An Article on Electrical Safety

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Abstract— Risk in electrical work is more than any other job even using household purposes, its needs some precaution. Any slippage has no excuse. Fatal incident of a person will create a void place in his organization and family too. We can assume that working in electrical system is similar to that of work in war field. Those who are involved in electrical job they should be alert for each and every second. Mistake or failure will not be any of any excuse. Electricity is blunt and rude.In present paper we would like to enlighten some important areas which need special attention and also create awareness among the people who are working or using electrical power systems. This article is an attempt to cover most of the sub-titles of the paper.

Key words: Safety; Earth fault; Standard; Earthing; Domestic Safety.

I. INTRODUCTION

Safety should be defined as reduction of risk to a level that is as low as reasonable and as practicable. It is a state of mind and environment that must become an integral part of each working procedure. This is what we mean by built-in or integrated safety and permanently effective.

Electrical safety is more important, because we could not apparently realize that, what amount of current a simple cable or a bare conductor carrying or at a glance we could not ascertain whether a conductor is live or dead. This harmless appearance could misguide us. And this is the root cause of most of electrical accident.

Risk is chance of something happening that will have an impact and could be counted by its consequence and likelihood.

Accident is an unexpected event causing loss of life or bodily injury and loss of property.

Accident is an unplanned event which hampers the process of production and adds miseries. Accidents occur either due to unsafe act or unsafe action of work or both.

Safety Precaution means to strictly follow the prescribed rules for safety of self, working personnel and tools to conduct electrical work, otherwise possibility of electric shock or hazards could be experienced.

Safety of an electrical installation could be ensured by proper insulation, good earthing system and adopting adequate protection and control systems.

Due to more peak value of AC voltage than DC voltage of same level, AC voltage is more dangerous. Whenever a person comes in direct contact with AC voltage he gets peak value (√2 times of rms value) i.e 100 times in a second, so he receives more electric shock.

230V AC means (√2x230 =) 325.27V AC

II. EARTH FAULT PROTECTION

Due to the rugged nature of construction work or even in industrial or house service, normal use of electrical equipment causes wear and tear which results breakage of insulation, short-circuits of supply system and other hazards. If there is no earth-fault protection like ELCI (Earth Leakage Circuit Interrupter), leakage current could find a path through the user's body, resulting electrical burns, fatal accident, fire or even explosion.

III. INDIAN STANDARDS AND REGULATIONS FOR ELECTRICAL SAFETY

Divisions of system voltages according to IE Rules'56

Low Voltage (LV)	Not Exceed 250 V
Medium Voltage (MV)	Not Exceed 650v
High Voltage (HV)	Not Exceed 33ooo V
Extra High Voltage (EHV)	Exceed 33ooo V

Table 1:

(Subject to percentage variation allowed)

CEA (Measures relating to Safety and Electricity Supply) Regulations, 2010:-

Instead of LT, MV, HV or EHV in IER, 1956 with CEA Safety Regulations, 2010 respective voltage ranges are used with regulations. (ie.250V, 650V, 33kV or above)

MNIMUM CLEARANCE BETWEEN LINE AND WORKMAN

0-750 V insulated or polythene covered conductors	300 mm
6.6KV	0.6 mtr
12 kV	0.9 mtr
33kV	1.2 mtr
69kV,	2.0 mtr
72kV	3.5 mtr
138kV	4.0 mtr
230kV	5.0 mtr
500kV	7.0 mtr

Table. 2:

Provided no guarding are required when an extra high voltage line crosses over another extra high voltage, low or medium voltage line or a road or a tram line.

IV. EFFECTS OF ELECTRIC CURRENT ON HUMAN BODY

– Two body functions

1) Breathing (Lungs)
2) Blood circulation (heart beat)

But it is more dangerous when a current flows across one hand to other hand or from one foot to other foot.

Three primary factors affect the severity of the electrocution/ shock when a person is became a part of an electrical circuit.

Amount of current flowing through the body (amperes)

A. Length Of Time The Body Is In The Circuit.

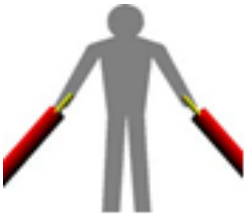

Fig. 1: Current flows through Both Hands

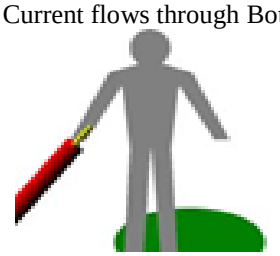

Fig. 2: Metallic part and Feet

Fig. 3: Hand and feet

Effects of a current passing through a human body depend on a number of inter-related factors. Those are:-

1) Current Path
2) Frequency
3) Current magnitude
4) Duration of time
5) Body Impedance
6) Body sensitivity

The Step and Touch Voltages are dangerous for human body. Human body may get electric shocks from step and touch voltages. From the safety point of view it is necessary to calculate step and touch voltage. High voltage test results shows the following values for the resistance of the human body: Hand to hand contact resistance is equal to 2330 Ohms, and the hand to feet resistance is equal to 1130 ohms, based on Dalziel's experiment. Resistance of a human body was assumed to be taken as 1000 Ohms.

V. EARTHING OF ELECTRICAL INSTALLATION

To provide a sufficient low resistance path to ground and to minimize rise in ground potential with respect to remote ground terminal, the grounding system is connected to every individual equipment structure.

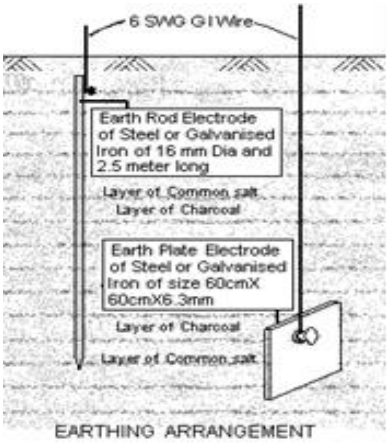

Fig. 4: Discontinuous Earthing Path

If the earthing path is broken or discontinuous, fault current may travel through the person's body causing electrical burns or even death.

To Avoid Hazards

- Ground all power supply systems, electrical circuits, and electrical equipment.
- Ensure earthing of each individual electrical equipment like welding machine, bar-bending machine etc.

VI. SOIL RESISTIVITY

Soil Resistivity is most necessary determining the design of the grounding system for new installations to meet ground resistance requirements. We could find a location with the lowest possible resistance. If soil condition is poor it could be overcome with more elaborate grounding systems.

The Soil Resistivity Test Meter (Fluke 1625) generates a known current through the two outer ground stakes and the drop in voltage potential is measured between the two inner ground stakes. Using Ohm's Law (V=IR), the Fluke tester automatically calculates the soil resistance.

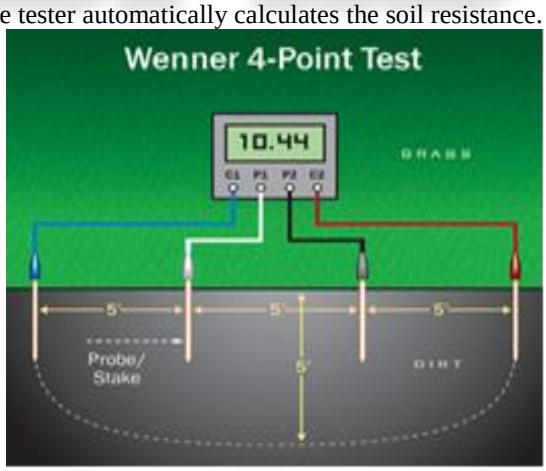

Fig. 5: Wenner 4-Point Test

VII. HOW SOIL RESISTANCE COULD BE MEASURED

To test soil resistivity, the ground tester could be connected as shown below:

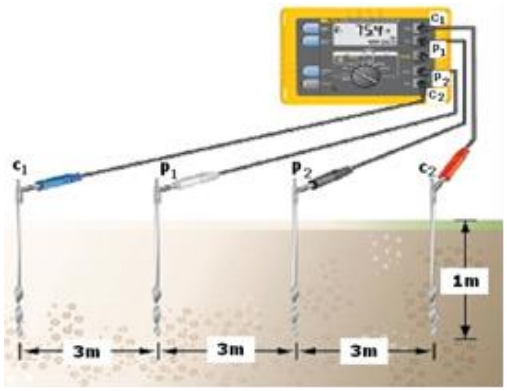

Fig. 6: Arrangement of Soil Resistivity test by Meter

It could be noted that four earth ground probes/ stakes are positioned in the soil in a straight line, equidistant from one another. The distance between earth ground stakes should be at least three times greater than the spikes depth. So if the depth of each ground stake is one meters, the distance between spikes is greater than 3 meters. The Fluke 1625 generates a known current through the two outer ground stakes C1 and C2 and the drop in voltage potential is measured between the two inner ground spikes P1 and P2. Using Ohm's Law (V=IR), the Fluke tester automatically calculates the soil resistance.

Because measurement results are often distorted and invalidated by underground pieces of metal, underground aquifers, etc. additional measurements where the stake's axis are turned 90 degrees is always recommended. By changing the depth and distance several times, a profile is produced that can determine a suitable ground resistance system.

VIII. SAFETY IN DOMESTIC INSTALLATIONS

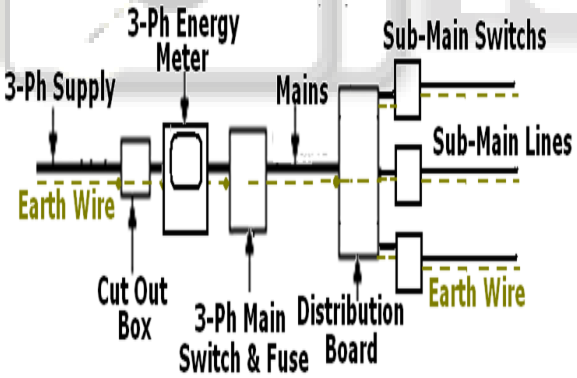

Fig. 7: Schemetic Diagram Of Domestic 3-Phase Power Supply

Earth continuity wire should run along the circuits and touch all metal parts.

Circuit Diagram of 230V, 1-Phase Earth Leakage Circuit Breaker (ELCB) is furnished below which is mainly used in Tera-Tera system (TT system i.e. Neutral Grounding System as per IS-3043). This is a Current Operated Device. According to IEC the term RCD (Residual Current Device) is applicable to differentiate from Voltage operated Devices.

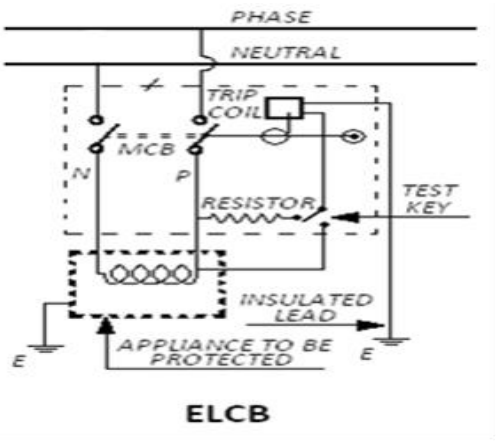

Fig. 8: ELCB

A. *Caution:*

During selection of MCB for ELCB which shall be installed along with suitable backup with matching Breaking Capacity of 2.5 kA or so but not 10kA or 15kA for general sub-main circuit.

Installation of GFCI / ELCB is highly recommended for all type of electrical circuits.

GFCI protection for temporary wiring is mandatory on construction sites at all times.

IX. LIGHTNING PROTECTION AND FIRE SAFETY IN BUILDINGS

A. *Types Of Lightning And Surge Voltage Curve Or Impulse Voltage Curve*

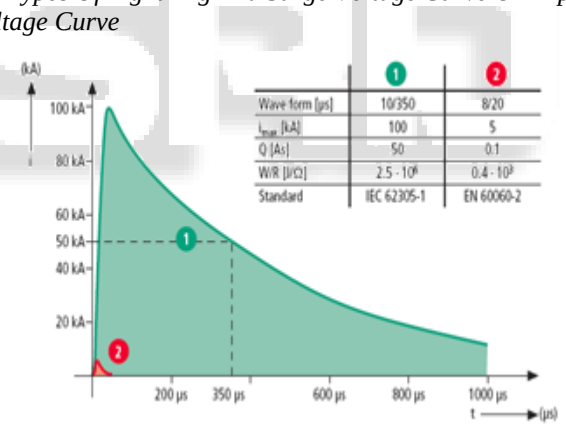

Fig. 9: Lightning and Surge Voltage Curve or Impulse Voltage Curve

The curve labeled "1" is typical of a lightning arrestor's capability, while the curve labeled "2" is typical for a surge arrestor. The green (and red) shaded area is a measure of the energy the device needs to absorb.

Huge surge current to the tune of several kilos Ampere flows through LA to earth within fraction of second during lightening. Every care should be taken so that this surge current will flow straight to earth without any obstacle. As such this earthing resistance of earthing conductor must be less than one ohm. Earth conductor of LA should go straight to earth separately and the same is not be connected with earth grid of a substation. LA installed for each phase should have separate and dedicated earth conductor.

A lightning arrester is a device used on electrical power systems and telecommunication systems to protect the equipment, cable and conductors of the system from the damaging effects of Lightning. Lightning arrester

has a high voltage terminal and a ground terminal. When a lightning surge (or switching surge, which is very similar) travels along the power line to the arrester, the current from the surge is diverted through the arrester to earth.

The lightning protection classes define parameters that are necessary for the installation of a lightning protection system. The table given below shows lightning protection classes.

Protection class	Peak lightning current
I	200kA
II	150kA
III	100kA
IV	100kA

Table 3:

X. CONCLUSIONS

It is suggested that the priority should be given for high risk related factors. Until people are not taking it cautiously, we will face many electrical hazards in indoor and outdoor also. We should follow proper Rules and Regulations to avoid accident and there should be trained personnel so that they can work with proper Rules and Regulations. Electrical hazards can cause burns, shocks and electrocution (death). Overhead wires are energized at lethal voltages. Repair of electrical cords or equipment is not recommended unless authorized. Qualified electricians are recommended to inspect electrical equipment. In damp locations, inspect electric cords and equipment in order to ensure they are in good condition; use a ground-fault circuit interrupter (GFCI). Precaution must be taken when working near electricity or with electrical equipments.

REFERENCES

[1] Doherty, M. (2011), 'Workplace Electrical Safety Standard, CSA Z462-08', Electrical Safety Workshop (ESW), 2011 IEEE IAS, 25-28 Jan. 2011, IEEE, pp. 1 – 4.
[2] Becker, T. (2010), 'Measuring performance of your Electrical Safety Program by audit', Petroleum and Chemical Industry Conference (PCIC), 2010 Record of Conference Papers Industry Applications Society 57th Annual, San Antonio, 20-22 Sept. 2010, IEEE, pp. 1 – 10.
[3] Croft, E., Summers, W., and Hartwell, F. P. (1953), Electrical Safety in the Workplace, 7th Ed, McGraw-Hill, New York, pp. 51-70.
[4] Doughty, R. L., Epperly, R. A., and Jones, R. A. (1991), 'Maintaining Safe Electrical Work Practices in a Competitive Environment', Industry Applications Society Annual Meeting, 1991., Conference Record of the 1991 IEEE, Vol. 2, 28 Sep 1991-04 Oct 1991, IEEE, pp. 1275 – 1283.
[5] Kumbhar, N. R., and Joshi, R. R. (2012), 'An Industrial Energy Auditing: Basic Approach', International Journal of Modern Engineering Research, Vol. 2, No. 1, pp. 313-315.
[6] Roberts, D. T. (2014), 'Integrating OHSMS, Risk Management & Electrical Safety', Electrical Safety
[7] Workshop (ESW), 2014 IEEE IAS, San Diego, CA., 4-7 Feb. 2014, IEEE, pp. 1-8.
[8] Roberts, D. T. (2013), 'Risk Management of Electrical Hazards', IEEE IAS Applications Magazine, Vol. 19, No. 3, p. 21.
[9] Sivaprakash, P. and Elangovan, R. K. (2013), 'A Study on Safety Audit System in Indian Engineering Industries', Life Science Journal, Vol. 10 (9(s)), pp. 236-240.
[10] IEEE Standards 1584-2002, IEEE Guide for Performing Arc-Flash Hazard Calculations New York, NY: IEEE.
[11] M.Wactor, et.al., 'Strategies for Mitigating the effects of Internal Arcing Fault in Medium Voltage, Metal Enclosed switch gear, " Proceeding of IEEE Transmission and Distribution conference and exposition vol. 1, pp 323-328, Oct / Nov 2001
[12] IEEE C37.20.7 2001 Guide for Testing Medium-Voltage Metal- Enclosed Switchgear for Internal Arcing Faults, New York, NY: IEEE

