ELECTRICAL SAFETY

LARSEN & TOUBRO LIMITED
Electricity is good servant but bad master. It can prove to be very dangerous if circuits are not properly protected. The major fault that appears in electrical network or equipment is termed as short circuit. In short circuit, the supply phase and neutral or earth is short circuited accidentally due to foreign metallic substance coming in contact with phase & neutral or earth or due to overload thereby damaging the insulation resulting in short circuit i.e. directly connected resulting in heavy current flow called "short circuit current".

This high current heats up the terminations, switches, plugs & cable due to which temperature rises to such a high degree that it is sufficient to generate sparking which further leads to fire.

PROTECTION OF CIRCUITS:

In order to restrict the short circuit currents and also to cut off or isolate the faulty circuit from electric supply so that high short circuit current is interrupted before fire starts, appropriate protective devices need to be used as given below:

**Rewirable Fuses**: It is strongly recommended that fuse wires of correct current rating should be used. **DO NOT INCREASE THE FUSE CAPACITY FOR PREVENTING OR ELIMINATING FREQUENT FUSE BLOW-UPS.**

It is essential to locate the causes and eliminate the same. Replacing fuse wires of higher capacity may invite troubles in the form of fire & damage to supply system and surroundings.

**HRC Fuses**: High Rupturing Capacity (HRC) fuses are capable of clearing short circuit & arcs. However, they are much more costlier and hence, application is mostly restricted to commercial & industrial wiring or higher capacity loads.

**MCBs**: Miniature Circuit Breakers are gaining increasing prominence in household and distribution wiring in shops & commercial establishments as it effectively forms combination of switch & fuse with specified level of fault clearing capacity. It can be used to protect individual circuits. It has an advantage since no replacement is required and it can be reset on elimination of fault and switched on again.
Electrical accidents are caused mainly by careless use of electricity, such as:

1) Lack of knowledge about functioning of equipment.
2) Using faulty electrical cords/sockets.
3) Use of extension cords without taking proper precautions.
4) Improper earthing of the device.
5) Faulty designs/inter-locks.

The major factor which plays a vital role in severity of electric shock is amplitude of current, and part of human body through which it passes. For accident to happen, current of sufficient magnitude must flow through vital organ thus impairing its function.

When a person accidentally touches a live wire, the severity depends upon the skin resistance of that person, which varies from 1 K Ohm to 11 M Ohms.

Generally current amplitude more than 30 milli Amps is sufficient to give shock which can be fatal.

**METHODS OF ACCIDENT PREVENTION**

**Grounding:**

- It has been observed that in many industrial, domestic and commercial premises, grounding system has become unreliable. It is essential that earth resistance should be as low as possible. It is specified that for protective purpose, the same should not exceed 0.2 Ohms.

- Under no circumstances, earthing wire in the house/flats should be connected to water pipes. This not only gives shock in your premises but to someone else also. Water pipes are coming down from terrace and are not earthed.

**Isolation transformers:**

Use of isolation transformers reduces the amount of leakage current considerably.
Electrical supply is available at the tip of the finger. As a source of power in some ways, it is less hazardous than steam or other prime movers. Failure to take proper precautions in its use creates conditions which can result in injury, fatality or damage to property. Elimination of most of these hazards is neither difficult nor expensive. However, ignoring them leads to serious accidents.

The hazards can be classified as:

1. Electric shock
2. Fire

Causes leading to fire are as under:

a) Overloading of conductors/cables and equipment.

b) Electrical heat source close to flammable materials.

c) Short circuits in wiring/cables.

d) Poor or loose connections giving rise to sparking.

e) Use of inferior grade materials/equipment.

f) Frequent blowing of fuses leading to heavy sparking.

g) Generation of static electricity.

Electrical fires could be avoided by taking, followina precautions:

1) Use good quality (ISI) wires/cables.

2) Avoid joints in wiring - soldering and proper mechanical joints should be made if the same cannot be avoided.

3) All wiring should be renewed after ageing.

4) Fuses used for protection should be of adequate capacity. The ratings should not be increased without ascertaining reason of fuse blowing.

5) Fuse boards should be away from combustible materials like paper, oil, curtains etc.
Electrical accidents are required to be intimated to the Electrical Inspector by persons on whose premises/electrical installation the accident takes place. The relevant provision of intimation of accidents is prescribed under rule 44A of Indian Electricity Rules 1956.

As stated in the rules, a telegraphic / telephonic report should be submitted to Electrical Inspector within 24 hours of knowledge of occurrence of fatal accident and a written report within 48 hours in prescribed format.
Accidents do not just happen - they are results of unsafe conditions or unsafe acts or combination of both!

In order that we prevent accidents, it is necessary to follow the guidelines given below:

1. Haste causes many accidents, be sure of what you are doing.
2. Immediately report to person in-charge any dangerous condition or practice you have observed.
3. Before working on motors or other rotating machines, make sure that it cannot be set in motion without your permission by removing fuses & installing danger board on controlling switch.
4. Thoroughly discharge all cables to earth before starting the work.
5. Place rubber mats in front of switchboards.
6. Do not close any switch unless you are familiar with the circuit which it controls and know the reasons for it being open.
7. Do not work on live circuits. Make sure that all safety precautions have been taken.
8. Do not close or open switch hesitantly. - do it quickly and positively.
9. Do not throw water on live electrical apparatus in case of fire. Use proper extinguisher.
1. All voltages shall be considered dangerous even though voltage may not be high enough to produce severe shock (80V onwards).

2. All electrical circuits are to be treated as live and no work i.e. maintenance repairs, cleaning etc is to be carried out on any part of the apparatus unless -
   - Such parts are dead i.e. totally de-energized.
   - Isolated and all steps taken to lock off from live conductors.
   - Effectively earthed.
   - Released to work by issuing work permit by authorised person.
   - Confirmation for de-energisation is received.

3. Visitors & unauthorized persons should not be allowed to touch or handle electrical apparatus or come in danger zone of high voltage equipment.

4. Loose clothing, metal (straps) watch, rings, chains etc. should be avoided.
ELECTRIC SHOCK

It can be defined as sudden & accidental stimulation of body's nervous system by electric current.

ELECTRIC SHOCK CAN BE FELT DUE TO FOLLOWING:

When body becomes part of the circuit and current enters at one point and leaves from the other point; which can happen -

With both wires of the electric circuit;

With one wire of the energized circuit and the ground;

With metallic part that has become hot by itself in contact with energized wire.

ELECTRIC SHOCK SEVERITY:

The severity of electric shock depends on -

– The rate of flow of current through the body.
– The path of the current through the body.
– The length of time the body is in circuit.
– Frequency of current.
– Phase of heart cycle when shock occurs.
– Physical and psychological condition of the person.

HUMAN RESISTANCE:

<table>
<thead>
<tr>
<th>Body area</th>
<th>Resistance to Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dry Skin</td>
<td>100K. Ohms to 660 K. Ohms</td>
</tr>
<tr>
<td>2. Wet skin</td>
<td>1K. Ohm</td>
</tr>
<tr>
<td>3. Hand to Foot</td>
<td>400 Ohms to 600 Ohms</td>
</tr>
<tr>
<td>4. Ear to Ear</td>
<td>100 Ohms</td>
</tr>
</tbody>
</table>

REASONS FOR ELECTRIC SHOCK:

Touching bare live conductor
Touching poorly insulated conductor
Open/short circuit due to equipment failure
Static electricity
Lightning
Touching body of an equipment which has become live.
Indian Electricity Rules 1956 was amended in 1985 to include use of ELCB as a mandatory requirement for more than 5 KW of electrical load to take care of electrical current leakages which may result into shock.

The salient features of this ELCB are -

- Current operated
- Operates on core balance current transformer principle.
- Operates even in case neutral failure.
- Trips within 30 milli seconds.
- Trip free mechanism - i.e. during fault resetting is impossible and trips even if held forcibly in "ON" position.
- Operational life - more than 20,000 operations upto 63 A and more than 10,000 operations for 80 A & 100Amps.
- 10 KA short circuit withstand capacity.
- Available upto 100A, 2 pole & 4 pole for sensitivities from 30 milli amps onwards.

*(100 A & 300 A sensitivities are also available depending upon requirements.)*
Static electricity is the energy flowing in circuits that are generally considered non-conductors of electricity. It is considered as nuisance hazard! However can cause fire & explosions when fuel, oxygen & heat are present in the vicinity.

Static electricity hazard exists only under the following conditions in combination:

a) Electric charge must be generated.

b) The charge must be accumulated in a liquid or solid causing an electric field to be formed in an accompanying gas mixture.

c) The electric field must cause spark with intensity sufficient to ignite gas mixture.

d) The gas mixture must be flammable.

e) Static electricity is also generated from frictional or rolling contact between bodies i.e. belts, agitation and mixing.

**PREVENTION OF STATIC ELECTRICITY:**

A. Prevent charge generation.

B. Prevent charge accumulation

C. Prevent discharge from being dangerous.

D. Take measures to render gas mixture non-flammable.

The bodies which are well insulated from each other and ground can only accumulate electrostatic charge - otherwise, charges leak away and recombine with their counterparts as fast as they are formed. Earthing is necessary to prevent accumulation of electric charge on equipment.
Lightning is a huge spark caused by electrical discharge taking place between clouds, within the same cloud and between clouds and the earth.

Lightning is one of the most serious causes of over voltages. Lightning apart from damaging power equipment due to failure of insulation, can also cause damage to buildings, farms etc. However damage to human beings is comparatively less.

The phenomenon of accumulating positive or negative charge on clouds is a result of some atmospheric processes during thunderstorms. Thus the cloud gets charged either positively or negatively and when it passes over the earth, it induces opposite charge on earth.

When the charge acquired by the cloud increases, it results into increased potential between earth and cloud. The lightning starts when the potential is of the order of 5-20 million volts. The lightning propagates through air in jerks at a speed approximately equal to speed of light and carries current in the vicinity of 100 amps.

The lightning stroke which appears to eye as a single flash is, in reality, made of number of separate strokes that travel down.

Whenever there is a thunderstorm, it is advisable that one should not -
- Sit under the tree
- Swim in open water
- Fly Kites.

The protection to the power lines and power equipment against lightning is provided as under:

1. Ground potential wires with sufficient mechanical strength are provided along with transmission lines to shield the live conductors from direct strokes.

2. Lightning arresters of different types are provided on outdoor switches/transformers for protection.

3. The lightning stroke can also affect high rise buildings hence to ensure safety of building & persons inside, the lighting conductor with spikes are provided at the tallest point of the building and this spike alongwith conductor is directly connected to earth pit in ground. Any charged cloud in the vicinity of the spiked conductor is discharged. Generally any charge coming in the periphery of 120 degrees of this conductor placed at highest point of building is taken care by this type of lightning conductor.
Electricity Boards or Supply Companies generally give single phase supply upto 5 KW connected load and 3 phase supply to consumers having load more than 5KW.

It is suggested that following precautions should be taken while carrying out wiring:

1. Always use copper wires/cables of adequate size or one size above the load requirement. Increase in size of the conductor reduces resistance thereby heat generation and fire hazard is minimised. This also reduces the energy loss in wiring.

2. Electrical power circuits and communication circuits e.g. telephone should run in separate conduits/casing capings.

3. The wiring for high power consuming equipment viz. air-conditioner, geyser etc. should be run separately with separate neutral brought from supply terminal. This reduces voltage fluctuation in other loads.

4. Normally, in house wiring single pole switches are used which ensure that switches are in the "live" or "phase" wire of the circuit connected to appliance. If the switch is connected in "neutral" wire, the equipment/circuit can give shock even though switch is in "off" position.

5. Proper earthing is must in house wiring. Only proper earthing will guarantee safety to you and your family (hence, earthing must be checked periodically).

6. All appliances are provided with 3 pin plugs. Please ensure that earthing wire is connected to all such plugs.

7. Always ensure that connections to sockets are made by 3 pin plugs and not by inserting loose wires or 2 pin plugs.

8. To prevent shocks & protection against fault in appliances, Earth Leakage Circuit Breaker (ELCB) needs to be installed.

9. In case of repeated tripping of ELCB, locate the fault and eliminate the same instead of by-passing ELCB.

10. Before adding heavy power consuming equipment viz. geyser, window AC etc. ensure that wiring is of adequate capacity to take this additional load.

11. Earthing wire should never be used as a return wire of any electrical circuit and it's use should be restricted only for the purpose of equipment body earthing.

12. (a) Standard practice of connecting wires for 3-pin sockets & plug top should be followed.

(b) While connecting 3 core cable to plug top, earthing wire should be little longer than P&N wires so that mechanical forces act equally on all the 3 wires.
SAFETY PRECAUTIONS IN DOMESTIC INSTALLATIONS

1. Do not touch an electric switch or appliance when hands are wet.
2. Be alert while replacing fuse/inserting plugs.
3. Do not use copper wire as a substitute for fuse wire.
4. Do not use wires with poor insulation.
5. Do not replace fuse unless cause is detected.
6. Do not hang wet clothes on electrical fittings/conducts.
7. Use 3 pin plugs and ensure that earth connection is proper.
8. Take help of qualified electrician for any alterations / modifications in wiring.
9. Do not replace bulb or any appliance with switch in "ON" condition.
10. Do not shift any appliance with switch in "ON" condition.
11. Check earthing frequently for physical damage, if any.
12. In case minor shock is felt anywhere, do not neglect it - contact licensed electrician.
13. Check the electrical specifications of equipment before it is switched "ON" viz. 110V, 230V, 110V, 440V etc.