

## **ELECTRICAL SAFETY**

1. The main hazards arising from the use of electrical equipment are:

- Electric shock
- Fire caused by overheated conductors
- Explosion due to a spark in a flammable atmosphere

To prevent electricity becoming a source of harm, electrical equipment should be:

- Installed correctly and be suitable for the application.
- Used correctly.
- Maintained in good condition.

### **2. Electric Shock**

Electric shocks occur when contact with a live conductor causes sufficient current to pass through the body to cause an injury. As a guide, voltages equal to or exceeding 50Vac or 120Vdc should be considered hazardous in a dry, unconfined, non-conductive location. These voltages must be reduced if the location is wet, confined or conductive.

For our purposes, and to avoid having to remember these voltages, 30V (either ac or dc) is taken to be the threshold above which live working conditions become applicable.

### **3. Buildings and Supplies**

All electrical installations normally fixed as part of a building (e.g. sub-stations, mains outlets, switchgear, power circuits, permanent lighting, emergency lighting, fire alarms, fuse boards etc.) are the responsibility of Estates. In order to maintain, alter and upgrade these installations Estates employs qualified electricians or, if necessary, outside approved electrical contractors. All work is executed in accordance with the latest edition of the IET (Institute of Engineering and Technology) regulations and British Standard Code of Practice.

Persons other than the above operatives must on no account alter or interfere with any of the installations. No attempt to repair fuses or circuit breakers should be made. Faults must be reported immediately to Estates.

### **4. Live Working**

The Electricity at Work Regulations prevents working on or near live terminals unless it is not otherwise possible to repair or test an appliance or installation without the power being applied. This requires considering all alternatives prior to going ahead with the work.

For our purposes working with live terminals in excess of 30 V, whether ac or dc, is considered to be Live Working.

In order to diagnose a fault in electrical/electronic apparatus it is normally necessary to take test measurements at various places within the circuit with the power applied. Whenever possible the application of probes to the test points should be done with the unit switched off and only powering up when everyone is clear of the equipment. This is not always possible and therefore careful controls are required in order to remove risk of accidental contact with live terminals. In working with live equipment, it is for test purposes only, no connection or disconnection of live terminals should be made with the equipment live.

Only persons trained and deemed competent are permitted to undertake live working. Some workers lack the necessary skills to work live and so pose a threat to their own health as well as to others and require close supervision. Trainees and other persons so designated must

not begin live work unless supervision is available. A list of those authorised to conduct such work must be maintained and displayed, if your name is not on it then do not start work.

The decision as to whether it is necessary to work with the equipment live is left to the individual worker with the necessary competency and authorization to perform such work.

#### 4.1 Test Equipment

The correct test equipment must be used when working live. Ensure that the test equipment you use:

- Is designed and fit for the purpose.
- Equipment and probes are of sufficient capacity for voltage and current and be in good condition.
- All protective elements are intact. (e.g. has someone removed the earth from the oscilloscope?)
- Meets required standards.

Whenever possible, and for all voltages above 30V, probes should be attached and detached with any electrical power removed and capacitors, or other charged components, safely discharged.

Protective devices should be used if possible but not be wholly relied upon as they will not protect against electrical circuits isolated from the mains supply.

#### 4.2 Precautions

Consider any dangers - ask yourself:

- Can the work be done with the equipment dead?
- Am I authorised to conduct live working at this voltage?
- Should I be accompanied by a colleague and is someone available to assist in an emergency?
- Is it absolutely necessary to work on or near equipment that is live at dangerous voltage or current levels?
- Have suitable precautions been taken to avoid injury?
- Am I competent to carry out this work unsupervised?
- Is there room to move or stand back in case of a problem or is there a risk of being knocked by a passer-by?
- Is the area cluttered with perhaps bottles of chemicals?
- Are you familiar with the appliance?
- Are the voltages/currents excessive such as in X-Ray or Laser equipment?
- Is the test equipment adequate?
- Is someone available to assist in an emergency?
- Could the lights be accidentally switched off leaving you in the dark?
- Does the area need to be cordoned off to prevent others from entering and risking themselves or the person working?

Set in place adequate precautions to prevent danger to yourself and others. These may include:

- The use of RCD's or isolating transformers.
- The use of lockouts, barriers and signs.
- The use of suitable insulation to cover dangerous terminals.

- Powering the circuit from a lower voltage. For example in some electronic devices you can by-pass the appliances built-in mains driven power supply and instead attach a bench power supply thus eliminating the mains voltages from the device.
- Be sure to familiarise yourself with the type of equipment under test. EG does it generate high voltages internally?
- Whenever possible attach probes to H.V. terminals when the equipment is dead.
- Use safety glasses where a danger of arcing exists.
- Do not work alone and ensure that someone is aware that you are working on live equipment and the location and nature of the equipment. This should consist of telling the supervisor and the person responsible for the area you are working. If necessary, work in pairs.
- Do not leave exposed live terminals unattended even for a moment. If you must leave the power on whilst not in attendance then dangerous terminals must be adequately covered by replacing and securing the covers. Persons within the area must be made aware of the danger by the use of signs such as 'Danger - Electric Shock Risk' or 'Danger - Live Conductors' placed adjacent to the equipment and where necessary kept out by the use of suitable barriers. Equipment being tested overnight must have all their terminals securely covered and adequate warning signs and barriers used.
- If there is a chance of insufficient light in the event of a main lighting failure then have a spare lamp operating from a local socket separate from the main lighting circuit.

## 5. Non-Live Working (Permanently Connected Mains Connections)

The major hazard is accidental switching on of the isolators by persons other than the technician carrying out the work. This may be because the technician has left the area for any reason and an individual unknowingly switches on the power to get a service running again. The technician then assumes that the equipment is still in the same condition as when left and is then exposed to the danger of electric shock. Further dangers include the risk of charged capacitors.

Other non-electrical dangers include, for example, the changing of blades on a circular saw, changing the head on a milling machine or chuck on a lathe etc. This type of work involves working with the hands in and around the rotating mechanism. If the power is accidentally applied then serious injury can result.

### 5.1 Non-Live Working Precautions

- Switch off the power at the isolator and lock it off with appropriate padlocks. If more than one person is working then it is preferable that each should have their own padlock.
- Verify using an appropriate tester that the equipment is in fact dead.
- Identify any capacitors or other sources of stored electrical energy and discharge using a recognized method. Do not short with a screwdriver.
- Use appropriate notices to alert others of the work.



## 6. In-House Manufacturing of Electrical/Electronic Equipment

The in-house manufacturing of electrical and electronic equipment is undertaken in specialist laboratories and workshops by trained and competent personnel.

## School of Engineering Laboratory & Workshop Policies & Guidance

The safety of the end user of the equipment is paramount and equipment must be designed, constructed, repaired and maintained to the highest possible standards taking into account:

- The intended end use of the equipment.
- The environmental conditions that it will be exposed to.

As far as possible the equipment should fail to safety. Access to live parts should not be possible without removing a screwed down cover. Mains leads should be of the correct current carrying capacity, be mechanically secured (a knot or a tie wrap is not sufficient as the cable can twist).

Where the appliance requires an earth to be fitted, the earth lead must be soldered or crimped to an earth tag firmly screwed down to an earth terminal on the chassis. The earth terminal must not be used for any other purpose.

All accessible metal part must be constructed so that they are provided with a permanent and reliable earth continuity path to the main earth terminal. Painted surfaces must have the paint removed at junctions to provide an adequate path.

Internal wiring and other live conductors must be insulated and secured to prevent conductors coming in contact with any exposed metal surfaces. Power outlets from the chassis must be arranged so that the sockets do not expose bare live pins when disconnected.

Care must be taken to select the correct value of fuse. When connecting mains plugs to commercial equipment, the manufacturers handbook should be consulted.

Where an instrument has been supplied with a non-standard mains lead (i.e. American colour coding) then the cable should be replaced with a standard UK cable.

Before being released for use, new or modified equipment with a potential to cause harm, should be inspected and tested by someone other than the person who constructed it and labelled accordingly.

<b>Revision Record</b>			
<b>Issue</b>	<b>Name</b>	<b>Date</b>	<b>Reason for review</b>
1	ES	31/5/2022	Transfer from main handbook
	ES	26/8/2022	Added alt text for images
	ES	17/11/2022	Modified wording around hazardous voltage levels.