1. INTERESTING FACTS:

 There is an estimated average of 70 electrocution fatalities associated with consumer products per year.

 The most recent data from the U.S. Consumer Product Safety Commission shows that there are nearly 400 electrocutions in the United States each year.

 Approximately 15 percent of electrocutions are related to consumer products (This includes Ham Radios and other electrical devices used in the Ham Shack.

Wiring hazards, including damaged or exposed wiring and household wiring, accounted for nearly 14 percent of these deaths.

 An estimated 360,900 residential building fires are reported to United States fire departments each year and caused an estimated 2,495 deaths, 13,250 injuries and $7 billion in property losses. The leading cause of the largest fires was electrical malfunction.

U.S. fire departments responded to an estimated annual average of 47,820 reported home structure fires involving electrical failure or malfunction in 2007-2011. These fires resulted in 455 civilian deaths, 1,518 civilian injuries and $1.5 billion in direct property damage.

Arc faults in a home are one of the leading causes for electrical wiring fires. Each year in the United States, over 40,000 fires are attributed to home electrical wiring. These fires result in over 350 deaths and over 1,400 injuries each year.

 Some type of electrical failure or malfunction was cited as factor contributing to ignition for 74% of electrical distribution or lighting equipment home structure fires.

SEVERAL STUDIES HAVE SHOWN THAT CIRCUIT BREAKERS THAT WERE NOT MAINTAINED AND TESTED WITHIN A 5 YEAR PERIOD HAVE A 50 PERCENT FAILURE RATE.

Whether you are a homeowner or a renter, electrical safety should be a top priority in your home and hamshack. Awareness of electrical hazards is the key to reducing the staggering number of electrically-related home fires, injuries and deaths that occur every year.

The voltage of the electricity and the available electrical current in regular businesses and homes has enough power to cause death by electrocution. Even changing a light bulb without unplugging the lamp can be hazardous because coming in contact with the "hot", "energized" or "live" part of the socket could kill a person.

People are injured when they become part of the electrical circuit. Humans are more conductive than the earth (the ground we stand on) which means if there is no other easy path, electricity will try to flow through our bodies.

1. **NEWS FLASH!!!**

 Never try to rescue another person if you are not trained to do so. Teach family members and friends how to remove power by throwing breakers at junction box. Do not contact a person who is involuntary attached to an electrical device

 Don’t allow your body to create a pathway to ground. Keep your legs close to each other

 Never use both hands when working on energized equipment. You do not want to create an electrical circuit that provides a pathway through your heart.

1. **PHYSICS OF ELECTRICAL HAZARDS**

NOTE: These may vary somewhat based on the individual’s body and health conditions.

1. Human response to a 60 cycle current:
2. 1 ma mild sensation
3. 1 – 3ma pain
4. 10 ma unable to release or be thrown clear
5. 30 ma stop breathing
6. 75 milliamp – 250ma fibrillation threshold heart action discoordinated most-likely fatal
7. 4 Amps Heart stops
8. 5 amps and greater tissue burning
9. Shock can lead to fatal falls (especially when on a ladder)

1. **SAFETY IN THE HAMSHACK**
2. Electrical Hazards
3. **Shock**: Direct contact with Electricity resulting in producing Heat and current flowing through the body
4. Damages and destroys tissue
5. Can result in death.
6. Distribution of current flow through body is a function of resistance of various paths through which current flows.
7. Critical path is called the shock circuit
8. Symptoms: includes mild tingling, violent muscle contractions, heart arrhythmia or Tissue damage (skin has 3 layers)
9. Voltage Magnitude: Higher the voltage the more the likelihood of puncturing the epidermis. Once punctured, the magnitude of current through body increases dramatically and lethally. **Do not change the position of a person who is latched to the voltage. Only cut-off the source of voltage. Teach friends and family members to trip breakers at junction box**
10. Ohms law applies to the body as well
11. The current path is from the source through the resistance of the body and then through the resistance of the earth and back to the source for an AC shock
12. Children are much more likely to occur more damage because of thin skin layers
13. Impact on Nervous System: pain, loss of control of body parts (paralysis, electrical hold onto source
14. Can result in Permanent damage including: Loss of sensation or function
15. Impact on Muscular System: Uncontrolled reflexes
16. Electrical paralysis above 10ma
17. Impact on heart includes change in heart rate and rhythm and highly likelihood of death.
18. Contrary to popular belief, it does not take a lot of current to kill someone. As little as 25 milliamps as well as the health of your body. Can’t put a fixed number because everyone’s body is unique. Children are more succeptable than adults
19. DC voltage causes more heating of tissue
20. The let-go threshold is higher for DC than AC
21. Arcing
22. Heat or pressure by an uncontrolled process. Arcing can cause burns
23. Toxic vapors caused by burning of materials and electric arcs based on materials (metals)
24. Ventricular fibrillation
25. occurs when applied electrical field overlaps cardiac cycle

1. ELECTROCUTION, AND CARDIAC ARREST

CURRENT LEVELS AS LOW AS 10 TO 30 MA CAN BE FATAL.

1. Degree of trauma is directly proportional to the length of time of contact.
2. The amount of heat delivered is directly proportional to the length of time of contact
3. Damage to nervous system can be fatal even for small amount of time
4. Impact based on frequency of electrical injury
5. DC to 10khz – heating and destructive cell membrane damage
6. 100KHZ to 100 mhz- heating of water and bodily fluids, and proteins
7. 100 MHZ to 100 GHZ dielectric heating of water and bodily fluids
8. While on a ladder or otherwise, contact with electricity can cause a major fall that can cause serious injuries including death. Muscle contractions, or a startle reaction, can cause a person to fall from a ladder, scaffold or aerial bucket.
9. PERSONAL IMPACT OF ALL OF THESE HAZARDS:
10. Influencing factors:
11. medical condition of victim,
12. victims response,
13. the path of the current flow,
14. the duration of the contact with the electricity,
15. the magnitude of the current,
16. the frequency of the current and
17. the magnitude of the voltage.
18. much higher likely impact of contact if person has medical problems such as heart or lung ailments
19. **Specific Hazards**
20. Don’t overload electrical outlets: can cause overheating and fires.
21. Never unplug or carry equipment by the cord.
22. Don’t run cords under carpets or furniture
23. Inspect cords for frays.
24. Ensure that that cords do not overheat. Can cause fires. If cord has been overheated (DESTROY OR GET RID OF. IT HAS BEEN DAMAGED)
25. Only use equipment and components that are laboratory tested (UL, CSA, etc) to fail safe.
26. Use GFCI-protected receptacles and test monthly.
27. If you have young children, protect receptacles from access.
28. Only purchase and use equipment that have 3 prong connectors with a 3rd ground connector
29. Always unplug equipment after use.
30. Use surge protectors. They are designed to protect for more than one surge

**C. SOURCE OF HAZARDS**

1. Electrical shock hazard in systems as low as 12 volts and high amperages

2. Electrical arc hazards: Your body can act as a conductor. It has a lower resistance than ground. An arc blast can include a potential pressure wave released from an arc flash. This wave can cause physical injuries, collapse your lungs, or create noise that can damage hearing.

3. Lightning arcs, and over voltages occur when the voltage between exceeds the dielectric strength of air. (IE: anything can become a conductor based on magnitude of voltage and distance between and area). Additionally, moisture in air and clouds assist.

4. Melting of wires occurs when air becomes superheated with passage of current through conductor

5. When 2 contacts part with high current an arc can occur

6. RF Burns: These are the most dangerous type of burns. Like being inside a microwave oven. Burns from the inside out. Causes: exposed connections, wires, faulty equipment and improper or lack of grounding.

7. Burns – physical contact, current flow, thermal or radiation caused by arcing contact with molten medal. Almost always 3rd degree with possibility of involving internal organs Growth centers destroyed in severe cases Cell Wall Damage resulting from enlargement of pores. Flame burns from materials that catch on fire from heating or ignition by electrical currents or an electric arc flash. Contact burns from being shocked can burn internal tissues while leaving only very small injuries on the outside of the skin.

 Thermal burns from the heat radiated from an electric arc flash. Ultraviolet (UV) and infrared (IR) light emitted from the arc flash can also cause damage to the eyes.

8. Stay away from high voltage lines. They can arc to your body then ground. Your body is a better conductor than ground. This also occurs when a person is hit by lightning. You do not have to touch a power line to be in danger. High-voltage electricity can jump to anyone who gets too close. Stay at least 10 feet away from power lines and their connections.

9. While on a ladder, use extreme caution.

1. **Avoidance**
2. It is recommended that the electrical systems in your house be inspected by a licensed professional on a routine basis. At a minimum at least once every two years. THIS COULD SAVE YOUR LIFE SOMEDAY.
3. Adequate protection
4. Use Safe practices
5. Never work on energized equipment when home alone.
6. Tell family members when you are going to work on equipment
7. Read manuals and brochures when purchasing equipment. They often tell about safety and hazards
8. Adequate maintenance. Must be done by a qualified individual
9. Identify problems and take corrective action

Intermittent operation of equipment, components, spells a disaster waiting to happen. Do not operate and get a licensed professional to repair/replace ASAP

1. Perform a safety and hazards analysis

Threats are most likely from:

1. electricity,
2. shorts
3. lightning,
4. fire
5. circuit overloading without adequate interruption.
6. rf transmissions
7. Improper bonding and/or grounding and lack thereof

 Safety measures: Learn CPR and/or provide automatic defibrillators. Know how to use them.

1. **HAM RADIO OPERATORS MUST HAVE A CULTURE OF SAFETY**
2. Many electrocutions and home fires can be prevented simply by understanding basic electrical safety principles and adhering to safe practices.
3. When going QRT or working on equipment make absolutely sure that all equipment and circuits are de-energized (common sense) and disconnected. Ground antenna connections or completely disconnect. Preference is to ground using proper procedures/connections. Automatic devices are now available (DX Engineering)
4. Protection against equipment malfunction:
5. Proper grounding is essential.
6. ENSURE THAT ALL CONNECTIONS ARE SOLID
7. PREVENTIVE ACTION AGAINST SHORTS (Discussed later)
8. PROPER SHEILDING AND COVERING OF ACTIVE CIRCUITS (Discussed later)
9. CHECK FOR CORROISION AND OVERHEATING. Once overheated, a device, component or circuit is damaged and can no longer be used.
10. PERFORM INFRARED INSPECTION OF ELECTRICAL SYSTEMS AT A PERIOD OF TIME THAT IS SUITABLE DUE TO YOUR SAFETY CONCERNS. HOT POINTS CAN BE DETECTED. ALSO BREAKDOWN OF CONDUCTORS DUE TO OVERHEATING
11. Adequate illumination to see what you are doing and where touching to equipment can be dangerous.
12. Watches, knives, necklaces all conduct electricity
13. beware of contact with equipment and electrical connections
14. Energized conductors should be covered or blocked to prevent contact
15. Do not use extension cords in low lying areas where water can accumulate also ensure that the current carrying capacity of cord exceeds that of the equipment connected to it
16. Don’t lift tools by their power cords
17. Try to get/use double insulated tools
18. If you have old 2 wire outlets without the 3rd ground connection replace them
19. Do not use cords and tools in wet environment
20. let others know when you are operating or using electrical equipment, radios and tools
21. It is a good idea to have a LICENSED ELECTRICIAN CONDUCT A TEST OF BREAKERS AND INSPECTION OF ELECTRICAL SYSTEM at routine intervals.
22. Always wear FLAME RESISTANT CLOTHING wh working on electronic/electrical circuits. ASTM CLOTHING STANDARDS F 1506
23. DO NOT WEAR SYNTHETIC MATERIALS.
24. WHERE THERE IS A POSSIBILITY OF HAVING A GROUND CIRCUIT VIA THE FLOORING, AN INSULATING RUBBER MATT COMPLYING WITH ASTM D 178 SHOULD BE USED
25. TOOLS SHOULD ALWAYS HAVE INSULATED HANDLES
26. BEFORE USE, INSPECT TOOLS FOR DAMAGED INSULATION ON WIRES. ETC.
27. **CIRCUIT BREAKERS AND GROUND-FAULT CIRCUIT INTERUPTERS**
28. MOST 120 VAC CIRCUITS ARE FED FROM STANDARD THERMAL-MAGNETIC MOLDED-CASE CIRCUIT BREAKERS. TO INTERUPT, MORE THAN 15 AMPS IS REQUIRED FOR BREAKER TO TRIP. THIS IS INSUFFICIENT PROTECTION AGAINST ELECTROCUTION. CURRENT LEVELS AS LOW AS 10 TO 30 MA CAN BE FATAL.
29. CIRCUIT Breakers can fail mechanically and electrically
30. The codes and standards recommend testing of breakers once a year by a licensed professional.
31. SEVERAL STUDIES HAVE SHOWN THAT CIRCUIT BREAKERS THAT WERE NOT MAINTAINED AND TESTED WITHIN A 5 YEAR PERIOD HAVE A 50 PERCENT FAILURE RATE.
32. **A GROUND-FAULT CIRCUIT INTERUPPTER IS ESSENTIAL** IF A GROUNDED PERSON TOUCHES THE HOT WIRE DOWNSTREAM OF THE GFCI, CURRENT WILL FLOW FROM THE HOT WIRE THROUGH THE PERSON AND WILL RETURN ON THE GROUND WIRE. CURRENTS ON THE HOT WIRE AND NEUTRAL WIRE ARE NOT EQUAL. THE CURRENT TRANSFORMER WILL PRODUCE AN OUTPUT TO THE SENSOR THAT WILL IN TURN CAUSE THEGFCI BREAKER CONTACTS TO OPEN THIS CAN SAVE THE LIFE OF A PERSON
33. A Class A Ground Fault Circuit Interrupter (GFCI) works by detecting any loss of electrical current in a circuit (GFCIs ARE SET TO TRIP WHEN THE DIFFERENCE BETWEEN THE HOT LEAD IS +- 5 MA (at a maximum of 6mA). When a loss is detected, the GFCI turns the electricity off before severe injuries or electrocution can occur. A painful non-fatal shock may occur during the time that it takes for the GFCI to cut off the electricity so it is important to use the GFCI as an extra protective measure rather than a replacement for safe work practices.
34. GFCI wall outlets can be installed in place of standard outlets to protect against electrocution for just that outlet, or a series of outlets in the same branch circuit. A GFCI Circuit Breaker can be installed on some circuit breaker electrical panels to protect an entire branch circuit. Portable in-line plug-in GFCIs can be plugged into wall outlets where appliances will be used.
35. It is important that you follow the manufacturer's instructions with respect to the use of a GFCI. Test permanently wired GFCIs monthly, and portable devices before each use. Press the "test" and "reset" buttons. Plug a "night light" or lamp into the GFCI-protected wall outlet (the light should turn on), then press the "TEST" button on the GFCI. If the GFCI is working properly, the light should go out. If not, have the GFCI repaired or replaced. Press the "RESET" button on the GFCI to restore power.
36. If the "RESET" button pops out but the "night light" or lamp does not go out, the GFCI has been improperly wired and does not offer shock protection at that wall outlet. Contact a qualified electrician to correct any wiring errors.
37. You may say, I know what I am doing and will do it myself. If failure, fire, shock or electrocution occurs and insurance company finds out, there is likelihood insurance may not pay.
38. Keep records of all maintenance and changes to electrical system.
39. **COMMON SENSE SAFETY PROCEDURES AND METHODS**

YOU ARE RESPONSIBLE FOR YOUR OWN SAFETY!!

1. THINK ABOUT WHAT YOU ARE DOING WHEN YOU ARE DOING IT! DO NOT HAVE YOUR MIND ELSEWHERE! BE AWARE

 B. STAY ALERT DO NOT WORK AROUND ELECTRICITY WHEN YOU ARE TIRED

 C. FOLLOW SAFE PROCEDURES: STANDARDIZE THEM

1. DON’T BE AFRAID TO ASK QUESTIONS AND ASSIST OTHERS WHEN IT COMES TO SAFETY
2. USE EQUIPMENT THAT IS DESIGNED TO DO THE JOB NOT OTHERS
3. YOU KNOW WHAT THE WORD ASSUME MEANS! NEVER ASSUME! ALWAYS CHECK TO MAKE SURE
4. ALWAYS KNOW IF THE EQUIPMENT IS ENERGIZED OR TURNED OFF.
5. TAG OUT BREAKERS AND EQUIPMENT: (DO NOT ENERGIZE)
6. ENSURE THAT YOUR STATION AND WORK AREA IS SAFE (CLEAN AND ORGANIZED)
7. DOUBLE CHECK YOURSELF
8. WHEN NOT IN USE MAKE SURE EQUIPMENT IS TURNED OFF
9. ALWAYS DISCONNECT POWER SOURCE AND DISCONNECT ANTENNA OR GROUND IT
10. ALWAYS INPECT EQUIPMENT AND CONNECTIONS PRIOR TO USE
11. HAVE A CHECKLIST
12. Keep liquids away from equipment and wires
13. USE 3 prong plugs
14. Surge protectors.
15. Proper overcurrent protection
16. Grounding or disconnecting of antennas when not in use
17. WARNING SIGNS
18. Locked hamshack or prevention of operation by others (children are often curious)
19. Be sure to unplug any lamp or appliance before working on it.
20. Test the wires before you touch them to make sure that the power has been turned off.
21. Never touch plumbing or gas pipes when performing a do-it-yourself electrical project
22. Working with tools requires skilled instruction and training. They can be deadly if not properly used or maintained.
23. Use ground fault circuit interrupters (GFCIs) with every power tool to protect against electric shocks.
24. Do not use power tools with an extension cord that exceeds 100 feet in length.

AB. Never use power tools near live electrical wires or water pipes.

AC. Use extreme caution when cutting or drilling into walls where electrical wires or water pipes could be accidentally touched or penetrated.

AD. If a power tool trips a safety device while in use, take the tool to a manufacturer-authorized repair center for service. TODAYS TOOLS ARE THROW AWAY TOOL

AE. Use tools with insulated grips.

AF. Appropriate personal protective gear should be worn when using power tools.

AG. Always follow manufacturers warnings and instructions

AH. Never operate electrical equipment while you are standing in water.

AI. Never repair electrical equipment unless qualified, authorized or you are absolutely sure that you know what you are doing. Always check yourself before testing for the first time after repairs.

AJ. Have a qualified electrician inspect electrical equipment that has gotten wet before energizing it. If corrosion occurs, replacement and repairs are needed.

AK. If working in damp locations, inspect electric cords and equipment to ensure that they are in good condition and free of defects, and use a ground-fault circuit interrupter (GFCI).

AL. OSHA’S “How Do I Work Safely with Flammable and Combustible Liquids? (Static Electricity) has more information. Should never leave gasoline in a generator while being stored. Have you ever noticed that when an airplane takes on fuel, a ground line is connected? This is to prevent static discharges that can cause explosions and flames. This theory should also be applied to generators. Ideally they should be grounded before fueling and starting. Nowadays, most fuel containers are made of non-conductive materials. Don’t assume to be safe. I know first-hand years ago, I was working in a major shipyard. A contractor tried to sell me non-metallic pipe-supports. I rubbed the support on a piece of paper. It became charged with static electricity. I said, I am not going to allow this to be used in fuel or oil tanks.

AM. Do not install antennas close to power lines. Must analyze if antenna were to fall or come down that it will not come into contact with power line. Also recommend a clearance of 49 feet from overhead lines.

AN. Use extension cords or equipment that is rated for the level of amperage or wattage that you are using.

AO. Always use the correct size fuse. Replacing a fuse with one of a larger size can cause excessive currents in the wiring and possibly start a fire. Slow blow fuses are for electrical equipment that has a high inrush current upon start up. Regular fuses are used for normal electronic equip.

AP. Be aware that unusually warm or hot outlets may be a sign that unsafe wiring conditions exists. Unplug any cords or extension cords to these outlets and do not use until a qualified electrician has checked the wiring. Once overheated, replace. Do not use again. Damage has occurred.

AQ Always use ladders made with non-conductive side rails (e.g., fibreglass) when working with or near electricity or power lines.

AR. Place halogen lights away from combustible materials such as cloths or curtains. Halogen lamps can become very hot and may be a fire hazard. FRANKLY, I WOULD NOT USE THEM.

AS. Risk of electric shock is greater in areas that are wet or damp. Install Ground Fault Circuit Interrupters (GFCIs) as they will interrupt the electrical circuit before a current sufficient to cause death or serious injury occurs.

AT. Use a portable in-line Ground Fault Circuit Interrupter (GFCI) if you are not certain that the receptacle you are plugging your extension cord into is GFCI protected.

AU. Make sure that exposed receptacle boxes are made of non-conductive materials.

AV. Know where the panel and circuit breakers are located in case of an emergency.

AX. Label all circuit breakers and fuse boxes clearly. Each switch should be positively identified as to which outlet or appliance it is for.

AY. Do not use outlets or cords that have exposed wiring.

AZ. Do not use portable cord-and-plug connected power tools with the guards removed.

BA. Do not block access to panels and circuit breakers or fuse boxes.

1. What are some tips for working with power tools?
2. Switch all tools OFF before connecting them to a power supply.
3. Disconnect and lockout the power supply before completing any maintenance work tasks or making adjustments.
4. Ensure tools are properly grounded or double-insulated. The grounded equipment must have an approved 3-wire cord with a 3-prong plug. This plug should be plugged in a properly grounded 3-pole outlet.
5. Test all tools for effective grounding with a continuity tester or a Ground Fault Circuit Interrupter (GFCI) before use.
6. Do not bypass the on/off switch and operate the tools by connecting and disconnecting the power cord.
7. Do not use electrical equipment in wet conditions or damp locations unless the equipment is connected to a GFCI.
8. Do not clean tools with flammable or toxic solvents.
9. Do not operate tools in an area containing explosive vapours or gases, unless they are intrinsically safe and only if you follow the manufacturer's guidelines.

 Intrinsic safety is a requirement that may be applicable to devices that are being operated in areas with flammable gases or fuels. It means that the device is incapable of igniting those gases. In short, an intriniscally safe piece of equipment won't ignite flammable gases. ISA-RP12-6 defines intrinsically safe equipment as "equipment and wiring which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration

BC. Do not tie cords in tight knots. Knots can cause short circuits and shocks. Loop the cords or use a twist lock plug.

BD. Always inspect extension cords prior to use. If damaged in anyway REPLACE.

BE. Eliminate Octopus Connections

 BF. Do not overload an outlet. Maximum amperage is based on the weakest current/load rating. Ideally, outlets in ham shack should be rated at 20 amperes. This may also require rewired back to junction box with proper wiring size and new rated circuit breakers.

 BG. Pull the plug, not the cord. Do not jerk cord from outlet. This is not an option.

 BH. Never Break OFF the Third Prong on a Plug.

 BI. If you have old 2 prong receptacles, replace them with 3 prong receptacles and ensure proper grounding of 3rd prong. If broken, replacement is essential.

 BJ. It is a good idea to replace old 2 prong cords of old equipment with 3 prong plugs.

 BK. Codes now require that exposed metal equipment enclosures be grounded.

 BL. Never Use Extension Cords as Permanent Wiring.

 BM. Use extension cords only to temporarily supply power to an area that does not have a power outlet.

 BN. Keep extension cords away from heat, water and oil. They can damage the insulation and cause a shock.

 BO. Do not allow vehicles to pass over unprotected extension cords. Extension cords should be put in protective wireway, conduit, pipe or protected by placing planks alongside them.

 BP. If you live in an old house that has old cloth wiring or otherwise that does not meet current NEC standards, please contact an electrician to perform an inspection and safety audit.

 BQ. Avoid running extension cords across doorways or under carpets.

 BR. In homes with small children, make sure your home has tamper-resistant (TR) receptacles.

 BS. Consider having additional circuits or outlets added by a qualified electrician so you do not have to use extension cords.

 BT. Avoid overloading outlets. Plug only one high-wattage appliance into each receptacle outlet at a time. This is a major cause of electrical fires.

 BU. If outlets or switches feel warm, frequent problems with blowing fuses or tripping circuits, or flickering or dimming lights, call a qualified electrician. Do not use in meantime.

 BV. Place lamps on level surfaces, away from things that can burn and use bulbs that match the lamp's recommended wattage.

 BX. Make sure your home has ground fault circuit interrupters (GFCIs) in the Hamshack, kitchen bathroom(s), laundry, basement, and outdoor areas.

 BY. Arc-fault circuit interrupters (AFCIs) should be installed in your home to protect electrical outlets. An Arc Fault Circuit Interrupter (AFCI) is a type of duplex receptacle or circuit breaker that breaks the circuit when it detects a dangerous electrical arc, in order to prevent electrical fires. An AFCI distinguishes between a harmless arc that occurs incidental to normal operation of switches, plugs and brushed motors and an undesirable arc that can occur, for example, in a lamp cord that has a broken conductor in the cord. AFCI breakers have been required for circuits feeding electrical outlets in bedrooms of homes by the electrical codes of Canada and the United States since the beginning of the 21st century; since 2014, U.S. code has required them for outlets in most rooms in houses.

Conventional circuit breakers only respond to overloads and short circuits; so they do not protect against arcing conditions that produce erratic, and often reduced current. An AFCI is selective so that normal arcs do not cause it to trip. The AFCI circuitry continuously monitors the current and discriminates between normal and unwanted arcing conditions. Once an unwanted arcing condition is detected, the AFCI opens its internal contacts, thus de-energizing the circuit and reducing the potential for a fire to occur.

 BZ. Working smoke alarms are essential in every household in every room including hamshack. Routinely test and replace batteries at least twice a year

 CA. Lightbulb wattage: If a light fixture specifies not to exceed a specific wattage bulb, do not place a higher wattage bulb in the fixture. However, adequate lighting is essential

 CB. Immediately de-energize, do not use, and get intermittent circuits and components repaired.

 CC. If wires, or any kind of equipment have/has an exposed conductor or circuit exposed, de-energize and get it removed or fixed ASAP. Warn family members and others not to contact and stay away from exposed wires, etc. Place warning signs nearby

 CD. Check grounding systems. If no ground is present, there is no ground-fault path to trip a circuit breaker or blow a fuse. (THIS CAN BE FATAL AND IS ABSOLUTELY NECESSARY)

CE. All electrical equipment should be plugged into surge protectors

CF. Check electrical panel for proper labels of equipment, components and receptacles

Always hire licensed professionals to test, inspect and repair equipment. Otherwise you could kill yourself and others. You may think you are qualified. However, if there is a failure in anyway, your insurance company will not pay

CG. Do not operate or connect equipment in wet or damp locations if absolutely necessary ensure the equipment is isolated from dampness or water. Damp concrete can conduct electricity.

1. **GENERAL REQUIREMENTS FOR GROUNDING**
2. Electrical driven tools are not safe without a ground connection or else double insulated and listed as such by UL, CSA, etc. Additionally should use tools with non-conductive handles.
3. Proper bonding and grounding of electrical equipment will substantially reduce the risk of electrical shock by eliminating the difference in potential.
4. Noncurrent carrying metal parts of equipment must be grounded . This is a code/law requirement.
5. All exposed metal components and equipment must be grounded to a common ground reducing the possibility of a difference of potential among them.
6. The path to ground from circuits, equipment and components must be permanent and continuous.
7. Must be capable of carrying the maximum ground fault current.
8. Do not use solder or sheet metal screws in your path to ground.
9. Grounding connections must be protected from physical damage either by location or means of enclosure. Not be capable of being damaged
10. No paint nor coatings shall be used.
11. Ground rods and other methods of grounding must be installed below the moisture level in the ground. If more than one ground rod is used, they must be separated by more than 6 feet horizontal.
12. You must use the best soil possible. Example pure dirt is much better than inorganic clay or gravel.
13. Solid copper is the best material for a ground rod
14. All equipment must be provided with a direct path to ground. No loops or alternative paths
15. DO NOT ASSUME THAT YOU HAVE A GOOD GROUND. GO OUT AND BUY AN 8 FOOT LONG GROUND ROD (CODE REQUIREMENT) AND INSTALL YOUR OWN. ALSO CONNECT IT TO THE GROUND COMPONENT OF YOUR ELECTRICAL SYSTEM. PROVIDE A DIRECT GROUND TO ALL OF YOUR EQUIPMENT.
16. Explore your house to see where the electrical system is grounded
17. GROUND THE METAL CLAD, metal sheathed or grounded metal raceway wiring
18. If you use a metal rack or structure ground it
19. No splices or joints in grounding conductor
20. National Electric Code Requirements (NFPA 70) for grounding. BTW: All local jurisdictions have adopted the NEC AS LAW!!!
21. NEC 250.66 determines the size of the conductor. For connections to a ground rod, pipe or Plate electrode, that part of the conductor that is the sole connection to the grounding electrode(s) shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire
22. Connections to Concrete-Encased Electrodes not required to be larger than 4 AWG copper wire.
23. For Ground Rings, conductor is not required to be larger than that of the Ground Ring.
24. For individual equipment, grounding conductors need not be larger than that of the circuit conductors supplying the equipment.
25. Table 250.122 of NEC provides the minimum sizes of Equipment Grounding Conductors based on the rating or setting of the automatic overcurrent device in the circuit ahead of the equipment.
26. For a 15 amp circuit, the minimum size of the ground conductor must be 14 AWG for copper and 12 AWG for aluminum.
27. For a 20 amp circuit, the minimum size of the ground conductor must be 12 AWG copper or 10 AWG aluminum .
28. For a 60 amp circuit, the minimum size of the ground conductor must be 10AWG copper or 8 AWG aluminum
29. For a 100 amp circuit, the minimum size of the ground conductor must be 8AWG copper or 6 AWG Aluminum
30. The minimum size of the main ground conductor that is connected to the ground electrode will be the size of the largest equipment grounding conductor.
31. The size of the conductor is based of the largest service-entrance conductor or equivalent area of parallel conductors.
32. NEC 250.68 (B) connection of grounding electrode conductor must be permanent and effective.
33. NEC 250.70 methods of connections include exothermic welding, (UL or CSA or equivalent) listed lugs, listed pressure connectors, listed clamps, and other listed means of connection.
34. No use of solder (very low melting point).
35. Grounding connections/joints must be maintained in a manner not to increase the resistance of the grounding system.
36. Connections must have proper mechanical methods and must not be capable of becoming corroded.
37. Note: IEEE Std 80, “Guide for Safety in Substation Grounding is an excellent resource for determining the minimum size of grounding conductors based on the type of connection used.
38. Connectors and splice connections must meet IEEE Std 837. Also refer to NEC Table 8.
39. Always assume that components capable of conducting electricity are energized at the highest voltage to which they are exposed to unless they are properly grounded. Inspect ground connections frequently
40. NEC Section 250.114 discusses the proper grounding of cord and plug-connected equipment.
41. The standards now require that all equipment must be provided with a 3 prong plug and be effectively grounded.
42. DO NOT USE ADAPTERS WHICH interrupt the continuity of the equipment grounding connection. THESE ARE NOT SAFE. Replace your electrical receptacle with a 3 prong outlet and ensure proper grounding of the green wire. THESE ARE STILL READILY AVAILABLE AND SHOULD BE OUTLAWED!
43. NEC 250.118 identifies types of equipment grounding conductors. Material to be used for ground conductors should either be copper or copper cladded aluminum. Although not illegal, I personally would not use aluminum conductors.
44. **BONDING:**
45. Non-current-carrying electrical parts capable of conducting electricity must be effectively grounded and bonded together.
46. **FUSES:**
47. Must be inspected on a routine basis for signs of overheating, lose connections, overload currents, and environmental conditions.
48. Always use proper sizes as recommended by the manufacture of the equipment.
49. For non-high inrush current equipment, it is recommended that fuses not exceed 125% of the full load current. Never exceed twice the rated current of the equipment.
50. When fuses are located in both the negative and positive electrical power cords, they must be the same size and from the same manufacturer.
51. Check the tightness of fuse mounting clips and hardware.
52. Don’t ever place aluminum foil across a fuse if you do not have the proper size. The fuse blew for a reason. This is asking for trouble!
53. **BATTERIES**
54. Electrical hazards:

1. Shock and arcing

2. Dangerous accumulation of heat is possible.

3. Severe burns

4. Do not wear jewelry and keep conductive tools away.

 B. Chemical Hazards:

 1. Chemicals destructive to human tissue, eyes and serious burns may occur.

 C. Explosion Hazards:

 1. Excessive heat.

 2. Excessive charging (Smart Chargers normally prevent this)

 a. Overcharging and too rapid of charging can cause hydrogen to escape.

 (1). Hydrogen can explode at concentrations of 4 percent or 5 percent by volume.

 3. Excessive discharging may occur

 a. Can cause a cell to pressurize and explode if it cannot properly vent.

 D. Safety Precautions:

 (1) Use low voltage gloves

 (2) Insulated tools

 (3) Non-conductive, non-sparking tools

 (4) Arc protection (face shield and flame retardant clothing)

 (5). To prevent exposure to dangerous Chemicals:

 AA. use Protective clothing (long sleeves and pants (not shorts))

 AB. Face shields and goggles

 AC. Chemically resistant gloves

 AD. Safety shoes

 AE. Ample supply of water

 AF. Eye and body wash station

 AG. Nuetralizing solution

1. NICAD – 7 oz boric acid per gallon of water
2. Lead acid 1 pound baking soda per gallon of water

 (6) Adequate ventilation is essential.

 AA. Hydrogen concentrations must be maintained at less than 1%

 (7). Class C fire extinguisher must be available

E. NATIONAL ELECTRIC CODE REQUIREMENTS FOR BATTERIES

 1. NEC ARTICLE 480

 a. 480.3 (A) Dissimilar Metals

 (1). Where mating dissimilar metals, antioxidant material suitable for the battery connection shall be used.

 b. 480.3 (B) Connections and conductors

 (1) Shall have a cross-sectional area that the temperature rise under maximum load conditions and at maximum ambient temperature shall not exceed the safe operating temperature of the conductor insulation or of the material of the conductor supports.

 (2) 480.3 (C) Electrical connections to battery shall not put mechanical strain on the battery terminals. Terminal plates shall be used where practicable

 (3) There should be a means of disconnecting all ungrounded connectors derived from a stationary battery system.

 (4) Battery terminals shall be accessible

 (5) Live parts shall be guarded against contact

 c. Batteries should be well ventilated

 (1). Ventilation shall be provided to prevent an accumulation of an explosive mixture if that possibility can exist. Adequate ventilation shall be provided in accordance with NFPA 1 Fire Code Chapter 52.

 d. NEC 480.8: (A) Racks and Trays shall be provided.

 (1) They should be non-conductive and be resistive to deterioration caused by the electrolyte

 (2) Batteries and battery racks must have a 1 inch clearance from walls

 (3) Battery stands can contact walls provided that the battery shelf has a free air space not less than 90% of its length.

 e. Egress from locations where batteries are located shall open in the direction of egress.

 f. Batteries must not be located in locations where gas piping is present

 g. Adequate lighting must be provided.

 h. Flame arrestors are necessary to prevent spark or flame under normal operating conditions

 i. Sealed cells must have pressure-release vents

1. INFORMATION TECHNOLGY EQUIPMENT/COMPUTERS (INCLUDES HAM RADIOS)
2. NATIONAL ELECTRIC CODE REQUIREMENTS - NEC 645
3. NEC 645.5 Supply Circuits and Interconnecting Cables
4. Branch Circuit Connectors-
5. The Branch Circuit Conductors supplying one or more units of information Technology equipment shall have an ampacity not less than 125% of the total connected load.
6. Power Supply Cords shall not exceed 15 feet.
7. Power Supply Cords must be laboratory tested and listed
8. Cords must be protected from physical damage
9. Do not have any unused cables laying around
10. NEC 645.15 Equipment Grounding and Bonding
11. All exposed non-carrying metal parts of Information Technology equipment shall be bonded to the equipment grounding conductor or shall be double insulated.
12. Doors to rooms containing IT equipment should open in the direction of egress.
13. SOLAR POWER SYSTEMS- NEC 690
14. NEC 690.4: All equipment must be listed by UL or equivalent
15. NEC 690.5 Ground Fault Protection
16. Must have a Ground-Fault Detection System and Interruption
17. Must be capable of detecting a ground fault in the PV array, dc current carrying conductors and components including intentionally grounded conductors
18. Must interrupt the flow of fault current.
19. Must be listed for providing ground fault protection
20. Overcurrent protection must be provided in accordance with NEC 240.5(b)(2)
21. Overcurrent Device ratings shall not be less than 125% of the maximum currents calculated
22. Inverters must be rated equal or greater than the load posed by the largest utilization equipment connected to the system
23. Conductors must be protected from over-currents in accordance with Article 240
24. Conductors must be sized based on the output rating of the inverter
25. DC Arc Fault protection must be provided in accordance with NEC 690.11
26. Rapid Shutdown method must be provided (NEC 690.12)
27. Disconnecting means must be provided in accordance with NEC 690.13 and must also be manually Operable (NEC 690.17)
28. Must not be able to disconnect the ground conductor (NEC 690.17).
29. Must be able to interrupt the maximum voltage and current (NEC 690.17 (E)
30. The system must be separate from the normal electrical system and its components (NEC 690.31)
31. All components of the system must be labeled.
32. Solar Power System must have grounding in accordance with NEC 690.42

**XIV GENERATORS**

1. Must comply with NEC Article 445
2. NEC 445.12 Generators must be protected from overload by inherent design, circuit breakers, fuses, protective relays or other identified overcurrent protective device
3. Cables led from Generator must have overcurrent protection rated at 115% of the nameplate current rating of the generator.
4. Conductors that must carry ground fault current must not be smaller than that required by NEC 250.30(A)
5. NEC 445.16 When passing through a barrier of any kind, bushings must be provided to protect conductors from openings having sharp edges.
6. NEC 445.20 Ground fault circuit Interrupter Protection must be provided

**XV. COMMUNICATIONS SYSTEMS**

 A. Chapter 8 of the National Electric Code

 1. Abandoned cables remaining in place must be tagged

 2. NEC 800.24 Communications circuits, cables and equipment shall be installed in a neat and workmanlike manner.

 3. Cables installed on ceilings and walls shall be secured by hardware, including straps, cable ties, hangers, or similar fittings designed and installed so as to not damage the cable.

 4. Non-metallic hardware must be listed as having low smoke and heat release properties.;

 5. Where cables run through walls, etc, the holes must be sealed to prevent spread of fire using heat/fire resistant materials. Proper firestops and methods must be provided

 6. NEC 800.25 Accessible portions of abandoned cables must be removed

 7. NEC 800.44 (A) Cables On Poles and In-Span

 (a) Relative Location

 (i) Where practical, communications wires and cables shall be located below the electric light or power conductors.

 (ii) Cables shall not be attached to a cross-arm that carries electric light or power conductors.

 (iii) Where both electric cables and communications cables are on the same span, there must be 12 in separation vertically.

 (iv) There must be a 40 inch separation horizontally

 (v) Communications cables and wires running above roofs shall have an 8 foot clearance

 (vi) Underground communications cables and wires in a raceway that also includes power lines/conductors shall be separated by means of brick, concrete, or tile partitions by means of a suitable barrier.

1. NEC 800.49 Metallic Conduit
2. Metallic Conduit that is used to contain communications cables must be grounded
3. NEC 800.50 (C) Where communications cables and wires enter a building, they must enter

Through a noncombustible, nonabsorbent insulated bushing or through a metal raceway

This is not required when the wires and cables are (1) metal-sheathed cable (2) pass through masonry and non-fused. Raceways and bushing shall slope upward from the outside. If not capable, loops shall be formed in the communications wires and cables immediately before they enter the building. Conduits and raceways for cables and wires entering buildings shall be grounded.

10. NEC 800.53 Lightning Conductors

1. Where practical, a separation of at least 6 feet shall be maintained between communications wires and cables on buildings and lightning conductors.

11. NEC 800.90 A (Lightning Arrestor)

1. A listed primary protector shall be provided on each circuit of an aerial wire
2. This should be fused
3. Ground rod wires shall not be smaller than 14 AWG and not be required to be larger than 6AWG
4. Both communications and power grounding electrode systems must be connected together in single and 2 family dwelling
5. Grounding wires should be a short as possible and not exceed 20 feet

They shall be run in straight lines as far as practical.

1. Grounding wires must be protected where exposed to physical damage
2. Where separate grounding rods or means are provided for both communications cables/wires and power systems, they must be interconnected by a jumper not smaller than 6AWG copper or equivalent
3. NEC 800.110 (C) (1) Communications cables/wires when run horizontally must be supported at intervals not exceeding 3 feet.
4. NEC 800.110 (C) (2) Vertical supports of communications cables/wires shall be supported at intervals not exceeding 4 feet and shall not have more than 1 connector/joint between supports

**XVI. RECEIVING ANTENNAS NEC 800**

1. NEC 810.11 Material
2. Antennas and lead-in conductors shall be constructed of hard-drawn copper, bronze, aluminum alloy or other high strength corrosion resistant material
3. Soft drawn copper or medium drawn copper shall be permitted for lead-in conductors where maximum span between supports is less than 35 feet.
4. NEC 810.12 Supports for wire strung Antennas
5. Outdoor antennas and lead-in conductors shall be securely supported
6. They shall not be attached to the electric service mast.
7. They shall not be attached to poles or similar structures carrying open electric light or power wires of over 250 volts between conductors.
8. Insulators supporting antenna conductors shall have sufficient mechanical strength to safely support the conductor.
9. Lead-in conductors shall be securely attached to the antenna (coax and 300 ohm twin lead)

C. NEC 810.13 Avoidance of Contacts with Conductors of Other Systems

 1. must not cross over open conductors of electric lighting and power circuits and shall be kept well away from such circuits so as to avoid the possibility of accidental contact

1. When proximity of lighting and power conductors below 250 volts cannot be avoided, the installation shall be such as to provide a clearance of at least 2 feet.
2. Antenna conductors shall be installed so as to not cross under open electric light or power conductors.
3. NEC 810.14 Splices in Receiving Antennas
4. Splices and joints in antenna spans shall be mechanically secure with approved splicing devices or by such means as will not appreciably weaken the conductors
5. NEC 810.15 Groundings
6. Masts and metal structures supporting antennas shall be grounded in accordance NEC810.21.
7. NEC 810.16 size of wire strung receiving antennas
8. Must be sized not less than given in Table 810.16(A).
9. Self-supporting Antennas
10. Outdoor antennas such as rods and flat, parabolic ,or dipole structures, shall be corrosion resistant and strong enough to remain intact when coated with ice and withstand wind loading conditions.
11. Must be located to avoid the possibility of the antenna or structure falling into or making accidental contact with power electrical lines
12. Lead-ins for Antennas
13. NEC 810.17 Size of Lead-in for Receiving Station antennas shall have a tensile strength as least as great as that of the conductors for the antennas
14. Where lead-ins contain more than one conductor, the combined tensile strength shall be the same as that of the antenna.
15. Lead-in conductors attached to house/building that are flexible cannot swing closer than 2 feet to the conductors of power circuits of 250 volts or less.
16. Where lead-in conductors are supported so as to ensure permanent separation, the separation distance shall not be less than 4 inches
17. The clearance between antenna lead-in conductors and any conductor forming part of a lightning protection system shall not be less than 6 feet.
18. Underground lead-in conductors shall be separated at least 12 inches from conductors of any light or power circuits.
19. Antennas and Lead-ins-Indoors shall not be closer than 2 inches to conductors of other wiring systems in the premises.
20. In boxes and enclosures Indoor antennas and indoor lead-ins may occupy the same box or enclosure with conductors of other wiring systems provided they are separated by an effective permanently installed barrier.

**XVII LIGHTNING PROTECTION SYSTEMS**

1. NFPA 780-2014, Standard for the installation of Lightning Protection Systems
2. Contains detailed information on grounding, bonding, and spacing from lightning protection systems
3. NFPA 780-2011, Standard for Installation of Lightning Protection Systems specifies the requirements for antenna lead-in systems that are contained in metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical equipment installed on buildings equipped with a lightning protection system
4. may require bonding or spacing from the lightning protection conductors
5. Separation of antenna lead-in conductors from lightning protection conductors is typically 6 feet through air or 3 feet through dense materials such as concrete, brick or wood.

3. Bonding conductors and grounding electrode conductor shall be copper, aluminum, copper-clad steel, bronze, or similar corrosion-resistant material.

1. Aluminum or copper-clad aluminum bonding conductors or grounding electrode conductors shall not be used where in direct contact with masonry or the earth or where subject to corrosive conditions
2. Where used outside aluminum or copper-clad aluminum conductors shall not be installed within 18 inches of the earth.
3. Insulation is not required on bonding conductors or grounding electrode conductors
4. Bonding conductors or grounding electrode conductor shall be securely fastened in place and shall be permitted to be directly attached to the surface without the use of insulating supports
5. Where supports are not provided, the conductors shall be increased to enable self-support
6. Where exposed to physical damage, these protectors must be protected to prevent damage
7. Where bonding conductors and grounding electrode conductors are installed in a metal raceway, both ends of the raceway shall be bonded to the conductor
8. Bonding conductors and grounding electrode conductors for antenna masts shall be run as straight as possible
9. Bonding and ground electrode conductors shall not be less than 10AWG for copper, 8 AWG for aluminium or 17AWG copper clad steel or bronze

XVII. TRANSMITTING ANTENNAS INCLUDING HAM RADIO ANTENNAS.

1. NEC 810.52 Size of Transmitting Antenna Conductors for ham radio stations must comply with Table 810.52
2. Antennas where the open span length is less than 150 feet for both hard drawn copper, copper clad steel or other high strength material must not be less than 14 AWG
3. Where the antenna open span length is over 150 feet the minimum size of hard drawn copper must not be less than 10 AWG. All other acceptable materials must not be less than12AWG wire
4. NEC 810.54 Open Antenna conductors attached to buildings shall be firmly mounted at least 3-in clear of the surface.
5. Supports must be nonabsorbent insulating such as treated pins or brackets equipped with insulators having not less than 3 inch creepage and airgap distances. Lead-in conductors attached to buildings shall also comply with these requirements
6. Metal sheathed coax cable does not have to comply with these requirements. However, it must be grounded in accordance with NEC 810.56
7. NEC 810.55 Lead-in conductors shall enter buildings by one of the following methods
8. Through a rigid, non-combustible, nonabsorbent insulated tube or bushing
9. Through an opening provided for the purpose in which the entrance conductors are firmly secured so as to provide a clearance of at least 2 inches.
10. Through a drilled window pane.
11. NEC 810.56 Protection against Accidental Contact
12. Lead in conductors to radio transmitters shall be located or installed so as to make accidental contact with them difficult.
13. NEC810.57 Lightning Arrestors
14. Unless grounded coax is used, antenna discharge units are required for transmitting stations. This is required for individual conductors.

NOTE: It is not just the height of an antenna that makes it susceptible to lightning strikes. Antennas and transmission line can accumulate static electrical charges that also increase the changes of lightning hitting an installation. To properly "draw off" this static electricity, a small device known as an antenna discharge unit must be included on the installation. The antenna discharge unit (also called a "Lightning arrestor") is connected to the transmission line at a point close to where the transmission line enters the house. One end of a ground wire is attached to the discharge unit. The other end of the wire is connected directly to the ground rod

1. NEC 810.58 (B) Size of Protective Bonding Conductor or Grounding Electrode Conductor for transmitting stations shall be as large as the antenna lead-in, but not smaller than 10 AWG copper or equivalent
2. NEC 810.70 Clearance of Antenna conductors and lead-ins shall be separated by at least 4 inches from any electrical conductor for lighting, power or signaling circuit

Note: This does not apply to raceways. However, there are specific requirements for raceways

XIX HAM RADIO TRANSMITTERS

1. NEC 810.71 Transmitters
2. Must be enclosed in metal frame or grille separated from the operating space by a barrier or equivalent means, all metallic parts of which are effectively connected to a bonding conductor or grounding electrode conductor
3. Metal handles and controls accessible to the operating personnel shall be effectively connected to an equipment grounding conductor if the transmitter is powered by the premises wiring system or grounded with a conductor in accordance with 810.21
4. Interlocks on Doors: All access doors shall be provided with interlocks that disconnect all voltages over 350 volts between conductors when the access door is opened. (Linear Amps, etc)clothes that melt (synthetic) wear flash/flame resistant clothing when possible

**XX FIRES**

1. HAVE A PLAN that the entire family is aware of. Practice it. Have a meeting place outside.

Have an exit plan.

1. Be aware that when a fire starts, children get scared and hide. Teach them not to do that.
2. Teach them to have an alternate plan if the first one cannot be used due to location of fire.
3. If you are on a 2nd or higher floor
4. Have a chained emergency ladder close to you that is used by opening a window, thrown out and attached to the window. Keep a hammer in same location as ladder to be used to break glass window if necessary.
5. Keeping doors closed inside house at all times slows the spreading of fires.
6. Understand the science and chemistry of fires
7. The fire triad: In order to have a fire, you have to have heat, fuel and oxygen. Take one of these away and the fire cannot exist
8. Not all fires are the same. Different fuels create different fires and require different types of fire extinguishing agents.
9. **Types of Fires:**
10. Class A fires are fires in ordinary combustibles such as wood, paper, cloth, trash, and plastics.
11. Class B fires are fires in flammable liquids such as gasoline, petroleum oil and paint. Class B fires also include flammable gases such as propane and butane. Class B fires do not include fires involving cooking oils and grease.
12. **Class C fires are fires involving energized electrical equipment such as motors, transformers, and appliances. Remove the power and the Class C fire becomes one of the other classes of fire.**
13. Class D fires are fires in combustible metals such as potassium, sodium, aluminum, and magnesium.
14. Class K fires are fires in cooking oils and greases such as animals fats and vegetable fats.
15. Types of Fire Extinguishers and their applications:
16. Water and Foam

 Water and Foam fire extinguishers extinguish the fire by taking away the heat element of the fire triangle. Foam agents also separate the oxygen element from the other elements.

1. **Water extinguishers are for Class A fires only - they should not be used on Class B or C fires.** The discharge stream could spread the flammable liquid in a Class B fire or could create a shock hazard on a Class C fire.
2. Carbon Dioxide extinguishers

 Carbon Dioxide fire extinguishers extinguish fire by taking away the oxygen element of the fire triangle and also be removing the heat with a very cold discharge.

 Carbon dioxide can be used on Class B & C fires. **They are usually ineffective on Class A fires.**

1. Dry Chemical extinguishers
2. Dry Chemical fire extinguishers extinguish the fire primarily by interrupting the chemical reaction of the fire triangle.

**(ii) Ordinary dry chemical is for Class B & C fires only. It is important to use the correct extinguisher for the type of fuel! Using the incorrect agent can allow the fire to re-ignite after apparently being extinguished successfully.**

1. **If the area has live electrical wiring, you'll need a Class C extinguisher. In general, an**

**A:B:C extinguisher, which handles all three, is likely to be the best choice for your home.**

**(e)Today's most widely used type of fire extinguisher is the multipurpose dry chemical that is effective on Class A, B, and C fires. This agent also works by creating a barrier between the oxygen element and the fuel element on Class A fires.**

1. Wet Chemical extinguishers

Wet Chemical is a new agent that extinguishes the fire by removing the heat of the fire triangle and prevents re-ignition by creating a barrier between the oxygen and fuel elements.

1. Clean Agent extinguishers
2. Halogenated or Clean Agent extinguishers include the halon agents as well as the newer and less ozone depleting halocarbon agents. They extinguish the fire by interrupting the chemical reaction of the fire triangle.
3. clean agent extinguishers are primarily for Class B & C fires. Some larger clean agent extinguishers can be used on Class A, B, and C fires.

1. Dry Powder extinguishers

Dry Powder extinguishers are similar to dry chemical except that they extinguish the fire by separating the fuel from the oxygen element or by removing the heat element of the fire triangle.

 However, dry powder extinguishers are for Class D or combustible metal fires, only. They are ineffective on all other classes of fires.

1. Water Mist extinguishers

 Water Mist extinguishers are a recent development that extinguish the fire by taking away the heat element of the fire triangle. They are an alternative to the clean agent extinguishers where contamination is a concern.

 Water mist extinguishers are primarily for Class A fires, although they are safe for use on Class C fires as well.

1. Cartridge-Operated Dry Chemical extinguishers

Cartridge Operated Dry Chemical fire extinguishers extinguish the fire primarily by interrupting the chemical reaction of the fire triangle.

1. Like the stored pressure dry chemical extinguishers, the multipurpose dry chemical is effective on Class A, B, and C fires. This agent also works by creating a barrier between the oxygen element and the fuel element on Class A fires.
2. Ordinary dry chemical is for Class B & C fires only. It is important to use the correct extinguisher for the type of fuel! Using the incorrect agent can allow the fire to re-ignite after apparently being extinguished successfully.

1. **How to size a fire-extinguisher**
2. A fire extinguisher's size is just one of several factors that determine its effectiveness. To protect yourself and your home in the event of an emergency, you need fire extinguishers that are not only the **right size but also of the right type and rating.** The product's type identifies what kinds of fires it can put out -- ordinary fires, oil or gas fires or electrical fires -- and its rating identifies how quickly it can work. Its size is actually less important than either of these other two variables.
3. **Examine the area where you plan to keep the fire extinguisher. Determine which types of fires might start there. For most home fires, you'll need a Class A extinguisher, which handles burning wood, fabric, paper and other standard household items. If the area contains any oil, gasoline, paint, paint thinners or grease, you'll need an extinguisher which can also tackle Class B fires.**
4. Consider how quickly a fire could spread in the area and how long it might take you to become aware of the emergency. Choose a higher or lower rating based on these factors. For example, a garage fire might spread before you knew it was happening, so choose a higher rating for an extinguisher for the garage; a small home office fitted with a fire alarm is likely to burn less quickly, so a lower rating is acceptable for such rooms. According to the Industrial Accident Prevention Association, a rating of 2A:10B:C should be enough for a home fire extinguisher.
5. **Look at the size of the area and where fires are most likely to start. For a large room, consider a large extinguisher, such as a 10-pound model. For a small room, a 5-pound model should be sufficient. If the fire is likely to begin in a small, specific location, look for a stove-top model that automatically activates when the area reaches a dangerous temperature.**
6. Go to a home improvement or hardware store and handle the fire extinguishers that fit your requirements for type, rating and size. Make sure you're able to lift and maneuver the products easily. If you aren't, select two smaller extinguishers instead of one larger model, and plan to use the second extinguisher in an emergency if the first one isn't large enough to put out the fire by itself.
7. **How to use a fire extinguisher**
8. Stand roughly 8 feet from the fire and hold the extinguisher in one hand. Make sure you have an escape route that you can easily access without heading past the fire.
9. Pull the pin on the fire extinguisher to release the handle. Toss the pin aside.
10. Aim the hose of the extinguisher at the base of the fire, not at the smoke or flames, then squeeze the handle firmly.
11. Sweep the contents of the extinguisher back and forth across the **base of the fire**, maintaining even pressure on the handle.
12. Stop spraying the extinguisher once the fire has gone out and call 911 for help if needed.