

Technician License Course Chapter 9

Lesson Module 18 – Safety and Amateur Radio



Electrical Injuries

- Shocks and burns.
- Low voltages can cause enough current to create problems.
- Equipment today uses lower voltage than tube equipment but it can still cause burns.

Effects of Electric Current in the Human Body

Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6-25 milliamperes (women) 9-30 milliamperes (men)	Painful shock, loss of muscular control; the freezing current or "can't let-go" range.
50-150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1000-4300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

* If the extensor muscles are excited by the shock, the person may be thrown away from the power source.
Source: W.B. Kouwenhoven, "Human Safety and Electric Shock," Electrical Safety Practices, Monograph, 112, Instrument Society of America, p 93, November 1968.



2014 Technician License Course

Electrical Safety

- Avoiding contact is the most effective way of practicing electrical safety
- Unplug equipment before working on it
- Keep one hand in your pocket
- Make sure equipment is grounded
- Use power from GFCI-protected circuits



2014 Technician License Course

Mitigating Electrical Hazards

- If working on live equipment is required:
 - Remove jewelry
 - Avoid unintentional touching of circuitry
 - Never bypass safety interlocks
 - Discharge high-voltage points and components to ground
 - Capacitors can store charge after power is off
 - Storage batteries are dangerous when shorted



2014 Technician License Course

Responding to Electrical Injury

- REMOVE POWER!
 - Have ON/OFF switches and circuit breakers clearly marked.
 - Install an emergency master power switch and make sure your family knows how to use it.
- Call for help.
- Learn CPR and first aid.



2014 Technician License Course

Electrical Grounding and Circuit Protection

- Make sure your station wiring meets code
- Most ham equipment does not require special wiring or circuits
 - Use 3-wire power cords
 - Use circuit breakers, circuit breaker outlets, or Ground Fault Circuit Interrupter (GFCI) circuit breakers or outlets
 - Use proper fuse or circuit breaker size
 - Don't overload single outlets or circuits



2014 Technician License Course

Grounding & Bonding at RF

- RF burns from “hot spots” at high RF voltage
 - Do not cause serious injury at ham power level
 - Prevent by bonding (connecting) equipment together with heavy wire or strap – braided strap not recommended at RF
 - Prevent by keeping people away from antennas and radial or counterpoise wires
- Ground equipment for AC safety



2014 Technician License Course

Lightning Protection

- Ground antennas and towers to local code
 - Use 8-ft ground rod for each tower leg
 - Bond rods to tower leg and the other rods
- Ground connections should be as short as possible
- Use lightning arrestors on a single ground plate where cables enter the house
- Unplug and disconnect equipment (including telephones and computers) and feed lines if lightning is expected



2014 Technician License Course

RF Exposure

- Electromagnetic radiation (EMR) is not the same as radioactivity – much lower energy
- RF energy heats body tissues
 - Heating depends on the RF intensity and frequency.
 - If precautions are taken, RF exposure is minimal and not dangerous.



2014 Technician License Course

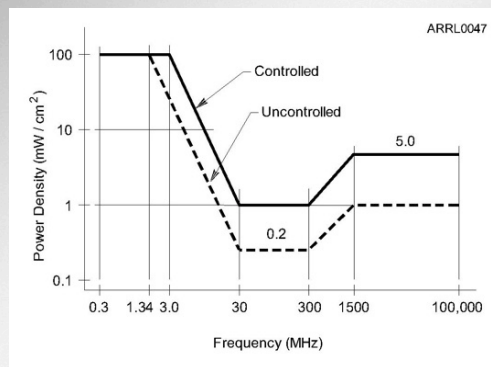
RF Intensity

- Power Density
 - Watts per square centimeter (w/cm^2)
- Higher power density means higher RF exposure
- RF absorption varies with frequency because of body part size
- Safe exposure levels have been established by the FCC



2014 Technician License Course

Maximum Permissible Exposure (MPE)



2014 Technician License Course

RF Environment

- Controlled Environment.
 - You know where people are standing in relation to your antenna and you can do something about it.
 - Higher power density is allowed because you can make adjustments if needed.
- Uncontrolled Environment.
 - You have no control of people near your antenna.
 - Lower power density is allowed because you cannot control or adjust the exposure of people.



2014 Technician License Course

Duty Cycle and Duty Factor

- Duty cycle is the percentage of time that a transmitter is on during the evaluation period, from 0 to 100%
 - Duty cycle = $100 \times (\text{time on} / \text{total time})$
- Duty factor is the same as duty cycle, but given as a number from 0 to 1.0
- Higher duty cycle or factor means higher average power density and exposure



2014 Technician License Course

Mode Duty Cycle

- Accounts for the different characteristics of the transmitted signal's waveform

Mode	Duty Cycle
Conversational SSB	20%
Conversational SSB	40%
SSB AFSK	100%
SSB SSTV	100%
Voice AM, 50% modulation	50%
Voice AM, 100% modulation	25%
Voice AM, no modulation	100%
Voice FM	100%
Digital FM	100%
ATV, video portion, image	60%
ATV, video portion, black screen	80%
Conversational CW	40%
Carrier	100%



2014 Technician License Course

RF Exposure Evaluation

- All fixed stations must perform an exposure evaluation.
 - Use online calculator (easiest)
 - Model exposure with software (difficult)
 - Measure RF power density (most difficult)
- At lower power levels, no evaluation is required. Varies with frequency – example: below 50 W at VHF.
- Re-evaluate exposure when station equipment or operating frequencies change.



2014 Technician License Course

Reducing RF Exposure

- Relocate or reorient antennas
- Raise the antenna
- Reduce antenna gain
- Reduce RF power output
- Change to a lower duty cycle mode



2014 Technician License Course

Mobile Safety

- Mobile Installations
 - Secure all equipment
 - Place equipment where you can operate it safely while driving
 - Know local rules for use of communications equipment while driving
 - May need hands-free microphone



2014 Technician License Course

Power Line Safety

- Keep antennas well away from power lines
- Check for power lines before installing antennas in trees
- Provide a minimum of 10 feet of clearance if antenna falls
- Never attach antennas or guy lines to utility poles or structures



2014 Technician License Course

Tower Work

- Basic tower safety
 - Proper clothing, hard hat and eye protection
 - Use a proper climbing harness, not a lineman's belt or rock-climbing gear
 - Don't climb a crank-up tower supported only by its lift cable – block and secure it first
 - Use a gin pole to lift heavy items
 - Don't work alone – use a ground crew



2014 Technician License Course