (28 MHz)

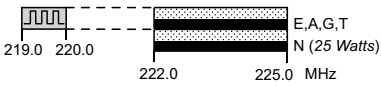


6 Meters (50 MHz)



2 Meters (144 MHz)

1.25 Meters (222 MHz)

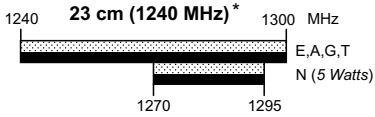


*Geographical and power restrictions may apply to all bands above 420 MHz. See The ARRL Operating Manual for information about your area.

70 cm (420 MHz)*

33 cm (902 MHz)*

23 cm (1240 MHz)*



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

US AMATEUR POWER LIMITS

At all times, transmitter power should be kept down to that necessary to carry out the desired communications. Power is rated in watts PEP output. Except where noted, the maximum power output is ***1500 Watts***.

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

2300-2310	MHz	47.0-47.2	GHz
2390-2450	MHz	76.0-81.0	GHz
3300-3500	MHz	122.25-123.0	GHz
5650-5925	MHz	134-141	GHz
10.0-10.5	GHz	241-250	GHz
24.0-24.25	GHz	All above 275	GHz

KEY

Note:

CW operation is permitted throughout all amateur bands except 60 meters.

MCW is authorized above 50.1 MHz, except for 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz

= RTTY and data

= phone and image

= CW *only*

= SSB phone

= USB phone *only*

= Fixed digital message forwarding systems *only*

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb at www.arrl.org* for more detailed band plans.

***ARRL** We're At Your Service*

ARRL Headquarters
225 Main Street, Newington, CT 0611-1494
www.arrl.org
860-594-0200 (Fax 860-594-0259)
email: hq@arrl.org

Publication Orders
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email: Newham@arrl.org

Exams 860-594-0300 vec@arrl.org

QnAbands4 rev. 2/25/2010

call districts (sometimes called areas), numbered 0 through 9. **Figure 2** is a map showing the US call districts.

You may keep the same call sign when you change license class, if you wish. You must indicate that you want to receive a new call sign when you apply for the exam or change your address.

The FCC also has a vanity call sign system. Under this system the FCC will issue an available call sign selected from a list of your preferred call signs. While there is no fee for an Amateur Radio license, there is a fee for the selection of a vanity call sign. The current fee and details of the vanity call sign system are available on the ARRL Web site at **www.arrl.org**.

How to Use This Book

The Element 2 exam consists of 35 questions taken from a pool of more than 350 questions. The *ARRL's Tech Q&A* is designed to help you learn about every question in the Technician exam question pool. Every question is presented just as it is in the question pool and as you will encounter it on the exam. Following every question is a short explanation of the answer.

Each chapter of the book covers one subelement from the question pool, beginning with the FCC Rules and ending with Safety. You may study the questions from beginning to end or select topics in an order that appeals to you.

If you are new to radio, you will probably find it easier to begin with the questions in subelement T3, T4 and T7 to learn about amateur equipment and the basics of radio signals. Then you can move on to the more technical topics covered by T5, T6, T8 and T9. Once you've learned

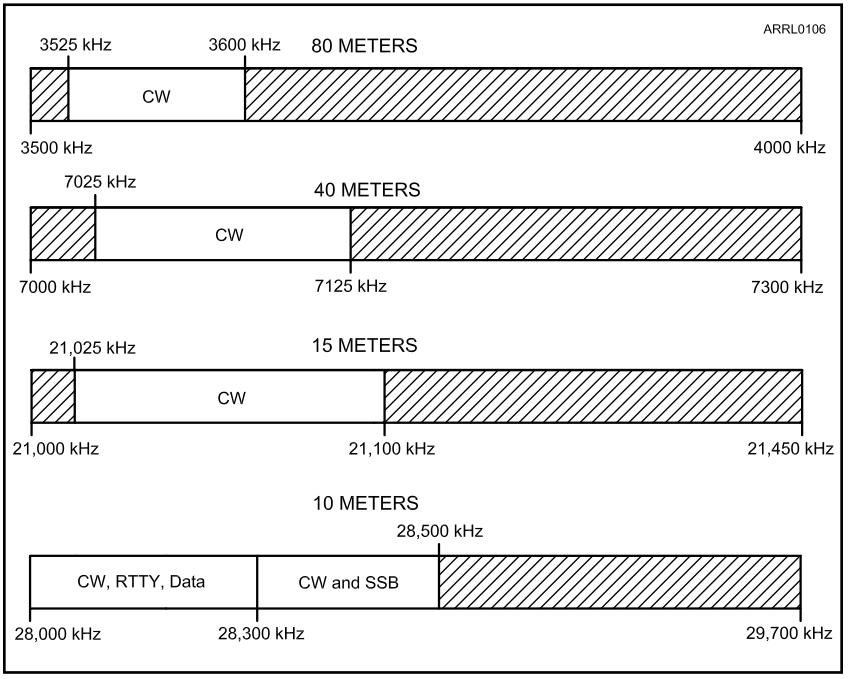


Figure 1 — This chart details the HF priviliges available to Technician licensees.

about how radios work, the subelements on operating (T2) and FCC Rules (T1) will make more sense. Finish up with T0 — Safety — and you'll be ready for your exam!

The *ARRL Ham Radio License Manual* (*HRLM*) is a good reference companion to the *Tech Q&A*. At the end of the explanation for every question, there is a reference to the page in the *HRLM* where you can find a discussion of the topics associated with the question.

There is additional supplemental material on the ARRL's Web site **www.arrl.org/ham-radio-license-manual** if you need extra help. In particular, there are links to math tutorials and every math problem on the exam is completely worked out to show you how it's done. To make the best use of the online reference material, bookmark the *Ham Radio License Manual* Web site to use as an on-line reference while you study.

The ARRL's New Ham Desk can answer questions emailed to **newham@arrl.org**. Your question may be answered directly or you might be directed to more instruction material. The New Ham Desk can also help you find a local ham to answer questions. Studying with a friend makes learning the material more fun as you help each other over the rough spots and you'll have someone to celebrate with after passing the exam!

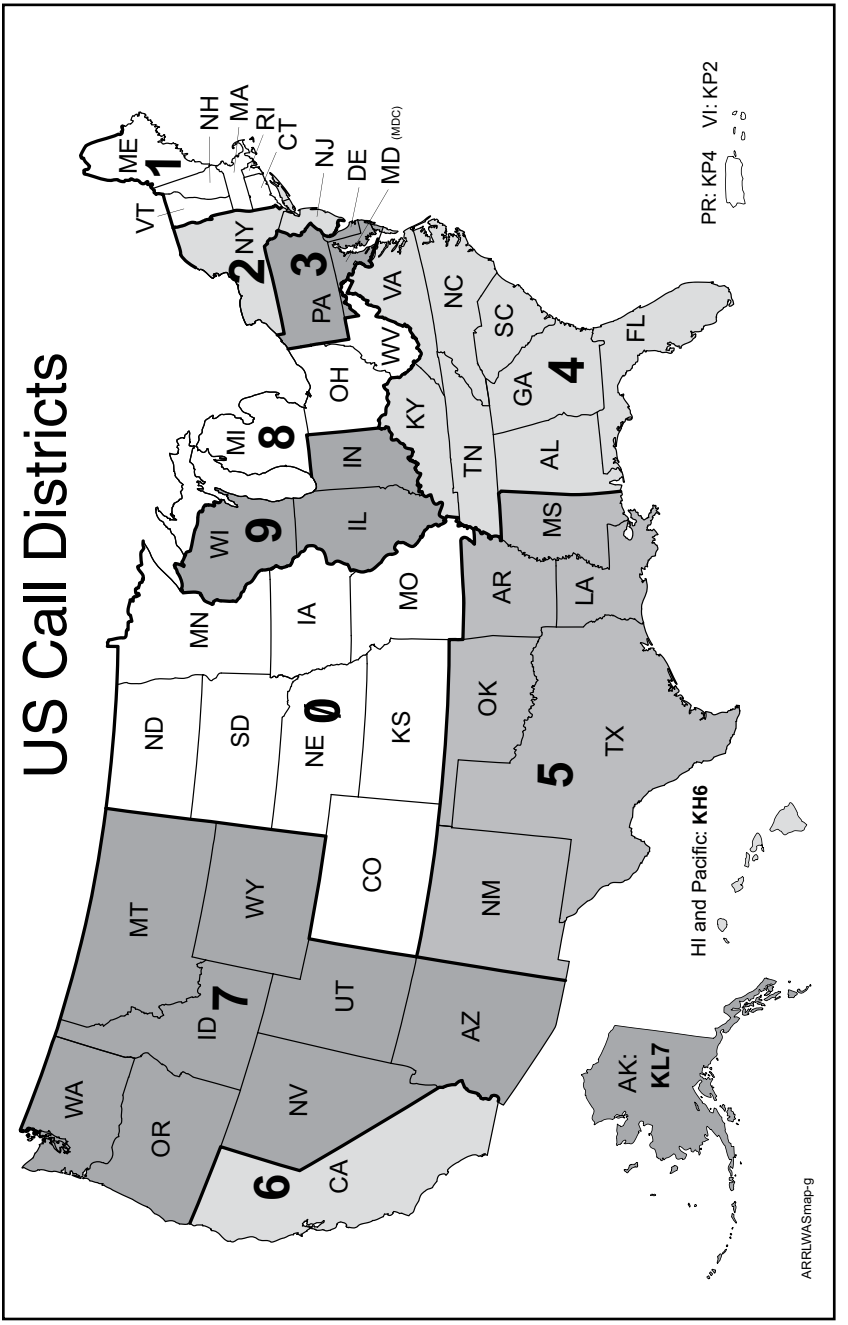


Figure 2—There are 10 US call sign areas. Hawaii and all Pacific possessions are part of the sixth call area and Alaska is part of the seventh. Puerto Rico and the US Virgin Islands are part of the fourth district.

Earning a License

All US amateur exams are administered by Volunteer Examiners who are certified by a Volunteer-Examiner Coordinator (VEC) that processes the examination paperwork and license applications for the FCC. A Question Pool Committee selected by the Volunteer Examiner Coordinators maintains the question pools for all amateur exams.

Once you make the commitment to study and learn what it takes to pass the exam, you will accomplish your goal. Many people pass the exam on their first try, so if you study the material and are prepared, chances are good that you will soon have your license. It may take you more than one attempt to pass the Technician license exam, but that's okay. There is no limit to how many times you can take it. Many Volunteer Examiner teams have several exam versions available, so you may even be able to try the exam again at the same exam session. Time and available exam versions may limit the number of times you can try the exam at a single exam session. If you don't pass after a couple of tries you will certainly benefit from more study of the question pools before you try again.

License Examinations

The FCC allows Volunteer Examiners to select the questions for an amateur exam, but they must use the questions exactly as they are released by the VEC that coordinates the test session. If you attend a test session coordinated by the ARRL/VEC, your test will be designed by the ARRL/VEC or by a computer program created by the VEC. The questions and answers will be exactly as they are printed in this book.

Before you can take an FCC exam, you'll have to fill out a copy of the National Conference of Volunteer Examiner Coordinators' (NCVEC) Quick Form 605. This form is used as an application for a new license or an upgraded license. The NCVEC Quick Form 605 is only used at license exam sessions. This form includes some information that the Volunteer Examiner Coordinator's office will need to process your application with the FCC. See **Figure 3**.

You should not use an NCVEC Quick Form 605 to apply for a license renewal or modification with the FCC. Never mail these forms to the FCC, because that will result in a rejection of the application. Likewise, an FCC Form 605 can't be used for a license exam application.

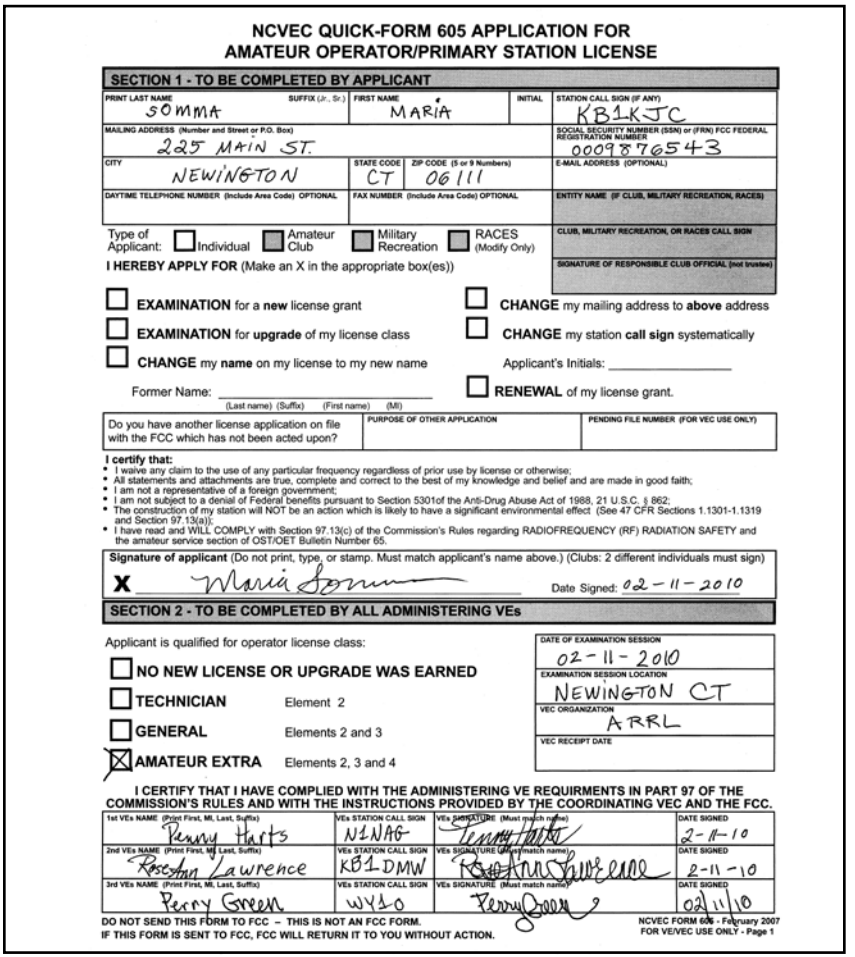
Finding an Exam Session

You can locate upcoming exam sessions in your area by using the ARRL's online Exam Search page. Browse to the ARRL's home page, **www.arrl.org**, and click the "Licensing, Education & Training" button to find complete information about taking a licensing exam. Registration deadlines and the time and location of the exams, are mentioned prominently in publicity releases about upcoming sessions. You can also contact the ARRL/VEC office directly or watch for announcements in the Hamfest Calendar and Coming Conventions columns in *QST*. Many local clubs sponsor exams, so they are another good source of information on exam opportunities.

Taking the Exam

By the time examination day rolls around, you should have already prepared yourself. This means getting your schedule, supplies and mental attitude ready. Plan your schedule so you'll get to the examination site with plenty of time to spare. There's no harm in being early. In fact, you might have time to meet and talk with another applicant which is a great way to calm pretest nerves. Try not to discuss the material that will be on the examination, as this may make you even more nervous. Relax so that you can do your best!

What supplies will you need? First, be sure you bring your current original Amateur Radio license, if you have one. Bring a photocopy of your license, too, as well as the original and a photocopy of any Certificates of Successful Completion of Examination (CSCE) that you plan to use for exam credit. Bring along several



NCVEC QUICK-FORM 605 APPLICATION FOR AMATEUR OPERATOR/PRIMARY STATION LICENSE

SECTION 1 - TO BE COMPLETED BY APPLICANT

PRINT LAST NAME / SUFFIX (Jr., Sr.)	FIRST NAME	INITIAL	STATION CALL SIGN (IF ANY)
SOMMA	MARIA		KB1KJC
MAILING ADDRESS (Number and Street or P.O. Box)			SOCIAL SECURITY NUMBER (SSN) or (FRN) FCC FEDERAL REGISTRATION NUMBER
225 MAIN ST.			0009876543
CITY	STATE CODE / ZIP CODE (5 or 9 Numbers)		E-MAIL ADDRESS (OPTIONAL)
NEWINGTON	CT 06111		
DAYTIME TELEPHONE NUMBER (Include Area Code) OPTIONAL	FAX NUMBER (Include Area Code) OPTIONAL		ENTITY NAME (IF CLUB, MILITARY RECREATION, RACES)
			CLUB, MILITARY RECREATION, OR RACES CALL SIGN
			SIGNATURE OF RESPONSIBLE CLUB OFFICIAL (not trustee)

Type of Applicant: ☐ Individual ☒ Amateur Club ☐ Military Recreation ☐ RACES (Modify Only)

I HEREBY APPLY FOR (Make an X in the appropriate box(es))

☐ **EXAMINATION** for a **new** license grant
☐ **EXAMINATION** for **upgrade** of my license class
☐ **CHANGE** my **name** on my license to my new name
Former Name: _____ (Last name) (Suffix) (First name) (MI)
☐ **CHANGE** my mailing address to **above** address
☐ **CHANGE** my station **call sign** systematically
Applicant's Initials: _____
☐ **RENEWAL** of my license grant.

Do you have another license application on file with the FCC which has not been acted upon?	PURPOSE OF OTHER APPLICATION	PENDING FILE NUMBER (FOR VEC USE ONLY)

I certify that:
- I waive any claim to the use of any particular frequency regardless of prior use by license or otherwise;
- All statements and attachments are true, complete and correct to the best of my knowledge and belief and are made in good faith;
- I am not a representative of a foreign government;
- I am not subject to a denial of Federal benefits pursuant to Section 5301of the Anti-Drug Abuse Act of 1988, 21 U.S.C. § 862;
- The construction of my station will NOT be an action which is likely to have a significant environmental effect (See 47 CFR Sections 1.1301-1.1319 and Section 97.13(a));
- I have read and WILL COMPLY with Section 97.13(c) of the Commission's Rules regarding RADIOFREQUENCY (RF) RADIATION SAFETY and the amateur service section of OST/OET Bulletin Number 65.

Signature of applicant (Do not print, type, or stamp. Must match applicant's name above.) (Clubs: 2 different individuals must sign)

X Maria Somma Date Signed: 02-11-2010

SECTION 2 - TO BE COMPLETED BY ALL ADMINISTERING VEs

Applicant is qualified for operator license class:

☐ **NO NEW LICENSE OR UPGRADE WAS EARNED**
☐ **TECHNICIAN** Element 2
☐ **GENERAL** Elements 2 and 3
☒ **AMATEUR EXTRA** Elements 2, 3 and 4

DATE OF EXAMINATION SESSION
02-11-2010
EXAMINATION SESSION LOCATION
NEWINGTON CT
VEC ORGANIZATION
ARRL
VEC RECEIPT DATE

I CERTIFY THAT I HAVE COMPLIED WITH THE ADMINISTERING VE REQUIRMENTS IN PART 97 OF THE COMMISSION'S RULES AND WITH THE INSTRUCTIONS PROVIDED BY THE COORDINATING VEC AND THE FCC.

1st VEs NAME (Print First, MI, Last, Suffix)	VEs STATION CALL SIGN	VEs SIGNATURE (Must match name)	DATE SIGNED
Penny Harts	N1NAG	Penny Harts	2-11-10
2nd VEs NAME (Print First, MI, Last, Suffix)	VEs STATION CALL SIGN	VEs SIGNATURE (Must match name)	DATE SIGNED
Roseann Lawrence	KB1DMW	Roseann Lawrence	2-11-10
3rd VEs NAME (Print First, MI, Last, Suffix)	VEs STATION CALL SIGN	VEs SIGNATURE (Must match name)	DATE SIGNED
Perry Green	WY1O	Perry Green	02/11/10

DO NOT SEND THIS FORM TO FCC – THIS IS NOT AN FCC FORM.
IF THIS FORM IS SENT TO FCC, FCC WILL RETURN IT TO YOU WITHOUT ACTION.

NCVEC FORM 605 - February 2007
FOR VE/VEC USE ONLY - Page 1

Figure 3—At the test session, the Volunteer Examiners will help you fill out an NCVEC Quick Form 605, which will be filed with the FCC.

sharpened number 2 pencils and two pens (blue or black in). Be sure to have a good eraser. A pocket calculator may also come in handy. You may use a programmable calculator if that is the kind you have, but take it into your exam "empty" (cleared of all programs and constants in memory). Don't program equations ahead of time, because you may be asked to demonstrate that there is nothing in the calculator memory. The examining team has the right to refuse a candidate the use of any calculator that they feel may contain information for the test or could otherwise be used to cheat on the exam.

The Volunteer Examiner team is required to check two forms of identification before you enter the test room. This includes your original Amateur Radio license, if you have one — not a photocopy. A photo ID of some type is best for the second form of ID, but is not required by the FCC. Other acceptable forms of identification include a driver's license, a piece of mail addressed to you or a birth certificate.

The following description of the testing procedure applies to exams coordinated by the ARRL/VEC, although many other VECs use a similar procedure.

Written Test

The examiner will give each applicant a test booklet, an answer sheet and scratch paper. You'll be shown where to sign your name and after that, you're on your own. The first thing to do is read the instructions.

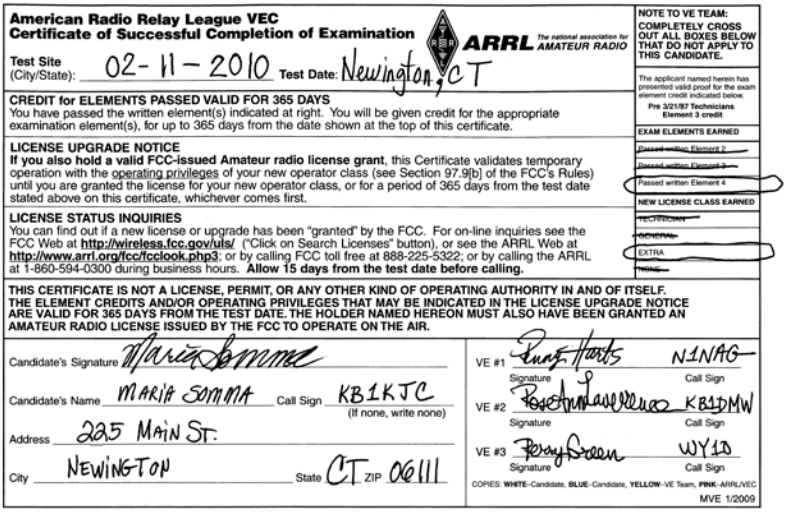
Next, check the examination to see that all pages and questions are there. If not, report this to the examiner immediately. When filling in your answer sheet make sure your answers are marked next to the numbers that correspond to each question.

Go through the entire exam, and answer the easy questions first. Next, go back to the beginning and try the harder questions. Leave the really tough questions for last.

If you don't know the answer to a question, make your best guess. There is no additional penalty for answering incorrectly. If you have to guess, do it intelligently: At first glance, you may find that you can eliminate one or more "distractors." Of the remaining responses, more than one may seem correct; only one is the best answer, however. To the applicant who is fully prepared, incorrect distractors to each question are obvious. Nothing beats preparation!

After you've finished, check the examination thoroughly. You may have read a question wrong or goofed in your arithmetic. Don't be overconfident. There's no rush, so take your time. Think and check your answer sheet. When you feel you've done your best, return the test booklet, answer sheet and scratch pad to the examiner.

The Volunteer Examiner team will grade the exam while you wait. The passing mark is 74%. (That means 26 out of 35 questions correct with up to 9 incorrect answers on the Element 2 exam.) You will receive a Certificate of Successful Completion of Examination (CSCE — see **Figure 4**) showing all exam elements that you pass at that exam session. That certificate is valid for 365 days. Use it as proof that you passed those exam elements so you won't have to take them over again next time you take a license exam.



American Radio Relay League VEC
Certificate of Successful Completion of Examination

ARRL The national association for AMATEUR RADIO

Test Site (City/State): 02-11-2010 Test Date: Newington, CT

CREDIT for ELEMENTS PASSED VALID FOR 365 DAYS
You have passed the written element(s) indicated at right. You will be given credit for the appropriate examination element(s), for up to 365 days from the date shown at the top of this certificate.

LICENSE UPGRADE NOTICE
If you also hold a valid FCC-issued Amateur radio license grant, this Certificate validates temporary operation with the operating privileges of your new operator class (see Section 97.9[b] of the FCC's Rules) until you are granted the license for your new operator class, or for a period of 365 days from the test date stated above on this certificate, whichever comes first.

LICENSE STATUS INQUIRIES
You can find out if a new license or upgrade has been "granted" by the FCC. For on-line inquiries see the FCC Web at **http://wireless.fcc.gov/uls/** ("Click on Search Licenses" button), or see the ARRL Web at **http://www.arrl.org/fcc/fcclook.php3**; or by calling FCC toll free at 888-225-5322; or by calling the ARRL at 1-860-594-0300 during business hours. **Allow 15 days from the test date before calling.**

THIS CERTIFICATE IS NOT A LICENSE, PERMIT, OR ANY OTHER KIND OF OPERATING AUTHORITY IN AND OF ITSELF. THE ELEMENT CREDITS AND/OR OPERATING PRIVILEGES THAT MAY BE INDICATED IN THE LICENSE UPGRADE NOTICE ARE VALID FOR 365 DAYS FROM THE TEST DATE. THE HOLDER NAMED HEREON MUST ALSO HAVE BEEN GRANTED AN AMATEUR RADIO LICENSE ISSUED BY THE FCC TO OPERATE ON THE AIR.

Candidate's Signature Maria Somma
Candidate's Name MARIA SOMMA Call Sign KB1KJC (If none, write none)
Address 225 MAIN ST.
City NEWINGTON State CT ZIP 06111

VE #1 Signature N1NAG Call Sign
VE #2 Signature KB1DMW Call Sign
VE #3 Signature WY1D Call Sign

COPIES: **WHITE**–Candidate, **BLUE**–Candidate, **YELLOW**–VE Team, **PINK**–ARRL/VEC
MVE 1/2009

NOTE TO VE TEAM:
COMPLETELY CROSS OUT ALL BOXES BELOW THAT DO NOT APPLY TO THIS CANDIDATE.

The applicant named herein has presented valid proof for the exam element credit indicated below.
Pre 3/21/87 Technicians Element 3 credit

EXAM ELEMENTS EARNED
~~Passed written Element 2~~
~~Passed written Element 3~~
Passed written Element 4

NEW LICENSE CLASS EARNED
~~TECHNICIAN~~
~~GENERAL~~
EXTRA
~~NONE~~

Figure 4 — The CSCE (Certificate of Successful Completion of Examination) is your test session receipt that serves as proof that you have completed one or more exam elements. It can be used at other test sessions for 365 days.

Forms and Procedures

To renew or modify a license, you can file a copy of FCC Form 605. In addition, hams who have held a valid license that has expired within the past two years may apply for reinstatement with an FCC Form 605.

Licenses are normally good for 10 years. Your application for a license renewal must be submitted to the FCC no more than 90 days before the license expires. (We recommend you submit the application for renewal between 90 and 60 days before your license expires.) If the FCC receives your renewal application before the license expires, you may continue to operate until your new license arrives, even if it is past the expiration date.

If you forget to apply before your license expires, you may still be able to renew your license without taking another exam. There is a two-year grace period, during which you may apply for renewal of your expired license. Use an FCC Form 605 to apply for reinstatement (and your old call sign). If you apply for reinstatement of your expired license under this two-year grace period, you may not operate your station until your new license is issued.

If you move or change addresses, you should use an FCC Form 605 to notify the FCC of the change. If your license is lost or destroyed, however, just write a letter to the FCC explaining why you are requesting a new copy of your license.

You can ask one of the Volunteer Examiner Coordinators' offices to file your renewal application electronically if you don't want to mail the form to the FCC. You must still mail the form to the VEC, however. The ARRL/VEC office will electronically file application forms. This service is free for any ARRL member.

Electronic Filing

You can also file your license renewal or address modification using the

FCC's Universal Licensing System (ULS) Web site, **www.fcc.gov/uls**. To use ULS, you must have an FCC Registration Number, or FRN. Obtain your FRN by registering with the Commission Registration System, known as CORES.

Described as an agency-wide registration system for anyone filing applications with or making payments to the FCC, CORES will assign a unique 10-digit FCC Registration Number (FRN) to all registrants. All Commission systems that handle financial, authorization of service, and enforcement activities will use the FRN. The FCC says use of the FRN will allow it to more rapidly verify fee payment. Amateurs mailing payments to the FCC — for example as part of a vanity call sign application — would include their FRN on FCC Form 159.

The online filing system and further information about CORES is available by visiting the FCC Web home page, **www.fcc.gov**, and clicking on the Commission Registration System link. Follow the directions on the Web site. It is also possible to register on CORES using a paper Form 160.

When you register with CORES you must supply a Taxpayer Identification Number, or TIN. For individuals, this is usually a Social Security Number. Club stations that do not have an EIN register as exempt.

Anyone can register on CORES and obtain an FRN. You don't need a license to be registered.

Once you have registered on CORES and obtained your FRN, you can proceed to renew or modify your license using the Universal Licensing System by clicking on the "Online Filing" button. Follow the directions provided on the Web page to connect to the FCC's ULS database.

Paper Filing

If you decide to "do the paperwork" on real paper instead of online, you'll need to get a blank FCC Form 605. This is not difficult! You can get FCC Form 605 with detailed instructions by contacting the FCC in any of these ways:

• FCC Forms Distribution Center, 9300 E. Hampton Dr, Capital Heights, MD 20743; tel 800-418-3676 (If you make a written request, write "Form 605" on the envelope.)

• FCC Forms "Fax on Demand" — tel 202-418-0177, ask for form number 000605

• FCC Forms On-Line — **www.fcc.gov/formpage.html** or **ftp.fcc.gov/pub/Forms/Form605**

The ARRL/VEC has created a package that includes the portions of FCC Form 605 that are needed for amateur applications, as well as a condensed set of instructions for completing the form. Write to: ARRL/VEC, Form 605, 225 Main Street, Newington, CT 06111-1494. (Please include a large business-sized stamped self-addressed envelope with your request.)

And Now, Let's Begin

The complete Technician question pool (Element 2) is printed in this book. Each chapter lists all the questions for a particular subelement (such as Operating Procedures — T2). A brief explanation about the correct answer is given after each question.

Table 3 shows the study guide or syllabus for the Element 2 exam as released by the Volunteer-Examiner Coordinators' Question Pool Committee in

February 2010. The syllabus lists the topics to be covered by the Technician exam, and so forms the basic outline for the remainder of this book. Use the syllabus to guide your study.

The question numbers used in the question pool refer to this syllabus. Each question number begins with a syllabus-point number (for example, T0C or T1A). The question numbers end with a two-digit number. For example, question T3B09 is the ninth question about the T3B syllabus topics.

The Question Pool Committee designed the syllabus and question pool so there are the same number of topics in each subelement as there are exam questions from that subelement. For example, three exam questions on the Technician exam must be from the "Operating Procedures" subelement, so there are three groups for that topic. These are numbered T2A, T2B, and T2C. While not a requirement of the FCC Rules, the Question Pool Committee recommends that one question be taken from each group to make the best possible license exams.

Good luck with your studies!

Table 3
Technician Class (Element 2) Syllabus

SUBELEMENT T1 — FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities
[6 Exam Questions — 6 Groups]

T1A Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules

T1B Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges

T1C Operator classes and station call signs; operator classes, sequential, special event, and vanity call sign systems, international communications, reciprocal operation, station license licensee, places where the amateur service is regulated by the FCC, name and address on ULS, license term, renewal, grace period

T1D Authorized and prohibited transmissions

T1E Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator

T1F Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection

SUBELEMENT T2 — Operating Procedures
[3 Exam Questions — 3 Groups]

T2A Station operation; choosing an operating frequency, calling another station, test transmissions, use of minimum power, frequency use, band plans

T2B VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics

T2C Public service; emergency and non-emergency operations, message traffic handling

SUBELEMENT T3 — Radio wave characteristics, radio and electromagnetic properties, propagation modes

[3 Exam Questions — 3 Groups]

T3A Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF and UHF; fading, multipath; wavelength vs. penetration; antenna orientation

T3B Radio and electromagnetic wave properties; the electromagnetic spectrum, wavelength vs. frequency, velocity of electromagnetic waves

T3C Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizon

SUBELEMENT T4 — Amateur radio practices and station setup

[2 Exam Questions - 2 Groups]

T4A Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

T4B Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

SUBELEMENT T5 — Electrical principles, math for electronics, electronic principles, Ohm's Law

[4 Exam Questions - 4 Groups]

T5A Electrical principles; current and voltage, conductors and insulators, alternating and direct current

T5B Math for electronics; decibels, electronic units and the metric system

T5C Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

T5D Ohm's Law

SUBELEMENT T6 — Electrical components, semiconductors, circuit diagrams, component functions

[4 Exam Groups - 4 Questions]

T6A Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

T6B Semiconductors; basic principles of diodes and transistors

T6C Circuit diagrams; schematic symbols

T6D Component functions

SUBELEMENT T7 — Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing

[4 Exam Questions - 4 Groups]

T7A Station radios; receivers, transmitters, transceivers

T7B Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces

T7C Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes

T7D Basic repair and testing; soldering, use of a voltmeter, ammeter, and ohmmeter

SUBELEMENT T8 — Modulation modes, amateur satellite operation, operating activities, non-voice communications

[4 Exam Questions - 4 Groups]

T8A Modulation modes; bandwidth of various signals

T8B Amateur satellite operation; Doppler shift, basic orbits, operating protocols

T8C Operating activities; radio direction finding, radio control, contests, special event stations, basic linking over Internet

T8D Non-voice communications; image data, digital modes, CW, packet, PSK31

SUBELEMENT T9 — Antennas, feedlines

[2 Exam Groups - 2 Questions]

T9A Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

T9B Feedlines; types, losses vs. frequency, SWR concepts, matching, weather protection, connectors

SUBELEMENT T0 — AC power circuits, antenna installation, RF hazards

[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, proximity to antennas, recognized safe power levels, exposure to others