
Safety
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Objectives

To become familiar with:

- Electrical safety, including the safety ground;
- What to do in case of electrical shock;
- Grounding the shack and tower;
- RF Exposure limits;
- Tower safety; and
- Lightning protection.

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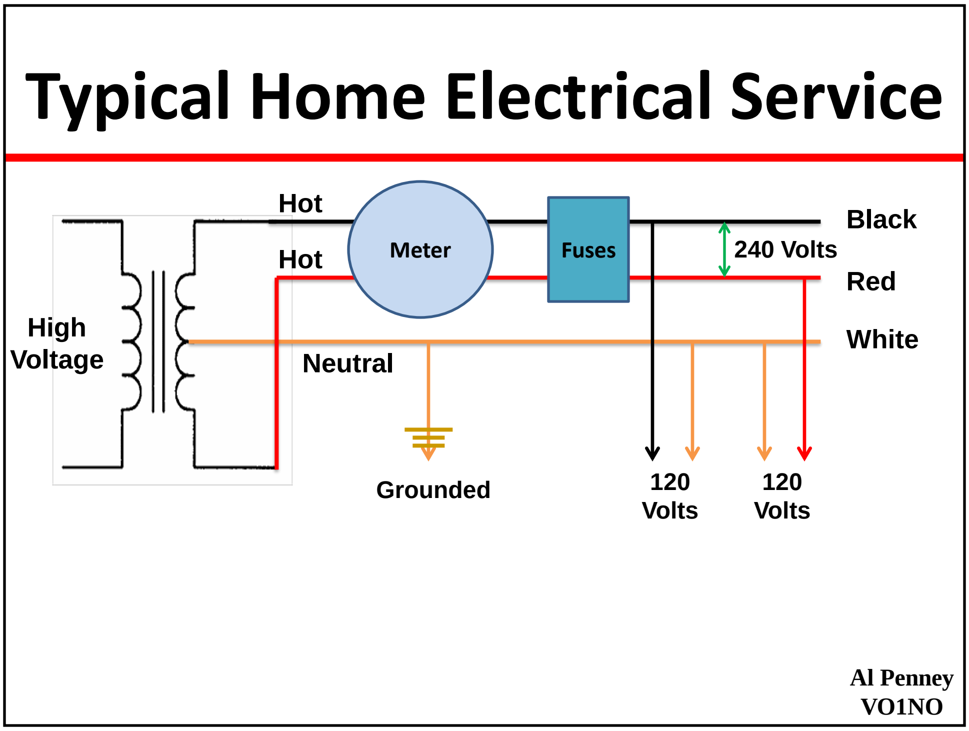
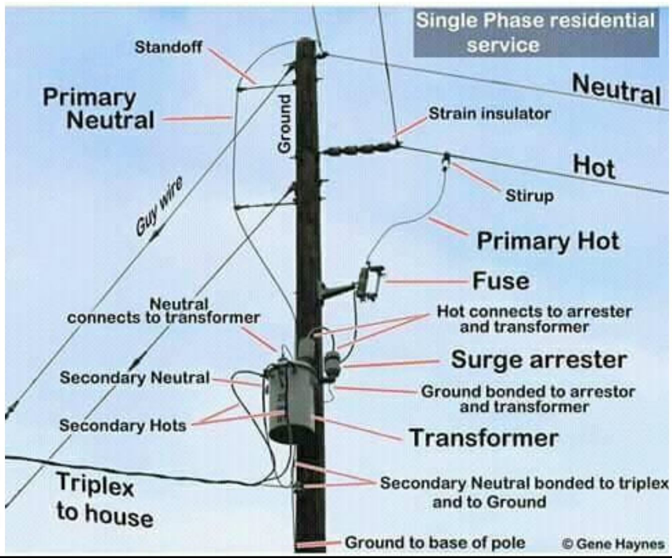
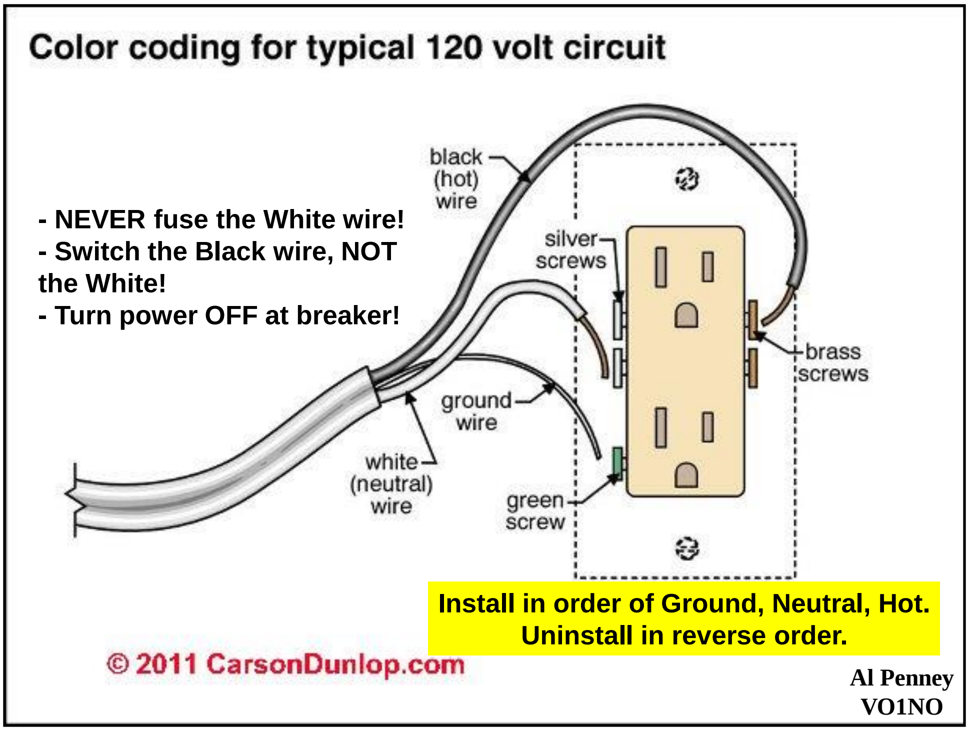


- Standard power for residential service in Canada is a 3-wire, single phase system, delivering 240 volts Alternating Current at 60 Hz.
- High voltage on the power poles (7000 VAC or more) is dropped to 240 VAC through a transformer.
- Center tap on transformer output is white, and grounded.
-Black and Red wires are "hot", and 240 VAC potential between them. They are 120 VAC potential with respect to the neutral wire.
-- Only the Hot wires are fused, NEVER the Neutral wire.
-The standard circuit is 120 VAC at 15 amps max.
-Stoves and clothes dryers are wired to the two hot wires, providing 240 VAC.
-The voltage may be described as 240/120 VAC, but can vary from that.

Residential Service Pole





- In this tutorial, you'll learn how to easily install a new electrical outlet receptacle in a single-gang wall box. Boxes come in styles designed for new construction, as well as style for remodeling or retrofit applications, known as old work boxes. This tutorial shows connecting a new outlet receptacle in an old work box that has been installed in an existing wall.
- An electrical receptacle is a ubiquitous electrical device that we use every day in our homes and work. It is designed to receive an electrical plug for lamps and other appliances, and in residential use, outlet receptacles are typically either 120-volt models (shown) or 240-volt models, such as those that are used for window air conditioners and other appliances. 120-volt receptacles are typically designed to receive a three-prong grounded plug, each with different sized blades. The rounded hole receives the ground blade, the narrow slot receives the hot blade and the long slot receives the neutral blade of the plug. 20-amp outlets also have a notch in the neutral receptacle slot for use with certain plugs on appliances that draw higher amperage.
- In older homes where there may be no circuit ground wire, the receptacles may be only two-slot models, without the grounding slot. When updating these receptacles, it's a good idea to use a GFCI receptacle, which improves the safety of the outlet in a situation where there is no ground wire.
- Preparation
- Before you start installing an outlet, it is critical that you first find the branch circuit breaker or fuse in your electrical service panel that feeds the receptacle you will be working on, and then turn off the power to the circuit wiring. The circuit breaker you turn off, or the fuse you remove will be rated for the proper amperage rating of the circuit. The markings on the circuit breaker or fuse will tell you if it is a 15- or 20-amp circuit, and therefore whether to install a 15-amp or 20-amp 120-volt outlet receptacle. (15-amp circuits require the use of 14-gauge conductor wires, while 20-amp circuits require 12-gauge conductor wires.)
- Once you have the right outlet for the job, the branch circuit is turned off and the electrical wiring is prepped for outlet installation, you are ready to proceed.
- Difficulty Level
- Easy
- Needed Tools and Materials
- 15-amp or 20-amp outlet receptacle
- Needle nose pliers
- Outlet cover plate
- Flat blade and Philips-head screwdrivers

Connect the Ground Wire to the Receptacle

1. Bend the last 3/4" of the bare copper ground wire in a "J" or "U" shape, and place the wire under the head of the green ground terminal screw on the receptacle, so that the wire end is looped clockwise around the screw.
2. Tighten the loop with needle nose pliers so it's a little snug over the screw, then tighten by turning the screw clockwise, making sure the ground wire is firmly tightened under the green screw head.

- Tip: To maximize safety, electricians connect the wires in a certain sequence: first the ground wire, then the neutral wire, and finally the hot wire. When disconnecting an outlet, reverse the order, removing the hotwire first and the ground wire last.

Connect the Neutral Wire

1. As in the previous step, bend the end of the white "neutral" wire in a "J" position and wrap the end of the "J" looped under the head of the silver-colored terminal screw in a clockwise direction.
2. Fasten the neutral wire to the outlet by turning the silver-colored terminal screw clockwise, making sure the wire is firmly tightened under the head of the screw.

- Tip: Examine the screws carefully: the silver-colored screws MUST connect to the white neutral wire. The brass-colored screw is for the black hot wire.

Connect the Hot Wire

- Fasten the last wire—the black "hot" wire—to the brass terminal screw in the same manner as the previous wires, by placing the "Hot" wire under the head of the brass terminal screw and turning the terminal screw clockwise, making sure the wire is firmly tightened under the head of the screw.

Secure the Outlet to the Electrical Box

1. With the conductors, all fastened to the outlet, gently bend the wires into the back of the box, deep enough so there is room for the receptacle to fit.
2. Gently push the receptacle into the box, holding the metal mounting strap.
3. Fasten the outlet to the box by threading the long fine thread screws that came with the outlet into the screw openings on the box. This will usually require a Philips-head screwdriver.

Install Cover Plate

1. Once the outlet is installed in the box, test for proper operation by turning the power to the circuit back on at the electrical service panel.
2. If the outlet functions properly, install the finish faceplate to the outlet. This will usually require a flat blade screwdriver.

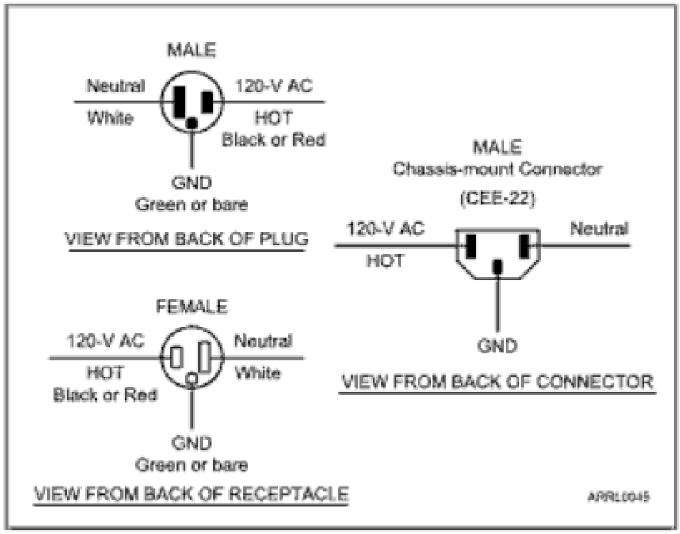


Figure 7-1 — The correct wiring technique for 120 V ac power cords and receptacles. The white wire is neutral and the green wire is the safety ground. The hot wire can be either black or red. These receptacles are shown from the back, or wiring side.

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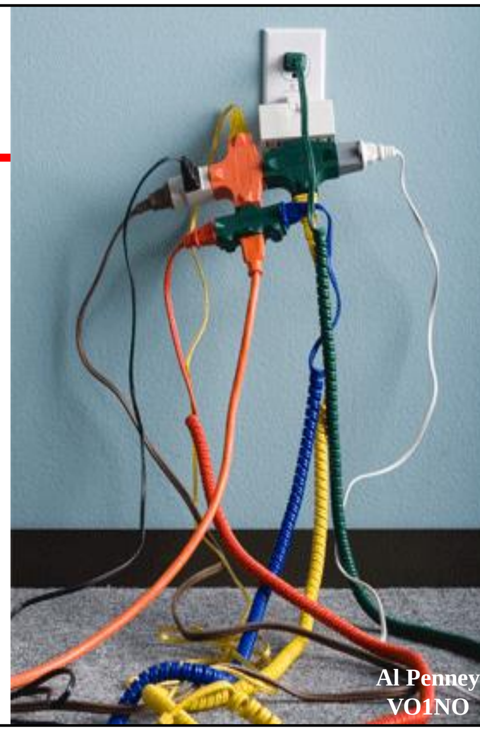
Warning Signs

- Lights often flicker, blink or dim momentarily.
- Circuit breakers trip or fuses blow often.
- Cords or wall plates are warm to the touch or discolored.
- Crackling, sizzling or buzzing is heard from outlets.
- Burning odour.
- Mild shock or “tingle” when touching switches or appliances.



James and Patty just moved into their new home. While it’s new to them, it’s an older home with a limited supply of electrical outlets.

James wants to plug several electronics into an outlet in the house’s living room. He figures, “What’s the big deal? I’ll just plug everything in through one outlet. It’ll be fine.” The problem is, James may be overloading that outlet and setting the stage for an electrical fire.

The electrical system of many older homes is not properly equipped to respond to today’s increased power demands. According to the National Fire Protection Association (NFPA), more than half of all homes in the U.S. are at least 30 years old. The wiring in many of these older homes was designed to handle around half of the electrical demands of today’s families with the ever-increasing use of gadgets, gizmos and appliances demanding power.

According to the NFPA and the Electrical Safety Foundation International, electrical fires are one of the leading causes of structure fire annually. Officials with the NFPA said in 2010, electrical fires accounted for nearly 13 percent of reported home fires. Those fires resulted in 420 fatalities, 1,520 injuries and $1.5 billion in property damage.

So, how can James, and you, prevent the dangers that can occur by overloading an outlet? Here are some tips:

•Never plug more than two appliances into an outlet at once or “piggyback” extra appliances on extension cords or wall outlets. Use only outlets designed to handle multiple plugs.

•Know the amount of power you’re placing on an outlet or circuit. Some recommend each outlet or circuit should not exceed 1,500 watts.

•Major appliances (refrigerators, dryers, washers, stoves, air conditioners, etc.) should be plugged directly into their own wall outlet since they are heavy power users.

•If you find you are overloading an outlet or circuit in your home, you may need to contact a professional to help resolve the problem.

You’ll also want to watch for these warning signs of electrical system overload. If you have any of these present, you should have your home inspected by a professional:

•Lights often flicker, blink or dim momentarily

•Circuit breakers trip or fuses blow often

•Cords or wall plates are warm to the touch or discolored

•Crackling, sizzling or buzzing is heard from outlets

If an electrical fire does occur, take these steps:

•Call 911 or another appropriate emergency service.

•If you must attempt to put out an electrical fire, use a dry fire extinguisher or baking soda. Never try to extinguish an electrical fire with water!

•If the fire is large, try to turn off the main power source. Do not try to handle the fire yourself.

Don’t make the same mistake James made. Never overload your home’s electrical outlets or circuits. It could prevent a fire and save lives!

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According to the National Fire Protection Association, 47,700 home fires in the U.S. are caused by electrical failures or malfunctions each year. These fires result in 418 deaths, 1,570 injuries, and $1.4 billion in property damage. Overloaded electrical circuits are a major cause of residential fires. Help lower your risk of electrical fires by not overloading your electrical system.

Overloaded circuit warning signs:

•Flickering, blinking, or dimming lights

•Frequently tripped circuit breakers or blown fuses

•Warm or discolored wall plates

•Cracking, sizzling, or buzzing from receptacles

•Burning odor coming from receptacles or wall switches

•Mild shock or tingle from appliances, receptacles, or switches

How to prevent electrical overloads:

•Never use extension cords or multi-outlet converters for appliances

•All major appliances should be plugged directly into a wall receptacle outlet. Only plug one heat producing appliance into a receptacle outlet at a time

•A heavy reliance on extension cords is an indication that you have too few outlets to address your needs. Have a qualified electrician inspect your home and add new outlets

•Power strips only add additional outlets; they do not change the amount of power being received from the outlet

The CPSC estimates more than 50% of electrical fires that occur every year can be prevented by Arc Fault Circuit Interrupters (AFCIs)

Only use the appropriate watt bulb for any lighting fixture, Using a larger watt light bulb may cause a fire

Extension Cord Hazards

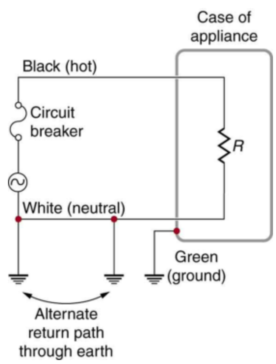
Extension cords, so commonly used at home and in industry, are also sources of the potential hazard. All cords should be regularly inspected for abrasion or cracking of insulation and repaired immediately. One sure method of removing a damaged cord from service is to unplug it from the receptacle, then cut off that plug (the “male” plug) with a pair of side-cutting pliers to ensure that no one can use it until it is fixed. This is important on job sites, where many people share the same equipment, and not all people there may be aware of the hazards.

Easy to install – just follow the instructions!

If you are looking for a Christmas gift for an annoying kid……

Electrical Safety

- Figure 1. Schematic of a simple AC circuit with a voltage source and a single appliance represented by the resistance *R*. There are no safety features in this circuit.



- Figure 2. The three-wire system connects the neutral wire to the earth at the voltage source and user location, forcing it to be at zero volts and supplying an alternative return path for the current through the earth. Also grounded to zero volts is the case of the appliance. A circuit breaker or fuse protects against thermal overload and is in series on the active (live/hot) wire. Note that wire insulation colors vary with region and it is essential to check locally to determine which color codes are in use (and even if they were followed in the particular installation).

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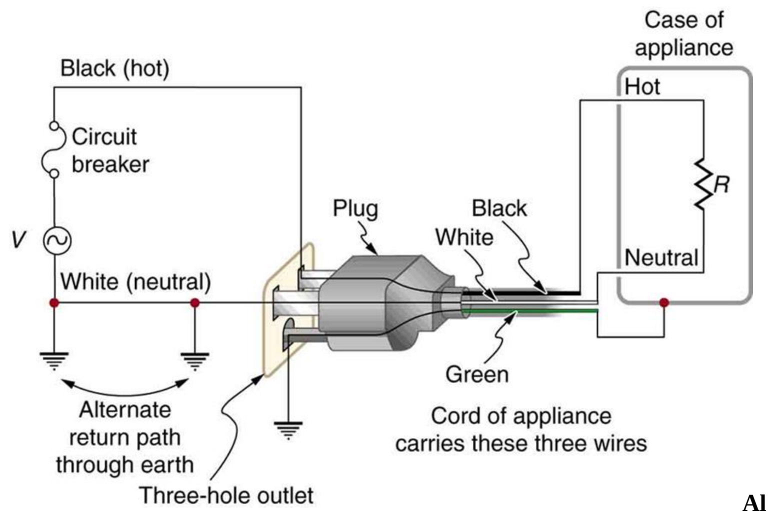
Electricity has two hazards. A *thermal hazard* occurs when there is electrical overheating. A *shock hazard* occurs when electric current passes through a person. Both hazards have already been discussed. Here we will concentrate on systems and devices that prevent electrical hazards. Figure 1 shows the schematic for a simple AC circuit with no safety features. This is not how power is distributed in practice. Modern household and industrial wiring requires the *three-wire system*, shown schematically in Figure 2, which has several safety features. First is the familiar *circuit breaker* (or *fuse*) to prevent thermal overload. Second, there is a protective *case* around the appliance, such as a toaster or refrigerator. The case's safety feature is that it prevents a person from touching exposed wires and coming into electrical contact with the circuit, helping prevent shocks.

Three Prong Plug System



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There are *three connections to earth or ground* (hereafter referred to as "earth/ground") shown in Figure 2. Recall that an earth/ground connection is a low-resistance path directly to the earth. The two earth/ground connections on the *neutral wire* force it to be at zero volts relative to the earth, giving the wire its name. This wire is therefore safe to touch even if its insulation, usually white, is missing. The neutral wire is the return path for the current to follow to complete the circuit. Furthermore, the two earth/ground connections supply an alternative path through the earth, a good conductor, to complete the circuit. The earth/ground connection closest to the power source could be at the generating plant, while the other is at the user's location. The third earth/ground is to the case of the appliance, through the green *earth/ground wire*, forcing the case, too, to be at zero volts.
The *live* or *hot wire* (hereafter referred to as "live/hot") supplies voltage and current to operate the appliance. Figure 3 shows a more pictorial version of how the three-wire system is connected through a three-prong plug to an appliance.

A note on insulation color-coding: Insulating plastic is color-coded to identify live/hot, neutral and ground wires but these codes vary around the world. Live/hot wires may be brown, red, black, blue or grey. Neutral wire may be blue, black or white. Since the same color may be used for live/hot or neutral in different parts of the world, it is essential to determine the color code in your region. The only exception is the earth/ground wire which is often green but may be yellow or just bare wire. Striped coatings are sometimes used for the benefit of those who are colorblind. The three-wire system replaced the older two-wire system, which lacks an earth/ground wire. Under ordinary circumstances, insulation on the live/hot and neutral wires prevents the case from being directly in the circuit, so that the earth/ground wire may seem like double protection. Grounding the case solves more than one problem, however. The simplest problem is worn insulation on the live/hot wire that allows it to contact the case, as shown in Figure 4. Lacking an earth/ground connection (some people cut the third prong off the plug because they only have outdated two hole receptacles), a severe shock is possible. This is particularly dangerous in the kitchen, where a good connection to earth/ground is available through water on the floor or a water faucet. With the earth/ground connection intact, the circuit breaker will trip, forcing repair of the appliance. Why are some appliances still sold with two-prong plugs? These have nonconducting cases, such as power tools with impact resistant plastic cases, and are called *doubly insulated*. Modern two-prong plugs can be inserted into the asymmetric standard outlet in only one way, to ensure proper connection of live/hot and neutral wires.

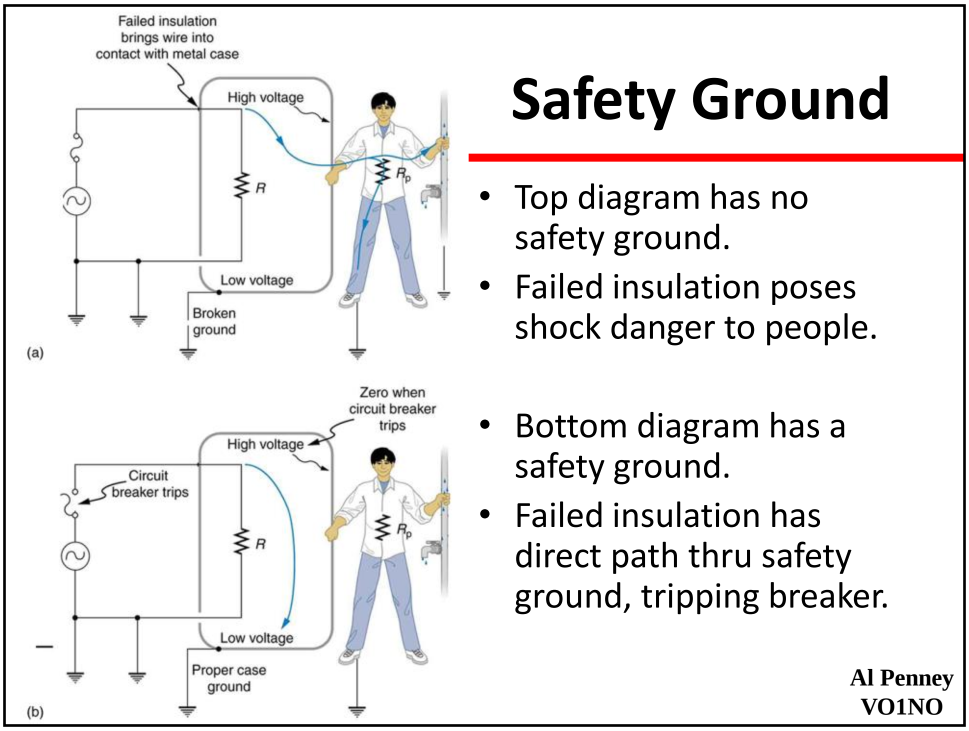

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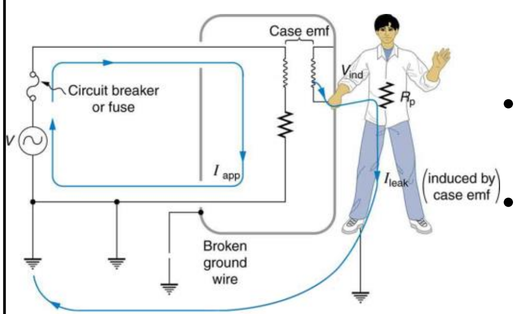
Figure 4. Worn insulation allows the live/hot wire to come into direct contact with the metal case of this appliance. (a) The earth/ground connection being broken, the person is severely shocked. The appliance may operate normally in this situation. (b) With a proper earth/ground, the circuit breaker trips, forcing repair of the appliance.

Electromagnetic Induction



- AC Current in appliance induces EMF on the appliance case.
- If case is not grounded, a shock hazard exists.
- EMF is called leakage current.

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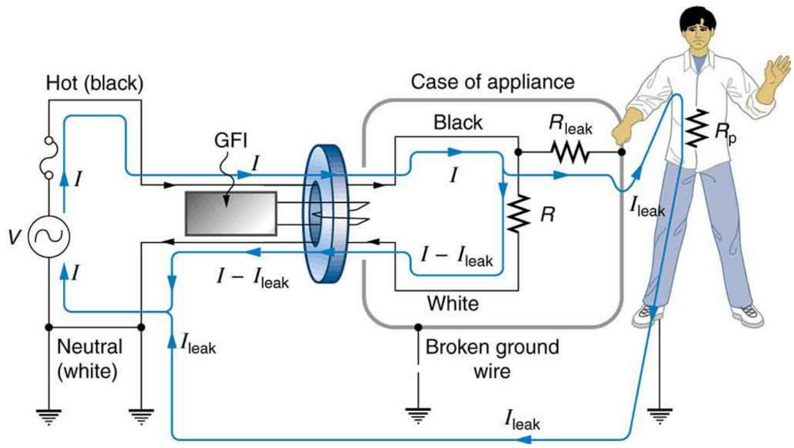
Electromagnetic induction causes a more subtle problem that is solved by grounding the case. The AC current in appliances can induce an emf on the case. If grounded, the case voltage is kept near zero, but if the case is not grounded, a shock can occur as pictured in Figure 5. Current driven by the induced case emf is called a *leakage current*, although current does not necessarily pass from the resistor to the case.

Figure 5. AC currents can induce an emf on the case of an appliance. The voltage can be large enough to cause a shock. If the case is grounded, the induced emf is kept near zero.

Ground Fault Interrupter Circuit



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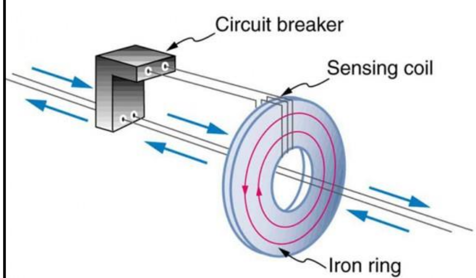
A *ground fault interrupter* (GFI) is a safety device found in updated kitchen and bathroom wiring that works based on electromagnetic induction. GFIs compare the currents in the live/hot and neutral wires. When live/hot and neutral currents are not equal, it is almost always because current in the neutral is less than in the live/hot wire. Then some of the current, again called a leakage current, is returning to the voltage source by a path other than through the neutral wire. It is assumed that this path presents a hazard, such as shown in Figure 6. GFIs are usually set to **interrupt the circuit if the leakage current is greater than 5 mA,** the accepted maximum harmless shock. Even if the leakage current goes safely to earth/ground through an intact earth/ground wire, the GFI will trip, forcing repair of the leakage.

GFCI



- If currents in the hot and neutral wire are equal but opposite then induced emf is zero.
- If currents are unequal, then sensing coil detects emf and trips breaker.

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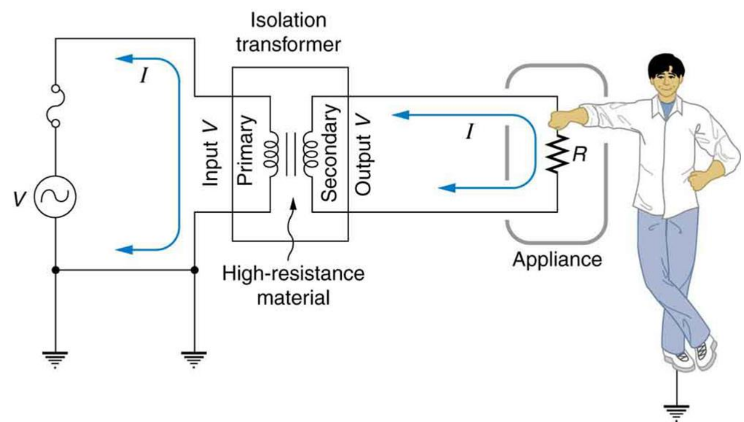
Figure 7 shows how a GFI works. If the currents in the live/hot and neutral wires are equal, then they induce equal and opposite emfs in the coil. If not, then the circuit breaker will trip.

Figure 7. A GFI compares currents by using both to induce an emf in the same coil. If the currents are equal, they will induce equal but opposite emfs.

Isolation Transformer



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Another induction-based safety device is the *isolation transformer*, shown in Figure 8. Most isolation transformers have equal input and output voltages. Their function is to put a large resistance between the original voltage source and the device being operated. This prevents a complete circuit between them, even in the circumstance shown. There is a complete circuit through the appliance. But there is not a complete circuit for current to flow through the person in the figure, who is touching only one of the transformer's output wires, and neither output wire is grounded. The appliance is isolated from the original voltage source by the high resistance of the material between the transformer coils, hence the name isolation transformer. For current to flow through the person, it must pass through the high-resistance material between the coils, through the wire, the person, and back through the earth—a path with such a large resistance that the current is negligible.

Effects of Electric Shock

- Muscle spasm;
- Cardiac arrest;
- External and internal burns;
- Damage to the nervous system; and
- Long term problems such as cataracts.

- Voltages as low as **30 volts** can be dangerous.
- Currents as low as **20 milliamps** through the **heart** can be **deadly.**

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A shock can cause muscle spasms

Muscles are stimulated by electricity. The effect depends on the intensity of the current and the type of muscle it travels through.

We've all felt a buzzing or tingling sensation that doesn't cause injury. That's the effect of a current as low as 0.25 milliamperes (mA) entering the body.

When a current above 10 mA travels through flexor muscles, such as the ones in our forearms that close the fingers, it causes a sustained contraction. The victim may be unable to let go of the source of the current, making the duration of the contact longer and increasing the severity of the shock.

When a current above 10 mA travels through extensor muscles, it causes a violent spasm. If the muscles affected are the hip extensors that lengthen the limbs away from the body, the victim may be propelled, sometimes many metres away!

Muscles, ligaments and tendons may tear as a result of the sudden contraction caused by an electric shock. Tissue can also be burned if the shock is lasting or the current is high.

A shock can cause cardiac arrest

If a current of 50 mA passes through the heart, it can cause cardiac arrest.

The heart is also a muscle, which beats to pump blood through the body. The rhythm of our heartbeat is controlled by electric impulses—it is these impulses that are monitored by an electrocardiogram. If a current from outside the body passes through the heart, it can mask these impulses and disturb the heart's rhythm. This irregular heartbeat is called arrhythmia and can even manifest as a total disorganization of the rhythm, known as ventricular fibrillation.

When ventricular fibrillation occurs, the heart stops pumping and the blood stops circulating. The victim rapidly loses consciousness and dies if a healthy heartbeat is not restored with a device called a defibrillator.

The arrhythmia can occur at the time of the shock or in the hours following the electric shock.

A shock can cause burns to tissues and organs

When a current above 100 mA passes through the body, it leaves marks at the points of contact with the skin. Currents above 10,000 mA (10 A) cause serious burns that may require amputation of the affected limb.

Some burns are easy to recognize because they look like the burns you can get from contact with heat. **Others may seem harmless but aren't: tiny charred craters indicate the presence of much more serious internal burns.**

Electrical burns often affect internal organs. They are caused by the heat generated from the body's resistance to the current passing through it. Internal damage may be much more serious than the external injuries suggest.

Internal burns often have serious consequences: scarring, amputation, loss of function, loss of sensation and even death. For example, if a lot of tissue is destroyed, the large amount of waste generated can cause serious kidney or blood circulation disorders.

A shock can affect the nervous system

Nerves are tissue that offers very little resistance to the passage of an electric current. When nerves are affected by an electric shock, the consequences include pain, tingling, numbness, weakness or difficulty moving a limb. These effects may clear up with time or be permanent.

Electric injury can also affect the central nervous system. When a shock occurs, the victim may be dazed or may experience amnesia, seizure or respiratory arrest.

Long-term damage to the nerves and the brain will depend on the extent of the injuries and may develop up to several months after the shock. This type of damage can also cause psychiatric disorders.

A shock can have other unexpected consequences

Other disorders can appear in the weeks or months following the shock, depending on which organs the current passed through. For example, if the current passed through the eyes, cataracts may develop over time.

Effects of Electric Shock

Bodily effect	Gender	DC	60 Hz AC	10 kHz AC
Slight sensation at point(s) of contact	Men	1 mA	0.4 mA	7 mA
	Women	0.6 mA	0.3 mA	5 mA
Threshold of bodily perception	Men	5.2 mA	1.1 mA	12 mA
	Women	3.5 mA	0.7 mA	8 mA
Pain, with voluntary muscle control maintained	Men	62 mA	9 mA	55 mA
	Women	41 mA	6 mA	37 mA
Pain, with loss of voluntary muscle control	Men	76 mA	16 mA	75 mA
	Women	51 mA	10.5 mA	50 mA
Severe pain, difficulty breathing	Men	90 mA	23 mA	94 mA
	Women	60 mA	15 mA	63 mA
Possible heart fibrillation after three seconds	Men	500 mA	100 mA	
	Women	500 mA	100 mA	

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Electric Shock and the Human Body

Electric shock is the physical act of electric current passing through the human body. The effects of electric shock can range from a slight tingling sensation, to immediate death. This handy chart is a good reference for how different types of current (AC and DC having different safety thresholds):

As you can see from the chart, 60 Hz AC is much more dangerous than DC or 10 kHz AC. This is because of the way the body works: to get a muscle to move, the brain has to send a tiny electrical signal along the nervous system to the muscle. The most important signals that we're concerned with are the ones being sent to the heart muscles: most people have a heart that beats at a frequency of about 60-100 beats per minute. If you want to test this, place your index and middle finger of your left hand on your neck, under your jaw and directly below your ear, then count the number of beats or pulses you can feel in a minute.

Why is low frequency current dangerous to the heart?

Because the heart beats at a fairly low frequency, low frequency current like the kind found in modern day power systems (60Hz in North America) is very dangerous because it can cause **heart fibrillation**. The heart is made up of a group of muscles that all have to work together to pump the blood through your body. Heart fibrillation is the medical term for when these muscles are no longer working together: your heart is off beat, and "flutters" or beats weakly but way faster than normal. This weakly beating heart can't pump blood through your body properly. The blood won't get to the lungs for oxygen, and the heart will quickly run out of oxygen and stop. The is known as cardiac arrest, or a heart attack.
DC and high frequency AC electricity are still very dangerous, but because they apply current continuously (or the current pulses so fast that your body thinks it's applying current continuously), it takes more current to override your body's natural electrical signals. Kind of like how your eyes can only see the world at 60 frames per second, and you just don't recognize faster speeds.
This is also why a defibrillator works: the paddles zap you with a big dose of DC current to stop your heart, but your brain is still sending signals telling the heart to operate like normal. If the heart is fluttering uncontrollably these signals from the brain wouldn't do much, but if the heart is stopped it just starts up again like business as usual.

Effects of electricity on other muscles

In addition to the nearly immediate death caused by electric current interfering with the heart, electric current can also activate your muscles, causing them to contract or flex. With DC, this usually causes one burst of muscle movement which could throw you away from whatever you're working on. AC, on the other hand, causes your muscles to continuously flex over and over again, which could cause you to spasm out of control. In both cases, the point where you lose control of your muscles is called the "Let-Go Current Threshold". For example, if you were shocked because you grabbed a wire, the current will cause your hand to grip the wire tightly and you won't be able to let go. The longer you are exposed to electricity, the more damage it causes, so this is clearly a very bad scenario. With both AC and DC, working from an elevated position (like on power lines) adds a risk of a fall injury if you lose control of your body from that high up in the air. If the muscles that move your limbs away from your body get activated first, you could throw yourself out of the bucket in the truck.

Electric Shock Burns

One last thing to worry about are electric burns. Just like a wire will break down due to heat when too much current moves through it, your body will burn during electric shock. The longer you have current moving through your body and the higher the amperage, the more severe the burns will be. One of the most dangerous parts of electric shock burns are that they burn you up from the inside out. Even after what seems like a non-fatal electric shock, the tissue inside your body could have been burned and scarred or killed. Dead and damaged tissue can all sorts of negative effects, including organ failure and amputation.

How can you prevent current from entering your body?

The human body has its own natural way to prevent current from entering it: skin resistance. The resistance of dry human skin can be as high as 100,000 ohms. This resistance gets dramatically reduced if the skin is wet (sweat is a salty liquid, and water mixing with the salt on the surface of your skin will drastically reduce skin resistance as well). The resistance of the human body can also be lowered by any breaks in the skin (like a cut that hasn't healed yet). You want to provide the path of greatest resistance to the electricity in order to stay safe, and an open cut is a great, easy spot for current to flow into your body.
Another thing to keep in mind is that the breakdown voltage of human skin is 500 volts. This means that, at 500V and higher, the outer layer of the skin is destroyed by the high electrical energies. This results in drastically lower skin resistance.
And, as always, be sure to wear appropriate personal protective equipment (PPE) for the job. PPE is designed to keep you safe, and that extra bit of insulation could save your life.
So, in summary: stay dry, stay covered, and wear your PPE!

What to do for Electric Shock

- DO NOT APPROACH!
- Turn power off.
- Call 911.
- Apply first aid.

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The danger from an electrical shock depends on the type of current, how high the voltage is, how the current traveled through the body, the person's overall health and how quickly the person is treated.

An electrical shock may cause burns, or it may leave no visible mark on the skin. In either case, an electrical current passing through the body can cause internal damage, cardiac arrest or other injury. Under certain circumstances, even a small amount of electricity can be fatal.

When to contact your doctor

A person who has been injured by contact with electricity should be seen by a doctor.

Caution

- Don't touch the injured person if he or she is still in contact with the electrical current.
- Call 911 or your local emergency number if the source of the burn is a high-voltage wire or lightning. Don't get near high-voltage wires until the power is turned off. Overhead power lines usually aren't insulated. Stay at least 20 feet (about 6 meters) away — farther if wires are jumping and sparking.
- Don't move a person with an electrical injury unless he or she is in immediate danger.

When to seek emergency care

Call 911 or your local emergency number if the injured person experiences:

- Severe burns
- Confusion
- Difficulty breathing
- Heart rhythm problems (arrhythmias)
- Cardiac arrest
- Muscle pain and contractions
- Seizures
- Loss of consciousness

Take these actions immediately while waiting for medical help:

- Turn off the source of electricity, if possible. If not, move the source away from you and the person, using a dry, nonconducting object made of cardboard, plastic or wood.
- Begin CPR if the person shows no signs of circulation, such as breathing, coughing or movement.
- Try to prevent the injured person from becoming chilled.
- Apply a bandage. Cover any burned areas with a sterile gauze bandage, if available, or a clean cloth. Don't use a blanket or towel, because loose fibers can stick to the burns.

Look over the area of the incident carefully. Rushing in to save someone might be your first impulse, but if the danger of electrical shock remains you will only injure yourself as well. Take a moment to assess the scene and look for any obvious dangers.[1]

- Check for the source of the electrical shock. Look to see if the victim is still in contact with the source. Remember that electricity can flow through the victim and into you.
- Never use water, even if there is a fire, as water can conduct electricity.
- Never enter an area where electrical equipment is used if the floor is wet.
- Use a fire extinguisher made for electrical fires. Fire extinguishers for use on electrical fires will be labelled as a C, BC, or ABC extinguisher.[2]

Call emergency services. It is very important that you call as quickly as possible for help. The sooner you call, the sooner help will arrive. Explain your situation as calmly and clearly as you can when you make the call.

- Explain that the emergency involves and electrical shock so the responders can be best prepared.
- Try not to panic. Keeping as calm as you can will help you relay the proper information.
- Speak clearly. Emergency services will need accurate and clear information. Speaking too quickly might lead to misunderstanding, which can waste valuable time.[4]
- Provide your address and phone number accurately.
- Most countries have made emergency service numbers easy to remember. Here are a few examples:
- USA-911
- UK – 999
- Australia – 000
- Canada - 911

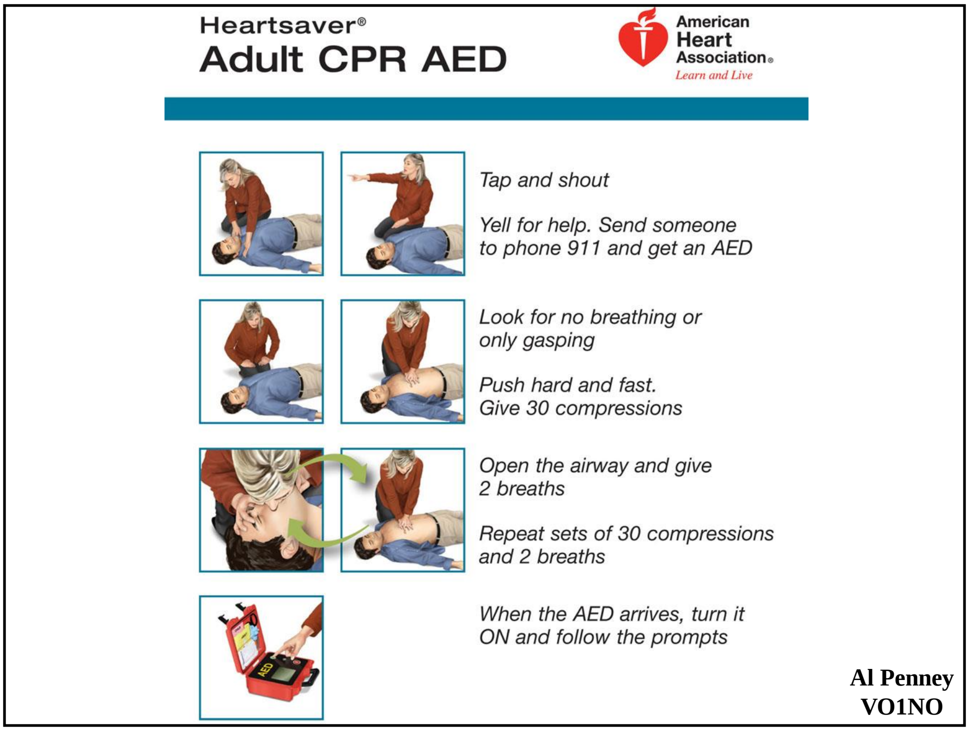
Shut off the current. If you can do so safely, turn off the electrical current. Don't attempt to rescue someone near a high-voltage line.[5] Shutting off the current at the power box, the circuit breaker or the fuse box is the preferred option. Follow these steps to turn the power off with a circuit breaker box:

- Open the circuit breaker box. Look for a rectangular block, with a handle, at the top of the fuse box.
- Grab the handle and flip it to the other side, just like a light switch.
- Try turning on a light or other electrical device to double check the power is off.

Separate the victim from the source. Don't touch the victim, even with a non-conducting instrument, if the electricity hasn't been shut off. Once you're sure there is no current, use a rubber or wooden stick, or any other non-conducting tool, to separate the victim from the source.[6]

- Examples of non-conducting materials include glass, porcelain, plastic and paper. Cardboard is another common, non-conducting material that you may use.[7]
- Conductors, which allow electricity to flow, include copper, aluminium, gold and silver. [8]
- If the victim has been hit by lightning, he or she is safe to touch.

Apply first aid.



CPR 101: These Are the CPR Steps Everyone Should Know

If a person is not breathing, his heartbeat will stop. Do CPR (chest compressions and rescue breaths) to help circulation and get oxygen into the body. (Early use of an AED—an automated external defibrillator—if one is available, can restart a heart with an abnormal rhythm.

First, open a person's airway to check if they are breathing (don't begin CPR if a patient is breathing normally). Then, get help. If you are not alone, send someone to call for help as soon as you have checked breathing. Ask the person to come back and confirm that the call has been made. (Check out these **emergency first-aid kit essentials**.)

Then follow these CPR steps:

1. Position your hand (above). Make sure the patient is lying on his back on a firm surface. Kneel beside him and place the heel of your hand on the centre of the chest.

2. Interlock fingers (above). Keeping your arms straight, cover the first hand with the heel of your other hand and interlock the fingers of both hands together. Keep your fingers raised so they do not touch the patient's chest or rib cage.

3. Give chest compressions (above). Lean forward so that your shoulders are directly over the patient's chest and press down on the chest about two inches. Release the pressure, but not your hands, and let the chest come back up.

Repeat to give 30 compressions at a rate of 100 compressions per minute. Not sure what that really means? Push to beat of the Bee Gees song "Stayin' Alive." (Learn how to recognize the **silent signs of a stroke**.)

Note: The American Heart Association recommends Hands-Only CPR (CPR without rescue breaths, which are detailed below) for people suffering out-of-hospital cardiac arrest. According to the AHA, only about 39 per cent of people who experience an out-of-hospital cardiac arrest get immediate help before professional help arrives; doing Hands-Only CPR may be more comfortable than doing rescue breaths for some bystanders and make it more likely that they take action. The AHA still recommends CPR with compressions and breaths for infants and children and victims of drowning, drug overdose, or people who collapse due to breathing problems.

4. Open the airway (above). Move to the patient's head. Tilt his head and lift his chin to open the airway again. Let his mouth fall open slightly.

5. Give rescue breaths (above). Pinch the nostrils closed with the hand that was on the forehead and support the patient's chin with your other hand. Take a normal breath, put your mouth over the patient's, and blow until you can see his chest rise.

6. Watch chest fall. Remove your mouth from the patient's and look along the chest, watching the chest fall. Repeat steps five and six once.

7. Repeat chest compressions and rescue breaths. Place your hands on the chest again and repeat the cycle of 30 chest compressions, followed by two rescue breaths. Continue the cycle.

Get more information about handling health emergencies and natural disasters in the book ***Reader's Digest: Quintessential Guide to Handling Emergencies***. You'll get must-know tips and tactics for preparing your home, stocking the right supplies, preventing and handling accidents, coping with medical situations, and keeping your family safe.

Learn how to recognize the **silent signs of a heart attack**.

Music for CPR Rhythm

- Good
  - "Stayin Alive" by the Bee Gees
  - "Walking on Sunshine" by Katrina and the Waves
  - "Dancing Queen" by Abba
  - "I Will Survive" by Gloria Gaynor
- Not so Good…
  - "The Sound of Silence" by Simon and Garfunkle
  - "Another One Bites the Dust" by Queen
  - "Die Young" by Black Sabbath

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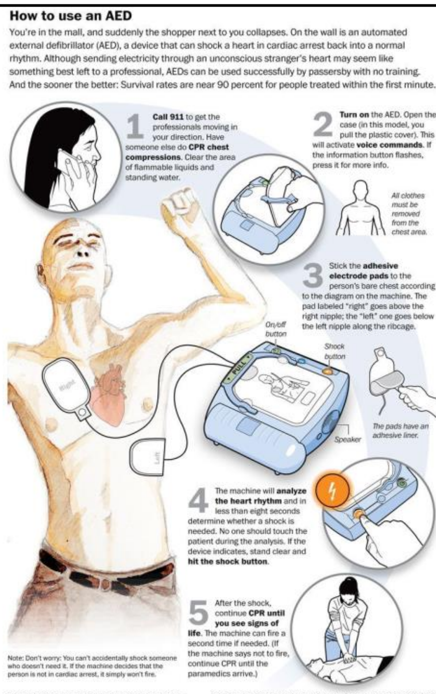
100 to 120 beats per minute for CPR



AED

- CALL 911!
- Turn on AED.
- Attach pads.
- AED will analyze heart rhythm.
- Follow AED instructions:
  - Shock
  - CPR

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An **automated external defibrillator** (**AED**) is a portable electronic device that automatically diagnoses the life-threatening cardiac arrhythmias of ventricular fibrillation (VF) and pulseless ventricular tachycardia, and is able to treat them through defibrillation, the application of electricity which stops the arrhythmia, allowing the heart to re-establish an effective rhythm.

With simple audio and visual commands, AEDs are designed to be simple to use for the layperson, and the use of AEDs is taught in many first aid, certified first responder, and basic life support (BLS) level cardiopulmonary resuscitation (CPR) classes.

The portable version of the defibrillator was invented in the mid-1960s by Frank Pantridge in Belfast, Northern Ireland.

Conditions that the device treats

An automated external defibrillator is used in cases of life-threatening cardiac arrhythmias which lead to sudden cardiac arrest, '*which is not the same as a heart attack. The rhythms that the device will treat are usually limited to:''*

1. Pulseless Ventricular tachycardia (shortened to VT or V-Tach) In ventricular tachycardia, the heart beats faster than normal, usually 100 or more beats a minute. The chaotic heartbeats prevent the heart chambers from properly filling with blood. As a result, your heart may not be able to pump enough blood to your body and lungs

2. **Ventricular fibrillation (shortened to VF or V-Fib),** a rapid quivering of the ventricular walls that prevents them from pumping.

In each of these two types of shockable cardiac arrhythmia, the heart is electrically active, but in a dysfunctional pattern that does not allow it to pump and circulate blood. In ventricular tachycardia, the heart beats too fast to effectively pump blood. Ultimately, ventricular tachycardia leads to ventricular fibrillation. In ventricular fibrillation, the electrical activity of the heart becomes chaotic, preventing the ventricle from effectively pumping blood. The fibrillation in the heart decreases over time, and will eventually reach asystole.

AEDs, like all defibrillators, are not designed to shock asystole ('flat line' patterns) as this will not have a positive clinical outcome. The asystolic patient only has a chance of survival if, through a combination of CPR and cardiac stimulant drugs, one of the shockable rhythms can be established, which makes it imperative for CPR to be carried out prior to the arrival of a defibrillator.

Effect of delayed treatment

Uncorrected, these cardiac conditions (ventricular tachycardia, ventricular fibrillation, asystole) rapidly lead to irreversible brain damage and death, once cardiac arrest takes place. After approximately three to five minutes in cardiac arrest, irreversible brain/tissue damage may begin to occur. For every minute that a person in cardiac arrest goes without being successfully treated (by defibrillation), the chance of survival decreases by 7 percent per minute in the first 3 minutes, and decreases by 10 percent per minute as time advances beyond ~3 minutes.

Requirements for use

AEDs are designed to be used by laypersons who ideally should have received AED training. However, sixth-grade students have been reported to begin defibrillation within 90 seconds, as opposed to a trained operator beginning within 67 seconds. This is in contrast to more sophisticated manual and semi-automatic defibrillators used by health professionals, which can act as a pacemaker if the heart rate is too slow (bradycardia) and perform other functions which require a skilled operator able to read electrocardiograms.

Bras with a metal underwire and piercings on the torso must be removed before using the AED on someone to avoid interference. American television show *Mythbusters* found evidence that use of a defibrillator on a woman wearing an underwire bra can lead to arcing or fire but only in unusual and unlikely circumstances.[8]

In a study analyzing the effects of having AEDs immediately present during Chicago's Heart Start program over a two-year period, of 22 individuals, 18 were in a cardiac arrhythmia which AEDs can treat. Of these 18, 11 survived. Of these 11 patients, 6 were treated by bystanders with absolutely no previous training in AED use.

Mechanism of operation

An AED is "automatic" because of the unit's ability to autonomously analyse the patient's condition. To assist this, the vast majority of units have spoken prompts, and some may also have visual displays to instruct the user.

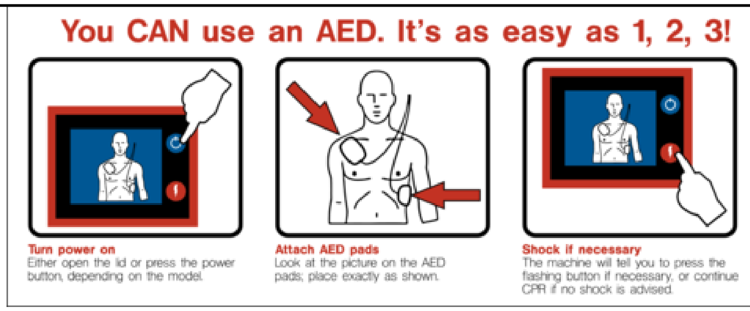
"External" refers to the fact that the operator applies the electrode pads to the bare chest of the victim (as opposed to internal defibrillators, which have electrodes surgically implanted inside the body of a patient).

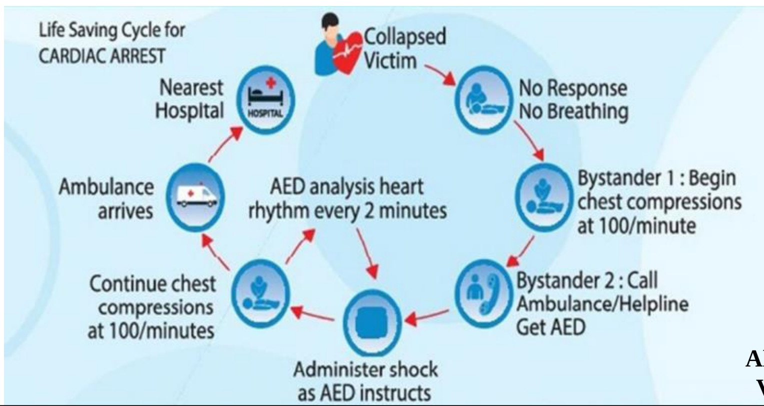
When turned on or opened, the AED will instruct the user to connect the electrodes (pads) to the patient. Once the pads are attached, everyone should avoid touching the patient so as to avoid false readings by the unit. The pads allow the AED to examine the electrical output from the heart and determine if the patient is in a shockable rhythm (either ventricular fibrillation or ventricular tachycardia). If the device determines that a shock is warranted, it will use the battery to charge its internal capacitor in preparation to deliver the shock. The device system is not only safer - charging only when required, but also allows for a faster delivery of the electric current.

When charged, the device instructs the user to ensure no one is touching the patient and then to press a button to deliver the shock; human intervention is usually required to deliver the shock to the patient in order to avoid the possibility of accidental injury to another person (which can result from a responder or bystander touching the patient at the time of the shock). Depending on the manufacturer and particular model, after the shock is delivered most devices will analyze the patient and either instruct CPR to be performed, or prepare to administer another shock.

Many AED units have an 'event memory' which store the ECG of the patient along with details of the time the unit was activated and the number and strength of any shocks delivered. Some units also have voice recording abilities to monitor the actions taken by the personnel in order to ascertain if these had any impact on the survival outcome. All this recorded data can be either downloaded to a computer or printed out so that the providing organisation or responsible body is able to see the effectiveness of both CPR and defibrillation. Some AED units even provide feedback on the quality of the compressions provided by the rescuer.

The first commercially available AEDs were all of a monophasic type, which gave a high-energy shock, up to 360 to 400 joules depending on the model. This caused increased cardiac injury and in some cases second and third-degree burns around the shock pad sites. Newer AEDs (manufactured after late 2003) have tended to utilise biphasic algorithms which give two sequential lower-energy shocks of 120–200 joules, with each shock moving in an opposite polarity between the pads. This lower-energy waveform has proven more effective in clinical tests, as well as offering a reduced rate of complications and reduced recovery time.





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If you are in a car when a power line falls on it, STAY IN THE CAR. When you are in the car you are not a part of electricity's path to the ground. Wait in the car until qualified electrical workers turn the power off and tell you it is safe to leave the vehicle. If people come near the car to help you, warn them to stay far away. Ask them to telephone 911 and the local electric utility for help.

If you MUST leave the car because of fire or other danger, JUMP away from the vehicle so no part of you touches the vehicle and ground at the same time. Land with both feet together, then shuffle away. Take very small steps and keep your feet in contact with each other and the ground constantly.
Do not try to help someone else from the car while you are standing on the ground. If you do, you will become a path for electricity and could be hurt or killed!

Once you jump from a car with a power line on it, the danger may not be over. Electricity can spread out through the ground in a circle from any downed line. The voltage drops as you move away from the point of contact. If one part of your body touches a high-voltage zone while another part of your body touches a low-voltage zone, you will become a conductor for electricity. This is why you should shuffle away from the line, keeping your feet close together.

Swimming pools are another source of trouble since people often operate radios and other powered appliances nearby. The National Electrical Code requires that special shock-detecting receptacles called Ground-Fault Current Interrupting (GFI or GFCI) be installed in wet and outdoor areas to help prevent shock incidents (more on these devices on the latter section of this chapter). These special devices have no doubt saved many lives, but they can be no substitute for common sense and diligent precaution. As with firearms, the best “safety” is an informed and conscientious operator.

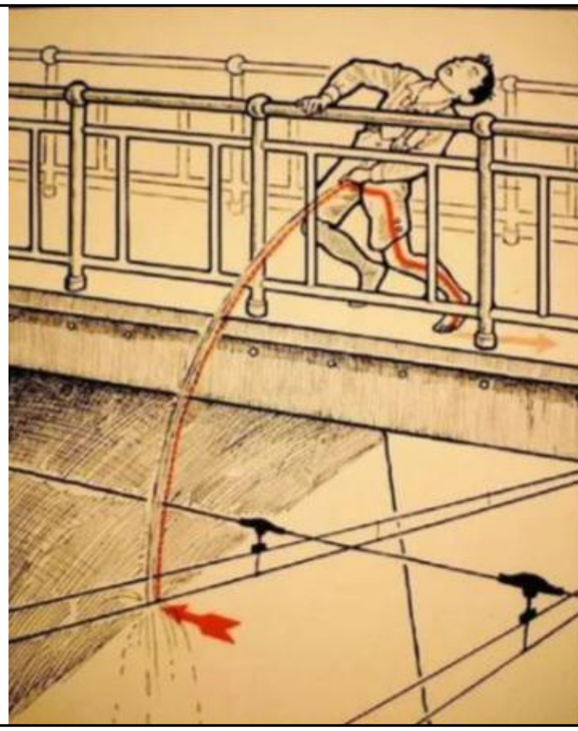
Darwin Awards

The **Darwin Awards** are a tongue-in-cheek honour, originating in Usenet newsgroup discussions around 1985. They recognise individuals who have supposedly contributed to human evolution by selecting themselves out of the gene pool via death or sterility by their own actions.

The project became more formalized with the creation of a website in 1993, and followed up by a series of books starting in 2000, authored by Wendy Northcutt. The criterion for the awards states, "In the spirit of Charles Darwin, the Darwin Awards commemorate individuals who protect our gene pool by making the ultimate sacrifice of their own lives. Darwin Award winners eliminate themselves in an extraordinarily idiotic manner, thereby improving our species' chances of long-term survival."

Accidental self-sterilisation also qualifies; however, the site notes: "Of necessity, the award is usually bestowed posthumously." The candidate is disqualified, though, if "innocent bystanders", who might have contributed positively to the gene pool, are killed in the process. The logical problem presented by award winners who may have already reproduced is not addressed in the selection process due to the difficulty of ascertaining if a person has or does not have children; the Darwin Award rules state that the presence of offspring does not disqualify a nominee.

People who have somehow miraculously survived their suicidal idiocy can be given an "Honourable Mention" if their attempted act of self removal is deemed worthy (and humorous).



An actual safety warning from the early 1900s about urinating on electric streetcar wires.

Station Grounds

- An effective ground is an important part of an Amateur station.
- Usually 3 grounds:
  - AC safety ground;
  - Ground at antenna for lightning protection; and
  - Equipment ground in station for EMI control.

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Grounds

An electrical ground is not a huge sink that somehow swallows noise and unwanted signals. Ground is a *circuit* concept, whether the circuit is small, like a radio receiver, or large, like the propagation

path between a transmitter and cable- TV installation. Ground forms a universal reference point between circuits.

This chapter deals with the EMC aspects of grounding. While grounding is not a cure-all for EMI problems, ground is an important safety component of any electronics

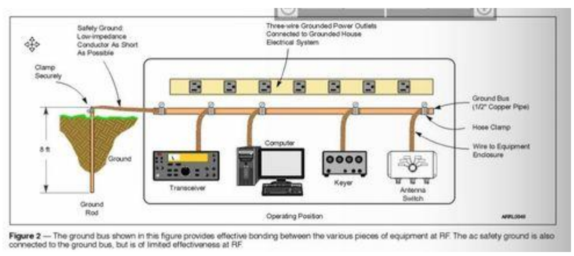
installation. It is part of the lightning protection system in your station and a critical safety component of your house wiring. Any changes made to a grounding system must not compromise these important safety considerations. Refer to the **Safety** chapter for important information about grounding.

Many amateur stations have several grounds: a safety ground that is part of the ac-wiring system, another at the antenna for lightning protection and perhaps another

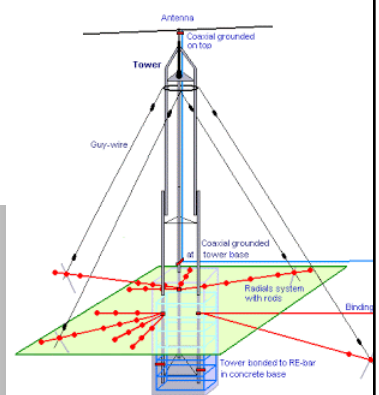
at the station for EMI control. These grounds can interact with each other in ways that are difficult to predict.

Grounding

AC Safety Ground



Station Equipment Ground



Antenna Lightning Ground

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Station Ground

- Keep grounding cables as **short as possible**.
- Some lengths will be resonant on your transmit frequencies, creating **RF hotspots** and allowing **RF to float around** in your shack.
- Single Point Ground to avoid ground loops.
- Can use **metallic cold-water pipes** as a ground.
- **NEVER** use natural gas or propane pipes!
- Proper grounding is a complicated topic – review the expert literature to assist you when it comes time to install your station!

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GROUNDS

As hams we are concerned with three kinds of ground, which are easily confused because we call each of them "ground."

The first is the power line ground, which is required by building codes to ensure the safety of life and property surrounding electrical systems. The *NEC* requires that

all grounds be *bonded* together; this is a very important safety feature as well as an *NEC* requirement. Ground systems to prevent shock hazards are generally referred

to as the *dc ground* by amateurs, although *safety ground* is a more appropriate term.

The previous section discussed some of the features of a lightning protection grounding system. Additional information on lightning, surge and EMI grounding

can be found in *The ARRL Antenna Book*. The *National Electrical Code* requires lightning protection ground rods to be separate from the power line safety

grounding electrodes. As discussed later, however, all grounding systems must eventually be bonded together.

An effective safety ground system is necessary for every amateur station. It provides a common reference potential for all parts of the ac system and reduces the possibility

of electrical shock by ensuring that all exposed conductors remain at that (low) potential. Three-wire electrical systems effectively ground our equipment for

dc and low frequencies. Unfortunately, an effective ground conductor at 60 Hz (5,000,000 m wavelength) may be an excellent antenna for a 20 m signal.

When stray RF causes interference or other problems, we need another kind of ground — a low-impedance path for RF to reach the earth or some other "ground" that

dissipates, rather than radiates, the RF energy. Let's call this an *RF ground.* In most stations, dc ground and RF ground are provided by the same system.

If you install ground rods, however, bond them to each other and to the safety ground at the electrical service entrance.

In older houses, water lines are sometimes used for the service entrance panel ground. It is a good idea to check that the pipes are electrically continuous from the panel to earth. (Consider that Teflon tape is often used to seal pipe joints in modern repairs.)

For decades, amateurs have been advised to bond all equipment cabinets to an RF ground located near the station. That's a good idea, but it's not easily achieved. "Near" in this use is 10 ft or less for HF operation, even less for higher frequencies.

At some stations, it is very difficult to produce an effective RF ground. When levels of unwanted RF are low, an RF ground may not be needed. Some think

that RF grounds should be isolated from the safety ground system — *that is not true! All grounds, including safety, RF, lightning protection and commercial communications,*

must be bonded together in order to protect life and property.

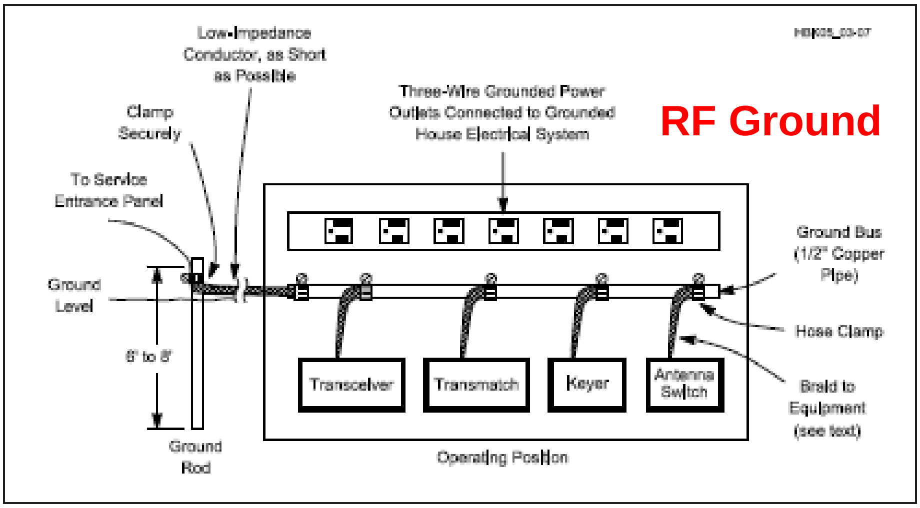

Fig 3.7 — An effective station ground bonds the chassis of all equipment together with low-impedance conductors and ties into a good earth ground. Note that the ground bus is in turn bonded to the service entrance panel. This connection should be made by a licensed electrician with #6 AWG (minimum size) copper wire.

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Fig 3.7 — An effective station ground bonds the chassis of all equipment together with low-impedance conductors and ties into a good earth ground. Note that the ground bus is in turn bonded to the service entrance panel. This connection should be made by a licensed electrician with #6 AWG (minimum size) copper wire.

The first step in building an RF ground system is to bond together the chassis of all equipment in your station. Choose conductors large enough to provide a low-impedance path. The *NEC* requires that grounding conductors be as large as the largest conductor in the primary power circuit (#14 for a 15-A circuit, #12 for 20 A). Copper strap, sold as “flashing copper,” is excellent for this application. Coax braid is a popular choice; but it is not a good ground conductor unless tinned, and then it’s no longer very flexible. It is best to use commercially made copper braid ground strap that is tinned and ampacity rated — wider straps make better RF grounds. Avoid solid conductors; they tend to break. Grounding straps can be run from equipment chassis to equipment chassis, but amore convenient approach is illustrated in **Fig 3.7**. In this installation, a 1/2-inch diameter copper water pipe runs the entire length of the operating bench. A wide copper ground braid runs from each piece of equipment to a stainless-steel clamp on the pipe.

After the equipment is bonded to a common ground bus, the ground bus must be wired to a good earth ground. This run should be made with a heavy conductor (copper braid is a good choice again) and should be as short and direct as possible.

Ground Rods

- **Copper-clad steel**
- Longer is better – electrical codes often recommend 10 feet (3 meters).
- Follow **applicable electrical codes**.
- Ground plate can be used where soil is shallow. Copper clad steel plate, 30 cm per side, buried to depth of 45 cm.
- Use heavy copper wire, securely attached.

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The earth ground usually takes one of two forms.

In most cases, the best approach is to drive one or more ground rods into the earth at the point where the conductor from the station ground bus leaves the house.

The best ground rods to use are those available from an electrical supply house. These rods are generally 8 ft long and made from steel with a heavy copper plating.

Do not depend on shorter, thinly plated rods sold by some home electronics suppliers, as they can quickly rust and soon become worthless.

Once the ground rod is installed, clamp the conductor from the station ground bus to it with a clamp that can be tightened securely and will not rust. Copper-plated clamps

made specially for this purpose (and matching the rods) are available from electrical supply houses. Multiple ground rods reduce the electrical resistance and improve the

effectiveness of the ground system.

Building cold water supply systems were used as station grounds in years past. Connection was made via a low-impedance conductor from the station ground

bus to a convenient cold water pipe, preferably somewhere near the point where the main water supply enters the house. (Hot water lines are unsuitable for grounding

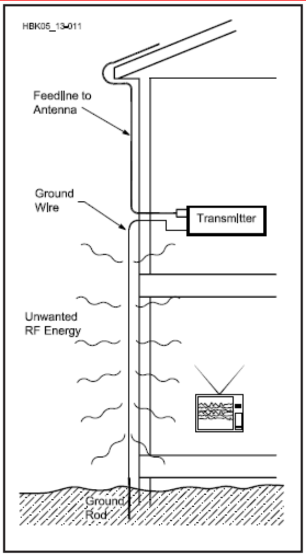
conductors.) Increased used of plastic plumbing both inside and outside houses is reducing the availability of this option.

If you do use the cold water line, ensure that it has a good electrical connection to the earth and attach it *outside* the structure to reduce EMI. As with ground rods,

ensure that the water line is also bonded to the service entrance panel.

Cadweld – uses powdered copper oxide and aluminum with a mold made of graphite.

Ground Hotspots



- If ground is ¼ wavelength (or multiples) then high impedance exists at equipment end.
- This will result in **RF “hotspots”** around the station when transmitting.

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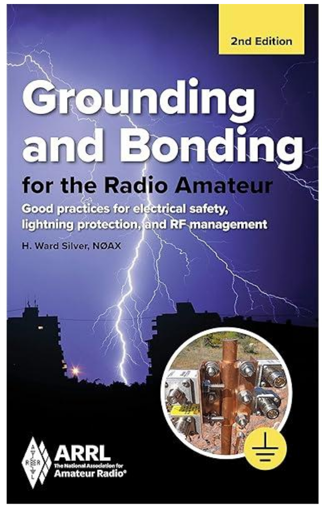
For some installations, especially those located above the first floor, a conventional ground system such as that just described will make a fine dc ground but will not provide the necessary low-impedance path to ground for RF. The length of the conductor between the ground bus and the ultimate ground point becomes a problem. For example, the ground wire may be about 1/4 wavelength (or an odd multiple of 1/4 wavelength) long on some amateur band. A 1/4-wavelength wire acts as an impedance inverter from one end to the other. Since the grounded end is at a very low impedance, the equipment end will be at a high impedance. The likely result is RF hot spots around the station while the transmitter is in operation. In this case, this ground system may be worse (from an RF viewpoint) than no ground at all.

In such cases it MAY be possible to avoid this problem by using wide copper flashing for the ground wire.

Excellent Reference



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Proper Station Grounding is Important!

Build your ham radio station with effective grounding and bonding techniques:

AC safety: Protect against shock hazards from ac-powered equipment by providing a safe path for current when a fault in wiring or insulation occurs.

Lightning protection: Keep all equipment at the same voltage during transients from lightning, and dissipate the lightning's charge in the Earth, away from equipment.

RF management: Prevent unwanted RF currents and voltages (also known as RF interference or RFI) from disrupting the normal functions of equipment.

Grounding and Bonding for the Radio Amateur shows you how to make sure your station follows current standards for lightning protection and communication systems. You'll learn effective grounding and bonding techniques for home stations (including condos and apartments), portable and mobile stations, towers, and outdoor antennas.

Station Power Requirements

- Simple station – single 12 VDC power supply – one circuit will suffice.
- Larger station – 100 Watt HF rig, rotator, 2M rig – two circuits recommended.
- Big station – several rigs, HF amplifiers – 2 or more 120 VAC plus a 240 VAC circuit recommended.
- Ideal situation is a single switch near door that controls all power **EXCEPT lights**.

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Fusing

- **NEVER** fuse the neutral line!
- **Never** replace a blown fuse/circuit breaker with a higher capacity replacement!
- Good idea to have a CO_2 or Dry Chemical **fire extinguisher** in the station as well.

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IMPORTANT INFORMATION ABOUT SURGE PROTECTORS

Most modern businesses and homes are supplied with 240-volt power systems. Heavy draw appliances such as air conditioners, dryers, and electric stoves operate on 240-volts and are not protected by surge protectors. Other appliances operate on 120-volts. These include computers, microwaves, stereo equipment and TV sets. These items are often used with surge protectors. The normal voltage flow will range from 110-120 volts. Surge Protectors are designed to trap the voltage that exceeds those limits. Excessive voltage occurs due to power spikes. When these spikes occur for a sufficient duration, this activates the trapping device, a Metal Oxide Varistor MOV), located in the surge protector. The MOV is the heart of surge
suppressors. The role of the MOV is to divert surge current. However, MOVs wear out with use. As more surges are diverted, the MOVs life span shortens, and failure becomes imminent. There is no forewarning or visual indications given - just failure. And while failing, they can reach very high temperatures, and actually start fires.

Most surge protectors will continue to function as a power strip, even though the surge trap mechanism may have been destroyed by the power spike. This presents two possible dangers: 1) If another power surge should occur, it can damage the equipment or appliances that are plugged into this surge protector, and 2) If sufficient voltage passes through the surge protector due to a second power spike, a resistant short may have been formed, allowing heating to occur and a fire to ignite.

When buying this equipment, look for a surge protector with an indicator light that tells you if the protection components are functioning. All MOVs will burn out after repeated power surges. Without an indicator light, you have no way of knowing if your protector is still functioning properly. Unfortunately due to manufacturing differences, the light may be "on" or "off" during proper operation. It is important to review the operating instructions provided with the surge protector.

Every year, thousands of fires result from surge protectors, power strips and electrical cords. Listed below are some suggestions to help prevent a possible fire from igniting.

* **USE ONLY SURGE PROTECTORS OR POWER STRIPS THAT HAVE AN INTERNAL CIRCUIT BREAKER. T**hese units will trip the breaker if the power strip is over loaded or shorted to prevent overheating and fire.
* Any surge protector or power strip that has frayed wires, or has a unit that is not working properly, replace them immediately.
* Surge protectors, power strips, or extension cords are not a substitute for permanent wiring.
* If at any time the surge protector or power strip is hot to the touch remove and replace the unit. The electrical load for this strip should be evaluated for overloading.
* Do not plug a surge protector or power strip into an existing surge protector or power strip. This practice is called "daisy chaining" or "piggy backing" and can lead to serious problems.
* The Underwriters Laboratory (UL) label must never be removed from the unit. On the underside of the casing, there should be the manufacturer's name and the name of the testing lab where the unit was tested.
* Do not locate a surge protector or power strip in any area where the unit would be covered with carpet, furniture, or any other item that will limit or prevent air circulation.
* Do not locate a surge protector in a moist environment.

All surge protectors or power strips need to be UL approved. Be sure that the product is listed as a TRANSIENT VOLTAGE SURGE SUPPRESSOR. This means that it meets the criteria for UL 1449, UL's minimum performance standard for surge suppressors. There are a lot of power strips listed by UL that have no surge protection components at all. They are listed only for their performance as extension cords. On a UL listed surge protectors, you will find a couple of ratings. Look for:

* Clamping voltage. This tells you what voltage will cause the MOVs to conduct electricity to the ground line. A lower clamping voltage indicates better protection. There are three levels of protection in the UL rating -- 330 V, 400 V and 500 V. Generally, a clamping voltage more than 400V is too high.
* Energy absorption/dissipation. This rating, given in joules, tells you how much energy the surge protector can absorb before it fails. A higher number indicates greater protection. Look for a protector that is at least rated at 200 to 400 joules. For better protection, look for a rating of 600 joules or more.
* Response time. Surge protectors don't kick in immediately; there is a very slight delay as they respond to the power surge. A longer response time tells you that your computer (or other equipment) will be exposed to the surge for a greater amount of time. Look for a surge protector that responds in less than one nanosecond.

Visually inspect all surge protectors or power strips on a regular basis to ensure that they are not damaged or showing signs of wear or damage. During the visual inspection, ensure that the plug is fully engaged in their respective outlets. The surge protector or power strips should always have either a polarized plug with one of the blades being larger then the other one or a three-prong grounded plug. Never use a three to two prong adapter to power the unit. Surge protectors or power strips should have a cord of no more than 6 feet in length. When the surge protector or plug strip is not in use, unplug the cord from the power source.

How Safe are Outlet Strips?
CAUTION: The switch in outlet strips is generally not rated for repetitive load break duty. Early failure and fire hazard may result from using these devices to switch loads. Misapplications are common (another bit of bad technique that has evolved from the use of personal computers), and manufacturers are all too willing to accommodate the market with marginal products that are "cheap."
Non-indicating and poorly designed surge protection also add to the safety hazard of using power strips. Marginally rated MOVs often fail in a manner that could cause a fire hazard, especially in outlet strips that have nonmetallic enclosures.

Electrical Safety

- If working on equipment:
  - **Turn off** and **Unplug** the equipment.
  - Wait 3 minutes for capacitors to discharge.
  - Remove cover, and use a **Shorting Stick** to ensure capacitors are discharged.
  - If you MUST have power applied, stand on a rubber mat and keep one hand in pocket.
  - **NEVER** work alone if working on live equipment.
  - Never wear headphones when working.

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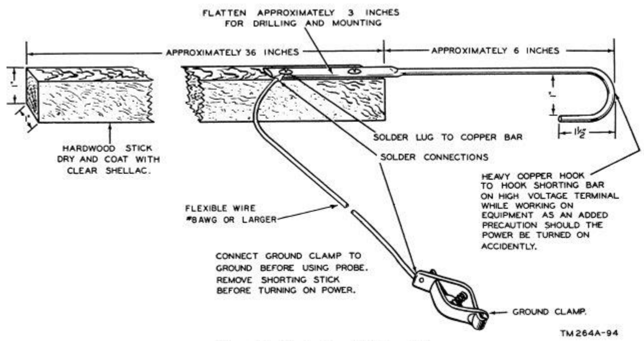

Figure 21. Construction of shorting stick.

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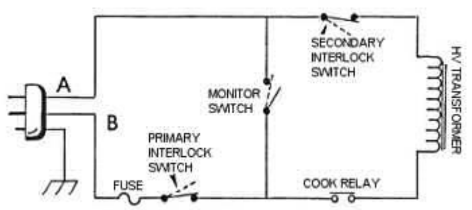
Safety Interlock

- A switch that **turns power off automatically** when a cabinet is opened.
- Do **NOT** defeat their purpose!
- They **DO NOT** mean that you can be complacent!



Simplified Interlock Monitor (Sensing) Circuit
(Shown with oven door closed)

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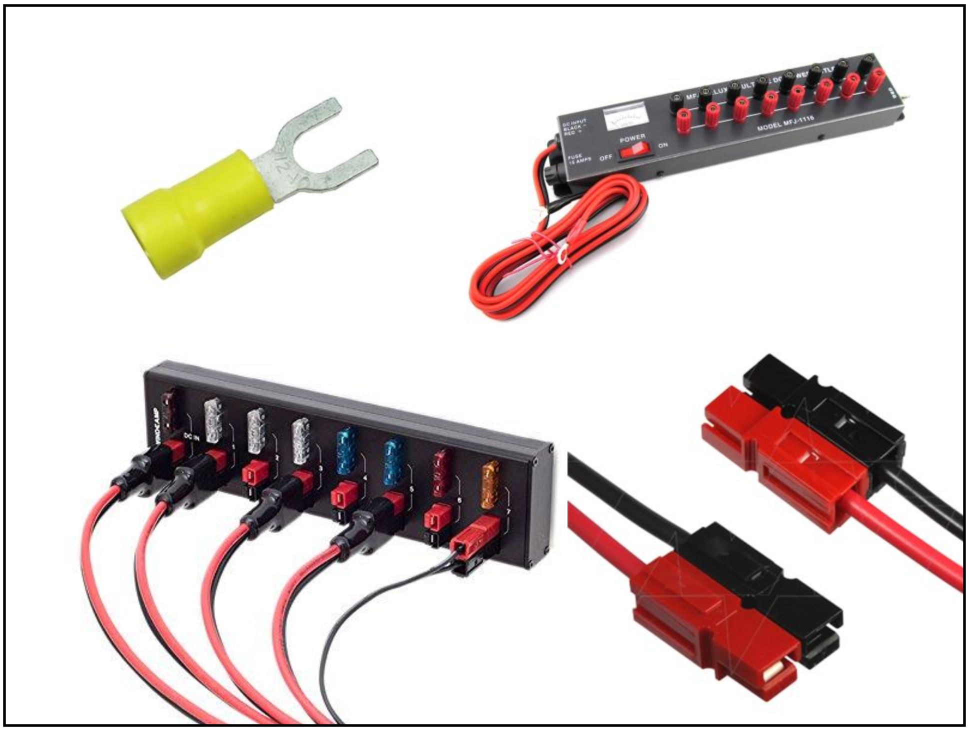
A
A-199703
DAIWA
SWITCH-MODE POWER
DC OUTPUT
30A
V. AD



Powerpole connectors

Stupid operator!

- Radios become lethal projectiles in event of an accident, and block the airbags.

- Radios also obstruct the driver's vision.

- One person cannot monitor all these radios at once, and the vehicle can't power them all simultaneously.

- People like this give Amateur Radio a bad name.

- For proper mobile installations, consult the website of Alan Applegate, K0BG: https://www.k0bg.com/

RF Exposure

- Two categories of RF Energy:
  - **Non-ionizing**:
    - Can cause heating of body tissue.
    - May also cause nerve stimulation.
  - **Ionizing**:
    - Can cause burns, radiation sickness, cancer and genetic damage.
- Spectrum **below** Ultraviolet is **non-ionizing**.

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Non-ionizing (or **non-ionising**) **radiation** refers to any type of electromagnetic radiation that does not carry enough energy per quantum (photon energy) to ionize atoms or molecules—that is, to completely remove an electron from an atom or molecule. Instead of producing charged ions when passing through matter, non-ionizing electromagnetic radiation has sufficient energy only for excitation, the movement of an electron to a higher energy state. In contrast, ionizing radiation has a higher frequency and shorter wavelength than non-ionizing radiation, and can be a serious health hazard; exposure to it can cause burns, radiation sickness, cancer, and genetic damage. Using ionizing radiation requires elaborate radiological protection measures, which in general are not required with non-ionizing radiation.

Ionizing radiation (**ionising radiation**) is radiation, traveling as a particle or electromagnetic wave, that carries sufficient energy to detach electrons from atoms or molecules, thereby ionizing an atom or a molecule. Ionizing radiation is made up of energetic subatomic particles, ions or atoms moving at high speeds (usually greater than 1% of the speed of light), and electromagnetic waves on the high-energy end of the electromagnetic spectrum.

Gamma rays, X-rays, and the higher ultraviolet part of the electromagnetic spectrum are ionizing, whereas the lower ultraviolet part of the electromagnetic spectrum and all the spectrum below UV, including visible light, nearly all types of laser light, infrared, microwaves, and radio waves are considered non-ionizing radiation. The boundary between ionizing and non-ionizing electromagnetic radiation that occurs in the ultraviolet is not sharply defined, since different molecules and atoms ionize at different energiess. Conventional definition places the boundary at a photon energy between 10 eV and 33 eV in the ultraviolet.

Typical ionizing subatomic particles found in radioactive decay include alpha particles, beta particles and neutrons. Almost all products of radioactive decay are ionizing because the energy of radioactive decay is typically far higher than that required to ionize. Other subatomic ionizing particles which occur naturally are muons, mesons, positrons, and other particles that constitute the secondary cosmic particles that are produced after primary cosmic rays interact with Earth's atmosphere. Cosmic rays are generated by stars and certain celestial events such as supernova explosions. Cosmic rays may also produce radioisotopes on Earth (for example, carbon-14), which in turn decay and produce ionizing radiation. Cosmic rays and the decay of radioactive isotopes are the primary sources of natural ionizing radiation on Earth referred to as background radiation. Ionizing radiation can also be generated artificially by X-ray tubes, particle accelerators, and any of the various methods that produce radioisotopes artificially.

Ionizing radiation is not detectable by human senses, so radiation detection instruments such as Geiger counters must be used to indicate its presence and measure it. However, high intensities can cause emission of visible light upon interaction with matter, such as in Cherenkov radiation and radioluminescence. Ionizing radiation is used in a wide variety of fields such as medicine, nuclear power, research, manufacturing, construction, and many other areas, but presents a health hazard if proper measures against undesired exposure are not followed. Exposure to ionizing radiation causes damage to living tissue, and can result in radiation burns, cell damage, radiation sickness, cancer, and death.

For frequencies from 3 kHz to 10 MHz, NS from induced electric fields within the body must be avoided. Experimental studies have demonstrated that electric and magnetic field exposures can induce internal electric fields (voltage gradients) within biological tissue which, if sufficiently intense, can alter the "resting" membrane potential of excitable tissues resulting in spontaneous depolarization of the membrane and the generation of spurious action potentials (5, 10, 11, 13, 14, 35, 41). Basic restrictions for the avoidance of NS are specified in this safety code in terms of maximum internal electric field strength within the body.

RF Exposure

- At **low levels** RF poses **no danger**.
- At higher levels, **heating of body tissue** can take place, depending on;
  - Frequency;
  - Power density;
  - Duty cycle; and
  - Exposure duration.
- **Eyes and testes** most susceptible – **do not aim UHF and microwave antennas at them!**

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WHAT BIOLOGICAL EFFECTS CAN BE CAUSED BY RF ENERGY?

Biological effects can result from exposure to RF energy. Biological effects that result from heating of tissue by RF energy are often referred to as "thermal" effects. It has been known for many years that exposure to very high levels of RF radiation can be harmful due to the ability of RF energy to heat biological tissue rapidly. This is the principle by which microwave ovens cook food. Exposure to very high RF intensities can result in heating of biological tissue and an increase in body temperature. Tissue damage in humans could occur during exposure to high RF levels because of the body's inability to cope with or dissipate the excessive heat that could be generated. Two areas of the body, the eyes and the testes, are particularly vulnerable to RF heating because of the relative lack of available blood flow to dissipate the excess heat load.

Safety Code 6

- **Safety Guidelines** for the maximum **limit of RF energy exposure** to the human body.
- Published by **Health Canada.**
- Concerned with devices that transmit.
- Applies to **ALL** transmitters.
- Portable transmitters (HTs, walkie-talkies etc.) used to be exempt from the regulations, but this **was changed in 1999.**

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Understanding Safety Code 6

The Government of Canada is committed to protecting the health and safety of Canadians from environmental risks, including those posed by exposure to radiofrequency (RF) electromagnetic fields - the kind of energy given off by various electronic devices such as cell phones and Wi-Fi, as well as broadcasting antennae and cell phone towers.

The purpose of Safety Code 6 is to establish safety limits for human exposure to RF fields in the frequency range from 3 kHz to 300 GHz. The safety limits in this code apply to all individuals working at, or visiting, federally regulated sites. The limits established in Safety Code 6 incorporate large safety margins to provide a significant level of protection for all Canadians, including those working near RF sources.

The Code is divided into two sections. The first section is an introduction that provides an overview of the purpose and rationale of the Code, specifically outlining what electromagnetic radiation is and where RF fields fall within the electromagnetic radiation spectrum. The introduction also provides a high level synopsis of what the literature indicates with respect to the health impacts from human exposure to RF fields and how these health effects have been used in the establishment of the exposure limits within Safety Code 6.

The second and most significant section of the Code provides details on what the exposure limits are. The exposure limits are specified as "basic restrictions" (exposure limits within the body) and "reference levels" (exposure limits outside the body). The Code concludes with definitions of key terms used throughout the Code and a list of the key literature or reference materials used in the revisions to the Code.

While Health Canada recommends limits for safe human exposure, Health Canada does not regulate the general public's exposure to electromagnetic RF fields. However, many provinces and territories apply the exposure limits in Safety Code 6 for general public exposure. Wireless devices and their associated infrastructure (such as cell towers) are regulated by Industry Canada, and are required to comply with Safety Code 6.

Health Canada scientists monitor the scientific literature on this issue on an ongoing basis. Safety Code 6 is reviewed on a regular basis to verify that the guideline provides protection against all known potentially harmful health effects.

When developing the exposure limits in Safety Code 6, Health Canada considers all peer-reviewed scientific studies. The exposure limits in Safety Code 6 are set well below the lowest exposure level (threshold) at which any scientifically-established, adverse health effect occurs and take into account the total exposure from all sources of RF energy.

Canada's limits are consistent with the science-based standards used in other parts of the world (e.g., the United States, the European Union, Japan, Australia and New Zealand) and provide protection against all known adverse health effects from RF energy.

Reviewing Scientific Evidence on Safety Code 6

Safety Code 6 is reviewed on a regular basis to verify that the guideline provides protection against all known potentially harmful health effects. Health Canada employs a weight-of-evidence approach when reviewing scientific evidence that may have an impact on Safety Code 6. The weight-of-evidence approach takes into account both the quantity of studies and, more importantly, the quality of those studies.

Poorly conducted studies (e.g. inadequate exposure evaluation, lack of appropriate control samples or inadequate statistical analysis), receive relatively little weight, while properly conducted studies (e.g. all controls included, appropriate statistics, complete exposure evaluation) receive more weight.

International Standards

The limits in Safety Code 6 are science-based exposure limits that are consistent with the science-based standards used in other parts of the world, including the United States, the European Union, Japan, Australia and New Zealand.

Large safety margins have been incorporated into these limits to provide a significant level of protection for the general public and personnel working near RF sources.

Internationally, a few jurisdictions (cities, provinces or countries) have applied more restrictive limits for RF field exposures from cell towers, although there is no scientific basis to support the need for such restrictive limits. Additionally, in many instances these more restrictive limits are not applied to other wireless devices in these same jurisdictions.

Safety Code 6 protects all Canadians

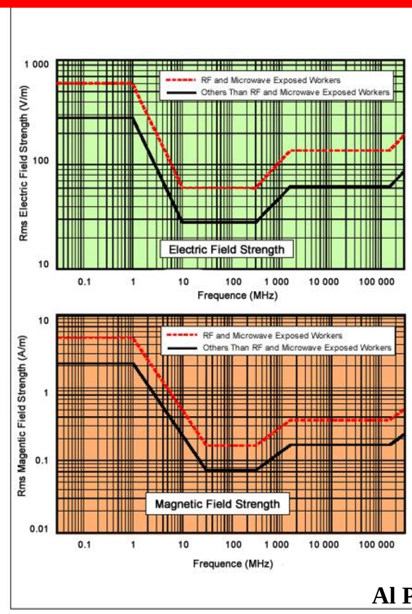
The Safety Code 6 limits for human exposure to RF fields are designed to provide protection for all age groups, including children, on a continuous (24 hours a day/seven days a week) basis.

This means that if someone, including a small child, were to be exposed to RF fields from multiple sources for 24 hours a day, 365 days a year, within the Safety Code 6 limits, there would be no adverse health effects. Safety Code 6 exposure limits are not device specific, but the limits do take into account the total exposure from all sources of RF fields. Health Canada scientists have concluded (and the Royal Society of Canada has agreed) on the basis of current scientific data, that no adverse health effects will occur from exposure to RF fields at the levels permitted by Safety Code 6.

Health Canada reminds all Canadians that their health is protected from RF fields by the human exposure limits recommended in Safety Code 6. The current Safety Code establishes and maintains a human exposure limit that is far below the threshold for potentially adverse health effects. The limits in Safety Code 6 provide protection against all known adverse health effects for all individuals.

Exposure Limits (Pre 2015!)

- Electric Field measured in Volts/meter (V/m), sometimes designated as VRMS/m
- **Frequencies from 30 to 300 MHz form the greatest risk** because **human body absorbs most energy in this range**
- **Max exposure** in this range is **28 V/m (E Field)**
- **Use this slide for test until ISED Question Bank catches up with updated Safety Code Six!**



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1.1 Purpose of the code

The purpose of this code is to specify maximum levels of human exposure to RF fields at frequencies between 3 kHz and 300 GHz, to prevent adverse human health effects in both controlled and uncontrolled environments.

In this code, controlled environments are defined as those where all of the following conditions are satisfied:

1. the RF field intensities in the controlled area have been adequately characterized by means of measurements or calculation,
2. the exposure is incurred by persons who are aware of the potential for RF exposure and are cognizant of the intensity of the RF fields in their environment and,
3. the exposure is incurred by persons who are aware of the potential health risks associated with RF field exposures and can control their risk using mitigation strategies.

Situations that do not meet all the specifications above are considered to be uncontrolled environments. Uncontrolled environments are defined as areas where either insufficient assessment of RF fields has been conducted or where persons who are allowed access to these areas have not received proper RF field awareness/safety training and have no means to assess or, if required, to mitigate their exposure to RF fields.

2. Maximum Exposure Limits

The scientific literature with respect to possible biological effects of RF fields has been monitored by Health Canada scientists on an ongoing basis. Since the last version of Safety Code 6 was published (2009), a significant number of new studies have evaluated the potential for acute and chronic RF field exposures to elicit possible effects on a wide range of biological endpoints including: human cancers; rodent lifetime mortality; tumor initiation, promotion and co-promotion; mutagenicity and DNA damage; EEG activity; memory, behaviour and cognitive functions; gene and protein expression; cardiovascular function; immune response; reproductive outcomes; and perceived electromagnetic hypersensitivity among others. Numerous authoritative reviews have summarized the current literature (4-8, 17-40).

Despite the advent of numerous additional research studies on RF fields and health, the only established adverse health effects associated with RF field exposures in the frequency range from 3 kHz to 300 GHz relate to the occurrence of tissue heating and nerve stimulation (NS) from short-term (acute) exposures. At present, there is no scientific basis for the occurrence of acute, chronic and/or cumulative adverse health risks from RF field exposure at levels below the limits outlined in Safety Code 6. The hypotheses of other proposed adverse health effects occurring at levels below the exposure limits outlined in Safety Code 6 suffer from a lack of evidence of causality, biological plausibility and reproducibility and do not provide a credible foundation for making science-based recommendations for limiting human exposures to low-intensity RF fields.

This safety code provides guidance for the avoidance of adverse human health effects resulting from exposure to RF fields, in terms of basic restrictions and/or reference levels. Basic restrictions are exposure indices within the body that should not be exceeded. These exposure indices are directly linked to established adverse health effects. The basic restrictions in this safety code are specified in terms of: a) internal electric field strength; and b) the rate of RF energy absorption (SAR). Since measurements of the SAR or internal electric field strength are often difficult to perform, reference levels for maximum human exposure to RF fields have also been specified in this safety code. The reference levels are specified in terms of unperturbed, externally applied electric- and magnetic-field strength, power density and in terms of electric currents in the body occurring from either induction or contact with energized metallic objects. They were established using dosimetric analyses that determined the levels of externally applied field strengths that would produce the basic restrictions within the body. While compliance with the basic restrictions is required, non-compliance with the reference levels does not necessarily mean that the basic restrictions are not respected. In such cases, additional measurements or calculations may be required to assess compliance.

For frequencies from 3 kHz to 10 MHz, NS from induced electric fields within the body must be avoided. Experimental studies have demonstrated that electric and magnetic field exposures can induce internal electric fields (voltage gradients) within biological tissue which, if sufficiently intense, can alter the "resting" membrane potential of excitable tissues resulting in spontaneous depolarization of the membrane and the generation of spurious action potentials (5, 10, 11, 13, 14, 35, 41). Basic restrictions for the avoidance of NS are specified in this safety code in terms of maximum internal electric field strength within the body.

For frequencies from 100 kHz to 300 GHz, tissue heating can occur and must be limited. Basic restrictions have been specified in this safety code for RF field exposures in the 100 kHz to 6 GHz frequency range, in terms of maximum whole-body SAR (averaged over the whole-body) and peak spatially-averaged SAR, (averaged over a small cubical volume). For frequencies above 6 GHz, RF energy absorption occurs predominantly in surface tissues (e.g. upper layers of skin) and the use of maximum SAR limits, either whole-body or averaged over a cubical volume, is not appropriate. In lieu of basic restrictions, reference levels are specified for maximum unperturbed, externally applied electric- and magnetic-field strengths and in terms of power density, for the avoidance of thermal effects.

Studies in animals, including non-human primates, have consistently demonstrated a threshold effect for the occurrence of behavioural changes and alterations in core body temperature of ~1.0°C, at a whole-body average SAR of ~4 W/kg (5-8, 11, 12, 14, 36). Thermoregulatory studies in human volunteers exposed to RF fields under a variety of exposure scenarios have provided supporting information on RF field induced thermal responses in humans (42). This information forms the scientific basis for the basic restrictions on whole-body average SAR in Safety Code 6. To ensure that thermal effects are avoided, safety factors have been incorporated into the exposure limits, resulting in whole-body-averaged SAR limits of 0.08 and 0.4 W/kg in uncontrolled- and controlled-environments, respectively.

Basic restrictions on peak spatially-averaged SAR have also been established in Safety Code 6 to avoid adverse thermal effects in localized human tissues (hot-spots). The peak spatially-averaged SAR limits reflect the highly heterogeneous nature of typical RF field exposures and the differing thermoregulatory properties of various body tissues. The peak spatially-averaged SAR limits pertain to discrete tissue volumes (1 or 10 g, in the shape of a cube), where thermoregulation can efficiently dissipate heat and avoid changes in body temperature that are greater than 1°C. As such, the peak spatially-averaged SAR limits for exposures in controlled environments are 20 W/kg for the limbs and 8 W/kg for the head, neck and trunk. For exposures in uncontrolled environments, the peak spatially-averaged SAR limits are 4.0 W/kg for the limbs and 1.6 W/kg for the head, neck and trunk.

For frequencies from 100 kHz to 10 MHz, since either NS or thermal effects could occur, depending upon the exposure conditions (frequency, duty cycle, orientation), basic restrictions for both internal electric field strength and SAR (whole-body and peak spatially-averaged) must be simultaneously respected. Safety Code 6 also specifies reference levels in the 3 kHz to 110 MHz frequency range, in terms of induced- or contact-currents (mA), for the avoidance of perception (nerve stimulation), shocks or burns (4, 6).

While the biological basis for the basic restrictions specified in this safety code has not changed since the previous version (2009), the reference levels have been updated to either account for dosimetric refinements in recent years (43-64) or where feasible, to harmonize with those of ICNIRP (10-11).

To determine whether the maximum exposure levels are exceeded, full consideration shall be given to such factors as:

1. nature of the exposure environment (controlled or uncontrolled environment);
2. temporal characteristics of the RF source (including ON/OFF times, duty factors, direction and sweep time of the beam, etc...);
3. spatial characteristics between the exposure source and target (i.e. near-field exposures, whole body or parts thereof);
4. uniformity of the exposure field (i.e. spatial averaging).

Where comparison is to be made to the SAR-based basic restrictions and/or reference levels at frequencies in the 100 kHz - 300 GHz range, higher exposure levels may be permitted for short durations of time under certain circumstances. For these situations, the field strengths, power densities and body currents averaged over any one tenth-hour reference period (6 minutes) shall not exceed the limits outlined in Sections 2.1 and 2.2.

SI units are used throughout this document unless specified otherwise.

Current Exposure Limits

Frequency (MHz)	Electric Field Strength (E_{RL}), (V/m, RMS)	Magnetic Field Strength (H_{RL}), (A/m, RMS)	Power Density (S_{RL}), (W/m²)	Reference Period (minutes)
10–20	27.46	0.0728	2	6
20–48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48–300	22.06	0.05852	1.291	6
300–6000	$3.142\ f^{0.3417}$	$0.008335\ f^{0.3417}$	$0.02619\ f^{0.6834}$	6
6000–15000	61.4	0.163	10	6
15000–150000	61.4	0.163	10	$616000 / f^{1.2}$
150000–300000	$0.158\ f^{0.5}$	$4.21\text{x}10^{-4}\ f^{0.5}$	$6.67\text{x}10^{-5}\ f$	$616000 / f^{1.2}$

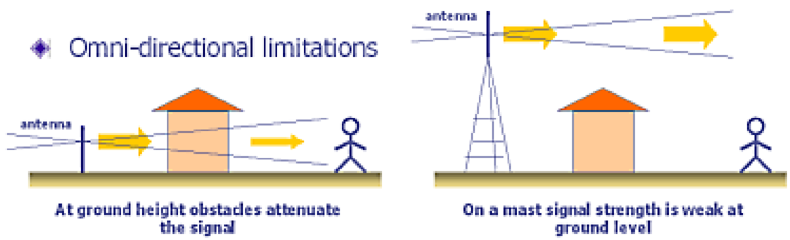
Frequency, f, is in MHz.

- Health Canada updated exposure limits in **2015**.
- Limits are generally similar, but **differ in details**.
- Use **previous slide** for test until ISED catches up!

Al Penney
VO1NO

RF Exposure vs Antenna Height

- Try to have antennas, especially directional antennas, **high** to **avoid exposing** humans to RF energy.



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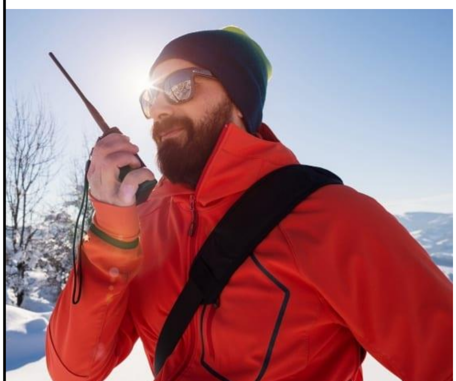
Holding an HT



- Keep HT antenna away from your head while transmitting to **reduce RF absorption** by your brain.

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Soldering Safety

- Tips are hot! (Duh!)
- Use the soldering iron stand – not the bench.
- Keep cord away from tip.
- Turn off and unplug when not in use.
- Use eye protection. Watch out for falling blobs.
- Wash hands when done.
- Work in ventilated area – dangerous fumes.
- Know where fire extinguisher is.
- Cold water for 15 minutes if burned.

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Soldering

Soldering Iron Safety

•Never touch the element or tip of the soldering iron. They are very hot (about 400°C) and will burn.
•Hold wires to be heated with tweezers or clamps.
•Keep the cleaning sponge wet during use.
•Always return the soldering iron to its stand when not in use. Never put it down on your workbench.
•Turn unit off or unplug it when not in use.

Work Safely with Solder, Flux and Cleaners

•Wear eye protection. Solder can "spit".
•Use lead free solder.
•Keep cleaning solvents in dispensing bottle to reduce inhalation hazards.
•Always wash your hands with soap and water after soldering.
•Read and understand the Safety Data Sheets (SDS) for all materials before beginning work.

Dangers of Lead Exposure

•Lead on your skin can be ingested and lead fumes can be given off during soldering. Other metal fumes can also be hazardous. Lead can have serious chronic health effects, such as reproductive problems, digestive problems, nerve disorders, memory and concentration problems, muscle and joint pain.

Avoid Toxic Fumes

•Work in a well-ventilated area. The smoke formed is mostly from the flux which can be irritating, a sensitizer and aggravates asthma. Avoid breathing it by keeping your head to the side of, not above, your work.
•A benchtop fume extractor may be necessary to remove harmful fumes caused by solder and flux from the soldering workstation by filtering the air.

Reduce Risk from Electricity

•Always use a grounded outlet and grounding prong to reduce the risk of electrical damage if a short circuit occurs in the equipment.
•Prevent damage to electrical cords during soldering. Keep them away from heated tips.

Fire Prevention

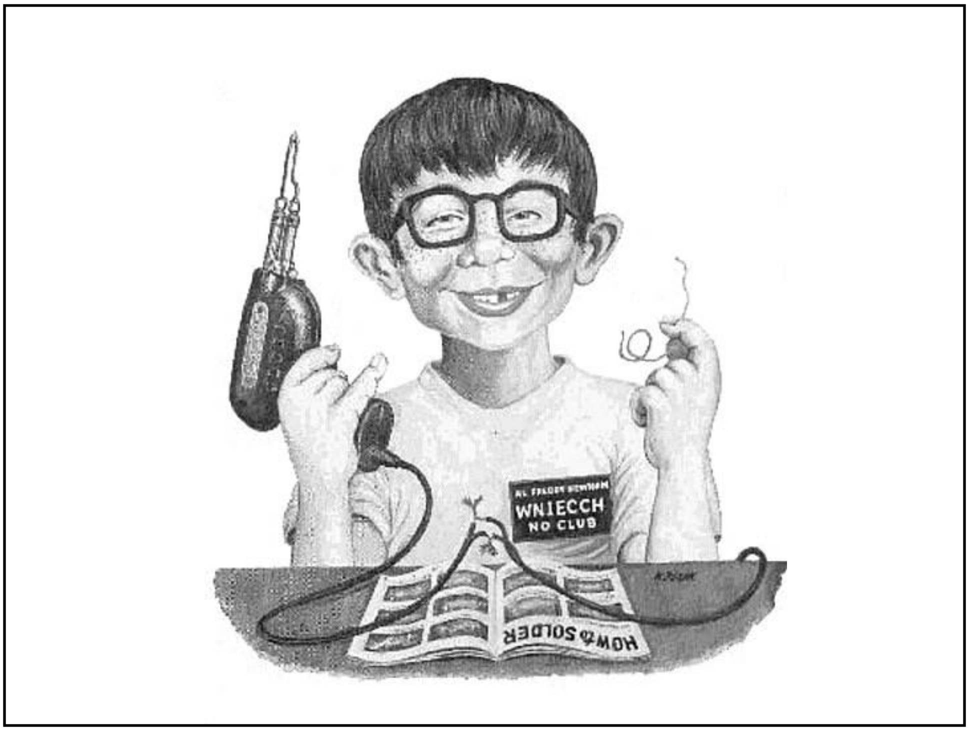
•Work on a fire-proof or nonflammable surface that is not easily ignited.
•Wear nonflammable or 100% cotton clothing that covers your arms and legs to help prevent burns.
•Know where your fire extinguisher is and how to use it.

First Aid

•Immediately cool the affected area under cold water for 15 minutes.
•Do not apply any creams or ointments. Cover with a band-aid.
•Seek medical attention if the burn covers an area bigger than 3 inches across.

Waste

•Discard lead and silver solder and dross in a container with a lid.
•Label the container: "Lead (Silver) Solder Waste for Recycling".
•Used solder sponges and contaminated rags must be disposed of as hazardous waste.
•Keep a lid on waste solder containers when not adding or removing material.



“What – me worry?” Alfred E. Neuman (E stands for Enigma)

Power Line Safety

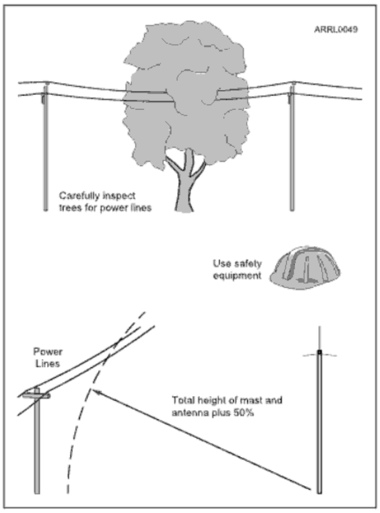


Figure 7-6 — Antennas or supports falling onto a power line can result in electrocution. Take extra care in siting and erecting your antenna to avoid a deadly accident!

- Towers and antennas must **never** be able to fall on power lines!
- Use height of **tower + 50%** (some recommend **twice tower height**).
- Be aware of **hidden** power lines!

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POWER LINES

Hundreds of people have been killed or seriously injured when attempting to install or dismantle antennas. In virtually all cases, the victim was aware of the hazards,

including the potential for serious electrical shock, but did not take the necessary steps to eliminate the risks.

Never install antennas, towers and masts near power lines. How far away is considered safe? Towers and masts should be installed twice the height of the installation

away from power lines. Every electrical wire must be considered dangerous. If the installation should contact power lines, you or those around you could be killed!

If you have any questions about power lines, contact your electrical utility, city inspector or a qualified professional.

If, for some reason your tower or antenna structure begins to fall, get away from it immediately! If it contacts energized lines, it can become a lethal hazard if you are touching any part of the conductive structure.If a coworker becomes energized, **do not touch the person!** The safest practice is to keep all others clear of the area, call 911, and just wait for the power company and rescue team to arrive and assist the victim. At some greater risk, a well-insulated pole such as fiberglass or PVC pipe — as long as possible for safety — can be utilized in an attempt to dislodge the live wire or collapsed metal structure from the victim (with moisture, etc., wood can be a *poor insulator* — especially at high voltages!).

If the victim can be well cleared of the hazard and is not breathing, immediately start CPR procedures and seek emergency assistance.

Remember, use caution and understand that during such an accident, the live conductor or live antenna structure can further move (lurch) suddenly and without warning. One accident is bad enough — there is no need to have two victims! It is best to just seek qualified emergency help if you are unsure of the situation-specific hazards.

Further information about tower safety appears in *The ARRL Antenna Book.*

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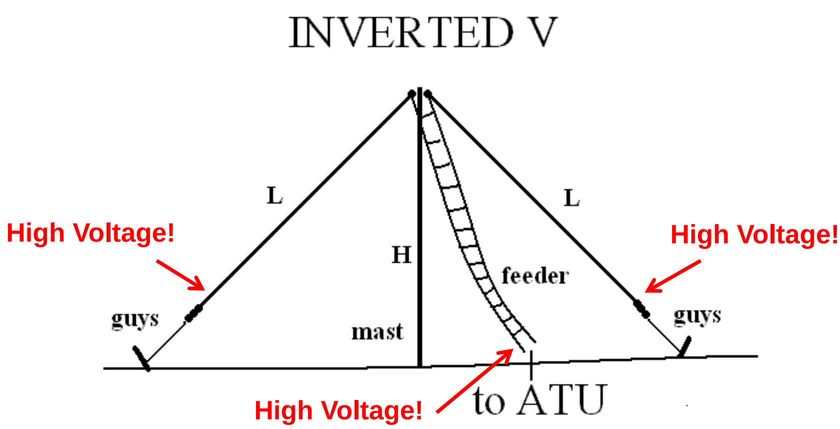
Beware High Voltages & RF Burns!



NOTE: Touching nearby conductors can also cause shock / RF burns!

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When a person touches an electrically energized object, he may experience an adverse effect. If the object is energized by a radio frequency (RF) source, the predominant contact hazard is burning of tissue at the point of contact and arises when the current drawn from the object exceeds a certain value. This RF burn hazard exists on various transmitting aerials and simple precautions can be taken to avoid it. However, such a hazard can also arise on metallic objects excited by radiation from transmitting aerials in their vicinity.

Touching an antenna while transmitting with it is never a good idea. Although the hazard with very low power levels such as that of a 5 watt HT transceiver is negligible, higher power levels can produce hazardous conditions for touching a radiating element. You should take precautions against the possibility of your antenna being accidentally touched by a person while you are transmitting.

Radio frequency radiation is non-ionizing radiation. This means that RF radiation does not strip electrons from atoms as can occur with ultraviolet, X-ray, and gamma ray radiation that has much higher frequencies than RF. Radio frequencies do not damage genetic material such as DNA by such molecular disruption. Thus, it is not possible to develop radiation poisoning from RF or by touching a transmitting antenna.

It is also not reasonable that touching a transmitting radio antenna could incite television interference of any kind.

However, RF radiation is absorbed by the tissues of our bodies and transformed into heat that the body must remove to avoid damage from overheating or burning – to avoid cooking, essentially. Human cells die at about 107 degrees Fahrenheit or above. When you come into contact with an RF transmitting element such as an antenna that is conducting RF electrical currents, those currents may seek a path to ground potential voltage through your tissues, quickly heating your tissues near the point of contact with the antenna. In some cases this can cause an RF burn.

It is also possible to receive an RF burn from other conductors that are resonating from nearby RF fields. For example, ground conductors, cables, or other metal components of your station may develop non-uniform "hot spots" when your station is radiating at high power or if a transmitting antenna is very close by, especially if these conductors have dimensions approaching a significant fraction of the transmitting frequency. Antennas are not the only hazardous element with RF burn potential!

The severity of an RF burn depends upon several factors:

•The strength of the electric field. This is the power output at the antenna where the contact is made. As noted, low power levels do not usually impose burns as the blood flow through tissues can readily carry away the mild heating imposed by low power RF. Higher power levels with stronger electric fields will, of course, impose more severe heating of tissue. Compare touching a 5 watt light bulb with touching a 60 watt light bulb, or a 100 watt light bulb. Although that is infrared heat, the relative comparison with RF energy is similar.

•The frequency. Our bodies are more efficient at absorbing frequencies in the VHF realm than others. So, an RF burn may be imposed at VHF frequencies with lower power levels than at other frequencies. Note that VHF includes the very popular 6-meter and 2-meter bands.

•How well grounded you are. The RF currents will seek a path through your tissue to ground potential. If you are very well grounded, such as standing barefoot in a puddle of sea water, you're going to provide a very nice path to ground and the currents will flow readily, burning your tissues at the contact point where currents are most concentrated.

•How much of your body contacts the radiating element. If you touch the antenna with your fingertip, a high concentration of RF will flow through the small area of your fingertip, potentially causing a severe burn. If you grab the antenna in the palm of your hand, a much larger surface area is in contact with the radiating element, and the RF current will be dispersed through that larger tissue area. The concentration of current in this case is lower, so tissue heating is less severe, but it may still burn you depending upon the other factors listed above. If the antenna is coursing with a kilowatt, you're definitely going to feel it in the palm of your hand (and beyond).

Radio frequency burns can be deep and very painful, much more so than a conventional infrared heat burn. First aid for RF burns is to apply cold water or ice to burned areas and seek immediate medical attention. Of course, prevention is the preferred course. Make sure it is not possible for humans to accidentally come into contact with your antenna, and if the antenna is within reach such as a mobile mounted element on a car, be sure no one is in contact with it before you push to talk.

Tower Safety

- Permanent tower installations require **careful** attention to detail and **proper hardware**.
- Consult **manufacturer's instructions** and **experienced** hams before starting your project.
- Always **wear helmets** when doing tower work!
- Climbers should use **Fall Protection Systems**.
- If tower starts to fall, let go and get clear!

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.Towers must have a properly engineered support, both for the tower sections themselves as well as guy wire attachments. Sometimes towers are braced to buildings for added support. The Antenna Supports chapter of *The ARRL Antenna Book* covers this subject in greater detail. Towers are available commercially in both guyed and self-supporting styles, and constructed of both steel and aluminum materials. Masts may be wood or metal. One popular and inexpensive mast used to support small antennas is the tubular mast often sold for TV antenna use. These come in telescoping sections, in heights from 20 to 50 ft.

Aluminum extension ladders are sometimes used for temporary antenna supports, such as at Field Day sites. One problem with this approach is the difficulty in holding down the bottom section while "walking up" the ladder. Do *not* try to erect this type of support alone.

Trees are sometimes pressed into service for holding one end of a wire antenna. When using slingshots or arrows to string up the antenna, be sure no one is in range before you launch.

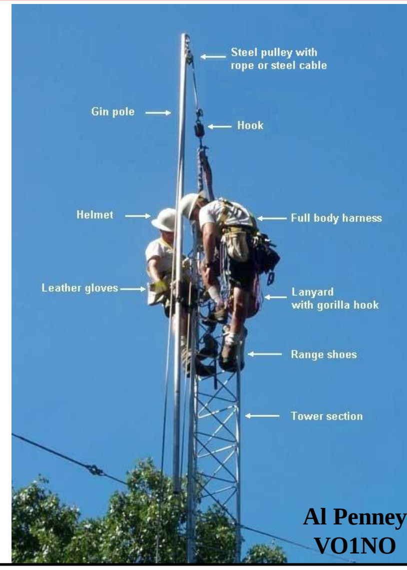
FACTORS TO CONSIDER WHEN SELECTING A TOWER

• Towers have design load limitations. Make very sure the tower you consider has the capacity to safely handle the antenna(s) you intend to install in the kind of environment that is applicable to your QTH.
• The antenna must be located in such a position that *it cannot possibly tangle with power lines, both during normal operation or if the structure should fall*.
• Sufficient yard space must be available to position a guyed tower properly. A rule of thumb is that the guy anchors should be between 60% and 80% of the tower height in distance from the base of the tower.
• Provisions must be made to keep children from climbing the support.
• Always write to the manufacturer of the tower before purchasing and ask for installation specifications, including guying data.
• Soil conditions at the tower site should be investigated. The footings need to be designed around actual soil conditions, particularly on a rocky site.

TOWER TIPS

• Beware of used towers. Have them professionally inspected and contact the manufacturer for installation criteria.
• Always follow manufacturer's instructions, using only parts that are designed for the model you have.
• Never rush into projects. Consult the most experienced amateurs in your community for assistance, especially if you are new to tower installation.
• Check with your local building officials.
• Liability may be increased with a tower installation. Check with your insurer to ensure your coverage is adequate.
• Consider your neighbors about any hazards your antennas may present to them.
• Don't let your installation become an "attractive nuisance." Take steps to install barriers so your tower cannot easily be climbed by others, particularly adventurous children.
• Use only the highest quality materials in your system.
• Make sure you have all the tools needed before starting. Some specialized tools (such as a gin pole) may be required.
• Never erect an antenna, tower or rotor during an electrical storm or rainstorm, or when lightning is a possibility.
• The assembly crew as well as those climbing the tower during erection must wear hard hats and use appropriate personal protective equipment including gloves, boots, climbing belt or harness. Don't forget that lifelines are needed when the belt is unattached from the tower while moving.
• Be careful not to over-stress the tower when it is being assembled. The tower manufacturer can offer suggestions that will avoid jeopardizing the tower.
• Install guy wires using the proper tools. Care should be exercised especially when handling loose, un-terminated, and sharp guy wire ends! Avoid wrapping guy wire around your hands to pull it into place, and instead use sufficient length to easily attach it to the anchors. Use tower-rated turnbuckles or similar devices to adjust tension evenly around the tower.
• Assign someone in the erection crew to monitor the use of safety equipment.
• After the tower is installed, keep the installation safe. Inspection and maintenance recommended by the tower's manufacturer should be carefully followed.
• If making attachments to houses or installations on roofs, have a qualified person determine that the method is adequate and the loading conditions are satisfactory.
• Avoid metal ladders if there are any utility lines in the vicinity. Assume that any line is energized — including cable television and telephone lines.

Fall Protection Systems



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Tower Work Preparation

- **Inspect** tower, guy wires, turnbuckles, all hardware.
- Turn **transmitters off** and **unplug** them.
- **Disconnect** the coax cable
- Ensure crank-up towers are all the way down.
- Inspect all **ropes and pulleys**.
- Inspect all **safety gear** – belts, harnesses, lanyards, fall arrest gear, connectors etc.

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Safety Gear

- Full body harness.
- Fall arrest equipment IAW applicable standards.
- Helmets for everyone.
- Safety boots – steel toe.
- Safety goggles.
- Work gloves.
- Sunscreen and insect repellent.
- Suspension Trauma can be deadly!

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Suspension trauma, also known as **harness hang syndrome** (**HHS**), **suspension syndrome**, or **orthostatic intolerance**, is an effect which occurs when the human body is held upright without any movement for a period of time. If the person is strapped into a harness or tied to an upright object they will eventually suffer the central ischaemic response (commonly known as fainting). Fainting while remaining vertical increases the risk of death from cerebral hypoxia. Since there is no evidence that these effects are specifically due to trauma, or caused by the harness itself, climbing medicine authorities have argued against the terminology of suspension trauma or harness hang syndrome and instead termed this simply "suspension syndrome".

People at risk of suspension trauma include people using industrial harnesses (fall arrest systems, abseiling systems, confined space systems), people using harnesses for sporting purposes (caving, climbing, parachuting, etc.), stunt performers, circus performers, and occupations that require the use of harnesses and suspension systems in general. Suspension shock can also occur in medical environments, for similar reasons.

In the UK the term "suspension trauma" has been replaced by "syncope" or "pre-syncope" as "trauma" suggests that there has been a physical injury that has resulted in the fallen person becoming unconscious. In the circumstances where a person has fallen into suspension on a rope/lanyard and has become unconscious, it is thought that the unconscious state "syncope" is due to a combination of orthostasis or motionless vertical suspension, with "pre-syncope" being the state before the person becomes unconscious where the fallen person may experience symptoms such as light-headedness; nausea; sensations of flushing; tingling or numbness of the arms or legs; anxiety; visual disturbance; or faintness. HSE Research Report RR708 2009 1 Introduction page 5 paragraphs 1 and 3 refers.

Cause

The most common cause is accidents in which the person remains motionless suspended in a harness for longer periods of time. Motionlessness may have several causes including fatigue, hypoglycemia, hypothermia or traumatic brain injury.

Symptoms

Onset of symptoms may be after just a few minutes, but usually occurs after at least 20 minutes of free hanging. Typical symptoms are pallor, sweating, shortness of breath, blurred vision, dizziness, nausea, hypotension and numbness of the legs. Eventually it leads to fainting, which may result in death due to oxygen deprivation of the brain.

Treatment

If someone is stranded in a harness, but is not unconscious or injured, and has something to kick against or stand on (such as a rock ledge or caving leg-loops) it is helpful for them to use their leg muscles by pushing against it every so often, to keep the blood pumping back to the torso. If the person is stranded in mid-air or is exhausted, then keeping the legs moving can be both beneficial and rather dangerous. On the one hand, exercising the leg muscles will keep the blood returning to the torso, but on the other hand, as the movements become weaker the leg muscles will continue to demand blood yet they will become much less effective at returning it to the body, and the moment the victim ceases moving their legs, the blood will immediately start to pool. "Pedaling an imaginary bicycle" should only be used as a last-ditch effort to prolong consciousness, because as soon as the "pedaling" stops, fainting will shortly follow. If it is impossible to rescue someone immediately, then it is necessary to raise their legs to a sitting position, which can be done with a loop of rigging tape behind the knees or specialized equipment from a rescue kit.

When workers are suspended in their safety harnesses for long periods, they may suffer from blood pooling in the lower body. This can lead to suspension trauma, although recent research shows that this may not always be the case. Once a worker is back on the ground after a fall has been arrested on a fall protection system, a worker should be placed in the “W” position. The “W” position is where a worker sits upright on the ground with their back/chest straight and their legs bent so that their knees are in line with the bottom of their chin. For added stability, make sure that the worker’s feet stay flat on the ground. In this position, a KED board can still be used if there are any potential spinal injuries and a worker needs stabilization before transport.

Previously, it was thought that once the worker is in this position, they will need to stay in that position for at least 30 minutes. Try to leave the worker in this position until their symptoms begin to subside. The time in the “W” position will allow the pooled blood from the legs to be slowly re-introduced back into the body. By slowing the rate at which the pooled blood reaches different organs, you are giving the body more of an opportunity to filter the pooled blood and maintain internal homeostasis.

Prevention

Prevention of suspension trauma is preferable to dealing with its consequences. Specific recommendations for individuals doing technical ropework are to avoid exhausting themselves so much that they end up without the energy to keep moving, and making sure everyone in a group is trained in single rope rescue techniques, especially the "single rope pickoff", a rather difficult technical maneuver that must be practiced frequently for smooth performance.

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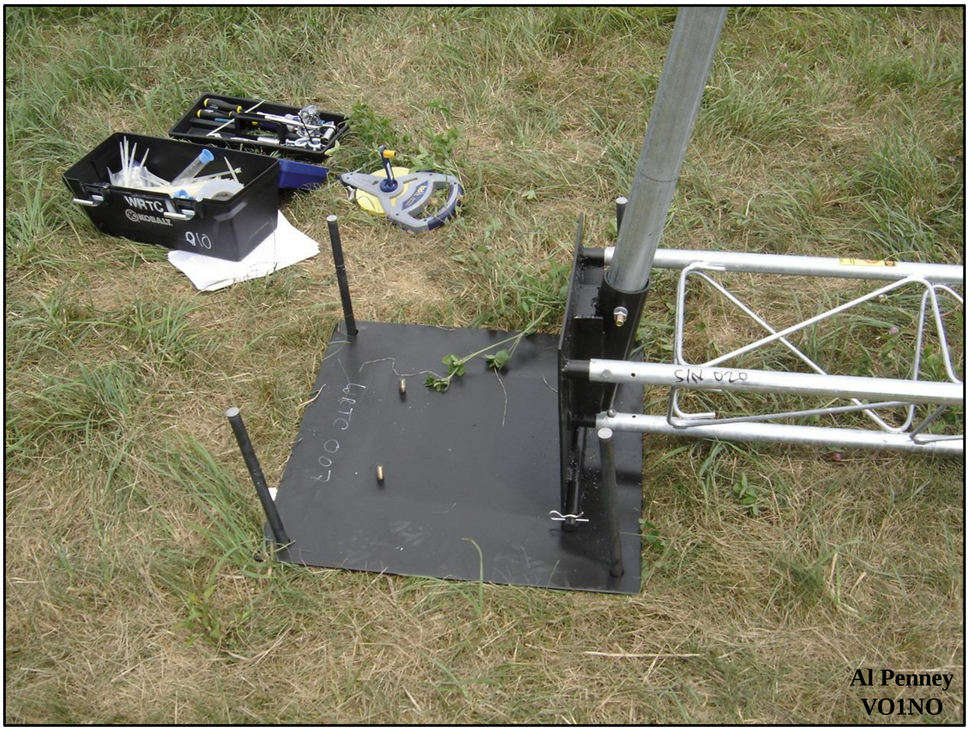
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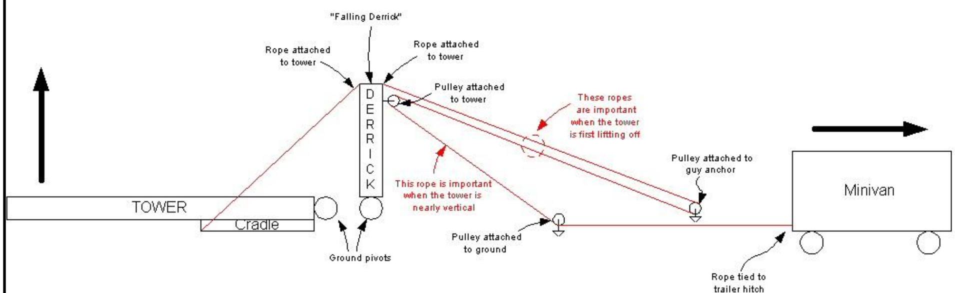
Falling Derrick

Pulley schematic for falling derrick method

N6RK, March 28, 2004



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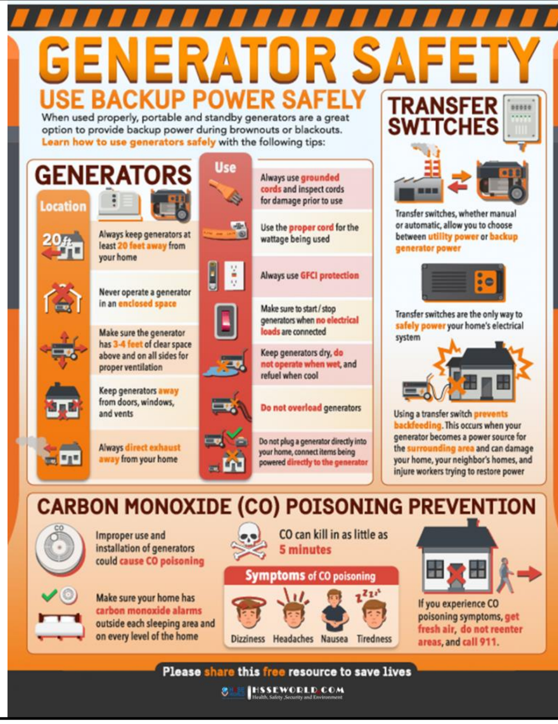

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Using a Generator at Home

The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire. Follow the directions supplied with the generator.

•To avoid electrocution, keep the generator dry and do not use in rain or wet conditions. Operate it on a dry surface under an open canopy-like structure, such as under a tarp held up on poles. Do not touch the generator with wet hands.

•Be sure to turn the generator off and let it cool down before refueling. Gasoline spilled on hot engine parts could ignite.

•Store fuel for the generator in an approved safety can. Use the type of fuel recommended in the instructions or on the label on the generator.

Local laws may restrict the amount of fuel you may store, or the storage location. Ask your local fire department.

Store the fuel outside of living areas in a locked shed or other protected area. To guard against accidental fire, do not store it near a fuel-burning appliance, such as a natural gas water heater in a garage.

•Plug appliances directly into the generator, or use a heavy duty, outdoor-rated extension cord that is rated (in watts or amps) at least equal to the sum of the connected appliance loads.

Check that the entire cord is free of cuts or tears and that the plug has all three prongs, especially a grounding pin.

•Never try to power the house wiring by plugging the generator into a wall outlet. Known as "backfeeding," this practice puts utility workers, your neighbors and your household at risk of electrocution.

•Remember, even a properly connected portable generator can become overloaded, resulting in overheating or generator failure. Be sure to read the instructions.

•If necessary, stagger the operating times for various equipment to prevent overloads.

How to Prevent Carbon Monoxide (CO) Poisoning When Using a Generator

•Never use a generator, grill, camp stove or other gasoline, propane, natural gas or charcoal-burning devices inside a home, garage, basement, crawlspace or any partially enclosed area.

•Keep these devices outdoors, away from doors, windows and vents that could allow carbon monoxide to come indoors.

•Opening doors and windows or using fans will not prevent CO buildup in the home. Although CO can't be seen or smelled, it can rapidly lead to full incapacitation and death. Even if you cannot smell exhaust fumes, you may still be exposed to CO. If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY - DO NOT DELAY.

•Install CO alarms in central locations on every level of your home and outside sleeping areas to provide early warning of accumulating carbon monoxide.

Test the batteries frequently and replace when needed.

•If the carbon monoxide alarm sounds, move quickly to a fresh air location outdoors or by an open window or door.

Call for help from the fresh air location and remain there until emergency personnel arrive to assist you.

Double Male Plug

- Used to backfeed a home's electrical system from a generator.

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Double Male Plug

- Used to backfeed a home’s electrical system from a generator.

BAD IDEA!

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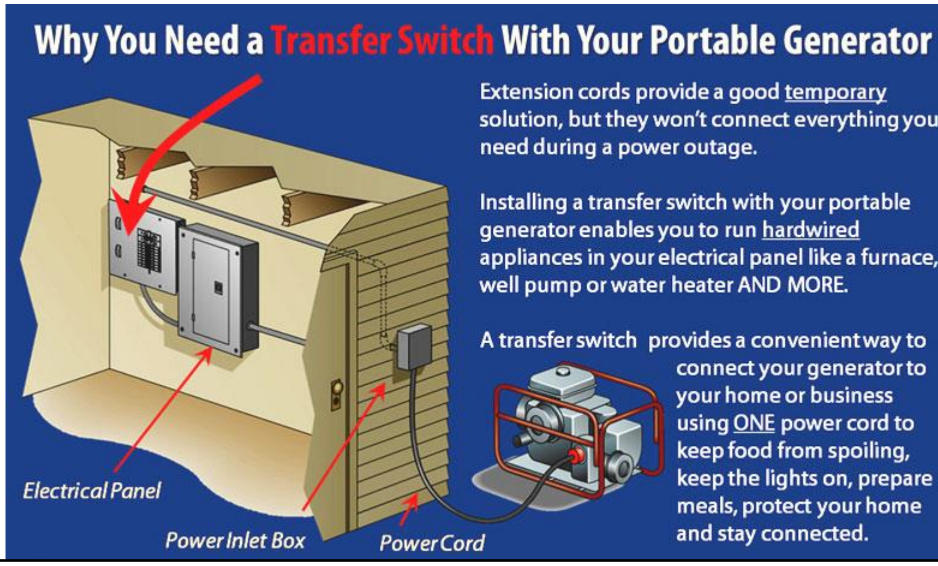
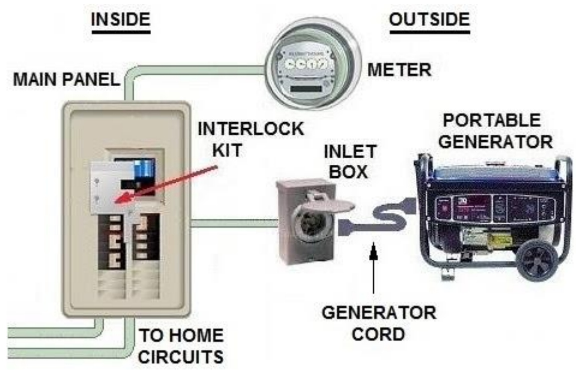
•
Don't attempt to backfeed your house
•Backfeeding means trying to power your home's wiring by plugging the generator into a wall outlet.
•This reckless and dangerous practice presents an electrocution risk to utility workers and neighbors served by the same utility transformer.
•It also bypasses some of the built-in household circuit protection devices, so you could end up frying some of your electronics or starting an electrical fire.
•Install a transfer switch before the next storm
•This critical connection will cost from $500 to $900 with labor for a 5,000-rated-watt or larger generator.
•A transfer switch connects the generator to your circuit panel and lets you power hardwired appliances while avoiding the glaring safety risk of using extension cords.
•Most transfer switches also help you avoid overload by displaying wattage usage levels.
•Never run a generator in an enclosed space, in partly enclosed areas like a garage, or indoors. This can lead to Carbon Monoxide Poisoning.
•If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY – DO NOT DELAY. Carbon Monoxide can kill you in minutes.
•Install CO alarms in central locations on every level of your home and outside sleeping areas to provide early warning of accumulating carbon monoxide.
•Test the batteries frequently and replace when needed.
•Use outdoors and far from windows, doors, vents, crawl spaces and in an area where adequate ventilation is available and will not accumulate deadly exhaust gas.
•Using a fan or opening doors and windows will not provide sufficient ventilation.
•Don't run a portable generator in the rain. Keep the generator dry.
•Start your generator at least once a month and let it run for a few minutes. If yours has a battery, trickle charge the battery from time to time to ensure it is ready to go.
•Before refueling, turn off a gasoline-powered generator and let it cool. Otherwise the gasoline can spill and potentially ignite from the heat.
•Stock up on extra gasoline and store it properly. Never store gasoline containers next to flame producing and heat generating devices.
•Avoid electrical hazards
•If you don't yet have a transfer switch, you can use the outlets on the generator if you follow certain precautions.
•It's best to plug in appliances directly to the generator.
•If you must use an extension cord, it should be a heavy-duty one for outdoor use, rated (in watts or amps) at least equal to the sum of the connected appliance loads.
•First check that the entire cord is free of cuts and that the plug has all three prongs, critical to protect against a shock if water has collected inside the equipment.
•How to Properly Size a Generator
•Add up the power requirements of the appliances and devices you will want to use. Check the back and sides of each appliance or device power supply for a label or nameplate that would document the wattage of the device.
•Add up the wattage of all the lightbulbs you will want to use
•Find the total amps you need by dividing the total calculated watts by your house voltage (which is typically 120 Volts).
•Choose a generator that produces more amps than you need because some machines draw up to 3 times as much power when starting up, and others lose efficiency over time.

Generator Transfer Switch



Generator Transfer Switch



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Generator Transfer Switch

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Globally, there are **approximately 40 to 50 flashes of lightning every second**, or nearly one and a half billion annually. Not only is the amount of strikes alarming, but **each strike can have between 100 million and 1 billion volts** and consumes billions of watts.

Such voltage and frequency cause irreparable personal injury and property damage, as well as unexpected equipment downtime, costly replacements and breaks in the production schedule. Lightning strikes may never be part of the schedule, but creating a defense for your facility with a lightning protection system should be.

Conduct the Lightning Current to Earth

The components required to do this are known as down conductors, which provide the interconnection of the air terminations to the earth-termination system. They generally follow the profile of the structure, without being positioned where safety to individuals could be compromised.

Down conductors should provide multiple parallel paths for the discharge of energy from the lightning to the ground. Doing so lowers the risk of current density, thus reducing the risk of side flashing. This also reduces electromagnetic radiation effects of the impulse current at points inside the structure.

In general, a down conductor system should:

•Provide multiple paths for lightning current.

•Be as short and straight as practical.

•Be spaced and use equipotential bonding rings.

•Be a direct continuation of the air-termination system.

•Not be installed in gutters or down spouts (even if PVC covered).

•Connect via a test joint to the earth termination network.

•Be fitted with external protection to reduce exposure to accidental damage or vandalism.

•Be fitted with three-millimeter, cross-linked polyethylene insulation where there is risk of danger due to touch potential.

Detailed requirements exist for type, spacing and more for various buildings, which can be found in the **ERICO Lightning Protection Handbook**.

Dissipate Current into the Earth

The reliable performance of the entire lightning protection system is dependent upon an effective earthing or grounding system.

Consideration for earthing systems must be given to:

•**Providing a low impedance network** to dissipate the fast-rising lightning impulse.

•Minimizing potential of touch and step hazards.

•Long-term performance of the system – i.e. quality of materials and connections.

Grounding systems can be comprised of:

•**Ground rods**

•Perimeter (ring) bare wire

•Radials

•**Ground plates**

•Concrete (rebar)

• Create an Equipotential Bond

Equipotential bonding is required to eliminate voltage gradients, which reduces the possibility of electric shock or electrical equipment fault.

Each product, from the air termination system to the conductors to the grounding system, must work in tandem to effectively transfer discharge from interception to dissipation—without posing risks to people or the building.

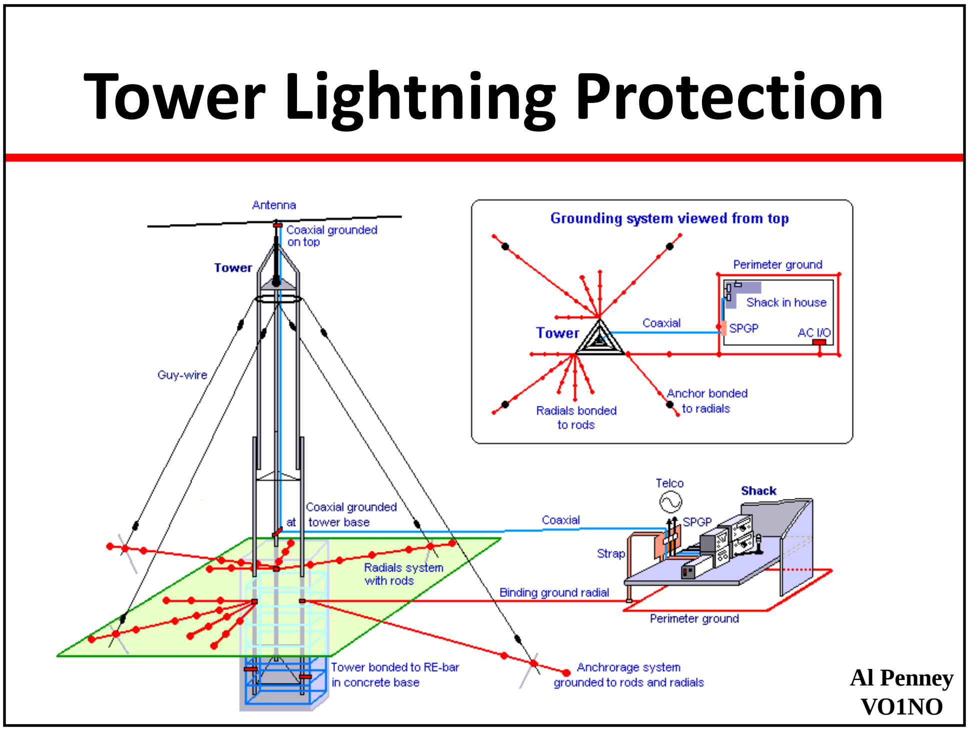
In achieving overall effectiveness, the lightning protection system must:

•Reduce thermal or mechanical damage to the structure.

•Avoid sparking, which may cause fire or explosion.

•Limit step and touch voltages to control the risk of injury to occupants.

•Avoid damage to internal electrical and electronic systems.



Tower and Antennas

Because a tower is usually the highest metal object on the property, it is the most likely strike target. Proper tower grounding is essential to lightning protection. The

goal is to establish short multiple paths to the Earth so that the strike energy is divided and dissipated.

Connect each tower leg and each fan of metal guy wires to a separate ground rod. Space rods at least 6 ft apart. Bond the leg ground rods together with a #6 AWG or

larger copper bonding conductor. Connect a continuous bonding conductor between the tower ring ground and the

entrance panel. Make all connections with fittings approved for grounding applications. ***Do not use solder for these connections.*** Solder will be destroyed in the heat

of a lightning strike.

Unless the tower is also a shunt-fed antenna, use grounded metal guys. For crank-up or telescoping towers, connect the sections with strap jumpers. Because

galvanized steel (which has a zinc coating) reacts with copper when combined with moisture, use stainless steel hardware between the galvanized metal and the

copper grounding materials.

To prevent strike energy from entering a shack via the feed line, ground the feed line *outside* the home. Ground the coax shield *to the tower* at the antenna and the

base to keep the tower and line at the same potential. Several companies offer grounding blocks that make this job easy.

All grounding media at the home must be bonded together. This includes lightning- protection conductors, electrical service,

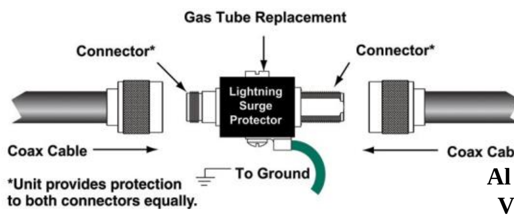
telephone, antenna system grounds and underground metal pipes. Any ground rods used for lightning protection or entrance-

panel grounding must be spaced at least 6 ft from each other and the electrical service or other utility grounds and then

bonded to the ac system ground as required by the *NEC*.

Radio Entrance Panel

- Use a **grounded panel** to bring coax and control lines into shack.
- **Lightning Arresters outside** & **close to ground**.
- **Surge suppressors** for control lines.



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A Radio Entrance Panel

We want to control the flow of the energy in a strike. Eliminate any possible paths for surges to enter the building. This involves routing the feed lines, rotator control cables,

and so on at least 6 ft away from other nearby grounded metal objects.

Every conductor that enters the structure should have its own surge suppressor including antenna system control lines at the Radio Entrance Panel and other services

where they connect to the ac system ground. They are available from a number of manufacturers, including ICE and PolyPhaser.

Both balanced line and coax arrestors should be mounted to a secure ground connection on the *outside* of the building. The easiest way to do this is to install a

large metal enclosure as a bulkhead and ground block. This bulkhead serves as the last line of lightning defense, so it's critical that it be installed properly. You can

home-brew a bulkhead panel from 1/8-inch copper sheet, bent into a box shape. Position the bulkhead on the building exterior, 4 to 6 inches (minimum) away from nearby

combustible materials. Install a separate ground rod for this panel and connect it to the bulkhead with a short, direct connection. Bond this ground rod to the rest

of the ground system. Mount all protective devices, switches and relay disconnects on the outside face wall of the bulkhead.

Lightning Arrestors

Feed line lightning arrestors are available for both coax cable and balanced line. Most of the balanced line arrestors use a simple spark gap arrangement, but a balanced

line *impulse* suppresser is available from Industrial Communication Engineers, Ltd (ICE), Indianapolis, IN.

Coaxial Cable Arrestors — DC blocking arrestors have a fixed frequency range. They present a high-impedance to lightning (less than 1 MHz) while offering a

low impedance to RF. DC continuity arrestors (gas tubes and spark gaps) can be used over a wider frequency range than those that block dc.

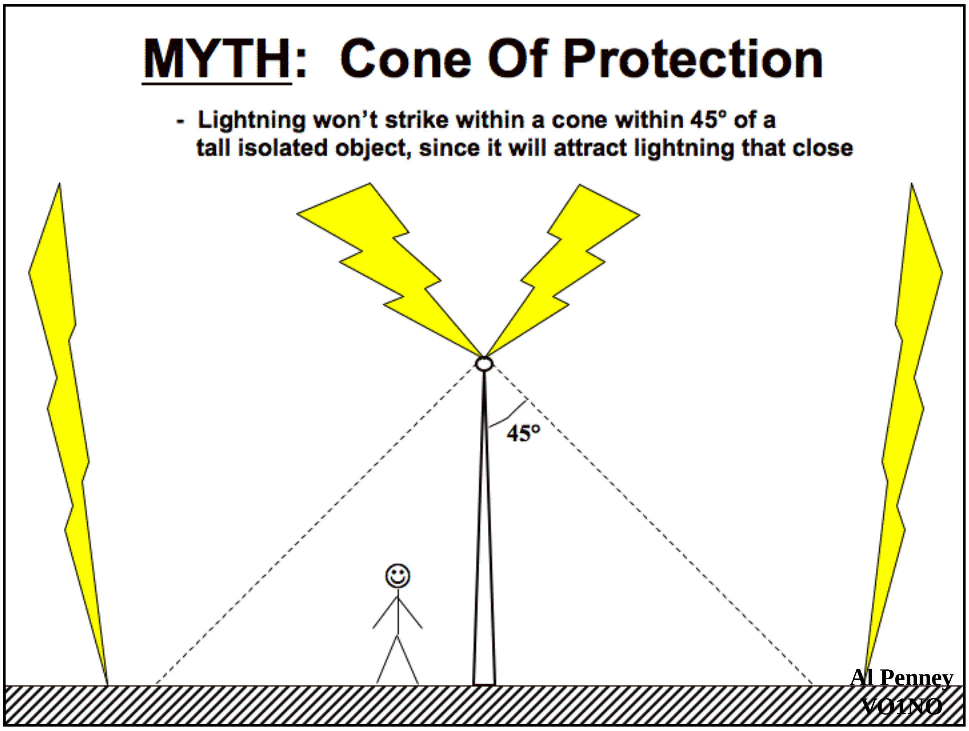
Where the coax carries supply voltages to remote devices (such as a mast-mounted preamp or remote coax switch), dc-continuous arrestors *must* be used.

Lightning Protection

- Commercial grade systems can absorb direct lightning strikes without equipment damage.
- Amateurs can rarely afford such systems.
- Best bet – **disconnect** all antennas, control lines telephone lines etc. **except ground**.
- **Unplug** equipment.
- **NEVER** operate during an electrical storm!
- Complicated topic – consult the experts!

Al Penney
VO1NO

http://www.arrl.org/files/file/QST/This%20Month%20in%20QST/June2017/Chusid-Morgan.pdf



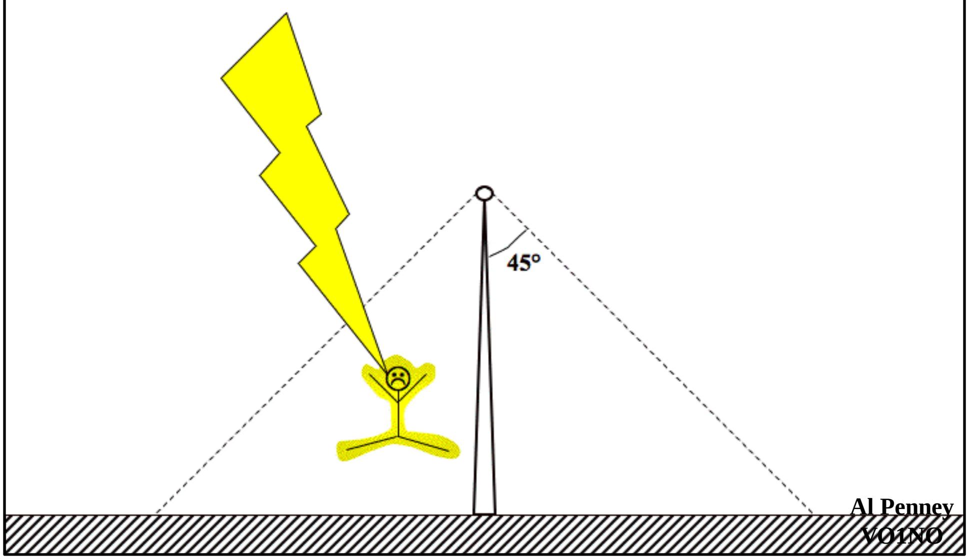
Some general comments about lightning. It has its own agenda. It is entirely capricious, random, and unpredictable. Man's attempts to fit lightning into a convenient box, with Codes and Standards to describe its behavior, are a best guess. The system of conventional lightning rods as commonly employed does represent the best method for providing a preferred pathway to ground.

Second, lightning safety for group or large scale outdoor events is very difficult - maybe impossible - to accomplish. Injuries at a June 1998 rock concert at RFK stadium in Baltimore are a good example. Some 35,000 people were there. Lightning rods were there. Still, some 13 people were badly injured by incoming lightning. In July 1998 in Las Vegas NV, five firefighters were injured when lightning struck their fire truck. At a soccer match in the Republic of the Congo (October 1998) 11 members of the team were killed by lightning.

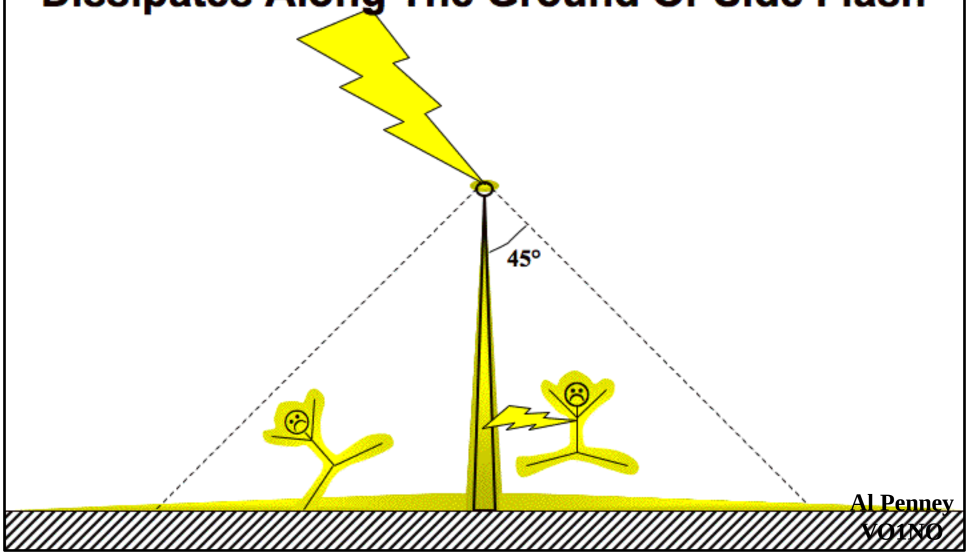
Third, the myths about lightning persist: LIGHTNING NEVER STRIKES TWICE (it hits the Empire State Building about 25 times a year.) RUBBER TIRES WILL INSULATE ME FROM LIGHTNING (it has traveled miles through space…a few inches of rubber mean nothing at all.) LIGHTNING CAN BE PREVENTED (unconfirmed/sheer advertising.) FIRST STRIKES FROM LIGHTNING CAN BE PREDICTED (unconfirmed/sheer advertising.) NEW HIGH-TECH TYPES OF LIGHTNING RODS CAN CONTROL LIGHTNING (unconfirmed/sheer advertising.)

So how to achieve lightning safety? It is a personal decision. Your decision. At the first sign of lightning or thunder, seek shelter. Good shelters are substantial buildings or fully enclosed metal vehicles. We suggest you remain in shelter for 30 minutes after the last observed thunder or lightning. "If you can hear it, clear it. If you can see it, flee it."

REALITY: Lightning Can Easily Strike Inside The So-Called "Cone Of Protection"



REALITY (continued): **Even If Lightning Strikes The Object, You're Still In Danger As It Dissipates Along The Ground Or Side Flash**



Each year lightning kills approximately 10 Canadians and injures approximately 100 to 150 others. So, how do you keep yourself and your family safe when lightning strikes? Read the tips and information below and stay safe!

The first and most important thing to remember is that if you can hear thunder, you are within striking distance of lightning. Take shelter immediately, preferably in a house or all-metal automobile (not convertible top). If caught outside far from a safe shelter, stay away from tall objects, such as trees, poles, wires and fences. Take shelter in a low lying area.

Once indoors, stay away from electrical appliances and equipment, doors, windows, fireplaces, and anything else that will conduct electricity, such as sinks, tubs and showers. Avoid using a telephone that is connected to a landline or touching devices that are plugged in for charging.

If you are in your car during lightning, do not park under tall objects that could topple, and do not get out if there are downed power lines nearby. If you are caught outside, don't stand near tall objects or anything made of metal, and avoid open water.

If caught on the water in a small boat with no cabin during thunder and lightning, quickly get to shore. Boats with cabins offer a safer environment, but it's still not ideal.

Remember, there is no safe place outdoors during a thunderstorm. Once in a safe location, remain there for 30 minutes after the last rumble of thunder is heard before resuming your outdoor activities.

People who have been struck by lightning do not carry an electrical charge and can be safely handled, but victims may be suffering from burns or shock and should receive medical attention immediately. If you come across someone who has been struck, call for medical assistance immediately and, if breathing has stopped, administer mouth-to-mouth or cardio-pulmonary resuscitation (CPR).

Additional precautions to take during a lightning storm

If caught outdoors:

•**Avoid putting yourself above the surrounding landscape.** Seek shelter in low-lying areas such as valleys, ditches and depressions but be aware of flooding.

•**Stay away from water.** Don't go boating or swimming if a storm threatens, and get to land as quickly as possible if you are already on the water. Lightning can strike the water and travel a substantial distance from its point of contact.

•**Stay away from objects that conduct electricity**, such as tractors, golf carts, golf clubs, metal fences, motorcycles, lawnmowers and bicycles.

•**Avoid being the highest point in an open area.** Swinging a golf club, or holding an umbrella or fishing rod can make you the tallest object and a target for lightning.

•**You are safe inside a car during lightning**, but be aware of downed power lines which may be touching your car. You are safe inside the car, but you may receive a shock if you step outside.

•**In a forest**, seek shelter in a low-lying area under a thick growth of small trees or bushes.

•**Keep alert for flash floods**, sometimes caused by heavy rainfall, if seeking shelter in a ditch or low-lying area.

Indoor Precautions:

•**Before the storm hits**, disconnect electrical appliances including computers, radios and television sets. Do not touch them during the storm.

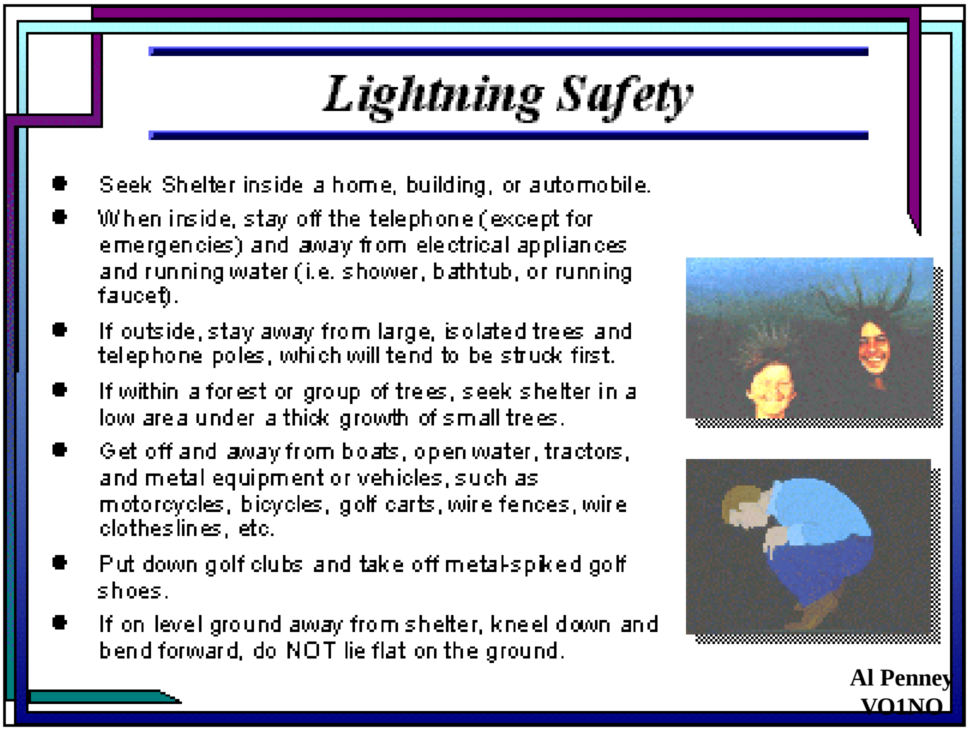
•**Don't go outside unless absolutely necessary.**

•**Keep as many walls as possible between you and the outside.** Stay away from windows.

•**Use battery operated or cordless devices only.** The electrical current from the lightning strike will travel through wires and cords using the path of least resistance. Electrical current will follow metal pipes and wires until it reaches the ground (or you, if you are connected through them).

•**Working on a plugged in computer, or holding a phone or other devices when they're charging are unsafe practices that should be avoided during lightning storms.** Cordless telephones are safe; however you could hear a very loud noise on the phone. This would be consistent with your house or somewhere nearby being struck by lightning.

•**Delay taking a shower, doing laundry, or washing the dishes by hand during a thunderstorm** because water is an electrical conductor. If lightning strikes your house or nearby, the lightning charge may travel through the pipes and you could be hurt.



When thunder roars, go indoors!

Every year in Canada, lightning can cause as many as 10 deaths and 164 injuries. You can avoid a tragedy like this by taking a few simple precautions.

If you can hear thunder, you can get hit by lightning. Take shelter immediately. If you cannot find a sturdy, fully enclosed building with wiring and plumbing, get into a metal-roofed vehicle. Stay inside for 30 minutes after the last rumble of thunder.

Direct strikes are responsible for only 5% of lightning-related deaths and injuries. Two other types of hazardous phenomena are caused by lightning. Ground current and side flash account for 60 to 80% of lightning-related injuries and deaths. A ground current is set up when lightning hits the ground, spreads out and sends a current through a victim. Side flash occurs when lightning hits a tall object, travels partly down the object and then jumps to a nearby victim.

Avoid the threat of lightning

- **To plan for a safe day, check the weather forecast first.** If thunderstorms are forecast, avoid being outdoors at that time or make an alternate plan. Identify safe places and determine how long it will take you to reach them.
- **Watch the skies for developing thunderstorms and listen for thunder.** As soon as you hear thunder, quickly get to a safe location. If you can hear thunder, you are in danger of being hit by lightning. More people are struck before and after a thunderstorm than during one.
- **Get to a safe place.** A safe location is a fully enclosed building with wiring and plumbing. Sheds, picnic shelters, tents or covered porches do NOT protect you from lightning. If no sturdy building is close by, get into a metal-roofed vehicle and close all the windows.
- **Do not handle electrical equipment, telephones or plumbing.** These are all electrical conductors. Using a computer or wired video game system, taking a bath or touching a metal window frame all put you at risk of being struck by lightning. Use battery-operated appliances only.
- **If on water, get to shore as quickly as possible.** The high waves and strong gusts of wind associated with sudden fast-moving storms can make it difficult for swimmers, boaters and water skiers to reach shore safely. Lightning that hits water travels well beyond its point of contact. Small boats with no cabin provide less protection than boats with enclosed cabins.
- **If caught outdoors far from shelter, stay away from tall objects.** This includes trees, poles, wires and fences. Take shelter in a low-lying area but be on the alert for possible flooding.

Outdoor events

It is impossible to issue accurate local forecasts months in advance. Since summer storms can develop quickly, you should have a weather safety plan ready for any large gathering. In your plan, you should

- adopt an emergency alerting strategy;
- schedule activities at times less likely to experience thunderstorms, such as the morning; and
- ensure participants know the location of a safe place that is close enough for them to reach quickly.

On the day of the activity

- Have a knowledgeable person monitor the weather, forecasts and warnings;
- be prepared to cancel or delay the event well before any storm threatens;
- inform organizers and volunteers of emergency plans; and
- do not resume outdoor activities until at least 30 minutes after the last rumble of thunder is heard.

First aid for lightning victims

- **Lightning victims do not carry an electrical charge and can be safely handled.**
- **Call for help.** Victims may be suffering from burns or shock and should receive medical attention immediately. Call 9-1-1 or your local ambulance service.
- **Give first aid.** If breathing has stopped, administer cardio-pulmonary resuscitation (CPR). Use an automatic external defibrillator if one is available.

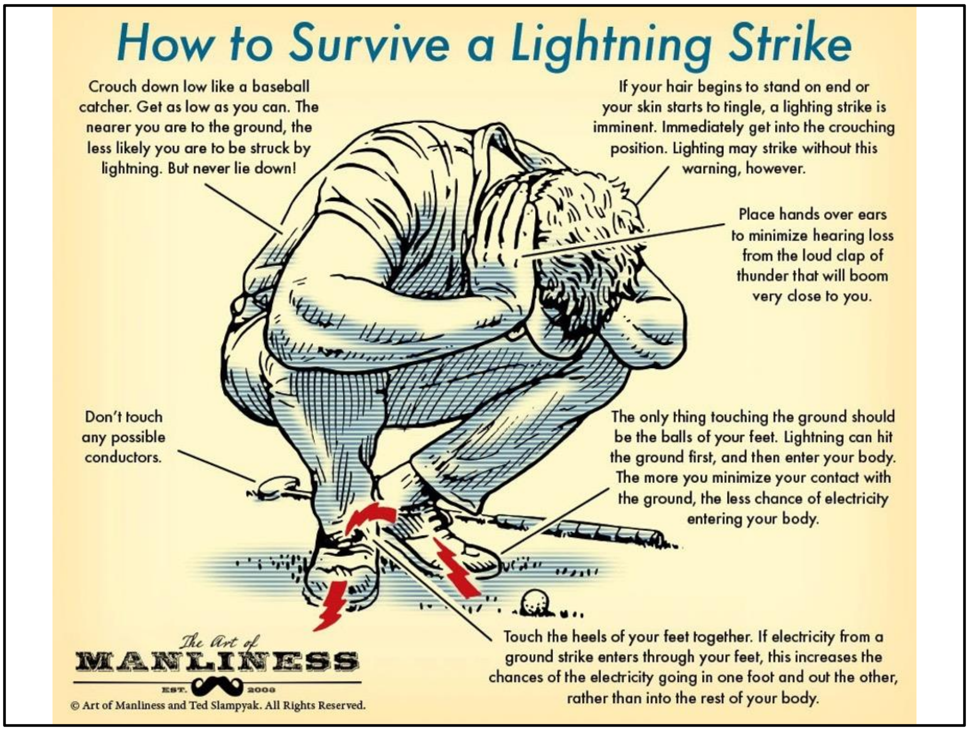
Stay informed: follow the most recent forecasts

Canada receives over two million lightning strikes a year on average. Many lightning deaths and injuries are associated with smaller local storms. It takes only one lightning bolt to change your life.

Environment Canada's Meteorological Service of Canada issues severe thunderstorm watches and warnings for storms that can produce damaging winds, heavy rain and hail. The service does NOT specifically warn for lightning. Watch the skies for threatening clouds and listen for thunder. Stay up to date with the latest weather forecasts and warnings by monitoring your favourite broadcast outlet, Weatheradio, or a hand-held mobile device.

Remember: in a thunderstorm, no place outdoors is safe. When thunder roars, go indoors!

For more information on lightning, visit Environment and Climate Change Canada's Lightning in Canada website.


How to Survive a Lightning Strike
Crouch down low like a baseball catcher. Get as low as you can. The nearer you are to the ground, the less likely you are to be struck by lightning. But never lie down!
If your hair begins to stand on end or your skin starts to tingle, a lighting strike is imminent. Immediately get into the crouching position. Lighting may strike without this warning, however.
Place hands over ears to minimize hearing loss from the loud clap of thunder that will boom very close to you.
Don't touch any possible conductors.
The only thing touching the ground should be the balls of your feet. Lightning can hit the ground first, and then enter your body. The more you minimize your contact with the ground, the less chance of electricity entering your body.
Touch the heels of your feet together. If electricity from a ground strike enters through your feet, this increases the chances of the electricity going in one foot and out the other, rather than into the rest of your body.
The Art of MANLINESS EST. 2008
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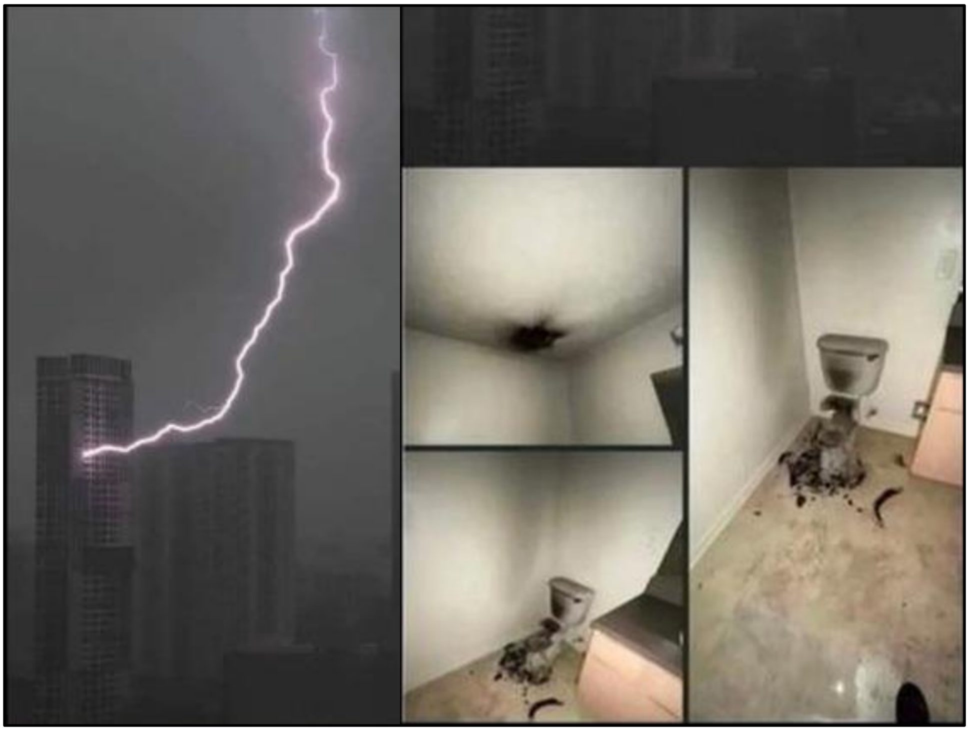
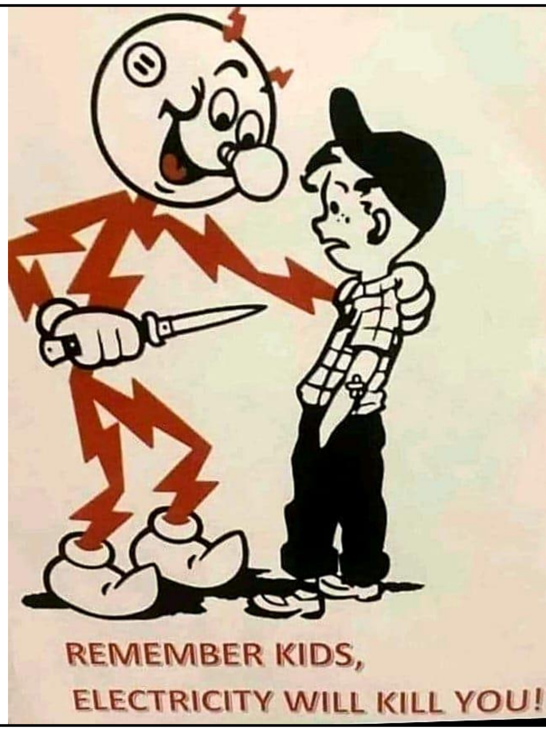
The 30-30 RULE
FARMERS' ALMANAC Since 1818
According to the National Weather Service, use a "30-30 rule" to determine how safe you are from a thunderstorm. Stand where visibility is good and nothing is obstructing your view of the storm. When you see the lightning, count the time until you hear thunder. If that time is 30 seconds or less, the thunderstorm is within 6 miles of you and is dangerous.
It is also recommended that you wait at least 30 minutes after a thunderstorm ends before returning to the outdoors, as the threat of lightning can continue after a storm subsides.
FarmersAlmanac.com
#FollowTheRooster




Questions?


REMEMBER KIDS,
ELECTRICITY WILL KILL YOU!

For Next Class:

- Review Chapter 16 of Basic Study Guide;
- Review ISED Regulations:
  - RIC-1
  - RIC-9
  - RBR-4
  - Radiocommunication Regulations
  - EMCAB-2
  - Go through the Question Bank.
- The end of the course is approaching!

Al Penney
VO1NO

Review Question 1

What is the purpose of the Safety Code 6?

- It gives RF exposure limits for the human body
- It lists all RF frequency allocations for interference protection
- It sets transmitter power limits for interference protection
- It sets antenna height limits for aircraft protection

Al Penney
VO1NO

Review Question 1

What is the purpose of the Safety Code 6?

• It gives RF exposure limits for the human body

• It lists all RF frequency allocations for interference protection

• It sets transmitter power limits for interference protection

• It sets antenna height limits for aircraft protection

< It gives RF exposure limits for the human body >

Al Penney
VO1NO

Review Question 2

According to Safety Code 6, what frequencies cause us the greatest risk from RF energy?

- 3 to 30 MHz
- 30 to 300 MHz
- 300 to 3000 MHz
- Above 1500 MHz

Al Penney
VO1NO

Review Question 2

According to Safety Code 6, what frequencies cause us the greatest risk from RF energy?

- 3 to 30 MHz
- 30 to 300 MHz
- 300 to 3000 MHz
- Above 1500 MHz

< 30 to 300 MHz >

Al Penney
VO1NO

Review Question 3

Why is the limit of exposure to RF the lowest in the frequency range of 30 MHz to 300 MHz, according to Safety Code 6?

- Most transmissions in this range are for a longer time
- The human body absorbs RF energy the most in this range
- There are more transmitters operating in this range
- There are fewer transmitters operating in this range

Al Penney
VO1NO

Review Question 3

Why is the limit of exposure to RF the lowest in the frequency range of 30 MHz to 300 MHz, according to Safety Code 6?

- Most transmissions in this range are for a longer time
- The human body absorbs RF energy the most in this range
- There are more transmitters operating in this range
- There are fewer transmitters operating in this range

< The human body absorbs RF energy the most in this range >

Al Penney
VO1NO

Review Question 4

According to Safety Code 6, what is the maximum safe power output to the antenna of a handheld VHF or UHF radio?

- 25 watts
- 125 milliwatts
- not specified
- 10 watts

Al Penney
VO1NO

Review Question 4

According to Safety Code 6, what is the maximum safe power output to the antenna of a handheld VHF or UHF radio?

- 25 watts
- 125 milliwatts
- not specified
- 10 watts

< not specified >

The exemption for portable equipment was withdrawn in 1999.

Al Penney
VO1NO

Review Question 5

Which of the following statements is NOT correct?

• Maximum exposure levels of RF fields to the general population, in the frequency range 10 to 300 MHz, is 28 V/m RMS (E-field)

• Permissible exposure levels of RF fields increases as frequency is increased from 300 MHz to 1.5 GHz

• Permissible exposure levels of RF fields increases as frequency is decreased from 10 MHz to 1 MHz

• Permissible exposure levels of RF fields decreases as frequency is decreased below 10 MHz

Al Penney
VO1NO

Review Question 5

Which of the following statements is NOT correct?

• Maximum exposure levels of RF fields to the general population, in the frequency range 10 to 300 MHz, is 28 V/m RMS (E-field)

• Permissible exposure levels of RF fields increases as frequency is increased from 300 MHz to 1.5 GHz

• Permissible exposure levels of RF fields increases as frequency is decreased from 10 MHz to 1 MHz

• Permissible exposure levels of RF fields decreases as frequency is decreased below 10 MHz

< Permissible exposure levels of RF fields decreases as frequency is decreased below 10 MHz >

Al Penney
VO1NO

Review Question 6

The permissible exposure levels of RF fields:

• decreases, as frequency is decreased below 10 MHz

• increases, as frequency is increased from 10 MHz to 300 MHz

• decreases, as frequency is increased above 300 MHz

• increases, as frequency is increased from 300 MHz to 1.5 GHz

Al Penney
VO1NO

Review Question 6

The permissible exposure levels of RF fields:

• decreases, as frequency is decreased below 10 MHz

• increases, as frequency is increased from 10 MHz to 300 MHz

• decreases, as frequency is increased above 300 MHz

• increases, as frequency is increased from 300 MHz to 1.5 GHz

< increases, as frequency is increased from 300 MHz to 1.5 Ghz >

Al Penney
VO1NO

Review Question 7

Which statement is NOT correct?

• Hand held transmitters are excluded from Safety Code 6 requirements

• Antenna gain, distance, transmitter power and frequency are all factors that influence the electric field strength and a person's exposure to radio energy

• Safety Code 6 uses different units for the magnetic field strength and the electric field strength when stating limits

• Safety Code 6 specifies lower exposure limits for the general public in uncontrolled areas than it does for people in controlled areas

Al Penney
VO1NO

Review Question 7

Which statement is NOT correct?

• Hand held transmitters are excluded from Safety Code 6 requirements

• Antenna gain, distance, transmitter power and frequency are all factors that influence the electric field strength and a person’s exposure to radio energy

• Safety Code 6 uses different units for the magnetic field strength and the electric field strength when stating limits

• Safety Code 6 specifies lower exposure limits for the general public in uncontrolled areas than it does for people in controlled areas

< Hand held transmitters are excluded from Safety Code 6 requirements >

Al Penney
VO1NO

Review Question 8

Which statement is correct?

• Portable transmitters, operating below 1 GHz, with an output power equal to, or less than 7 watts, are exempt from the requirements of Safety Code 6

• Safety Code 6 sets limits for RF exposure for all radio transmitters regardless of power output

• Safety Code 6 regulates the operation of receivers only

• The operation of portable transmitting equipment is of no concern in Safety Code 6

Al Penney
VO1NO

Review Question 8

Which statement is correct?

• Portable transmitters, operating below 1 GHz, with an output power equal to, or less than 7 watts, are exempt from the requirements of Safety Code 6

• Safety Code 6 sets limits for RF exposure for all radio transmitters regardless of power output

• Safety Code 6 regulates the operation of receivers only

• The operation of portable transmitting equipment is of no concern in Safety Code 6

< Safety Code 6 sets limits for RF exposure for all radio transmitters regardless of power output >

Al Penney
VO1NO

Review Question 9

Which of these statements about Safety Code 6 is FALSE?

- Safety Code 6 sets limits for induced currents, electrical field strength and magnetic field strength from electromagnetic radiation
- Safety Code 6 set limits for allowable rates at which RF energy is absorbed in the body (Specific Absorption Rate)
- Safety Code 6 sets limits in terms of power levels fed into antennas
- Safety Code 6 sets limits for contact currents that could be drawn from ungrounded or poorly grounded objects

Al Penney
VO1NO

Review Question 9

Which of these statements about Safety Code 6 is FALSE?

• Safety Code 6 sets limits for induced currents, electrical field strength and magnetic field strength from electromagnetic radiation

• Safety Code 6 set limits for allowable rates at which RF energy is absorbed in the body (Specific Absorption Rate)

• Safety Code 6 sets limits in terms of power levels fed into antennas

• Safety Code 6 sets limits for contact currents that could be drawn from ungrounded or poorly grounded objects

< Safety Code 6 sets limits in terms of power levels fed into antennas >

Al Penney
VO1NO

Review Question 10

Why would there be a switch in a high-voltage power supply to turn off the power if its cabinet is opened?

• To keep dangerous RF radiation from leaking out through an open cabinet

• To keep dangerous RF radiation from coming in through an open cabinet

• To turn the power supply off when it is not being used

• To keep anyone opening the cabinet from getting shocked by dangerous high voltages

Al Penney
VO1NO

Review Question 10

Why would there be a switch in a high-voltage power supply to turn off the power if its cabinet is opened?

• To keep dangerous RF radiation from leaking out through an open cabinet

• To keep dangerous RF radiation from coming in through an open cabinet

• To turn the power supply off when it is not being used

• To keep anyone opening the cabinet from getting shocked by dangerous high voltages

< To keep anyone opening the cabinet from getting shocked by dangerous high voltages >

Al Penney
VO1NO

Review Question 11

How little electrical current flowing through the human body can be fatal?

- More than 20 amperes
- Current flow through the human body is never fatal
- As little as 20 milliamperes
- Approximately 10 amperes

Al Penney
VO1NO

Review Question 11

How little electrical current flowing through the human body can be fatal?

- More than 20 amperes
- Current flow through the human body is never fatal
- As little as 20 milliamperes
- Approximately 10 amperes

< As little as 20 milliamperes >

Al Penney
VO1NO

Review Question 12

Which body organ can be fatally affected by a very small amount of electrical current?

- The liver
- The lungs
- The heart
- The brain

Al Penney
VO1NO

Review Question 12

Which body organ can be fatally affected by a very small amount of electrical current?

- The liver
- The lungs
- The heart
- The brain

< The heart >

Al Penney
VO1NO

Review Question 13

What is the minimum voltage which is usually dangerous to humans?

- 2000 volts
- 30 volts
- 100 volts
- 1000 volts

Al Penney
VO1NO

Review Question 13

What is the minimum voltage which is usually dangerous to humans?

- 2000 volts
- 30 volts
- 100 volts
- 1000 volts

< 30 volts >

Al Penney
VO1NO

Review Question 14

What should you do if you discover someone who is being burned by high voltage?

• Immediately drag the person away from the high voltage

• Run from the area so you won't be burned too

• Turn off the power, call for emergency help and provide first-aid if needed

• Wait for a few minutes to see if the person can get away from the high voltage on their own, then try to help

Al Penney
VO1NO

Review Question 14

What should you do if you discover someone who is being burned by high voltage?

• Immediately drag the person away from the high voltage

• Run from the area so you won’t be burned too

• Turn off the power, call for emergency help and provide first-aid if needed

• Wait for a few minutes to see if the person can get away from the high voltage on their own, then try to help

< Turn off the power, call for emergency help and provide first-aid if needed >

Al Penney
VO1NO

Review Question 15

What is the safest method to remove an unconscious person from contact with a high voltage source?

- Call an electrician
- Remove the person by pulling an arm or a leg
- Turn off the high voltage switch before removing the person from contact with the source
- Wrap the person in a blanket and pull him to a safe area

Al Penney
VO1NO

Review Question 15

What is the safest method to remove an unconscious person from contact with a high voltage source?

• Call an electrician

• Remove the person by pulling an arm or a leg

• Turn off the high voltage switch before removing the person from contact with the source

• Wrap the person in a blanket and pull him to a safe area

< Turn off the high voltage switch before removing the person from contact with the source >

Al Penney
VO1NO

Review Question 16

Before checking a fault in a mains operated power supply unit, it would be safest to FIRST:

• check action of capacitor bleeder resistance

• remove and check fuse from power supply

• turn off the power and remove power plug

• short out leads of filter capacitor

Al Penney
VO1NO

Review Question 16

Before checking a fault in a mains operated power supply unit, it would be safest to FIRST:

• check action of capacitor bleeder resistance

• remove and check fuse from power supply

• turn off the power and remove power plug

• short out leads of filter capacitor

< turn off the power and remove power plug >

Al Penney
VO1NO

Review Question 17

Fault finding in a power supply of an amateur transmitter while the supply is operating is not a recommended technique because of the risk of:

- overmodulation
- blowing the fuse
- electric shock
- damaging the transmitter

Al Penney
VO1NO

Review Question 17

Fault finding in a power supply of an amateur transmitter while the supply is operating is not a recommended technique because of the risk of:

• overmodulation

• blowing the fuse

• electric shock

• damaging the transmitter

< electric shock >

Al Penney
VO1NO

Review Question 18

For best protection from electrical shock, what should be grounded in an amateur station?

- All station equipment
- The antenna transmission line
- The AC power line
- The power supply primary

Al Penney
VO1NO

Review Question 18

For best protection from electrical shock, what should be grounded in an amateur station?

• All station equipment

• The antenna transmission line

• The AC power line

• The power supply primary

< All station equipment >

Al Penney
VO1NO

Review Question 19

If a separate ground system is not possible for your amateur station, an alternative indoor grounding point could be:

• a metallic cold water pipe

• a plastic cold water pipe

• a window screen

• a metallic natural gas pipe

Al Penney
VO1NO

Review Question 19

If a separate ground system is not possible for your amateur station, an alternative indoor grounding point could be:

• a metallic cold water pipe

• a plastic cold water pipe

• a window screen

• a metallic natural gas pipe

< a metallic cold water pipe >

Al Penney
VO1NO

Review Question 20

Which of these materials is best for a ground rod driven into the earth?

- Iron or steel
- Fiberglass
- Copper-clad steel
- Hard plastic

Al Penney
VO1NO

Review Question 20

Which of these materials is best for a ground rod driven into the earth?

- Iron or steel
- Fiberglass
- Copper-clad steel
- Hard plastic

< Copper-clad steel >

Al Penney
VO1NO

Review Question 21

If you ground your station equipment to a ground rod driven into the earth, what is the shortest length the rod should be?

- 1.2 metre (4 ft.)
- 2.5 metres (8 ft.)
- 3 metres (10 ft.)
- The station ground system must conform to applicable electrical code requirements

Al Penney
VO1NO

Review Question 21

If you ground your station equipment to a ground rod driven into the earth, what is the shortest length the rod should be?

- 1.2 metre (4 ft.)
- 2.5 metres (8 ft.)
- 3 metres (10 ft.)
- The station ground system must conform to applicable electrical code requirements

< The station ground system must conform to applicable electrical code requirements >

Answer "3 metres (10 ft.)" used to be the correct answer. As codes change from province to province, IC has elected to move to "The station ground system must conform to applicable electrical code requirements" as the correct answer.

Al Penney
VO1NO

Review Question 22

Where should the green wire in a three-wire AC line cord be connected in a power supply?

- To the fuse
- To the chassis
- To the white wire
- To the “hot” side of the power switch

Al Penney
VO1NO

Review Question 22

Where should the green wire in a three-wire AC line cord be connected in a power supply?

• To the fuse

• To the chassis

• To the white wire

• To the “hot” side of the power switch

< To the chassis >

Al Penney
VO1NO

Review Question 23

If your third-floor amateur station has a ground wire running 10 metres (33 feet) down to a ground rod, why might you get an RF burn if you touch the front panel of your HF transceiver?

• Because the transceiver's heat-sensing circuit is not working to start the cooling fan

• Because the ground rod is not making good contact with moist earth

• Because the ground wire has significant reactance and acts more like an antenna than an RF ground connection

• Because of a bad antenna connection, allowing the RF energy to take an easier path out of the transceiver through you

Al Penney
VO1NO

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< Because the ground wire has significant reactance and acts more like an antenna than an RF ground connection >

Al Penney
VO1NO

Review Question 24

What is one good way to avoid stray RF energy in your amateur station?

• Use a beryllium ground wire for best conductivity

• Keep the station's ground wire as short as possible

• Make a couple of loops in the ground wire where it connects to your station

• Drive the ground rod at least 4m (14 feet) into the ground

Al Penney
VO1NO

Beryllium is actually an insulator!

Review Question 24

What is one good way to avoid stray RF energy in your amateur station?

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< Keep the station’s ground wire as short as possible >

Al Penney
VO1NO

Beryllium is actually an insulator!

Review Question 25

Which statement about station grounding is TRUE?

- If the chassis of all station equipment is connected with a good conductor, there is no need to tie them to an earth ground
- The chassis of each piece of station equipment should be tied together with high impedance conductors
- RF hotspots can occur in a station located above the ground floor if the equipment is grounded by a long ground wire
- A ground loop is an effective way to ground station equipment

Al Penney
VO1NO

Review Question 25

Which statement about station grounding is TRUE?

• If the chassis of all station equipment is connected with a good conductor, there is no need to tie them to an earth ground

• The chassis of each piece of station equipment should be tied together with high impedance conductors

• RF hotspots can occur in a station located above the ground floor if the equipment is grounded by a long ground wire

• A ground loop is an effective way to ground station equipment

< RF hotspots can occur in a station located above the ground floor if the equipment is grounded by a long ground wire >

Al Penney
VO1NO

Review Question 26

On mains operated power supplies, the ground wire should be connected to the metal chassis of the power supply. This ensures, in case there is a fault in the power supply, that the chassis:

- develops a high voltage compared to the ground
- does not develop a high voltage with respect to the ground
- does not become conductive to prevent electric shock
- becomes conductive to prevent electric shock

Al Penney
VO1NO

Review Question 26

On mains operated power supplies, the ground wire should be connected to the metal chassis of the power supply. This ensures, in case there is a fault in the power supply, that the chassis:

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• does not develop a high voltage with respect to the ground

• does not become conductive to prevent electric shock

• becomes conductive to prevent electric shock

< does not develop a high voltage with respect to the ground >

Al Penney
VO1NO

Review Question 27

The purpose of using a three-wire power cord and plug on amateur radio equipment is to:

- prevent the plug from being reversed in the wall outlet
- prevent internal short circuits
- make it inconvenient to use
- prevent the chassis from becoming live

Al Penney
VO1NO

Review Question 27

The purpose of using a three-wire power cord and plug on amateur radio equipment is to:

• prevent the plug from being reversed in the wall outlet

• prevent internal short circuits

• make it inconvenient to use

• prevent the chassis from becoming live

< prevent the chassis from becoming live >

Al Penney
VO1NO

Review Question 28

Why should you ground all antenna and rotator cables when your amateur station is not in use?

- To lock the antenna system in one position
- To avoid radio frequency interference
- To make sure everything will stay in place
- To protect the station equipment and building from lightning damage

Al Penney
VO1NO

Review Question 28

Why should you ground all antenna and rotator cables when your amateur station is not in use?

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• To avoid radio frequency interference

• To make sure everything will stay in place

• To protect the station equipment and building from lightning damage

< To protect the station equipment and building from lightning damage >

Al Penney
VO1NO

Review Question 29

You want to install a lightning arrestor on your antenna transmission line, where should it be inserted?

- Anywhere on the line
- Outside, as close to the to the earth grounding as possible
- Close to the antenna
- Behind the transmitter

Al Penney
VO1NO

Review Question 29

You want to install a lightning arrestor on your antenna transmission line, where should it be inserted?

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• Outside, as close to the to the earth grounding as possible

• Close to the antenna

• Behind the transmitter

< Outside, as close to the to the earth grounding as possible >

Al Penney
VO1NO

Review Question 30

How can amateur station equipment best be protected from lightning damage?

• Never turn off the equipment

• Disconnect the ground system from all radios

• Disconnect all equipment from the power lines and antenna cables

• Use heavy insulation on the wiring

Al Penney
VO1NO

Review Question 30

How can amateur station equipment best be protected from lightning damage?

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• Disconnect all equipment from the power lines and antenna cables

• Use heavy insulation on the wiring

< Disconnect all equipment from the power lines and antenna cables >

Al Penney
VO1NO

Review Question 31

What equipment should be worn for working on an antenna tower?

- A grounding chain
- Approved equipment in accordance with applicable standards concerning fall protection
- A reflective vest of approved color
- A flashing red, yellow or white light

Al Penney
VO1NO

Review Question 31

What equipment should be worn for working on an antenna tower?

• A grounding chain

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• A flashing red, yellow or white light

< Approved equipment in accordance with applicable standards concerning fall protection >

Al Penney
VO1NO

Review Question 32

Why should you wear approved fall arrest equipment if you are working on an antenna tower?

• To keep the tower from becoming unbalanced while you are working

• To safely hold your tools so they don't fall and injure someone on the ground

• To prevent you from accidentally falling

• To safely bring any tools you might use up and down the tower

Al Penney
VO1NO

Review Question 32

Why should you wear approved fall arrest equipment if you are working on an antenna tower?

• To keep the tower from becoming unbalanced while you are working

• To safely hold your tools so they don't fall and injure someone on the ground

• To prevent you from accidentally falling

• To safely bring any tools you might use up and down the tower

< To prevent you from accidentally falling >

Al Penney
VO1NO

Review Question 33

For safety, how high should you place a horizontal wire antenna?

- As close to the ground as possible
- High enough so that no one can touch any part of it from the ground
- Above high-voltage electrical lines
- Just high enough so you can easily reach it for adjustments or repairs

Al Penney
VO1NO

Review Question 33

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• Above high-voltage electrical lines

• Just high enough so you can easily reach it for adjustments or repairs

< High enough so that no one can touch any part of it from the ground >

Al Penney
VO1NO

Review Question 34

Why should you wear a hard hat if you are on the ground helping someone work on an antenna tower?

• So someone passing by will know that work is being done on the tower and will stay away

• To protect your head from something dropped from the tower

• So you won't be hurt if the tower should accidentally fall

• To keep RF energy away from your head during antenna testing

Al Penney
VO1NO

Review Question 34

Why should you wear a hard hat if you are on the ground helping someone work on an antenna tower?

• So someone passing by will know that work is being done on the tower and will stay away

• To protect your head from something dropped from the tower

• So you won’t be hurt if the tower should accidentally fall

• To keep RF energy away from your head during antenna testing

< To protect your head from something dropped from the tower >

Al Penney
VO1NO

Review Question 35

Why should your outside antennas be high enough so that no one can touch them while you are transmitting?

- Touching the antenna might radiate harmonics
- Touching the antenna might cause television interference
- Touching the antenna might cause RF burns
- Touching the antenna might reflect the signal back to the transmitter and cause damage

Al Penney
VO1NO

Review Question 35

Why should your outside antennas be high enough so that no one can touch them while you are transmitting?

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• Touching the antenna might reflect the signal back to the transmitter and cause damage

< Touching the antenna might cause RF burns >

Al Penney
VO1NO

Review Question 36

What safety precautions should you take before beginning repairs on an antenna?

• Turn off the main power switch in your house

• Be sure to turn off the transmitter and disconnect the transmission line

• Be sure you and the antenna structure are grounded

• Inform your neighbors so they are aware of your intentions

Al Penney
VO1NO

Review Question 36

What safety precautions should you take before beginning repairs on an antenna?

• Turn off the main power switch in your house

• Be sure to turn off the transmitter and disconnect the transmission line

• Be sure you and the antenna structure are grounded

• Inform your neighbors so they are aware of your intentions

< Be sure to turn off the transmitter and disconnect the transmission line >

Al Penney
VO1NO

Review Question 37

What should you do for safety when operating at UHF and microwave frequencies?

• Keep antenna away from your eyes when RF is applied

• Make sure that an RF leakage filter is installed at the antenna feed point

• Make sure the standing wave ratio is low before you conduct a test

• Never use a horizontally polarized antenna

Al Penney
VO1NO

Review Question 37

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• Never use a horizontally polarized antenna

< Keep antenna away from your eyes when RF is applied >

Al Penney
VO1NO

Review Question 38

What should you do for safety if you put up a UHF transmitting antenna?

- Make sure the antenna is near the ground to keep its RF energy pointing in the correct direction
- Make sure you connect an RF leakage filter at the antenna feed point
- Make sure that RF field screens are in place
- Make sure the antenna will be in a place where no one can get near it when you are transmitting

Al Penney
VO1NO

Review Question 38

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< Make sure the antenna will be in a place where no one can get near it when you are transmitting >

Al Penney
VO1NO

Review Question 39

What should you do for safety, before removing the shielding on a UHF power amplifier?

- Make sure the amplifier cannot accidentally be turned on
- Make sure that RF leakage filters are connected
- Make sure the antenna transmission line is properly grounded
- Make sure all RF screens are in place at the antenna transmission line

Al Penney
VO1NO

Review Question 39

What should you do for safety, before removing the shielding on a UHF power amplifier?

• Make sure the amplifier cannot accidentally be turned on

• Make sure that RF leakage filters are connected

• Make sure the antenna transmission line is properly grounded

• Make sure all RF screens are in place at the antenna transmission line

< Make sure the amplifier cannot accidentally be turned on >

Al Penney
VO1NO

Review Question 40

Why should you make sure the antenna of a hand-held transceiver is not close to your head when transmitting?

- To keep static charges from building up
- To help the antenna radiate energy equally in all directions
- To reduce your exposure to the radio-frequency energy
- To use your body to reflect the signal in one direction

Al Penney
VO1NO

Review Question 40

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• To keep static charges from building up

• To help the antenna radiate energy equally in all directions

• To reduce your exposure to the radio-frequency energy

• To use your body to reflect the signal in one direction

< To reduce your exposure to the radio-frequency energy >

Al Penney
VO1NO

Review Question 41

How can exposure to a large amount of RF energy affect body tissue?

- It paralyzes the tissue
- It causes hair to fall out
- It heats the tissue
- It lowers blood pressure

Al Penney
VO1NO

Review Question 41

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- It causes hair to fall out
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- It lowers blood pressure

< It heats the tissue >

Al Penney
VO1NO

Review Question 42

Which body organ is the most likely to be damaged from the heating effects of RF radiation?

- Eyes
- Heart
- Liver
- Hands

Al Penney
VO1NO

Review Question 42

Which body organ is the most likely to be damaged from the heating effects of RF radiation?

- Eyes
- Heart
- Liver
- Hands

< Eyes >

Al Penney
VO1NO

Review Question 43

Depending on the wavelength of the signal, the energy density of the RF field, and other factors, in what way can RF energy affect body tissue?

- It has no effect on the body
- It heats the tissue
- It causes ionizing radiation poisoning
- It causes blood flow to stop

Al Penney
VO1NO

Review Question 43

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• It heats the tissue

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< It heats the tissue >

Al Penney
VO1NO

Review Question 44

If you operate your amateur station with indoor antennas, what precautions should you take when you install them?

- Locate the antennas close to your operating position to minimize transmission line length
- Locate the antennas as far away as possible from living spaces that will be occupied while you are operating
- Position the antennas parallel to electrical power wires to take advantage of parasitic effects
- Position the antennas along the edge of a wall where it meets the floor or ceiling to reduce parasitic radiation

Al Penney
VO1NO

Review Question 44

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< Locate the antennas as far away as possible from living spaces that will be occupied while you are operating >

Al Penney
VO1NO

Review Question 45

Why should directional high-gain antennas be mounted higher than nearby structures?

- So they will be dried by the wind after a heavy rain storm
- So they will not damage nearby structures with RF energy
- So they will receive more sky waves and fewer ground waves
- So they will not direct RF energy toward people in nearby structures

Al Penney
VO1NO

Review Question 45

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< So they will not direct RF energy toward people in nearby structures >

Al Penney
VO1NO

Review Question 46

For best RF safety, where should the ends and center of a dipole antenna be located?

• Close to the ground so simple adjustments can be easily made without climbing a ladder

• As high as possible to prevent people from coming in contact with the antenna

• Near or over moist ground so RF energy will be radiated away from the ground

• As close to the transmitter as possible so RF energy will be concentrated near the transmitter

Al Penney
VO1NO

Review Question 46

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< As high as possible to prevent people from coming in contact with the antenna >

Al Penney
VO1NO


Questions?


Annapolis Valley
Amateur Radio
Club
VA1AVR


EMERGENCY
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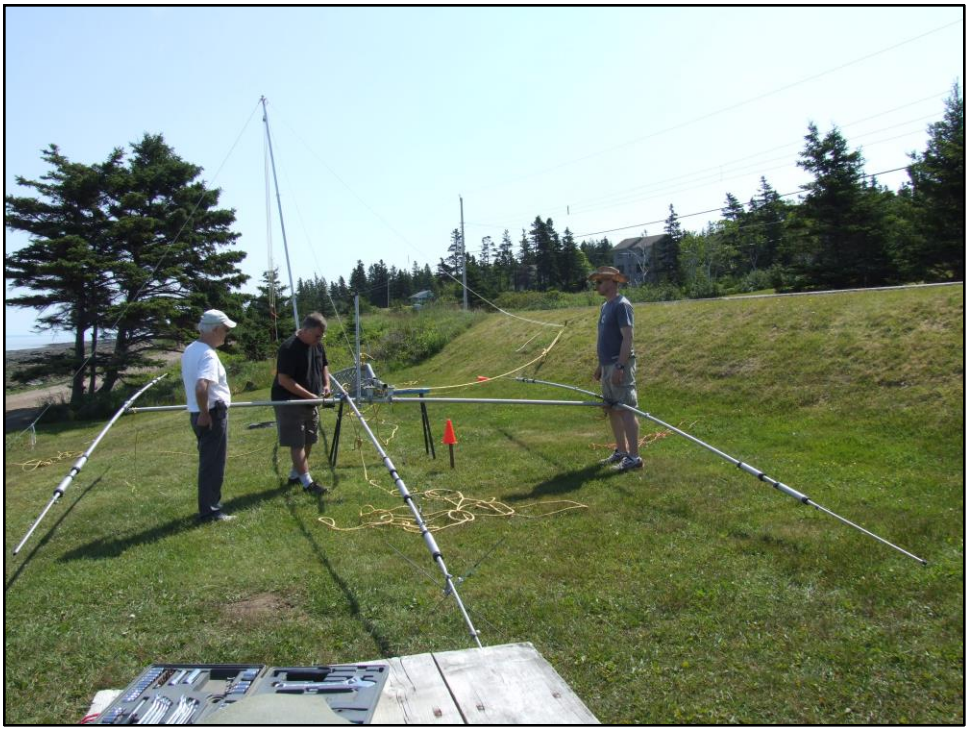

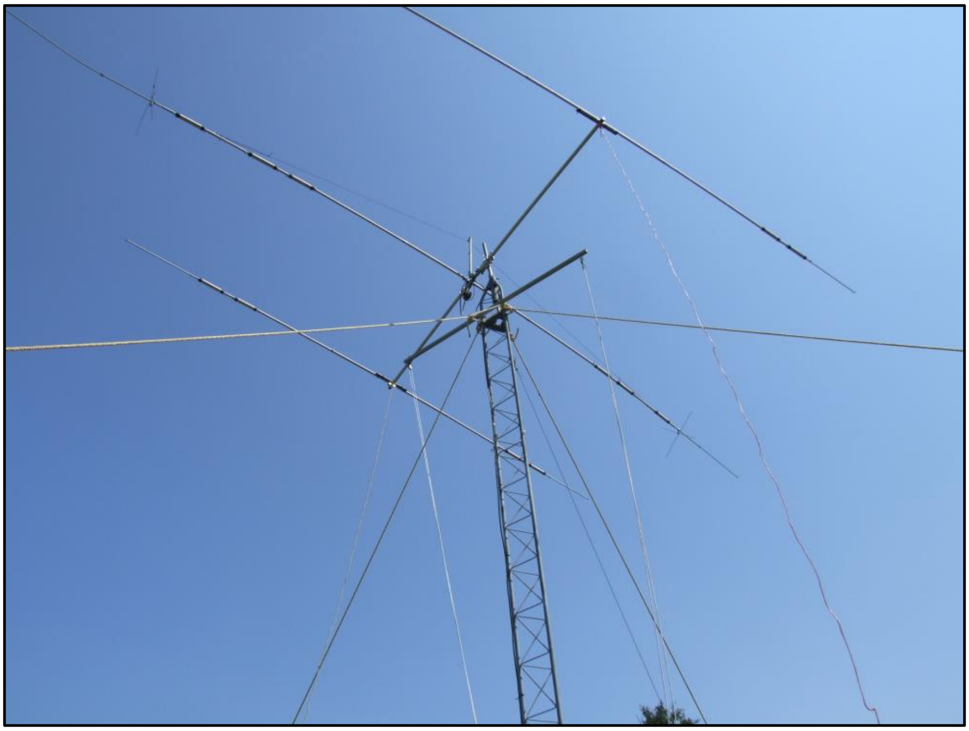


Questions?