HRLM HOME PAGE
Chapter 1 – Introduction

Supplemental Information, Corrections and Updates to the Ham Radio License Manual

Determine the version of the manual you are using by referring to the first page of the preface inside your copy. Look for the text box with the copyright information where you'll also find the edition and printing information. Then click on the link below to find updated material related to your manual.

Reference Library: Explore these resources!

ARRL On-Line Resources

- We Do That! - Information about Amateur Radio and how to become a "ham" operator.
- ARRL New Ham Desk -This is the address for email when you need extra explanation on a topic or just have a question.
- ARRL Licensing Information
- Club Search Page - Find clubs in your area
- License Search - Look up other license holders in your area or search for your own call sign after passing your exam.
- Licensing Class - Find license classes in your area
- Exam Session Search - Locate upcoming exam sessions
- First Steps in Radio

On-Line Practice Exams
Practice with the actual questions until you're confident of success!

- QRZ.com
- eham.net
- AA9PW.com
- KB0MGA.net

Math Tutorials

- A Helpful Discussion about Power and Decibels
- A Helpful Discussion About Converting Units
- Tutorial on Scientific Notation
- The Metric System
- Tutorials on Math for ARRL On-Line Courses and License Exams

Operating Resources

- *ARRL Operating Manual* - covers many ham radio operating topics
- *Ham Radio for Dummies* - your "desktop Elmer" covering operating and technical topics

- *QST*
- ARRL Bulletins - Bulletins on general news, DX, Propagation, satellite tracking information (Keplerian)
- W1AW - the ARRL's club station broadcasts bulletins and code practice all year long

Quick Reference Operating Aids

- Amateur Radio Spectrum Band Chart – includes recent revisions for Technician privileges
- Communication Procedures, ITU Phonetic Alphabet, RST System, UTC Time Conversion Chart

Popular Ham Radio Web Sites

- Yahoo! groups - enter "ham radio" into the Search window
- Yahoo group for new hams
- eham.net - Web portal with news, email lists, and classified ads
- QRZ.com - Web portal and call sign database
- Googlegroups - enter "ham radio" into the Search Groups window
- QSL.net - Numerous individual and club Web pages
- AC6V's Amateur Radio and DX Reference Guide - Glossaries, links, and files on all facets of Amateur Radio

Ham Radio Organizations

- AMSAT - largest amateur satellite organization
- Handi-ham - resource for disabled hams and ham students
- TAPR - sponsor and organizer of digital communications initiatives
- YLRL - activities of interest to female operators

Emergency Response Organizations

- Amateur Radio Emergency Service (ARES) – ARRL-sponsored emergency communications organizations
- Radio Amateur Civil Emergency Service (RACES) - works with civil defense agencies
- Salvation Army Team Emergency Radio Network (SATERN) – provides humanitarian relief and assistance
- Hurricane Watch Net (HWN) — works with the National Hurricane Center
- SKYWARN Severe weather watch and reporting system — works with the National Weather Service

FCC and International Telecommunications Union Web Sites

- FCC Wireless Telecommunications Bureau
- FCC Universal Licensing System
- ITU

Additional Resources

- ARRL Publications - The ARRL is the largest publisher of books and materials for hams and about ham radio.
- Ham Radio History - more information on how ham radio came to be the worldwide phenomenon it is today.
- Glossary
- List of Abbreviations

CHAPTER TWO RESOURCE PAGE
Chapter 2 – Radio and Signal Fundamentals

General Introductions and Tutorials on Radio

First Steps in Ham Radio - a series of articles intended to help you get started.
ARRL Technical Information Service - numerous links and articles on a variety of technical topics

Waves and Spectrum (page 2-3)

The Wikipedia's entry on Waves has many links to all aspects of waves: frequency, phase, wavelength, etc. Links to tutorials and simulations are provided at the end (bottom) of the entry. You will find a great deal of information about the electromagnetic and radio spectrum in the Wikipedia, as well.

Frequency and Wavelength (page 2-5)

Lesson 2 from this collection of animated tutorials on waves illustrates the relationship between frequency and wavelength.

Modes and Modulation (pages 2-6 through 2-9)

Modulation
Wikipedia entry on Modulation- a comprehensive review of modulation

AM
ARRL Technical Information Service - plenty of articles and links about AM
Williamson Labs AM illustration page - animated page showing how AM works
AMfone - a Web site about AM operating on the HF bands

SSB
Williamson Labs SSB illustration - animated page showing how SSB works
Wikipedia entry on Single Sideband - in-depth treatment with the theory

FM / PM
Understanding FM Transmitters - a *QST* article about FM
Williamson Labs FM illustration page - animated page showing how FM and PM work
Wikipedia entry on Frequency Modulation - in-depth treatment with the theory

Repeaters (page 2-11)

Repeaters- What They Are And How To Use Them – An ARRL Technical Information Service tutorial
Repeaters – The general ARRL TIS page on Repeaters

CHAPTER THREE RESOURCE PAGE
Chapter 3 – Electricity, Components, and Circuits

General Introductions and Tutorials on Radio and Electronics

First Steps in Ham Radio - a series of articles intended to help you get started.
ARRL Technical Information Service - numerous links and articles on a variety of technical topics
The ARRL Handbook - the oldest and best radio handbook around
Understanding Basic Electronics - introduction to the electronics of radio

Math Tutorials

- A Helpful Discussion about Power and Decibels
- A Helpful Discussion About Converting Units
- Tutorial on Scientific Notation
- The Metric System
- Tutorials on Math for ARRL On-Line Courses and License Exams

Ohm's Law and Power (pages 3-4 and 3-5)

This Ohm's Law tutorial explains where Ohm's Law comes from and shows how to use the Ohm's Law circle for problem solving. The Wikipedia entries on electrical power and the watt explains how power is calculated and the difference between power and energy.

The worked-out solutions to each of the Technician exam problems involving Ohm's Law and power are at the bottom of this Web page . This on-line calculator is also handy for solving Ohm's Law and power problems.

Resistors and Capacitors (pages 3-6 through 3-8)

- The different types of resistors are illustrated on Wikipedia and theseYouTube videos explains what resistors are and the resistor value color code. Potentiometers (variable resistors) or "pots" are explained in this tutorial. This article from the ARRL's "Lab Notes" series discusses capacitors. Here's an article on the color codes that designate the value of electronic components by their colored markings.

Diodes and Transistors (page 3-10)

This "How Stuff Works" page explains the basics of semiconductor components like diodes and transistors without going into unnecessary detail.

Electrical Protective Components and Ground (page 3-11 and 3-12)

More How Stuff Works pages explain the basics of fuses, circuit breakers, and surge protection. Ground Fault Circuit Interrupter (GFCI) circuit breakers are discussed separately. The *ARRL Handbook* also covers these components in the Electrical Fundamentals chapter and the Safety chapter. Grounding and the difference between Earth and chassis grounding are explained here.

Schematic Diagrams (page 3-14)

The ARRL's Technical Information Service includes the articles How to Read Circuit Diagrams, Part I and How to Read Circuit Diagrams, Part II. The articles may be old, but they are accurate!

Superheterodyne Receivers (page 3-18)

The Wikipedia entry on "superhet" receivers covers how they work and a bit of the history of how they came to be.

Technician Exam Power Problems (Subelement topic T5C)

T5C09 - How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes?

Power equals Voltage multiplied by Current
P = E x I = 13.8 V x 10 A = 138 W

T5C10 - How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes?

Power equals Voltage multiplied by Current
P = E x I = 12 V x 2.5 A = 30 W

T5C11 - How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 120 watts?

Current equals Power divided by Voltage
I = P / E = 120 W / 12 V = 10 A

Technician Exam Ohm's Law Problems (Subelement topic T5D)

T5D04 - What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts?

Resistance equals Voltage divided by Current
R = E / I = 90 V / 3 A = 30 Ω

T5D05 - What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?

Resistance equals Voltage divided by Current
R = voltage divided by current = E / I = 12 V / 1.5 A = 8 Ω

T5D06 - What is the resistance of a circuit that draws 4 amperes from a 12-volt source?

Resistance equals Voltage divided by Current
R = voltage divided by current = E / I = 12 V / 4 A = 3 Ω

T5D07 - What is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?

Current equals Voltage divided by Resistance
I = E / R = 120 V / 80 Ω = 1.5 A

T5D08 - What is the current flowing through a 100-ohm resistor connected across 200 volts?

Current equals Voltage divided by Resistance
I = E / R = 200 V / 100 Ω = 2 A

T5D09 - What is the current flowing through a 24-ohm resistor connected across 240 volts?

Current equals Voltage divided by Resistance
I = E / R = 240 V / 24 Ω = 10 A

T5D10 - What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

Voltage equals Current multiplied by Resistance
V = I x R = 0.5 A x 2 Ω = 1 V

T5D11 - What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?

Voltage equals Current multiplied by Resistance
V = I x R = 1 A x 10 Ω = 10 V

T5D12 - What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?

Voltage equals Current multiplied by Resistance
V = I x R = 2 A x 10 Ω = 20 V

CHAPTER FOUR RESOURCE PAGE
Chapter 4 – Propagation, Antennas, and Feed Lines

Here are two useful print references on antennas:
Simple and Fun Antennas for Hams – an introduction to antennas and feed lines
The ARRL Antenna Book – the amateur's comprehensive antenna and propagation reference

Miscellaneous Antenna and Feed Line Topics

Along the way, you might find yourself needing some assistance with the concepts behind the decibel (dB) as explained in this tutorial, A Helpful Discussion about Power and Decibels. (The questions on the Technician exam involving decibels are worked out at the end of this page. The ARRL's tutorial "The Art of Soldering" can be found in the Technical Information Service.

General Resources for Propagation (pages 4-1 through 4-4)

The ARRL's Technical Information Service Web page on Propagation is a great resource for introductory to advanced articles on many types of propagation. The Web page also has an extensive list of links to other propagation Web sites.

General Resources for Antennas (pages 4-5 through 4-8 and 4-15)

Since antennas are so fundamental to Amateur Radio, the ARRL literature is full of information about antennas, such as the ARRL Technical Information Service's "How Antennas Work" Web page. A complete series of antenna tutorials is found in the Antenna-Theory Web site's Fundamentals area.

Feed Lines and SWR (pages 4-8 through 4-18)

The two types of feed lines used by amateurs are Coaxial Cable and Parallel-Conductor. How well the feed lines are matched to the antenna or load is measured by SWR. This interesting SWR simulator/calculator allows you to vary the antenna or load impedance to see the effect on power transfer and how the radio wave is reflected in the feed line. Try the article "Do You Need An Antenna Tuner?" for more information about these common ham shack accessories. There are also articles on transmission lines and SWR in the ARRL's Technical Information Service.

The on-line Times-Microwave Cable Calculator allows you to figure the cable's signal loss at any frequency and for any length of cable and was used to generate Table 4-1.

Technician Exam Decibel Problems (Subelement Topic T5B)

Note - the questions ask only for the amount of change in decibels (dB), so use the absolute value of all calculations as your answer.

T5B09 - What is the approximate amount of change, measured in decibels (dB), of a power increase from 5 watts to 10 watts?

dB = 10 log (final power / initial power)
dB = 10 log (10 watts / 5 watts) = 10 log (2) = 10 (0.3) = 3 dB

T5B10 - What is the approximate amount of change, measured in decibels (dB), of a power decrease from 12 watts to 3 watts?

dB = 10 log (final power / initial power)
dB = 10 log (3 watts / 12 watts) = 10 log (0.25) = 10 (-.6) = -6 dB (the magnitude of the change is 6 dB)

T5B11 - What is the approximate amount of change, measured in decibels (dB), of a power increase from 20 watts to 200 watts?

dB = 10 log (final power / initial power)
dB = 10 log (200 watts / 20 watts) = 10 log (10) = 10 (1) = 10 dB

CHAPTER FIVE RESOURCE PAGE
Chapter 5 – Amateur Radio Equipment

"Choosing A Ham Radio" is found as a supplement in the back of the Ham Radio License Manual, or you can download it as a PDF document.

Modulation and Power (page 5-3)

If you are looking for more information about modulation, start with the Wikipedia entry on Modulation.

Squelch (page 5-6)

The squelch function is discussed more completely in the supplement "Choosing A Ham Radio" listed at the start of this section.

Sound Card Modems (page 5-8)

Instead of a separate device, many digital modes use the sound card built in to all recent computers to connect them to a radio. The article introducing the digital mode PSK31 illustrates the typical use of a sound card for this purpose.

Packet Radio, Radioteletype (RTTY), APRS, and Winlink (page 5-9 and 5-10)

The four-part series of articles about digital modes will provide lots of background information about these popular forms of digital communication used by hams. You can find more information about using digital modes at:

Winlink - organization that has developed and maintains the worldwide ham radio email network.
APRS - the home page of the Automatic Position Reporting System
TAPR - sponsor and organizer of digital communications initiatives

And in this print reference, *ARRL's HF Digital Handbook* .

Rules about Commercial Content (page 5-13)

You'll want to be sure you understand the FCC's Part 97 rules (Part 97.113 – Prohibited Transmissions) on commercial content and use of Amateur Radio.

Mobile Operation (page 5-14)

If you're interested in operating from a vehicle, be sure to bookmark KØBG's Web page on Mobile Amateur Radio. Alan is an enthusiastic and prolific author on the subject.

Generators (page 5-15)

Given the interest in emergency and disaster-preparedness, there are a lot of on-line resources on this and related topics. Start with the How Stuff Works pages on generators and inverters.

Batteries (page 5-16 through 5-18)

A comprehensive Web site on the subject, Battery University is a resource for many questions about batteries. In addition, the ARRL Technical Information Service page on batteries has several ham-specific articles and links to more battery resources.

Ferrite and Interference Suppression (page 5-19 through 5-22)

Managing interference is an important part of successful ham radio – bookmark the ARRL Technical Information Service page on RFI and EMI for its many useful articles and tutorials. A fine, if somewhat technical, tutorial by K9YC on the use of ferrite components for interference suppression is available online, as well.

RF Grounding (page 5-23)

This is the link to the referenced page on RF Grounding.

CHAPTER SIX RESOURCE PAGE
Chapter 6 – Communicating With Other Hams

Operating Procedures (page 6-2)

The most complete reference is the ARRL Operating Manual, now in its ninth edition. Online, you can find resources in the On The Air section of the ARRL's Web site.

Grid Square Locators (page 6-4)

The Maidenhead system of defining location by grid square is defined on the ARRL Web site, including a grid square calculator, and in this Wikipedia article.

Official Observer (OO) Program (page 6-7)

The ARRL's Amateur Auxiliary is an organization of volunteers that help the Amateur Service remain self-policing and individual amateurs to operate with higher standards.

Keeping a Log (page 6-8)

The popular Web site (maintained in memory of AC6V) keeps a long list of software for logging your contacts. The ARRL also maintains a database of contacts called Logbook Of the World. Many hams have their own QSL cards and exchange them either direct through the mail or via the international system of QSL bureaus.

Band Organization (pages 6-9 through 6-11)

You'll need to refer to the online amateur band plans and beacon lists. The Northern California DX Foundation's system of HF beacons is also a great way to find out whether a band is open and to where! You can also find who your regional Frequency Coordinator is through the ARRL Web site. And everyone needs a frequency chart of the ham bands!

Digital Repeaters (page 6-19)

The four most-used digital repeater or relay protocols are:

Internet Relay Linking Project (IRLP)
Echolink
D-STAR
WIRES-II

National Traffic System and Radiograms (page 6-22 and 6-23)

The organization and practices of the National Traffic System are available online and a properly formatted radiogram can be seen here. The ARRL's FSD-218 is a handy single-page reference for traffic handling. You can locate nets using the ARRL's Net Search service.

Emergency Operation and Employee-Employer Relations (page 6-25 and 6-26)

The FCC's Part 97 rules (Part 97.113 – Prohibited Transmissions) control the use of Amateur Radio transmissions in support of your employer. These rules are changing rapidly, so watch for notices of question pool and FCC rule changes. If you are a member of an emergency communications team, ask your leadership for information. The ARRL has prepared a set of guidelines on the subject and will update it as necessary.

Emergency Communications or "Emcomm" (page 6-27 and 6-28)

Part 97.407 of the FCC Rules covering RACES operation
Federal Emergency Management Agency (FEMA)
ARRL On-line Emcomm Courses

Batteries as Emergency Power Sources (page 6-28 and 6-29)

As referenced in Chapter 5, Battery University is a great resource for information about the use and maintenance of batteries.

DX-ing, Awards, Special Events and Contesting (pages 6-30 and 6-31)

The ARRL's Operating Manual is your best single source for information on these and other ham radio activities. Enjoy browsing the more than 3,000 different awards on K1BV's Web directory of ham radio award programs. For online information, go to the On The Air section of the ARRL's Web. For fun, check out the following Web sites and print references:

The Complete DXer by Bob Locher W9KNI
Contesting.com
ARRL Contests
CQ VHF Contests
ARRL Contest Update - biweekly email newsletter, free to ARRL members
National Contest Journal - bimonthly magazine on contesting
Field Day

Amateur Satellites (page 6-32 and 6-33)

The best place for comprehensive information on Amateur Radio satellites is the AMSAT organization that coordinates most amateur satellite information.

Amateur Satellites - general information about communicating through the amateur satellites
Amateur Radio on the ISS - learn all about contacting the International Space Station
AMSAT - largest amateur satellite organization

Earth-Moon-Earth or "Moonbounce" - information on this lengthiest of contacts and other interesting operating activities on the VHF+ bands

Special Modes (page 6-34 and 6-35)

If you're interested in "fast-scan" TV, check out ATV-TV and the P.C. Electronics Web sites. Slow-scan TV is comprehensively covered at KB4YZ's Web site. Meteor scatter communications is discussed in general on its Wikipedia article and more specifically to ham's at N5KDA's popular Web site. You can find the software you need and more information on K1JT's WSJT page. The Wikipedia article on Radio-Controlled models is a good place to start for information on using ham radio in this novel way.

CHAPTERS SEVEN AND EIGHT RESOURCE PAGE
Chapter 7 – Licensing Regulations
Chapter 8 - Operating Regulations

You'll find these useful references for the exam and later when you're on the air:

FCC Part 97 Rules and Regulations

Frequently Asked Questions About Rules and Regulations

Amateur Exams (pages 7-4 through 7-6)

The ARRL Volunteer Examiner Coordinator Web site has complete information about amateur licensing exams.

FCC Web Sites (page 7-9)

FCC Wireless Telecommunications Bureau
FCC Universal Licensing System
FCC Online Forms

Amateur Frequency Allocations and Band Plans (pages 7-10 through 7-15)

US Amateur Frequency Chart
ITU Amateur Primary and Secondary Allocations (FCC Part 97.301)
US Amateur Band Plans
US National Council of Frequency Coordinators

International Regulations (pages 7-16 through 7-18)

International Telecommunications Union
International Operating Permits

Vanity Call Program (page 7-20 and 7-21)

ARRL's Vanity Call Web site
Vanity Headquarters – Call sign database

Armed Forces Day (page 8-13)

The annual Armed Forces Day Crossband Test is coordinated by the Army branch of the Military Auxiliary Radio System (MARS) and each year's rules can be found on their Web site.

CHAPTER NINE RESOURCE PAGE
Chapter 9 - Safety

These are excellent links to have handy at any time - not just when you're studying for your license! The need for safety never goes away...

Electrical Safety
Electrical Injury – an online guide to responding to shocks and burns
Grounding
Lightning Protection
RF Exposure
RF Exposure Evaluation – a guide to evaluating your station
Mobile installation – from KØBG's Mobile Operating Web site
Antenna and tower installation – from Universal Radio

Print references on safety

RF Exposure and You – the ARRL's printed reference guide
The ARRL Handbook – refer to the Safety chapter
The ARRL Antenna Book – specific information on antenna and tower installation
The *National Electrical Code* - the master reference for electrical safety
Up The Tower by K7LXC – how to install and maintain antennas and towers