Amateur Radio License

Safety
Test Format

• 35 questions from a pool of 300
• You need to get 26 right (74%)
• Multiple choice
• Calculators allowed (but you don’t really need one)
• You have to take this on-line
Test

• No Stanford test due to Covid
• Several online sites
• hamstudy.org has a list
• You schedule it yourself
• Not as much fun
Today's Topics

- Digital Radio
- Safety: Chapter 9
  - Electrical Safety
  - RF Exposure
  - Mechanical Safety
Digital Radio
Digital Radio

- Repeaters that use the internet (VoIP)
- DStar (ICom, Kenwood)
- C4FM, Wires (Yaesu)
- DMR — Digital Mobile Radio (Lots of companies)
Echo Link and IRLP

- Linked repeaters using “Voice over IP” (the internet)

- Type in access code, address of the repeater to link to using DTMF tones (same tones a phone uses)

- Acts like one big repeater, even though far apart

- IRLP is RF on both ends, Echo Link can use a computer
Digital Mobil Radio (DMR)
DMR

• Each user has an ID

• Your repeater tells the network you are there

• You can connect to an individual user directly (rare)

• You can connect to a “talk group” (most common)
• TAC 310 is a talk group
• I tell my repeater I want to access TAC 310 by selecting it on the radio, and hitting the PTT button momentarily
• Other people do the same for their repeaters.
• We all hear all the traffic on the talk group, all over the world.
DMR

• Lots of talk groups, can be based on geography, interest, or organization

• Your local repeater may be transmitting several talk groups at the same time, but you’ll only hear the one you selected. You can also listen to everything

• You can send text to specific users, as well as SMS messages to/from phones
DMR Radios

- Looks just like the UV-5R
- Radioddity DMR internals
- $65
- A real challenge to program
- Don’t get the DM-5R! It costs about the same, but doesn’t work on DMR networks
DMR Hotspots

• Raspberry Pi-Zero and RF daughter card
• Acts like a DMR repeater (100 mW)
• It connects to the DMR servers over WiFi
• Also does DStar, C4FM, P25 …
• $110
• Non-trivial to program

Zumspot
### Pi-Star Digital Voice Dashboard for AG6WH

#### Gateway Activity

<table>
<thead>
<tr>
<th>Time (PST)</th>
<th>Mode</th>
<th>Callsign</th>
<th>Target</th>
<th>Src</th>
<th>Dur(s)</th>
<th>Loss</th>
<th>BER</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:49:46 Feb 20th</td>
<td>DMR Slot 2</td>
<td>KM4UJP</td>
<td>TG 310</td>
<td>Net</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:49:33 Feb 20th</td>
<td>DMR Slot 2</td>
<td>K9DWO</td>
<td>TG 310</td>
<td>Net</td>
<td>9.8</td>
<td>0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:47:53 Feb 20th</td>
<td>DMR Slot 2</td>
<td>KG5DGG</td>
<td>TG 310</td>
<td>Net</td>
<td>2.6</td>
<td>0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:46:55 Feb 20th</td>
<td>DMR Slot 2</td>
<td>N5JOJ</td>
<td>TG 310</td>
<td>Net</td>
<td>2.0</td>
<td>54%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:46:38 Feb 20th</td>
<td>DMR Slot 2</td>
<td>3128509</td>
<td>TG 310</td>
<td>Net</td>
<td>0.8</td>
<td>0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:45:52 Feb 20th</td>
<td>DMR Slot 2</td>
<td>N3HFB</td>
<td>TG 310</td>
<td>Net</td>
<td>1.7</td>
<td>0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:45:28 Feb 20th</td>
<td>DMR Slot 2</td>
<td>KD2DRL</td>
<td>TG 310</td>
<td>Net</td>
<td>1.4</td>
<td>75%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:43:31 Feb 20th</td>
<td>DMR Slot 2</td>
<td>KL4HX</td>
<td>TG 310</td>
<td>Net</td>
<td>3.0</td>
<td>14%</td>
<td>0.0%</td>
</tr>
<tr>
<td>15:42:24 Feb 20th</td>
<td>DMR Slot 2</td>
<td>AG6WH</td>
<td>TG 310</td>
<td>RF</td>
<td>0.4</td>
<td>0%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

#### Local RF Activity

<table>
<thead>
<tr>
<th>Time (PST)</th>
<th>Mode</th>
<th>Callsign</th>
<th>Target</th>
<th>Src</th>
<th>Dur(s)</th>
<th>BER</th>
<th>RSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:42:24 Feb 20th</td>
<td>DMR Slot 2</td>
<td>AG6WH</td>
<td>TG 310</td>
<td>RF</td>
<td>0.4</td>
<td>0.9%</td>
<td>S9+46dB</td>
</tr>
</tbody>
</table>

**Modes Enabled**

- D-Star: DMR
- YSF: P25
- YSF XMode: NXDN
- DMR XMode: POCASAG

**Network Status**

- D-Star Net: DMR Net
- YSF Net: P25 Net
- YSF2DMR: NXDN Net
- YSF2NXDN: YSF2P25
- DMR2NXDN: DMR2YSF

**Radio Info**

- **Trx**: TX DMR Slot 2
- **Tx**: 438.760000 MHz
- **Rx**: 438.760000 MHz
- **FW**: ZUMspot:v1.3.3
K M 4 U J P

Jonathan Goodson
849 EAST BEACH DRIVE
SAINT GEORGE ISLAND, FL 32328
USA

QSL: eQSL

Email: Use mouse to view..

XML Subscriber

Lookups: 12062

QRZ Record # 2088217

QRZ Admin KM4UJP


Class General  Codes: HAI

Effective 2018–10–22

Expires 2026–06–02

Latitude 29.670877 (29° 40' 15" N)

Longitude -84.841779 (84° 50' 30" W)

Grid Square EL79nq

Geo Source User supplied

US State Florida

US County Franklin

Bearing 92° 9' E (from ACSW/}

Log a NEW contact with KM4UJP...
Electrical Hazards
Electrical Hazards

- Shocks
- Burns
- Even small currents can cause problems

**Table 7-1**

<table>
<thead>
<tr>
<th>Current (1 Second Contact)</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mA</td>
<td>Just Perceivable</td>
</tr>
<tr>
<td>5 mA</td>
<td>Maximum harmless current.</td>
</tr>
<tr>
<td>10 - 20 mA</td>
<td>Lower limit for sustained muscular contractions.</td>
</tr>
<tr>
<td>30 - 50 mA</td>
<td>Pain</td>
</tr>
<tr>
<td>50 mA</td>
<td>Pain, possible fainting. “Can’t let go” current.</td>
</tr>
<tr>
<td>100 - 300 mA</td>
<td>Normal heart rhythm disrupted. Electrocution if sustained current.</td>
</tr>
<tr>
<td>6 A</td>
<td>Sustained heart contractions. Burns if current density is high.</td>
</tr>
</tbody>
</table>
Electrical Safety

• Avoid contact

• Most modern equipment is low voltage, low hazard

• Old equipment (tube amps for example) can be high voltage, quite hazardous
Mitigating Electrical Hazards

• If power is required:
  • Remove jewelry.
  • Avoid unintentional touching of circuitry.
  • Never bypass safety interlocks.
  • Capacitors hold a charge even when power is off.
  • Storage batteries are dangerous when shorted
Mitigating Electrical Hazards

• Turn off power when working inside equipment!

• Make sure equipment is properly grounded and circuit protected!

• Keep one hand in pocket when working around high voltage circuits.
Responding to Electrical Injury

• REMOVE POWER!
  • Have ON/OFF switches and circuit breakers clearly marked.
• Call for help.
• Learn CPR and first aid.
Lightning Safety

• Antennas are not struck any more frequently than trees or tall structures.

• Ground all antennas.

• Use lightning arrestors.

• Disconnect antenna cables and power cords during storms.

• Disconnect telephone lines from computer modems.
What health hazard is presented by current flowing through the body? (T0A02)

A. By heating tissue
B. It disrupts the electrical functions of cells
C. It causes involuntary muscle contractions
D. All of these choices are correct
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In the US, what is connected to the green wire in a three-wire electrical AC plug? (T0A03)

A. Neutral
B. Hot
C. Safety ground
D. The white wire
In the US, what is connected to the green wire in a three-wire electrical AC plug? (T0A03)

A. Neutral  
B. Hot  
C. Safety ground  
D. The white wire  

White is neutral, black or red is hot
Which of these precautions should be taken when installing devices for lightning protection in a coaxial cable feedline? (T0A07)

A. Include a parallel bypass switch for each protector so that it can be switched out of the circuit when running high power

B. Include a series switch in the ground line of each protector to prevent RF overload from inadvertently damaging the protector

C. Keep the ground wires from each protector separate and connected to station ground

D. Ground all of the protectors to a common plate which is in turn connected to an external ground
Which of these precautions should be taken when installing devices for lightning protection in a coaxial cable feedline? (T0A07)

A. Include a parallel bypass switch for each protector so that it can be switched out of the circuit when running high power

B. Include a series switch in the ground line of each protector to prevent RF overload from inadvertently damaging the protector

C. Keep the ground wires from each protector separate and connected to station ground

D. **Ground all of the protectors to a common plate which is in turn connected to an external ground**
What kind of hazard might exist in a power supply when it is turned off and disconnected? T0A11

A. Static electricity could damage the grounding system

B. Circulating currents inside the transformer might cause damage

C. The fuse might blow if you remove the cover

D. You might receive a shock from the charge stored in large capacitors
What kind of hazard might exist in a power supply when it is turned off and disconnected? T0A11

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Which of the following establishes grounding requirements for an amateur radio tower or antenna? (T0B11)

A. FCC Part 97 Rules
B. Local electrical codes
C. FAA tower lighting regulations
D. Underwriters Laboratories’ recommended practices
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B. Local electrical codes

C. FAA tower lighting regulations

D. Underwriters Laboratories’ recommended practices
RF Exposure
RF Exposure

• Exposure to high levels of RF can cause problems.

• If precautions are taken, RF exposure is minimal and not dangerous.

• RF energy can heat body tissues.

• Heating depends on the RF intensity and frequency.
RF Power Density

- Actual transmitter power.
  - Higher power, higher risk.
- Antenna gain and proximity.
  - Beam antennas focus available energy.
  - Physical proximity or standing in the beam increases risk.
- Mode duty cycle.
  - More time at high power level, higher risk.
Antenna Proximity

• Controlled Environment:
  • You know where people are standing in relation to your antenna and you can do something about it.
  • More power is allowed because you can make adjustments if needed.

• Uncontrolled Environment:
  • You have no idea, or have no control of people near your antenna.
  • Less power is allowed because you have to assume the worse case scenario.
RF Exposure and Frequency

- When body parts act like antennas, those parts absorb RF energy at certain frequencies (wavelengths) more efficiently and increase risk.

- RF exposure risk varies with frequency.

- More caution is dictated at some frequencies more than other frequencies.
RF Exposure and Frequency

![Graph showing RF Exposure and Frequency with controlled and uncontrolled conditions.}]
## Mode Duty Cycle

- Higher duty cycle, greater RF exposure

### Operating Duty Factor of Modes Common

<table>
<thead>
<tr>
<th>Mode</th>
<th>Duty Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversational SSB</td>
<td>20%</td>
</tr>
<tr>
<td>Conversational SSB</td>
<td>40%</td>
</tr>
<tr>
<td>SSB AFSK</td>
<td>100%</td>
</tr>
<tr>
<td>SSB SSTV</td>
<td>100%</td>
</tr>
<tr>
<td>Voice AM, 50% modulation</td>
<td>50%</td>
</tr>
<tr>
<td>Voice AM, 100% modulation</td>
<td>25%</td>
</tr>
<tr>
<td>Voice AM, no modulation</td>
<td>100%</td>
</tr>
<tr>
<td>Voice FM</td>
<td>100%</td>
</tr>
<tr>
<td>Digital FM</td>
<td>100%</td>
</tr>
<tr>
<td>ATV, video portion, image</td>
<td>60%</td>
</tr>
<tr>
<td>ATV, video portion, black screen</td>
<td>80%</td>
</tr>
<tr>
<td>Conversational CW</td>
<td>40%</td>
</tr>
<tr>
<td>Carrier</td>
<td>100%</td>
</tr>
</tbody>
</table>
RF Exposure Evaluation

• All fixed stations must perform an exposure evaluation. Several methods are available to do this.

• At lower power levels, no evaluation is required. Varies with frequency – example: below 50 W at VHF.

• Relocating antennas is one way to reduce RF exposure.

• Also, regardless of the exposure evaluation results, make sure that people cannot come into contact with your antennas – RF burns are painful.
## Evaluation Thresholds

<table>
<thead>
<tr>
<th>Band (m)</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80, lower</td>
<td>500</td>
</tr>
<tr>
<td>40</td>
<td>500</td>
</tr>
<tr>
<td>20</td>
<td>225</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>1.25</td>
<td>50</td>
</tr>
<tr>
<td>0.7</td>
<td>70</td>
</tr>
<tr>
<td>0.23</td>
<td>200</td>
</tr>
<tr>
<td>0.13, higher</td>
<td>250</td>
</tr>
</tbody>
</table>
Which of the following frequencies has the lowest Maximum Permissible Exposure limit? (T0C02)

A. 3.5 MHz
B. 50 MHz
C. 440 MHz
D. 1296 MHz
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B. 50 MHz
C. 440 MHz
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What factors affect the RF exposure of people near an amateur radio antenna? (T0C04)

A. Frequency and power level of the RF field
B. Distance from the antenna to the person
C. Radiation pattern of the antenna
D. All of these choices are correct
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B. Distance from the antenna to the person

C. Radiation pattern of the antenna

D. All of these choices are correct
Why do exposure limits vary with frequency? (T0C05)

A. Lower frequency RF fields have more energy than higher frequency fields

B. Lower frequency RF fields do not penetrate the human body

C. Higher frequency RF fields are transient in nature

D. The human body absorbs more RF energy at some frequencies than at others
Why do exposure limits vary with frequency? (T0C05)

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B. Lower frequency RF fields do not penetrate the human body

C. Higher frequency RF fields are transient in nature

D. The human body absorbs more RF energy at some frequencies than at others
Which of the following is an acceptable method to determine that your station complies with FCC RF exposure regulations? (T0C06)

A. By calculation based on FCC OET Bulletin 65
B. By calculation based on computer modeling
C. By measurement of field strength using calibrated equipment
D. All of these choices are correct
Which of the following is an acceptable method to determine that your station complies with FCC RF exposure regulations? (T0C06)

A. By calculation based on FCC OET Bulletin 65
B. By calculation based on computer modeling
C. By measurement of field strength using calibrated equipment
D. All of these choices are correct
Why is duty cycle one of the factors used to determine safe RF radiation exposure levels? (T0C10)

A. It affects the average exposure of people to radiation

B. It affects the peak exposure of people to radiation

C. It takes into account the antenna feedline loss

D. It takes into account the thermal effects of the final amplifier
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B. It affects the peak exposure of people to radiation

C. It takes into account the antenna feedline loss

D. It takes into account the thermal effects of the final amplifier
Physical Safety
Driving

- Amateur radio exempt from CA cell phone law
- Doesn’t cover two way radios
- People still get tickets
- Make sure equipment is secure, that you can operate it safely
Antenna Towers

- Power lines and trees
- Lightning and grounding
- Climbing towers
Tower Installation

- Clear of trees and power lines.
- If it falls it won’t hit anyone or cross power lines.
  No closer than 10 feet from power line if the tower falls over.
- Towers should use proper grounding techniques.
Tower Work

- Proper clothing, hard hat and eye protection.
- Climbing harness.
- Gin pole: used for lifting tower sections and antennas.
- Don’t climb a crank-up tower supported by its cable.
- Don’t work alone.
Under what circumstances is it safe to climb a tower without a helper or observer? (T0B03)

A. When no electrical work is being performed

B. When no mechanical work is being performed

C. When the work being done is not more than 20 feet above ground

D. Never
Under what circumstances is it safe to climb a tower without a helper or observer? (T0B03)

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B. When no mechanical work is being performed

C. When the work being done is not more than 20 feet above ground

D. Never
Which of the following is an important safety precaution to observe when putting up an antenna tower? (T0B04)

A. Wear a ground strap connected to your wrist at all times

B. Insulate the base of the tower to avoid lightning strikes

C. Look for and stay clear of any overhead electrical wires

D. All of these choices are correct
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C. Look for and stay clear of any overhead electrical wires

D. All of these choices are correct
What is the minimum safe distance from a power line to allow when installing an antenna? (T0B06)

A. Half the width of your property

B. The height of the power line above ground

C. \( \frac{1}{2} \) wavelength at the operating frequency

D. So that if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power lines
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A. Half the width of your property

B. The height of the power line above ground

C. $\frac{1}{2}$ wavelength at the operating frequency

D. So that if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power lines
What is considered to be a proper grounding method for a tower? (T0B08)

A. A single four-foot ground rod, driven into the ground no more than 12 inches from the base

B. A ferrite-core RF choke connected between the tower and ground

C. Separate eight-foot long ground rods for each tower leg, bonded to the tower and each other

D. A connection between the tower base and a cold water pipe
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Why should you avoid attaching an antenna to a utility pole? (T0B09)

A. The antenna will not work properly because of induced voltages

B. The utility company will charge you an extra monthly fee

C. The antenna could contact high-voltage power wires

D. All of these choices are correct
Why should you avoid attaching an antenna to a utility pole? (T0B09)

A. The antenna will not work properly because of induced voltages

B. The utility company will charge you an extra monthly fee

C. The antenna could contact high-voltage power wires

D. All of these choices are correct
That’s It!

• Good luck with the exam!