Chapter 8

Safety

Electric Shock

The human body can conduct electricity and is susceptible to electrical shock. Electrical shock can range from mild tingling to severe burns and even death. The high voltage is not normally fatal as demonstrated by coming into accidental contact with` the spark plug lead of a motor car. If the accompanying current is sufficiently high enough, the heart is affected, and this may lead to death. With higher current values and the body is burnt internally and externally.

Safe Work Australia states that between 2003–15, one hundred and forty-two (142) workers died due to contact with electricity (an average of 11 workers each year). It also identifies the types of equipment that poses greater risk than others.

- Portable electrical equipment including plugs and sockets; electrical connections; the cable itself. All are especially vulnerable to damage.
- Extension leads, particularly those connected to equipment that is frequently moved, can suffer similar problems.

Mains Circuit Breakers

Older style houses may still be fitted with wire fuses. A licenced electrician should be engaged to replace the fuses with Circuit Breakers (CB) and install a Residual Current Circuit Breaker (RCCB) also known as a Residual Current Device (RCD) or safety switch. Fuses require an excess of the rated current to flow through the fuse wire before the fuse blows and are generally slower to react to excess current that a CB.

An RCCB/RCD will save your life by ensuring that in case of a current leakage or an imbalance in current, which could result in electrocution, the current is cut off. A CB will save your home from electrical fires by ensuring that the wires are not overheated and that there is no overload on the electric circuit. You need to ensure that you have both in your house. A 30-mA current through your body is enough to cause cardiac arrest or irreversible damage to your body.

The RCCB/RCD is a safer device as they immediately cut off the power source when electricity leaking to earth is detected at a level that is harmful to humans. I know they work well from personal experience.

Mains Wiring

As experimenters, homebrewers and repairers of our equipment plugged into the 240 VAC (50 Hz) mains, we need to be mindful of electric shock-hazards. The socket outlet (General Power Outlet (GPO)) on the wall is the source of electricity and is usually rated at 10 Amps. Any hard-wired equipment (e.g., Ovens, cook tops) or anything behind that GPO can only be altered or repaired by a licenced electrician. The work must comply with the Australian/New Zealand Wiring Rules AS/NZS 3000:2018.

Our area of focus extends from the three-pin plug, which plugs into the GPO, and lead that supplies power to our communications equipment.

The Three Pin Plug.

The standard three pin power plug used in Australia is also utilized in New Zealand, Fiji, Tonga, Solomon Islands, Cook Islands, Papua New Guinea, and several other Pacific Island countries.[i]

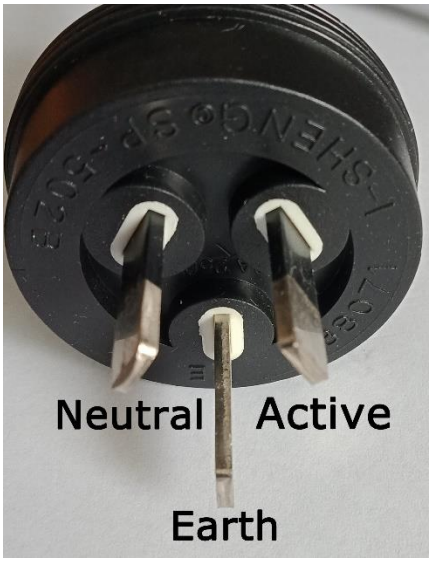

Figure 1: Three pin power plug.

Wire Colours

The neutral conductor is normally coloured blue and is the return path for the circuit.

The Earth conductor is coloured green with a yellow tracer. This wire must be connected to the metal case of any equipment. The Earth provides protection if the equipment fails. The Earth pin is electrically connected to an Earth stake near your power box.

Deliberately disconnecting the Earth and operating the equipment is an extremely dangerous practice.

Older equipment may have the older coloured wiring fitted.

- Active – Red
- Neutral – Black
- Earth - Green

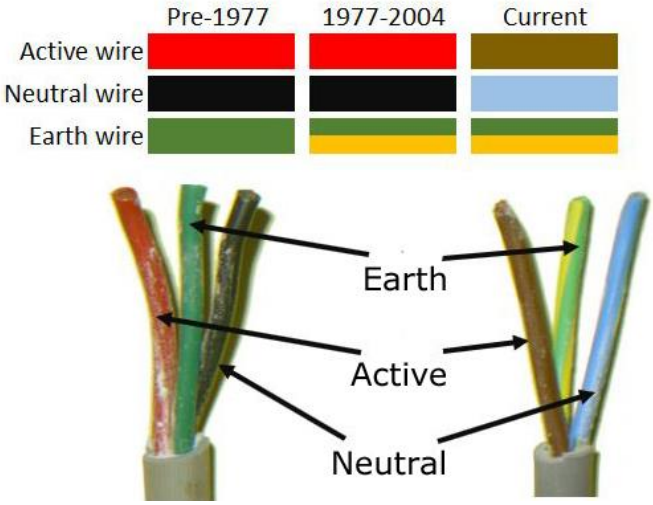

Figure 2: Wiring colours.

Testing

Using a multimeter set correctly to test the voltage on the wires will produce the following results.

- Between Active and Neutral, the reading is 240 V.
- Between Active and Earth, the reading is 240 V.
- Between Neutral and Earth, the reading should be 0 V.

A worthy practice is to perform a continuity check between the metal chassis of the equipment and the Earth pin. If there is no continuity, repair the Earth lead before proceeding.

Other Hazards

Before opening any communications equipment for service or repair, unplug the device from the mains. Inspect the cable for any breaks or bare wires.

Once the case is open, some capacitors may still be holding their full charge. Caution is especially required if the equipment is valve operated as they may have many hundreds of volts in circuits around the valve.

Some hazardous substances were used in older communications equipment that are dangerous or even toxic to humans. Caution should be exercised when rebuilding or repairing older equipment.

Safety in the Shack

Electric shock

The Human body can be damaged by current flowing through the skin and muscles. The muscle can spasm severely. If the heart muscle spasms severely, the heart he most dangerous condition is when the current is sufficiently high to cause the heart may go into ventricular fibrillation. Fibrillation is when the heart is not pumping normally, and the blood is no longer circulated. This can lead to death.

Our skin resistance will determine the amount of current which will flow through our body if we touch a live conductor. If the voltage is high enough, burns may also result.

As radio operators, we need to be cautious when dealing with 240V AC mains equipment. If the equipment also is fitted with valves and transformers, the voltages may be in the thousands.

Some tips when working with mains equipment are:

- Wear insulated shoes Not bare foot.
- Isolate the power.
- Ideally have a co-worker.
- Ensure the equipment is grounded.

Current level and affects.

- At 0.001 amps the sensation is discernible.
- At 0.01 amps pain is experienced
- Between 0.01 amps and 0.1 amps breathing will become difficult and severe shock will be experienced.
- From 0.1 to 1-amp severe burns can occur, breathing stops and death almost certainly can result.

Disconnected earths.

Deliberately disconnecting the earth is an extremely dangerous practice. When working on mains equipment, the earth is the last wire removed and the first wire to be replaced.

Bare conductors
Keep body parts away from any bare conductors in equipment.

Capacitors
Capacitors look innocuous but can still retain a deadly charge. A charged capacitor which can supply sufficient current to kill. Discharge any unknown capacitors with an insulated screwdriver before handling.

Mains wiring
The standard power point (often referred to as a GPO- General Purpose Outlet) supplies 240 Volts at 50 Hz to our equipment and are usually rated at 10amps. Loads on these power points should be monitored and overloading prevented.
Mobile or Portable antennas
Before erecting any antenna at a mobile of portable site, look up. Ensure the antenna will not contact any overhead power lines.

Flexible Mains Cords
The Active conductor, coloured brown, is the dangerous wire.
The neutral conductor, coloured blue, is at or near-earth potential. The neutral carries the return current from any piece of equipment plugged into the GPO.
The Earth conductor, coloured green with a yellow trace, must be connected to the metal case of any equipment.

Earth connector
If the equipment fails and the equipment case becomes live, the earth lead will shunt the current to earth. The circuit breaker will trip, and the hazard is removed from the equipment.

Fuses
A fuse is designed to melt when the current exceeds the fuse ratings. This will open the circuit and stop the supply of electricity. If you house or shack is fitted with main fuses, have them replaced with circuit breakers.

Circuit breakers (CBs)
CBs come in various names and types. They are quicker to operate than fuses and require far less leakage current.

Lightning
Lightning is not friendly with antennas and radio equipment and can cause extensive damage. If lightning is predicted in our area, close the station, disconnect radios from antenna and earth all the antenna cables coming into the shack.

Lightning arrestors can be installed if lightening is a constant hazard.

Surges or spikes from a lightning strike can induce spikes in cabling and wiring. Insulation breakdown and damage can often be caused this way.

RF hazards
The high RF power levels in transmitters and amplifiers are a risk in themselves.
Shielding of the high-power compartments helps to contain the RF energy and to prevent unwanted exposure to RF fields.

At Microwave frequencies, RF fields can become a hazard to eyesight as the concentrated energy can affect the eyes.

Hazardous chemicals
Items include:

- acids such as sulphuric acid in batteries
- alkalis such as caustic soda,
- Polychlorinated Biphenyls. (PCB) in transformer insulating oils,
- etchants such as ferric chloride
- ammonium persulphate,
- insulators such as
- beryllium oxide
- asbestos

Precaution should be taken when handling any chemical.

- Wear gloves.
- Wear eye protection.
- Wear breathing apparatus if needed.
- Have soap and water on hand in case of a spill.

Gases
Charging a lead-acid battery generates gases. Only charge lead acid batteries in open spaces or well-ventilated areas.

Go to Chapter 7 Questions.

Have fun and stay safe.

[i] Wikipedia.

