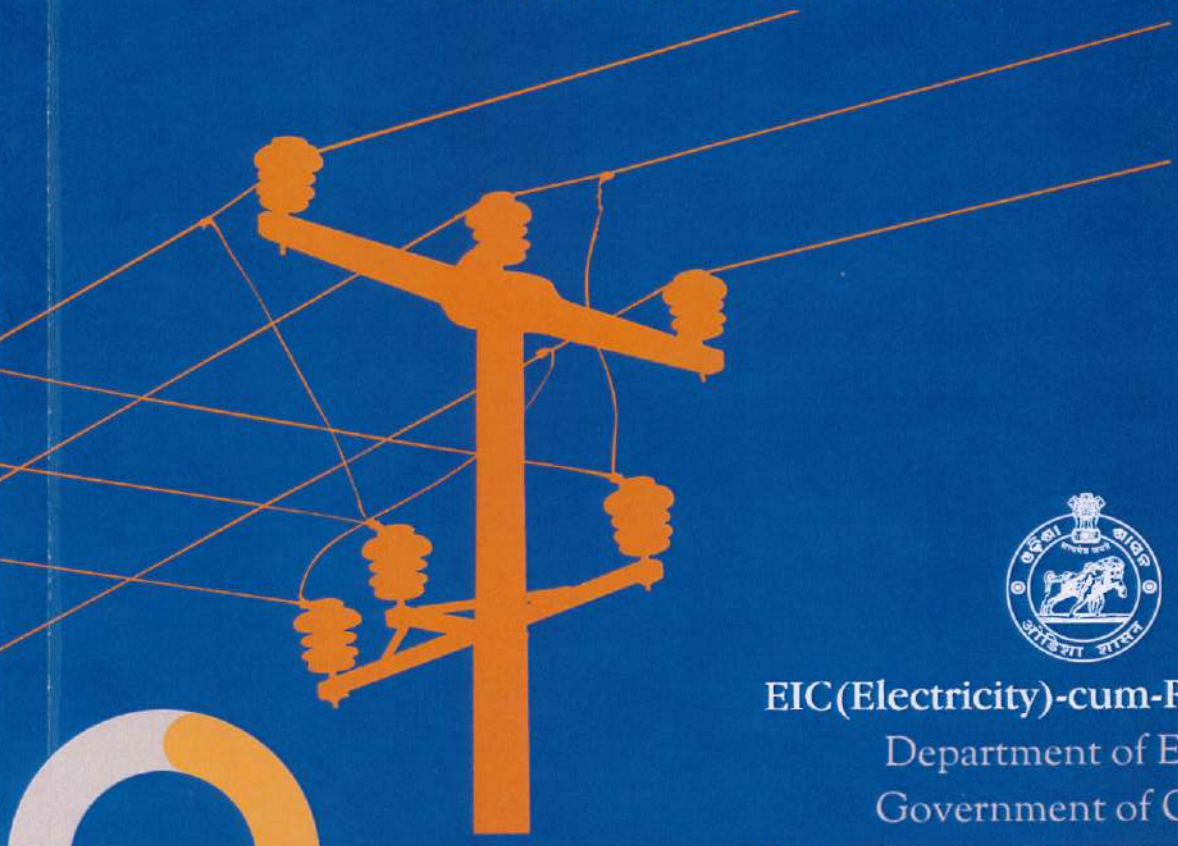
SURAKSHA SANDESH

ANNUAL ELECTRICAL SAFETY REPORT
2020-21

ON THE OCCASION OF 2ND NATIONAL ELECTRICAL SAFETY WEEK
26 JUN 2021 TO 02 JUL 2021



EIC(Electricity)-cum-PCEI,Odisha
Department of Energy
Government of Odisha

LIGHTNING

IT'S DANGEROUS

'STAY INDOOR & SAVE LIVES'

National Electrical Safety Week 2021

'Observe Electrical Safety-
Save Lives Save Property'

ବିଦ୍ୟୁତ୍ ସୁରକ୍ଷା ନିୟମ ମାନ,
ସୁରକ୍ଷିତ ହେବ ଧନ ଜୀବନ

SHRI DIBYA SHANKAR MISHRA
Minister of State (Ind. Charge)
Energy, Industries, Micro, Small &
Medium Enterprises, Home (s), Odisha

MESSAGE

I am very happy to learn that the **National Electrical Safety Week (NESW)** is being observed from 26th June every year. The augmentation of electricity infrastructure due to rapid industrialization and consumer also need to adequately address the risk of electrical accidents. Hence, electrical safety and prevention of electrical accidents need to be attached highest priority by all sectors.

Under the able, dynamic and visionary leadership of our Hon'ble Chief Minister, Odisha has brought in major leap in energy sector. As sensitive citizen and responsible stakeholder, we should sincerely ensure Electrical Fire Safety, especially in household consumption, keeping in view the significant help of emerging technologies and learn the importance of surge protecting devices to keep electrical equipment more efficient and less damaging. As observance of the week gives emphasis on safety and preventive measures to adopt, our HRD in electricity sector should go for massive awareness drive to keep the objective very much fruitful.

I am sure that the accident analysis report published by the EIC(E) under the guidance of the Department shall be useful in prioritizing key interventions for the minimization of electrical accidents. I hope this NESW 2021 would raise awareness and enthusiasm on electrical safety among the public, industries, and the electrical workforce and renew their commitment to promote a participating approach towards safer use of Electricity.

(Capt. Dibya Shankar Mishra)

SHRI NIKUNJA BIHARI DHAL, IAS
Principal Secretary to Government
Department of Energy

MESSAGE

Electricity is a basic necessity for us in the 21st Century. As dependent as we are on electricity, it is crucial for us to be careful about how we use it. Slightest carelessness in handling electricity can lead to serious accident/injury. There is a need to create awareness among the public and to make safety a social movement.

In our State fatal and non-fatal incidents due to electricity are a cause of worry. Electrical safety is becoming a prominent health and safety issue. On closer analysis it is found that majority of these incidents are preventable with adequate awareness and adoption of simple safety measures.

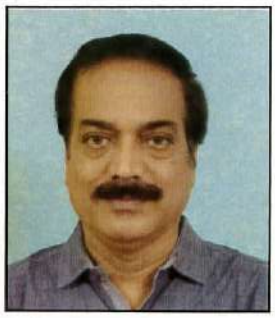
The National Electrical Safety Week will be observed during 26th June to 2nd July, 2021 to sensitise the general public about safe use of electricity and promote a culture of safety with active participation of all stakeholders. Various activities are proposed to be organised during this period. I take this opportunity to convey my best wishes to the engineers, supervisors and workmen of various power utilities & urge them to create a culture of safety at their workplaces.

I also congratulate EIC (Electricity) for bringing out the Electrical Safety Report on this occasion.

22/6/2021

(Nikunja B. Dhal)

SHRI SANTOSH DAS
EIC (Electricity) - cum -
Principal Chief Electrical Inspector,
Odisha



MESSAGE

Twenty Sixth June of every year is being observed as "National Electrical Safety Week" (NESW) exclusively for the electricity sector spearheaded by Central Electricity Authority, Ministry of Power, Govt. of India. Electricity has become such an integral part of our daily life that many of us don't give much thought to how much our everyday activities depend on electricity, being the most reliable source of energy. More importantly, we tend to overlook the hazards associated with electricity and fail to treat it with the respect it deserves. Electricity has long been recognized as a serious workplace hazard, exposing employees to electric shock, electrocution, burns, fires and explosion etc.

I take this opportunity to present the annual safety report "Suraskhya Sandesh" on the observance of NESW-21. An effort has been made to analyze the accident cases reported during 2020-21 on different prospectives of the electrical system under different situations. The objective of the analysis and diagnosis of causes is to prevent occurrence of similar accidents as well as to seek a general improvement on the safety management aspects. The observance of this NESW-21 will definitely raise awareness and commitment among all stakeholders. Spreading awareness among consumers and general public through social media can be extremely helpful in minimizing electrical accidents. Hope, all concerned shall rise on to this occasion to adopt zero tolerance to electrical safety violations at work place and enforce mandatory periodic safety audit of electrical installations.

Santosh Das

Santosh Das

Do not touch electrical appliances or wires with **WET HANDS**.
Monitor the humidity in rooms where there is electricity

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Analysis of Electrical Accidents for the FY 2020-21 (Period from 01.04.2020 to 31.03.2021)

Introduction

The COVID-19 pandemic has disrupted economic activity in India. The national lockdown imposed by Govt. was successful in containing the spread of the pandemic by restricting mobility. Offices, commercial establishments, cinemas, industries, hospitality sector, transport sector etc. were affected during the lockdown. Electricity consumption was thus grossly affected due to slow down or closure of various economic activities.

Like previous years, analysis and investigation of electrical accidents was carried out for the financial year 2020-21. Analysis of such accidents is a critical element of safety assessment and management. The over-riding purpose of carrying out such review and analysis is to prevent occurrence of similar accidents, as well as to seek a general improvement in the safety practices and management. This analysis shall be extremely helpful in planning key interventions with a structured approach for addressing the existing shortcomings in a time bound manner.

In Electrical accidents not only valuable human lives are lost but also animals. The Department of Energy, Govt. of Odisha attaches highest priority for preventing electrical accidents. Planned interventions through strengthening of electrical infrastructure of the HT and LT networks such as converting LT lines to AB cables, shifting of electrical sub-stations and lines from the premises of School and Anganwadi centers are some of such schemes to prevent electrical accident. Govt. of Odisha has also extended special support to the distribution sector to strengthen the electrical network in elephant corridors to prevent elephant electrocutions. The recent safety audit of Hospitals and COVID care centers was undertaken to find out the shortcomings in the electrical installations, to avoid possible fire in these critical medical establishments.

Adherences to safety practices by the industries have resulted in minimization of electrical accidents to a great extent. However, some reports reveal that the probabilities of electrical accidents are more during construction activities rather than during day to day operations. Enforcement of safety policy and promotion of safety culture by the management helps in bringing down all such accidents. To mitigate any emergency and disaster like situation, preparedness by organization is an invaluable method to minimize the damage and loss of life.

This analysis was undertaken in an attempt to find out the causes of which can help in providing necessary insight to the policy makers for planning strategies and road maps for minimizing electrical accidents.

Analysis of Accidents:

An attempt is made to analyze electrical accidents for the FY 2020-21 (Period from 01.04.2020 to 31.03.2021) based on fatalities, voltage level and broad reasons of accidents besides division wise details etc.

The abstract of the accidents is enclosed as Annexure-I for reference. For the purpose of analysis, the entire state has been divided into four zones commensurate with the DISCOM jurisdictions i.e. Central Zone (CZ), Western Zone (WZ), South Zone (SZ) and North Eastern Zone (NEZ). Central Zone has 20 divisions encompassing 9 districts, Western Zone with 17 divisions and 9 districts, North Eastern Zone with 16 divisions and 5 districts and the South Zone with 20 divisions and 8 districts, which also includes few overlapping districts. Table 1 provides zone wise information of human and animal cases, both fatal and non-fatal.

Zone wise comparison:

Description/ Zones	CZ	WZ	SZ	NEZ	Total
Total Nos. of Accident Cases and victims	30 (43)	48 (60)	25 (33)	61 (74)	164 (210)
i No. of Human Fatal Cases (Victims)	**19 (21)**	**35 (35)**	**17 (19)**	**47 (50)**	**118(125)**
ii No. of Human Non-Fatal Cases (Victims)	9 (14)	4 (8)	7 (13)	6 (11)	26 (46)
iii No. of Elephant Fatal Cases(Victims)	01(01)	0	0	01(02)	02 (03)
iv No. of other Animal Fatal Cases (Victims)	03(07)	10 (17)	01 (01)	07 (11)	21 (36)
v No. of other Animal Non-Fatal Cases (Victims)	0	0	0	0	0 (0)

Table-1: Abstract of accidents (Human)for the FY 2020-21

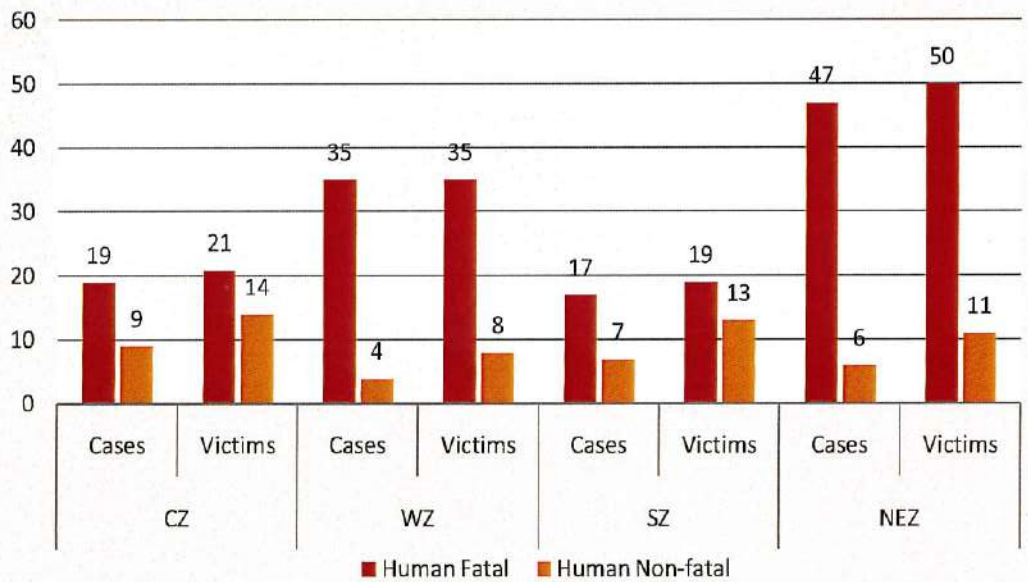


Figure-1:

Zone wise electrical accident (Human cases & Victims) details for the FY 2020-21

Analysis of zone wise accident details (Table-1 and fig-1) indicate that 125 electrocution deaths(human) have occurred from total 164 accident cases reported during the FY 2020-21, however it is observed that 125 human fatal victims have resulted from 118 accident cases. The maximum numbers of electrical accident cases (47) have been reported from the North-Eastern Zone with maximum number of human fatalities (50). However, considering the total consumer base, it can be inferred that the probability of accidents in the North Eastern Zone should be lower than the other zones. However, the length of LT lines of North Eastern Zone is much higher than all other zones.

Analysis of last four years accident details:

Year	Human			Animal		
	Fatal	Non-Fatal	Total	Fatal	Non-Fatal	Total
2017-18	130	27	157	72	1	73
2018-19	108	26	134	89	1	90
2019-20	178	67	245	40	2	42
2020-21	125	46	171	39	0	39

Table-2: Electrical Accidents during the period from 2017-18 to 2020-21

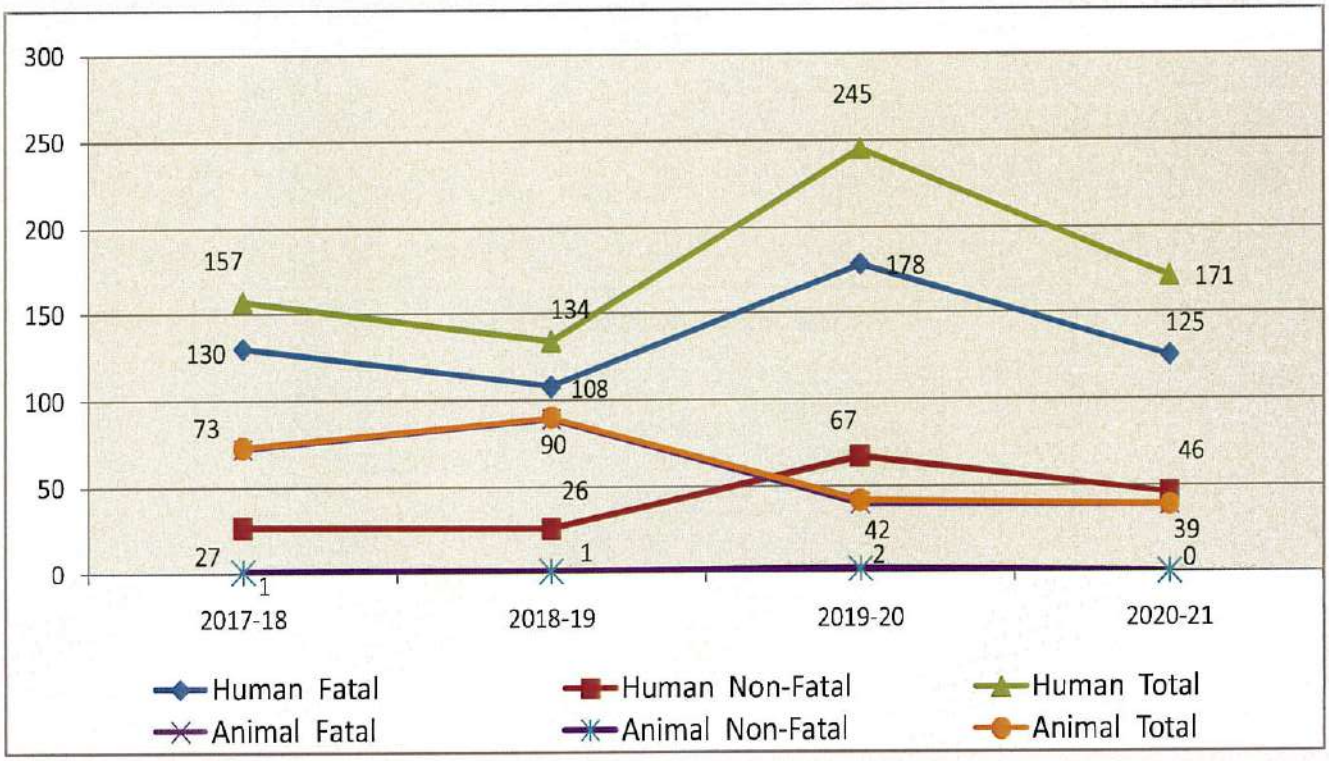


Figure-2: Trend of Electrical Accidents for the period from 2017-18 to 2020-21.

Analysis of the accident statistics for the last four year period (Table-2 and Fig-2) clearly indicates the onset of a downward trend from the earlier rising trend of electrical accidents and the causalities due to electrocution. From130 human electrocution deaths in 2017-18, the figure had increased to 178 in 2019-20 which was quite alarming. However, in this FY2020-21, the human electrocution deaths have come down. Many of these accidents can be attributed to the lack of proper maintenance and up keeping of the distribution infrastructure. However, there has also been substantial increase in the number of electrical consumers in the state besides expansion of the transmission and distribution network which has also further aggravated the issue faced by the DISCOMs in maintaining the distribution network in safe condition. Hon'ble National Human Right Commission taking cognizance of 24 such filed accident cases and the electrocution deaths in the State, have issued directives to concerned authorities for necessary corrective measures besides issuing orders for release of compensation to the next of kin of the victims.

Analysis based on Voltage level:

If we analyze the voltage level of the accidents (Fig-3), it can be clearly seen that maximum numbers of electrical accidents occur in the 11KV system alone. It can be concluded from the past statistics that 11KV system has always been responsible for the majority of the accidents. The average percentage of such accidents in 11kv is 59% of the total number of accidents reported during the period, whereas it was only 54% last year. The accidents in the 11KV systems comprises of accidents occurring mostly in the feeders and Sub-stations.The percentage of accidents occurring in the LT systems with a figure of 35% also contributes significantly to the total number of accidents.

Voltage level of Accidents (%)		CZ	WZ	SZ	NEZ	All Zones
i	L.T (up to 440 V)	29%	45%	24%	33%	35%
ii	H.T (11 K.V)	62%	48%	72%	64%	59%
iii	H.T (33 K.V)	9%	7%	4%	3%	6%
iv	E.H.T (132 K.V)	0%	0%	0%	0%	0%

Table-3: Zone wise Voltage level of Electrical Accidents for the FY 2020-21

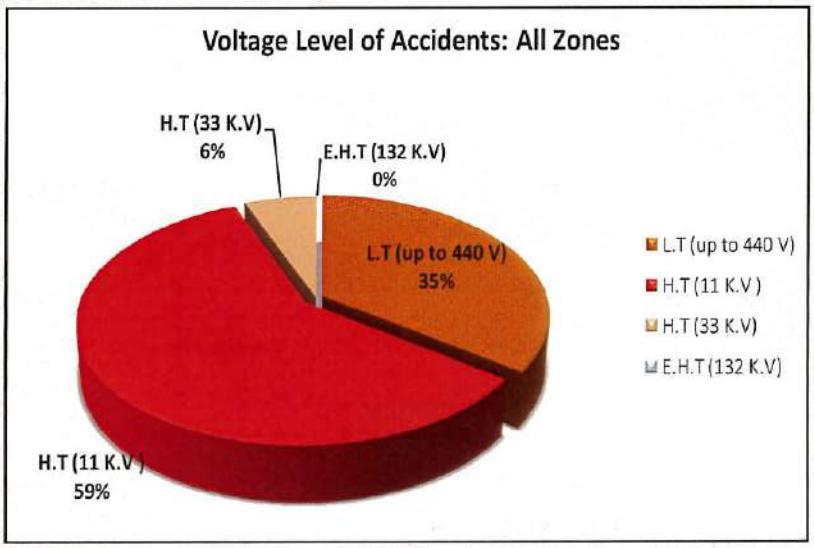


Figure-3: Voltage levels of electrical accidents of the statefor the FY 2020-21.

Analysis based on network length and voltage level of feeders:

However, analyzing in terms of the length of distribution networks available as on 31.01.2021 as per Annual activity report 2020-21 of the Energy Department, the length of electrical networks in LT (212761 Km) followed by HT 11 KV (159950 Km) and then HT 33KV (15087 Km). The total circuit kms of all the feeders are 387799 Km in length. Hence, a common perception shall be that maximum accidents should be in LT system rather that 11KV HT. However, looking into the LT network though the length is maximum, yet the danger from this network is less since during the last few years many of these LT lines have already been converted to AB cabling, which is not so in case of HT lines.

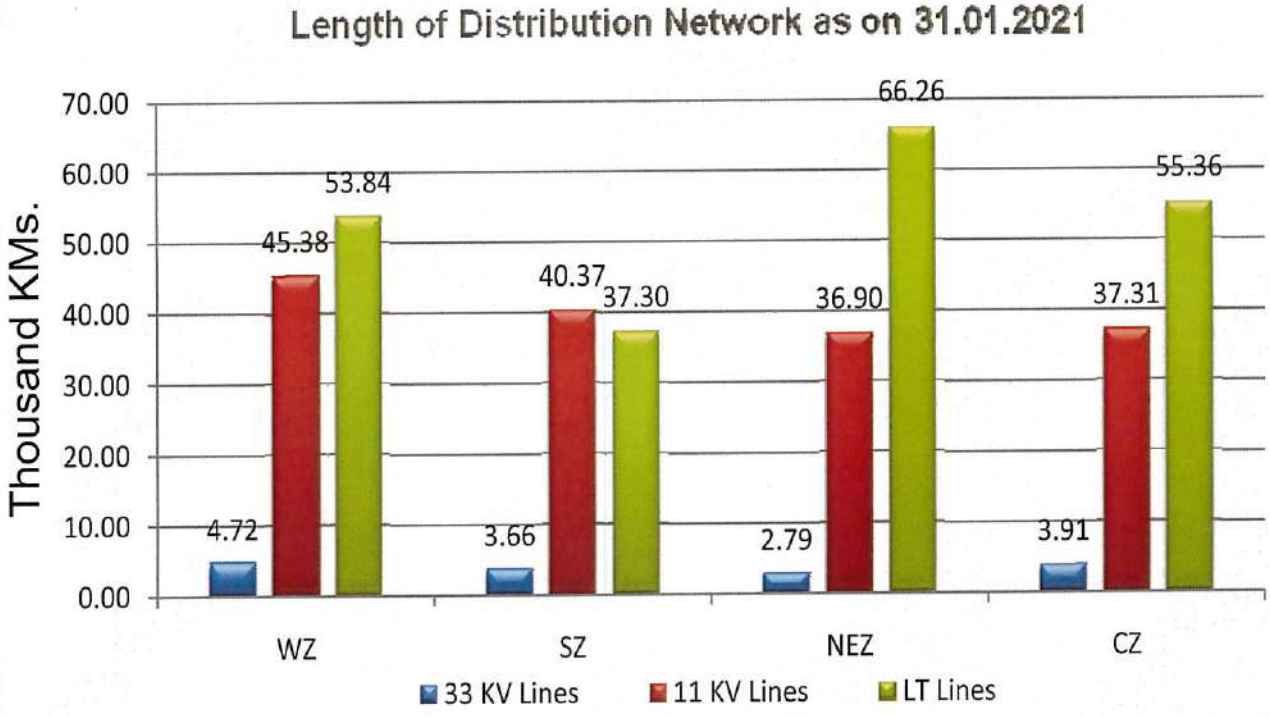


Figure-4: Zone wise comparison of feeder lengths of the distribution network as on 31.01.2021

Feeder

From the zone wise circuit Kilometers of feeders in figure-4, it has been found that the contribution of 33KV feeders is only 4% of the overall length where as for the 11KV feeders it is 41% and for LT feeders it is maximum with a figure of 55%.

Moreover, the11KV HT feeders contributes towards a greater number of accidents due to unavailability of adequate protection mechanism, vulnerability to rain, storms and other natural calamities, inadequate maintenance and also due to unauthorized construction near the lines and their ease of access, besides some shortcomings in their design and implementation aspects. Faults in the 33KV and higher voltages are adequately protected and isolated through a robust protection system inbuilt into the HT and EHT systems to avoid any grid disturbance which is not available in case of 11KV and LT systems.

Accident within consumer premises:

Many of the LT system accidents have been reported from consumer premises. The consumer's casual perception of electrical safety and ignorance on the hazardous nature of the LT system has resulted in many accidents. Using service wires for other purpose such as drying of clothes, un-availability of proper earthing within the consumer premises, laxities by the DISCOMS in adopting safety prescriptions such as earthing of poles, maintaining proper clearances for LT lines etc. are some of the major reasons. In many cases the victims are ignorant about the dangerous nature of electricity and sometimes they get electrocuted while trying to rescue their near and dears from electrical accidents. It may be opportune to mention that many accidents occurring in case of unauthorized connections go unreported unless it is subsequently highlighted in the print and electronic media. The distribution licensees many times don't report electrical accidents occurring within consumer premises citing jurisdiction issues.

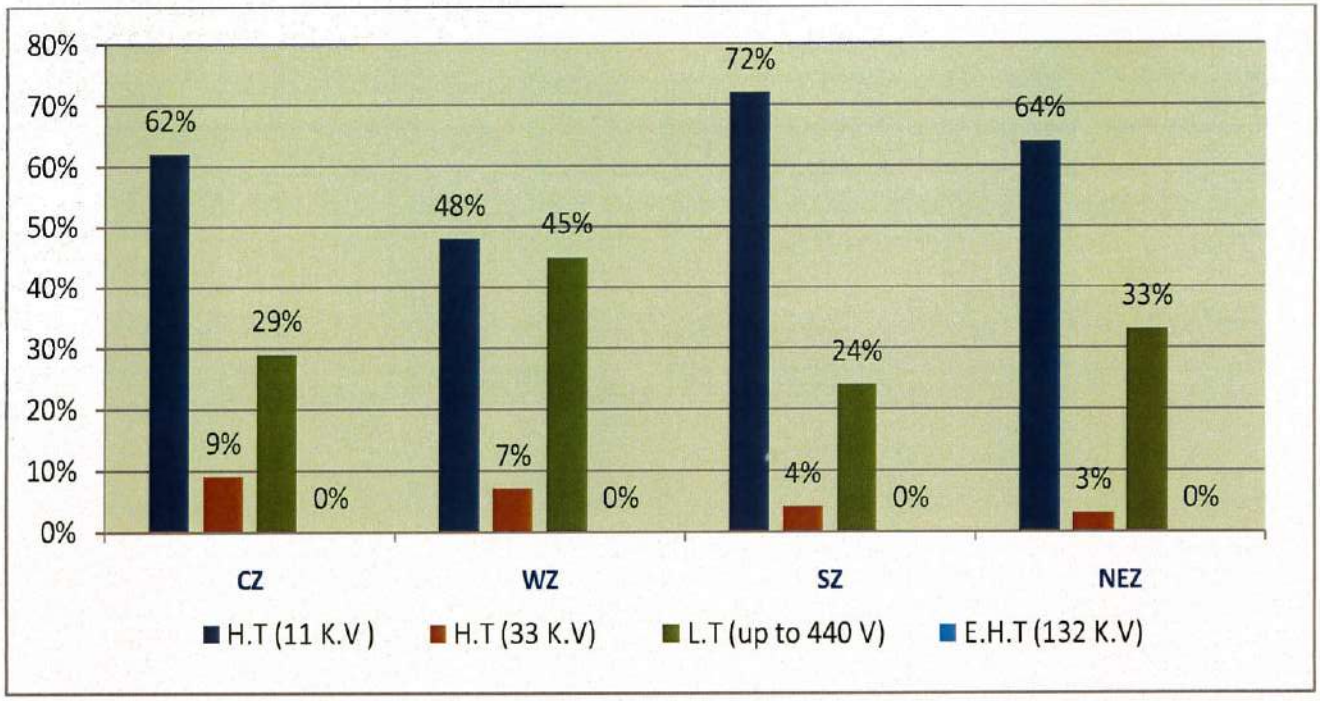


Figure-5: Zone wise comparison of Voltage levels of electrical accidents for the FY 2020-21

Correlation of voltage level and feeder lengths:

Zone wise comparison of voltage level of accidents along with its correlation with the feeder lengths indicates the predominant contribution of the 11KV HT to the accident figure in all the four zones which clearly highlights the danger imminent from the 11KV systems alone. Though few 33KV accidents have been reported, their numbers are lower due to comparatively lower concentration of the 33KV systems (only 5%) and their better feeder protections and monitoring, since most of these feeders either supply the distribution substations or large consumers.

Major causes:

An analysis of major causes of electrical accidents is given in Fig-6. It is observed that out of the accidents occurring in distribution systems, on an average,30%of these cases can be attributed to accidental contact with live wires. Due to inadequate ground clearance, human being and animals sometimes come in contact with live conductors. Even vehicles with passengers have come in contact with live lines with lower ground clearance over road crossings, resulting in many human fatalities. Failure and bursting of pin insulators have been reported as one of the reasons of snapping of conductors. Since many of these feeders pass through forest areas, due to proximity and lower clearance with the trees, these conductors come in contact with tree branches which subsequently results into snapping of the conductors due to frequent arcs, mostly during rainy seasons. Also, the joints made in the lines sometimes fail leading to snapping of conductors. Though there has been prescribed number of conductor joints for a specific span, availability many such joints increase the failure rates leading to snapping of conductors.

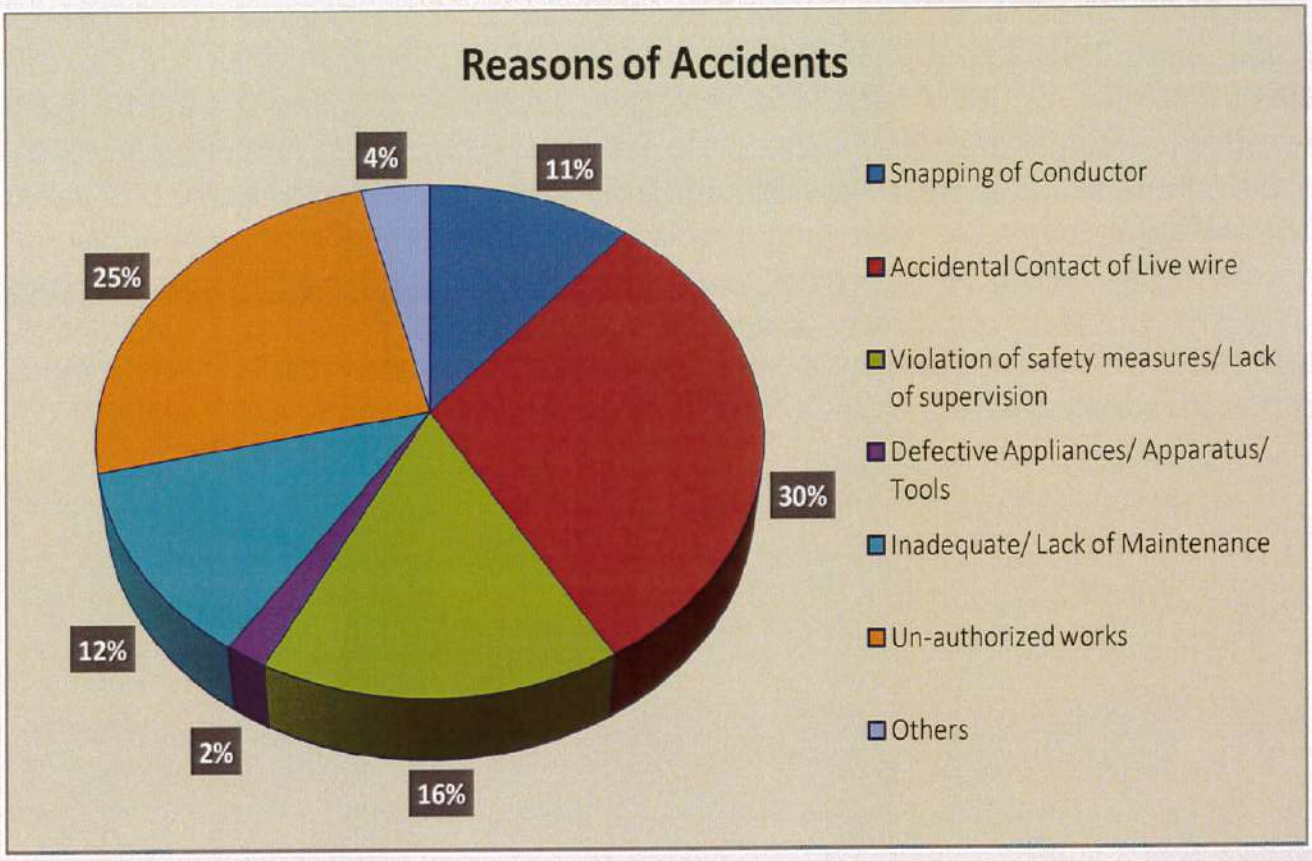


Figure-6: Major causes of electrical accidents in % for the FY 2020-21

Lightning has also been reported as one of the major reasons of failure of insulators. Many instances of accidents due to conductor snapping are reported after lightning and thunderstorms. Due to voltage surges, the insulators burst resulting in dislocation of the conductors from the insulators or poles, leading to extremely low sag or snapping of conductors. Since no mechanism is available in the 11KV or LT feeders

to isolate such low impedance faults, such snapping go un-noticed unless reported by some responsible passerby or villagers. Thus electrical accidents due to the snapping of conductors have resulted in both human and animal fatalities during many occasions.

Unauthorized works:

It is also observed from the figure-6 that almost 25% of these accidents have been reported to be occurring due to unauthorized operation and maintenance of the system. It has been noticed that villagers often resort to unauthorized operation and maintenance of distribution lines such as replacement of fuse, operating line isolators and meet with electrical accidents. Many of the accidents have also resulted in the death of the distribution company employees or outsourced workers of contractor engaged by them due to adoption of improper line clearance permits. Most of these electrocution deaths have occurred due to unavailability or unused personal protective equipment at the workplace.

Many times, distribution companies engage in experienced persons such as helper or workers who do not possess the required qualification or permit to work which has also resulted in electrical accidents. Lack of proper supervision has also resulted in human fatalities. Due to inadequate knowledge on the feeder connectivity arrangement and improper supervision, many times persons have worked in a live line assuming that it has been already isolated, due to mere ignorance. Some cases of accidents have also been reported where persons working on the distribution network have met with accidents due to accidental charging of the line during maintenance. Many of the electrocution deaths result due to fall from height due to electric shock rather than from electrocution.

In many occasions, it has been noticed that due to violation of safety measures by the consumer/ public by constructing buildings/ temporary sheds without maintaining safe permissible distance from live lines, resulting in many electrical accidents which accounts for 16% of the total number of accidents.

Reason of Accidents		CZ	WZ	SZ	NEZ	All Zones
i	Snapping of Conductor	0%	12%	16%	14%	11%
ii	Accidental Contact of Live wire	15%	45%	16%	33%	30%
iii	Violation of safety measures/ Lack of supervision	20%	12%	12%	24%	16%
iv	Defective Appliances/ Apparatus/ Tools	0%	0%	4%	5%	2%
v	Inadequate/ Lack of Maintenance	10%	14%	20%	0%	12%
vi	Un-authorized works	40%	17%	32%	19%	25%
vii	Others	15%	0%	0%	5%	4%

Table-4: Zone wise reason of Electrical Accidents for the FY 2020-21

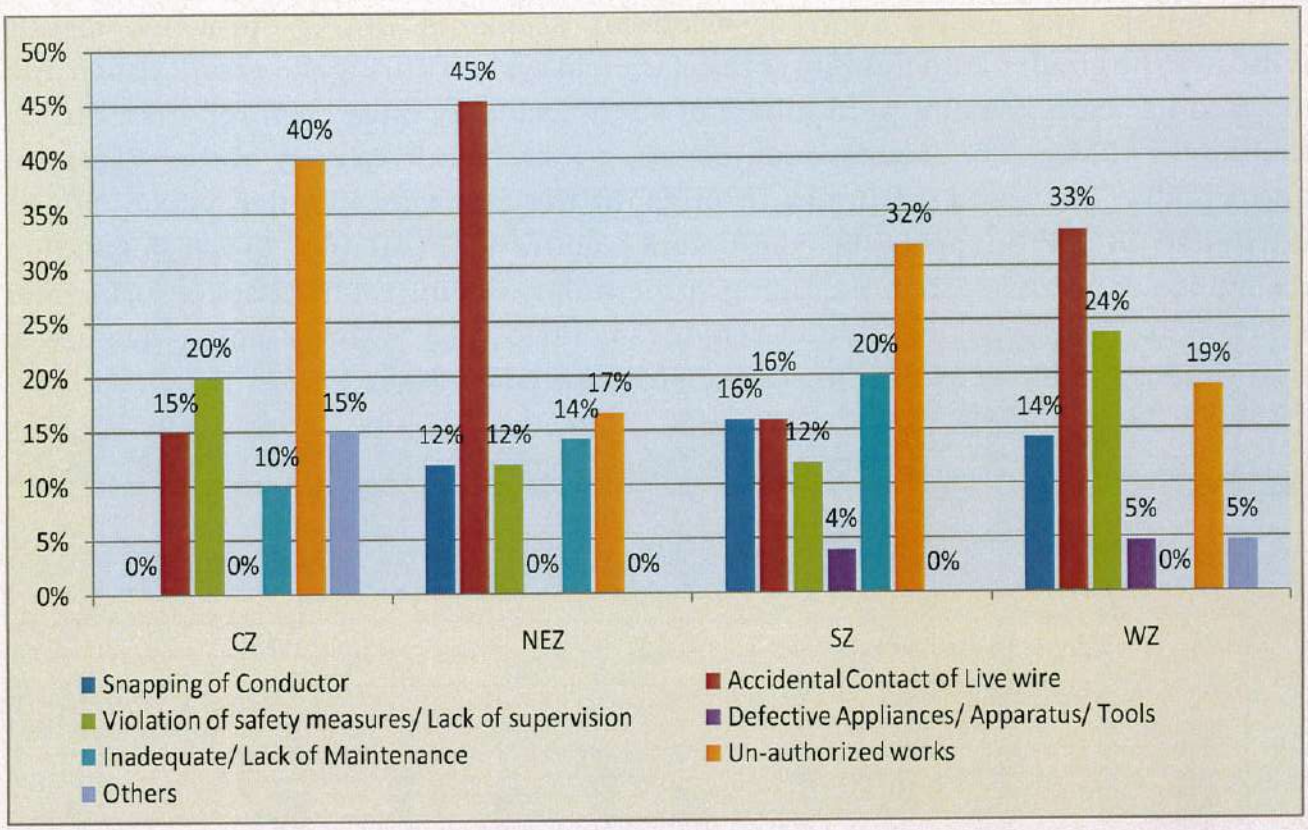


Figure-7: Zone wise comparison ofreasons of electrical accidents in % for the FY 2020-21

Zone wise analysis of major reasons:

Zone wise comparison of major reasons of electrical accidents indicates that the 40% of accidents in CZ and 32% of accidents in SZ has resulted due to unauthorized work where electrical maintenance works have been carried out by unauthorized persons who are during many occasions are found to be engaged by franchisees or contractors for supplying manpower to the distribution licensees and even villagers as discussed earlier. Accidental Contact of live wire is observed to be the major contributor to accidents in WZ and NEZ. Violation of safety measure or lack of supervision of works is observed to be consistently present as one of the largest contributors to electrical accidents besides accidental contact with live wires and unauthorized work. Though it is mandatory to carry out all electrical works under the supervision of a licensed and designated electrical supervisor, in most of the cases, such supervision is completely absent resulting in accidents. During many occasions due to violation of safety precautions such as using discharge rods or live line testers or improper line clearance or isolation of systems, many accidents occur where the victim comes in contact with live systems while undertaking repair works. The lack of enforcement of using personal protective equipment at work places greatly increases the fatality rates.

Month wise distribution:

Month wise distribution of electrical accidents in Fig-8provides clearly indicates the greater vulnerability of the electrical system during the pre monsoon and monsoon season. Maximum numbers of such accidents have been reported during the month of May, the pre-monsoon period, due to high frequency of thunderstorm and squalls. The trend continues throughout the monsoon months, which can be attributed to the snapping of conductors, failure of insulators, lower insulation resistance of overall system including vulnerability during maintenance works, and also due to increase in cultivation activities contributing towards more exposure to the unattended and defective electrical distribution networks.

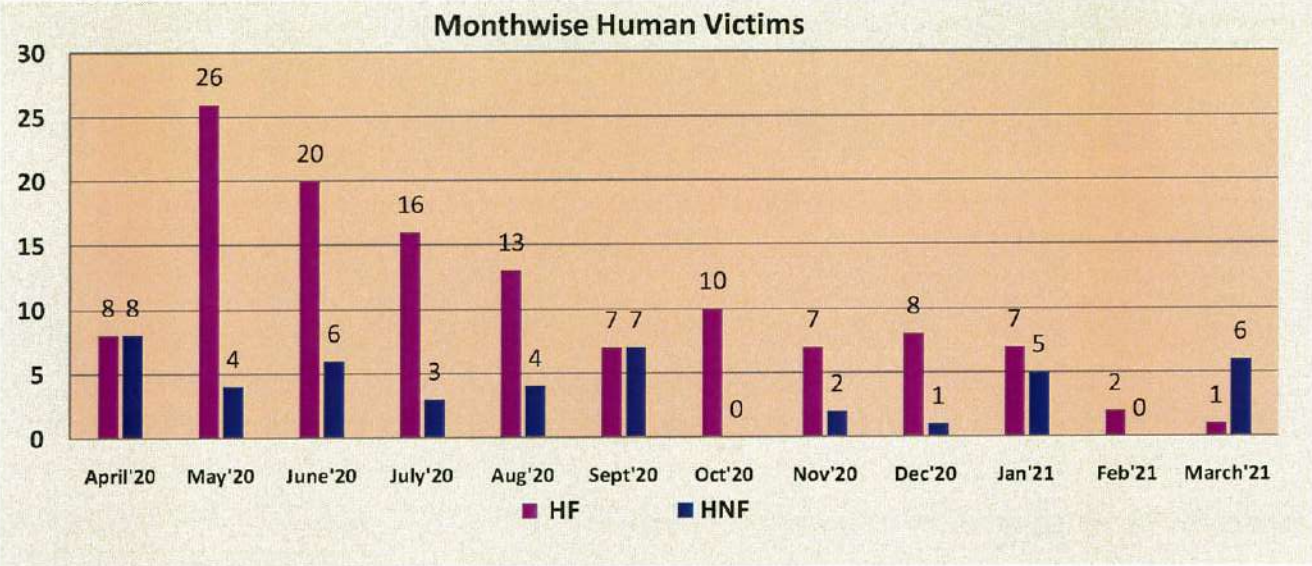


Figure-8: Month wise distribution of human fatal and non-fatal accident cases for the FY 2020-21

Division and district wise analysis:

The division wise analysis of all the accident cases has also been carried out which indicates that the maximum number of fatalities have occurred in SED, Sonepur under WZ with 06 human fatal in 6 cases. SED, Sonepur and JED, Jharsuguda having 6 accidents each are recorded as most number of accident division under Western Zone. BED, Baripada (6accidents), BSED, Bhadrak (7accidents) and RED, Rairangpur (4accidents) having 5 human fatalities each are recorded as most number of accident division under North Eastern Zone. RED, Rayagada (4 Human Fatalities), BNED, Bhanjanagar (1 HF)and JED, Jeypore (2 HF) having 3 accidents each are recorded as most number of accident division under South Zone. AED, Angul having 4 human fatalities in 4 accidents and KED-I, Kendrapada with no fatalities in 4 accidents are recorded as most number of accident division under Central Zone. Though the number of accidents has come down in RED, Rairangpur (8 accidents in 2019-20 to 4 in 2020-21) and RED, Rayagada (7 accidents in 2019-20 to 3 in 2020-21), still then in this FY 2020-21 also, these divisions have recorded higher number of accident under North-Eastern Zone and South Zone Respectively.

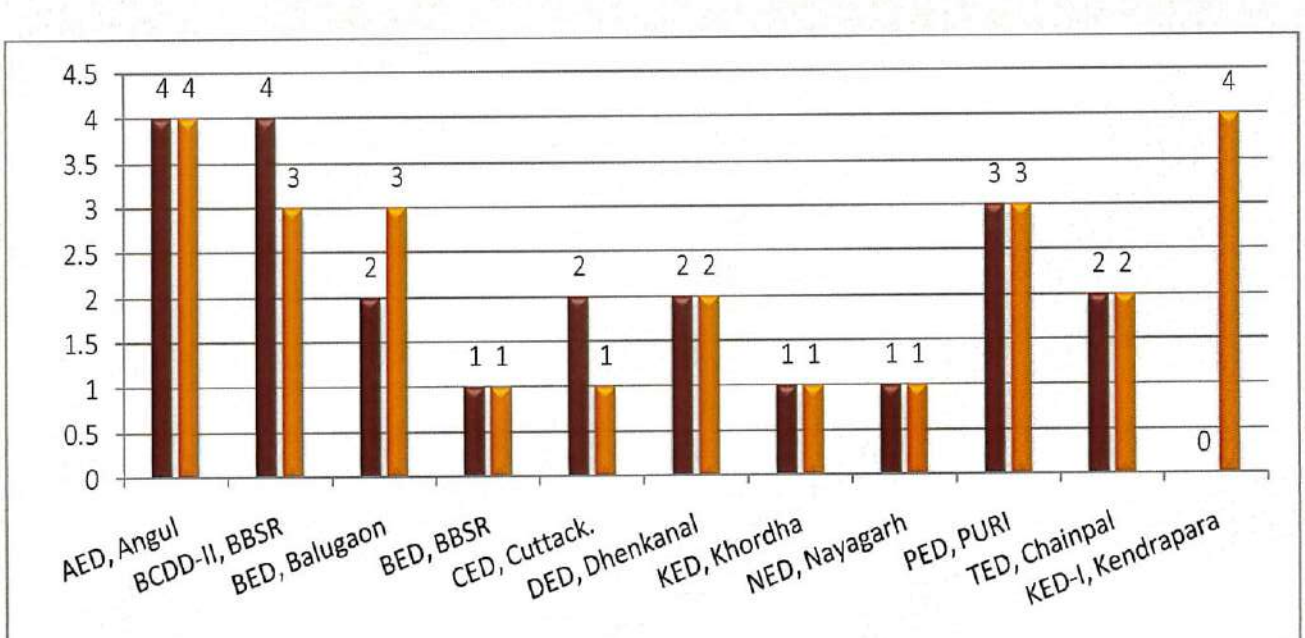


Figure-9: Division wise distribution of accidents of CZ for the FY 2020-21

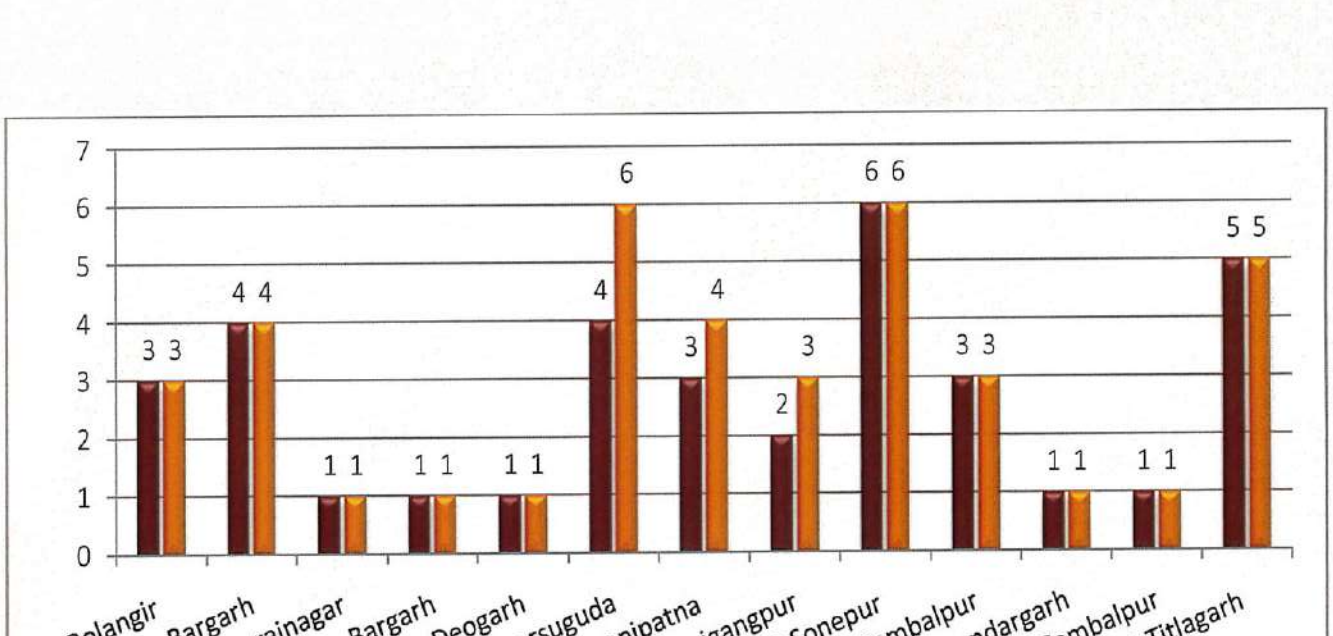


Figure-10: Division wise distribution of accidents of WZ (Western Zone) for the FY 2020-21

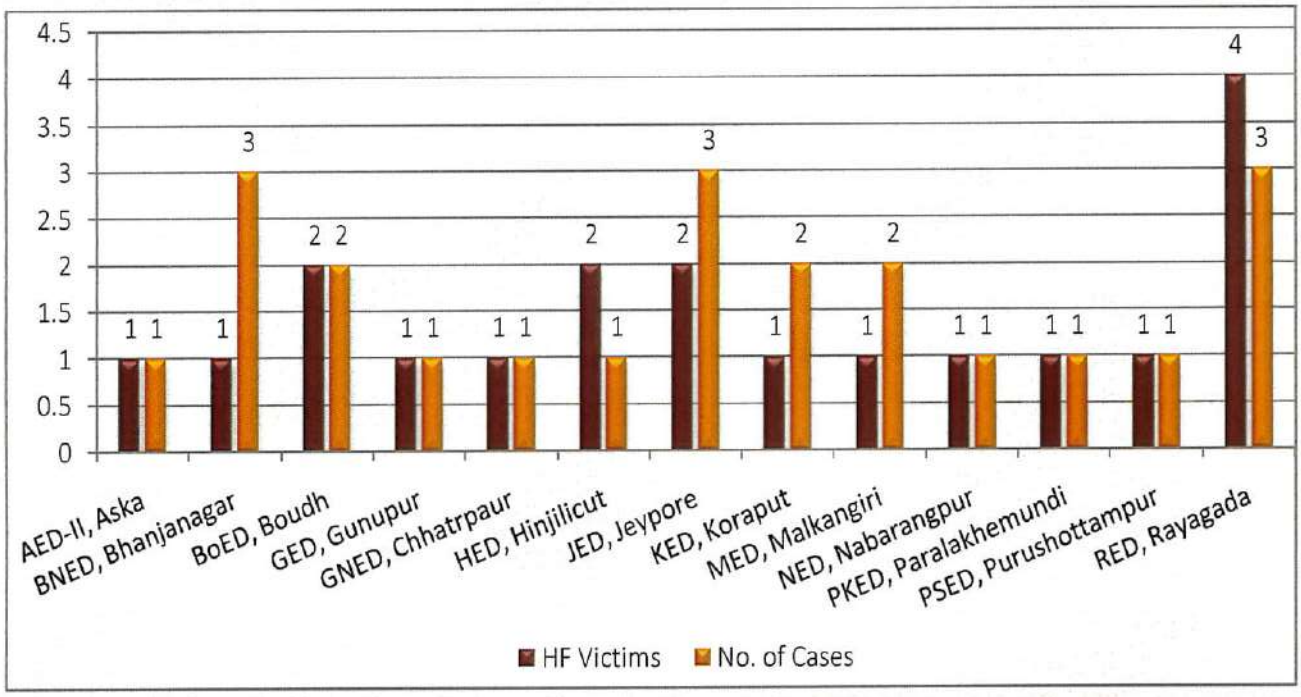


Figure-11: Division wise distribution of accidents of South Zone (SZ) for the FY 2020-21

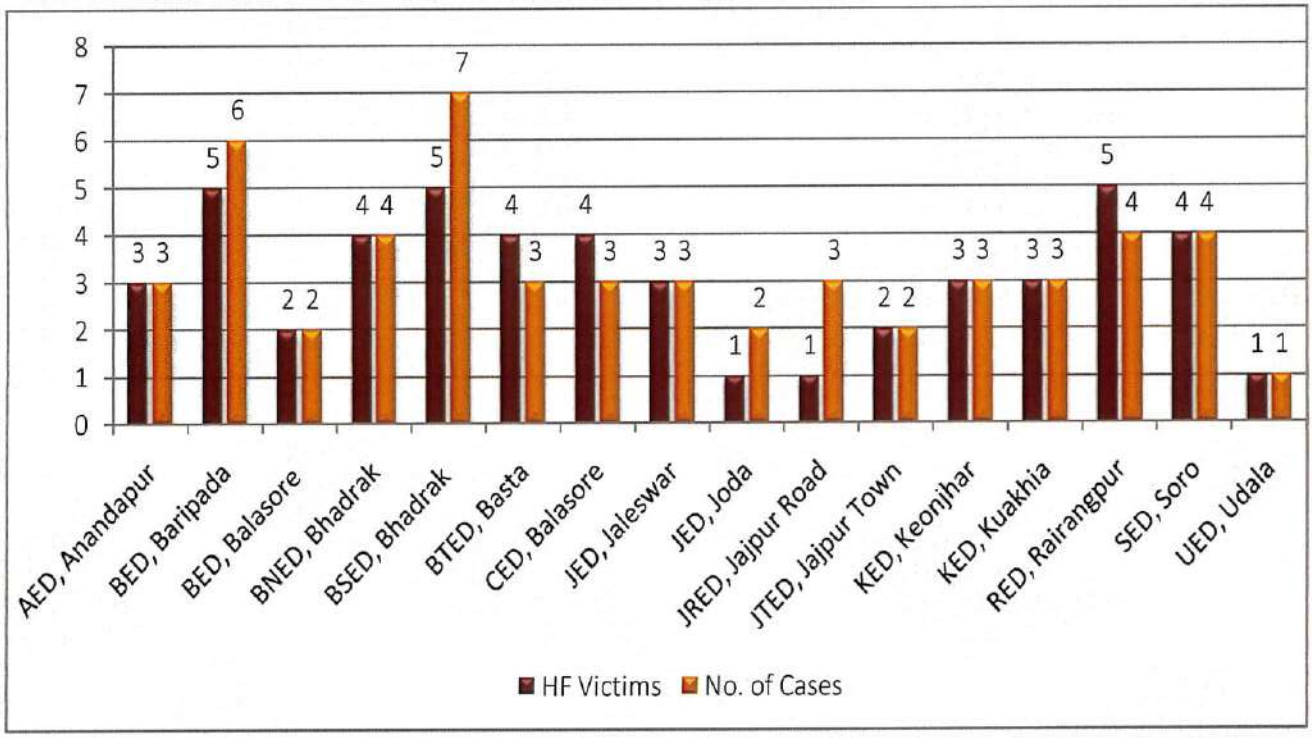


Figure-12: Division wise distribution of accidents of North Eastern Zone (NEZ) for the FY 2020-21

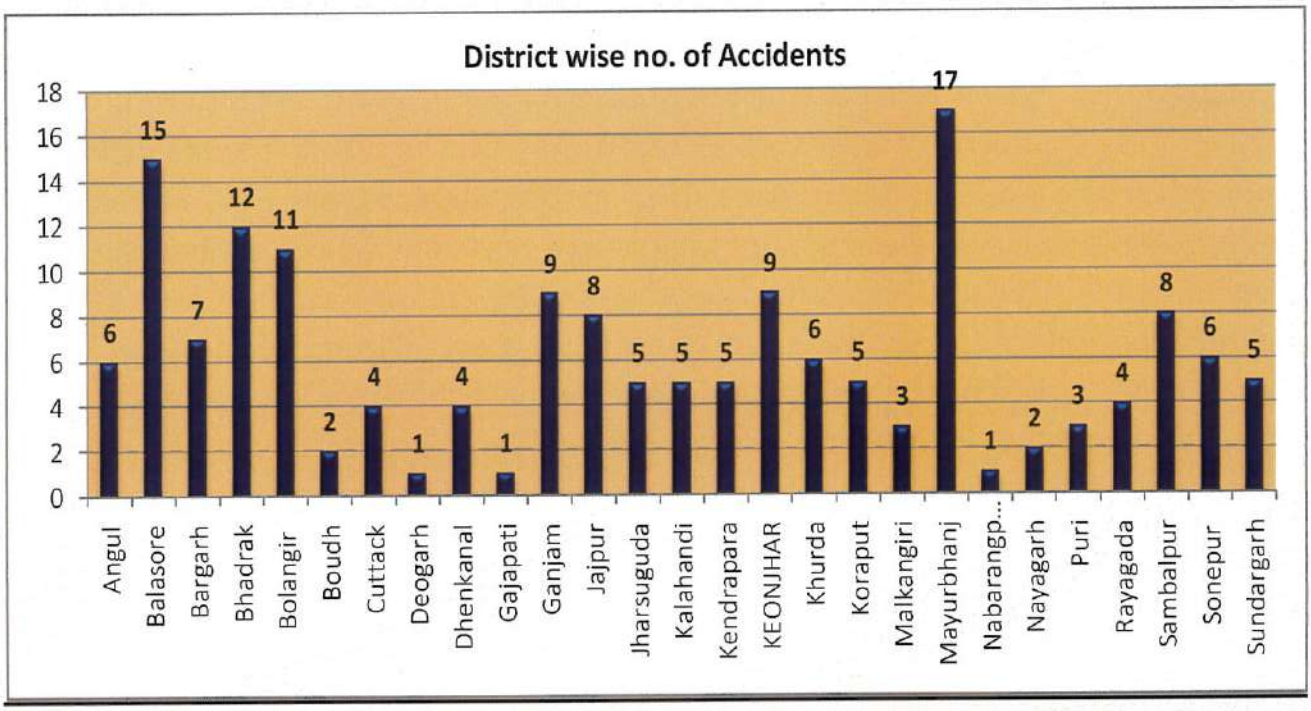
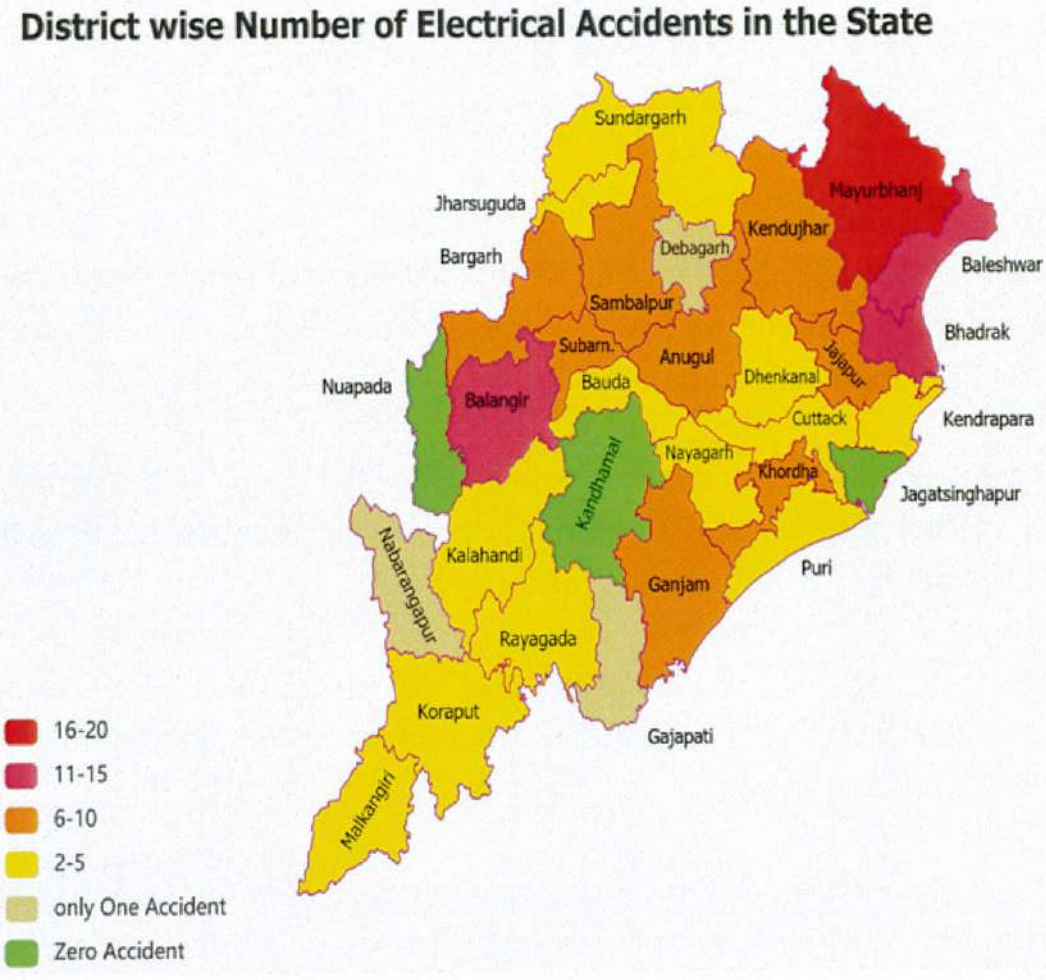


Figure-13: District wise distribution of accidents for the FY 2020-21



Analysis of Elephant Accidents:

Table 5 provides the zone wise details of elephant and other animal electrical accidents. Out of 3 electrocution deaths of elephants in 2 accidents during the FY 2020-21, 02 numbers of elephant electrocution deaths in single accident, has occurred in the North Eastern Zone itself at Gurudeba Forest Area of Keonjhar district. Another single electrocution death has occurred at Benipathar village of Dhenkanal district. 36 electrocution deaths of other animals such as cow, bullock, and buffaloes has been reported from 21 accident cases. These electrocution deaths have mostly resulted by the animal coming in contact with sagged or snapped electric lines, due to contact with charged earth wires of the poles or the charged poles, or while grazing in fields which have been charged from snapped conductors.

	Description	CZ	WZ	SZ	NEZ	Total
1	Total No. of Elephant Fatal Cases	1	0	0	1	2
2	Total No. of Elephant Fatal Victims	1	0	0	2	3
3	Total No. of Other Animal Fatal Cases	3	10	1	7	21
4	Total No. of Other Animal victims	7	17	1	11	36

Table-5: Zone wise Elephant and other animal accident details for the FY 2020-21

Conclusion

Accident details of human fatal and non-fatal cases, elephant and other animal fatal and non-fatal cases, voltage level of accidents, major reason of accidents etc. for the FY 2020-21were analyzed. It is heartening to note that no electrical accident has been reported for the EHT system. The analysis clearly reveals that:

- The highest vulnerability of human and animals is posed by the 11KV system followed by the LT system. The number of electrical accidents and fatalities in the 11KV and LT system alone accounts for 94% of the total accident cases.

- Accidental contact with live electric wire, due to low ground clearance or sagging of conductors or during unsafe maintenance works, turns out to be the major causes of electrical accidents.

- Violation of safety measures, lack of supervision and accidental contact with live wire by the workmen are also found to be the other major causes, accounting for nearly 22% and 23% of accidents.

The outcome of these observations clearly prioritizes the following key interventions:

❖ Preparing an exhaustive list of all vulnerable locations in the existing 11kV and LT system in a time bound manner. Use of social media can be adopted to collect information on such details directly from the consumers or general public. Interventions in the 11kV system alone have the potential to drastically reduce the number of electrical accidents and fatalities.

❖ Prioritizing and addressing the existing deficiencies in the system and ensuring that all existing installations, new additions and alterations to 11kV and LT systems are fully compliant to the prescribed Central Electricity Authority (Technical Standards for construction of electrical plants and electric lines) Regulations2010, CEA (Measures Relating to Safety and Electric Supply) Regulations 2010 besides other applicable Indian Standards.

❖ Adoption of zero tolerance to electrical safety violations at work place and mandatory periodic safety audit of electrical installations.

❖ Creating awareness among the consumers and general public regarding safe use of electricity and safety best practices through planned IEC interventions can be extremely helpful in minimizing electrical accidents.

Development of the power sector is essential to sustain economic growth. With increasing dependency on electricity, the transmission and distribution infrastructure needs to be further augmented through installation of still more number of lines, sub-stations etc. Such augmentation needs to be strongly supported through rigorous implementation, monitoring and verification frameworks along with strict enforcement of safety standards and protocols. It needs to be ensured that adoption of safety practices seamlessly integrates and co-exists as an integral and inseparable part of the power system so that valuable lives and properties can be saved.

"Accidents begins where safety ends"

Annexure-I

Abstract of Electrical Accidents (01.04.2020 to 31.03.2021)

		Description/ Zones	CZ	WZ	SZ	NEZ	Total
1		**Total Nos. of Accident Cases and victims**	30 (43)	48 (60)	25 (33)	61 (74)	164 (210)
	i	No. of Human Fatal Cases (Victims)	**19 (21)**	**35 (35)**	**17 (19)**	**47 (50)**	**118(125)**
	ii	No. of Human Non-Fatal Cases (Victims)	9 (14)	4 (8)	7 (13)	6 (11)	26 (46)
	iii	No. of Elephant Fatal Cases (Victims)	01(01)	0	0	01(02)	02 (03)
	iv	No. of Other Animal Fatal Cases (Victims)	03(07)	10 (17)	01 (01)	07 (11)	21 (36)
2		**Nos. of cases referred by:**	**CZ**	**WZ**	**SZ**	**NEZ**	**Total**
	i	NHRC	2	15	3	4	24
	ii	OHRC	0	0	0	0	0
	iii	Others	28	21	22	57	128
3		**Voltage level of Accidents (%)**	**CZ**	**WZ**	**SZ**	**NEZ**	**Average**
	i	L.T (up to 440 V)	29%	45%	24%	33%	35%
	ii	H.T (11 K.V)	62%	48%	72%	64%	59%
	iii	H.T (33 K.V)	9%	7%	4%	3%	6%
	iv	E.H.T (132 K.V)	0%	0%	0%	0%	0%
4		**Reason of Accidents (%)**	**CZ**	**WZ**	**SZ**	**NEZ**	**Average**
	i	Snapping of Conductor	0%	12%	16%	14%	11%
	ii	Accidental Contact of Live wire	15%	45%	16%	33%	30%
	iii	Violation of safety measures/ Lack of supervision	20%	12%	12%	24%	16%
	iv	Defective Appliances/Apparatus/tools	0%	0%	4%	5%	2%
	v	Inadequate/ Lack of Maintainance	10%	14%	20%	0%	12%
	vi	Un-authorized works	40%	17%	32%	19%	25%
	vii	Others	15%	0%	0%	5%	4%
5		**DISCOM Division wise no. of Accidents**	**CZ**	**WZ**	**SZ**	**NEZ**	**Total**
	i	Divisions with less than 5Accidents	13	8	15	14	50
	ii	Divisions with between 5 to9 Accidents	0	5	0	2	7
	iii	Divisions with more than9Accidents	-	-	-	-	-

Technical Articles

DISTINCTION NOTE ON GROUNDING AND EARTHING SYSTEM- A PROLOGUE TO EQUIPMENT AND HUMAN SAFETY

INTRODUCTION

Every 3 phase power network in ideal is considered as a balanced symmetrical system. When fault occurs, the balanced symmetrical components get disturbed, resulting in unbalanced currents and voltages in the network. The fundamental definition of fault is described as the condition for which current rises suddenly with dip of system voltage. Moreover, sudden rise of current is always dangerous to the system, if not allowed to dissipate or disconnect from the supply voltage at the very quickest time. The impact and consequence of current is to develop heat in the winding with possible threat of damage on the system.

The possible areas at which the impact of fault current could be handled are 1. Good and Proper Earthing system for quick dissipation of fault current 2. The appropriate and suitable protection Scheme for quick action time for disconnection of the faulty part from the system. Even the working of proper protection scheme demands earthing on the system. Hence EARTH connection to the electrical; system plays the very vital role. In practice each electrical equipment is required to be connected to earth system for two different purposes. The electrical circuit is to be connected to earth for controlling of the abnormal change of the electrical parameters during the fault condition and the metallic enclosure is required to be connected to earth for the quick discharge of current if the metallic body gets connected to live part.

This article has been described with the detail of the distinction between these two systems and different processes that get adopted for maintaining these in the electrical networks.

1. Distinction between GROUNDING and EARTHING

"GROUND" in literal meaning is being understood as the 'top portion" of the soil and "EARTH" the 'underneath' part of it. But electrical science describes a clear - cut distinction between both. Accordingly, they are conspicuously being spelt as "GROUNDING" and "EARTHING" respectively. Based on the interpretations in relation to the concepts and theories of electrical engineering, each terminology carries its own meaning. However fortunately, they culminate on 'safety' as the 'finishing point'. Despite both meeting points (ground & earth) remaining same, the circuits and paths they portray can be different. Through this article, following definitions are being reemphasized- rather re appraised. They are proven and time tested versions. Hope our beloved readers – either in electrical and/or non-electrical profession (younger and elderly) – shall be able to appreciate, find them palatable as well as easily digestive!

"GROUNDING": Ensuring connectivity between "current carrying components" of the whole electrical system and the earth is called GROUNDING. This segment deals with the actual quantum potential in the circuit which may result into a "full flow of fault current" during any abnormal situation. Therefore, the system becomes part of the circuit and does the role of controlling all electrical parameters during such a condition.

"EARTHING": Ensuring connectivity between "non - current carrying components" of the whole electrical system and the earth is called EARTHING. Therefore, this system deals with controlling of electrical parameters all through the metallic non-current carrying parts during an un-expected/ non- desirable contact of "electrically live" components with other "non-live" metallic ones.

End of the day, functioning of both the above systems is aimed at safeguarding of people and the equipment. In the process, engineers associated with the design selection, installation, operation & maintenance management of the most important electricity driven utility among almost all occupations, tend to agree upon one moot fact. That pertains to the significant need for developing 'best practices' towards the upkeep of both Earthing and Grounding. Thereby, the system becomes an integral chain link of a safety network. For more clarity a summation could be like this:

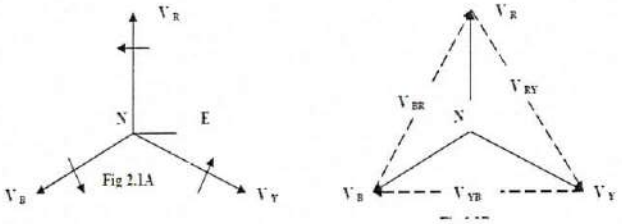
If GROUNDING facilitates the protection of equipment against work interruption, damage or destruction. EARTHING takes care of Life safety!!

Basic requirement for the creation of such a situation calls for a perfect ZERO POTENTIAL and quick discharge of fault current during abnormal conditions like imbalance in the system, contact of live parts to the metallic enclosures etc., So to maintain this system intact as far as feasible, EARTH being the

universal conductor is chosen as the 'fourth' wire in the electrical system. This conductor is maintained underneath the ground by laying metallic devices like electrodes, flats, plates, rods etc., The system efficiency depends upon the pattern of burying the conductors, their size, distance of separation and design aspect of the underground layout/ routing.

1.1. Ground fault in UN GROUNDED system:

For the case of balanced 3 Phase condition, the voltage at the neutral point (Star connection) becomes zero either of neutral being earthed or not. But for the case of un-grounded system (Floating Neutral), during abnormal condition (Unbalance, Fault) and depending upon the pattern of earth fault in the network, certain voltage develops on the neutral till to the maximum of phasor magnitude and healthy phases to the limit 1.732 times of the phasor value. Similarly for the condition of impendance earthing, the required voltage becomes the proportionate of the maximum value. So it can be concluded here that Grounding in the electrical system plays the role of controlling the abnormal rise of the voltage in the system with quick dis-charge of fault current to avoid the damage in the network.



1.1. Effects as per IEEE 242-1986 7.2.5.

i. Ungrounded systems have the potential and probability of severe over-voltages discharge to ground, which can be as high as six or eight times phase voltage on specific occasions. This can puncture insulation and result into additional ground faults.

ii. The occurrence of a second ground fault (before the first fault is cleared) will result in a Phase to-Ground-to-Phase fault, usually termed as arcing. This can be of a magnitude large enough to do damage during some situations or too small to activate over-current interruption devices in time to prevent or minimize damage.

iii. Ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service. On the contrary they possess the disadvantages of transient over-voltages, difficulty in locating the first fault and burn downs from a second ground fault.

1.2. NOTES ON SYSTEM GROUNDING:-

System grounding could be taken in three different forms, depending upon the system network and severity of the variation of electrical parameters during fault; these forms are applied in the system. Some condition where fault current becomes very high beyond the control of the materials used in the system, resistance earthing is best suitable to limit this current with use of sensitive protection scheme for quick isolation of faulty part from the system.

i. Un-grounded scheme
ii. Solid Grounding
iii. Resistance Grounding (Low Resistance/ High Resistance)

1.2.1. Un-grounded scheme:- It is the system in which there is no intentional connection between the system and adjacent ground surface. This system does not help to identify the ground fault, rather it develops unwanted voltage on the healthy phases as like described before. Delta connected network has no scope of using ground connection in the system.

1.2.2. Solid Grounding Scheme:- In this system, the neutral reference point is directly connected to the ground mat and the theorical behavior of the system during fault condition has already been described before in this article.

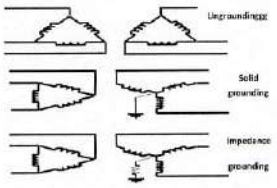
1.2.3. Imendance Grounding:- For ungrounded system, during fault condition, severe rise of voltage occurs in the healthy phases of the system. This phenomenon can be eliminated or controlled by the use of grounding the neutral point. But sometimes this value becomes very high and to limit this fault current suitable resistance can be added to the neutral path of the grounding system. Transient over voltage factor is also to be considered during the design of the resistance value. Normally it is designed to meet the criterion of Ro < Xco (Xco= Distributed capacitive reactance and Ro= Zero sequence resistance of the system, Xo= Zero sequence reactance X1= +ve seq. reactance) and Xo < 3 X1.

This grounding could be taken as 1. Resistance grounding 2. Reactance grounding

1.2.4. Resistance Grounding:- In this system the connected element on the neutral path contains maximum of resistance with minimum of reactance. So arcing grounds gets eliminated with reduction of fault current to even less than 3 phase short circuit current. But due to development of neutral voltage during fault condition, voltage on healthy phase rises till to the period of tripping action from protective

relays. Moreover the insulation of each phase is also designed to withstand this rise of voltage.

1.2.5. Reactance Grounding:- In this system the connected element on the neutral path contains maximum of reactance (coil) with minimum of resistance. This grounding has special case of application and used for the equipment/ system network with very low zero sequence reactance to avoid the flow of excessive ground fault current High impedance grounding system



Sl	Grounding Scheme/features
1.	Ungrounded Scheme 1. Generally not used, if so then for small machines in parallel 2. Fault location is difficult 3. Protection principle is on open-delta scheme (U0)
2.	Solid or Low impedance Grounding a. Low resistance grounding b. Low reactance grounding 1. High ground fault current in the system. 2. Fault location towards neutral becomes easy 3. Differential protection function is used. 4. Also I0 principle protection is used 5. Current limiting can be attended up to 1.5 times the normal rating. 6. Limiting of Transient over voltage to 2.5 times or less of the phase to earth voltage Cost of grounding resistor is more and possible damage may occur during higher ground fault condition.

a. High resistance grounded (distribution transformer grounding)
b. High resistance grounded (Neutral resistor grounding)
c. High resistance grounded (Ground transformer grounding)
1. Fault current gets limited.
2. Mechanical stress, fault damage are reduced
3. Transient over voltage is also limited.
4. Grounding device is economical comparison to neutral resistor.
5. Protection scheme with U0 (95 %)
6. 100 % protection by injection of frequency or 3rd harmonic principle
7. I0 measurement principle is used.

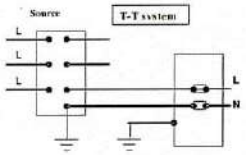
1.1. TYPES OF EARTHING SYSTEM:

For safety of the working personnel, the metallic parts (exposed non-current conducting segments) of the electrical equipment are connected to earth and its design pattern depends upon the requirement and suitability of the system network. During abnormal conditions like faults or contacts between live and non-live metallic parts, the fault current flows through the 'Equipment earthing' conductor and returns to the 'Supply Source' instead of passing through operator's body in case he/she accidentally touches the metallic part. The pattern of flow of return current to source depends upon the use of earth connection to the equipment body. Followings are the good safety practices to be adhered to for such system.

All non-current carrying metal parts associated with HV /EHV installation shall be effectively earthed to an earthing to:
(i) Limit the 'step and touch' potential to tolerable values.
(ii) Limit ground potential rise to tolerable value
(iii)Maintain the resistance of earth connection to safe limit.
Regulation No. 48 (Equipment and installation >650 V pertaining to Electricity Rules) also duly covers the above aspect.

In addition, as per BS 7671 and IS 3047, five types of earthing system are usually advisable based on the interphase between grounding and equipment earthing. Broadly it is classified into three parts (TT, TN and IT). The first letter is indicative of connection of system earthing, second one for the equipment earthing and the third about the concept for neutral and protective conductor. (Where, T=Earth (from the French word Terre), N=Neutral, S=Separate, C=Combined & I=Isolated).

a. TT
b. TN-S
c. TN-C
d. TN-CN-S(PME),
e. IT

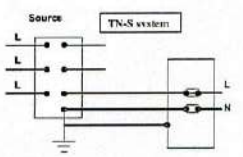


1.4.1. TT –Both earthing are not connected electrically. This system has the Earthing at 'Source end' and metallic extraneous conducting part is connected for local earthing

1.4.2. TN – This is the Source System. Therein, metallic exposed parts of the installation are electrically connected with the earthing system. TN is further classified into

1.4.3. TN-S, TN-C, & TN-C-S systems

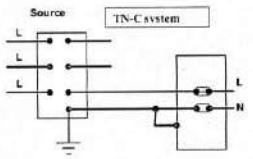
1.4.3.1. TN-S :- In this , Neutral of the source is connected with earth at one point only, preferably near to the source and the protective earth conductor is connected to the neutral. This PEC (Protective Earth Conductor) is connected separately.



1.4.3.2TN-C: In this, both Neutral of the source and protective earth conductor are combined, connected and run through the total system as 'neutral wire' with earthing at one point only,

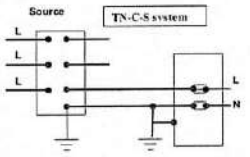
preferably near to source.

1.4.3.3. TN-C-S: This is similar to the TN-C system, except that there could be separate earth connection at consumers' premises. Sometimes due to the availability of multiple earthing throughout the network, this is also called PME (Protective Multiple Earthing).



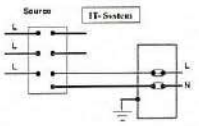
1.4.3.4. One Single conductor categorized as Neutral is run to the total network. The PEC is usually connected and separated by provision of LINK.

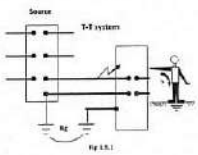
1.4.4. IT– This system has the Neutral either unearthed or earthed through high impedance and the exposed conductive parts of the installation are connected to electrically independent of earth electrodes at the consumers' premises.



1.5. SAFETY ASPECTS: -

Thanks to the ongoing narratives on the grounding/earthing system, the pattern of further discussions should encourage us to explore the basics of the end point – i.e., assured SAFETY. This needs to be addressed in a focused manner from the point of view to save people as well as equipment. The connection of grounding to the electrical system shall be linked to the flow of fault current and least time availability of this dangerous energy in the system. Now the magnitude of this current and pattern of flow depend upon the earthing arrangement. This calls for subsequent connection of an earthing conductor to the grounding system. Sometimes during the dissipation of this current to ground causes the GPR (Ground Potential Rise) Followed by the generation of an -intolerable value of 'Touch and Step' Potential, in turn causing harm to the working personnel .





1.5.1 Equipment Safety Consideration:

Electrical equipment has windings and insulation as the main constituents for safe control of all 'electrical' parameters. Insulation among the windings is arranged such a way to protect the equipment from the voltage breakdown

and avoid the leakage of live current to earth system. To achieve this, quality and quantity of insulation with its positioning in the equipment becomes very significant when it comes to safe management of system voltage. Similarly flow of current and its effect on the system like development of heat (Temperature) rise on the winding should be ascertained. This can result into subsequent damage to the system depending upon the sizing of winding conductor used in the system vis-à-vis the network arrangement.

During fault condition, both the electrical parameters (current and voltage) change (fluctuate) on its magnitude and phase angles. Depending on the development of required potential, the fault current takes its own path to flow. Being detected by the available protection scheme, the system enables quick isolation of the faulty part from the healthy part. Maximum cases of damage become severe due to the flow of faulty current through the equipment. This happens because of the development of excessive heat on the winding. Accordingly, engineers plan for the control of this current during fault condition. Pattern of the design is considered in two methods as mentioned below:

i. Provision of Protective device for quick detection and isolation of the faulty parts. (Like use MCBs, MCCBs, RCBs, Sensitive Relays with its circuitry)
ii. Provision of system arrangement for reduction of fault current (Use of proper Earthing system for quick flow to universal Earth Sink).

1.5.2: Personal Safety Considerations:

The vulnerable areas of concern in the electrical system at which human safety precedes everything else could be identified as follows.

i. All Possibilities of touching the metallic enclosure part of an electrical equipment
ii. Chances of touching other metallic installations in the system
iii. Probabilities of walking along the affected areas under 'fault condition'.

The accidental touch of live conductor to the extraneous metallic enclosure of the equipment causes 'exposure' based voltage potential within it. Based on the impedance path in the system, this fault current attempts to flow to the source of its origin. With reg. to certain conditions of solid earthing system, the current magnitude can go high, but quickly it gets discharged to the ground. But in the presence of some other conditions related to any impendence in between, there could be enhance of resistance resulting delay discharge of fault current into the ground, subsequent heating and damage of the system or electrocution of the living part. Hence it is always advisable not to use impedance (resistance/reactance) for equipment earthing and it should be allowed to move at the easiest path to the universal earth mat in the system.

The potential responsible for the current to pass through the human body is described in three different manners Touch Potential (On touching the LIVE part and causing the current flow through body), Step Potential (The current path resulting between the feet), and Transferred Potential (Due to Electrified Device and because of induction, the close vicinity metal conductor may result the

development of Electrical Potential and inadvertent touch of this body by any living being is called Transferred Potential and dangerous to the Living being also). The development of the potential on the metallic part depends upon the use of earthing system and its connectivity to the faulted parts. In case of non-earthing, the potential magnitude across the victim either due to touching on a faulted part or walking on the affected area depends upon the fault current and the resistance offered by the affected parts of the person.

Example: In case of a TT System of connection, where an accidental contact with a live conductor to metallic part occurs, the victim can be exposed to the available voltage. Now thanks to earthing of this structure, the fault current will try to flow towards the source through one path containing adequate earth resistance. Obviously, the other path could be through human body. In the latter case, the consequence depends on the resistance offered by the victim's affected part. This situation may as well cause electrocution in case the current value exceeds the tolerance limit. Similarly, for other kind of connection, the 'flow of fault current' and corresponding safeguards to the human being can be ascertained based on the earthing system,

For the design of universal earth mat system following assumptions are considered:

1.5.3: Concept on Electric Shock: The flow of electric current and its effect on vital organ of the body that results into muscular pain and ventricular fibrillation followed by severed blockage of blood circulation. This can be called ELECTRIC SHOCK. The consequences if electric shock can vary based upon the following factors.

$H = I^2 Rt$

Where H= Energy absorbed by the body
R= Resistance of the body
I= Electric current flow
t= duration of current flow

i. Magnitude of electric current
ii. Duration of current flow
iii. Frequency of current involved

The flow of current on any system depends upon the potential difference between the points of consideration. When this concept of flow is considered for the human being, the resistance of the body and voltage applied across decides the quantity of current flow. But the design of the human body has certain limitations with reg. to the capacity to withstand the current flow and related data of current values are listed below:

- Perception current = 1mA
- Let go current = 1 to 6 mA
- Muscular contraction current = 9 to 20 mA
- Ventricular fibrillation current = 60 to 100mA
- Resistance of Human body = 2500 – 3000 Ohms

Normal design value of resistance (Between one hand to both feet or between one foot to the other foot) = 1000 Ohm.

1.5.4: The other minimum technical design values to be considered is described in this table.

Terms	Value	Terms	Value
Surface Resistivity for crushed rock	3000 Ohm- mtr	Ambient Temp.	50 0 C
Resistivity of Steel	15 Micro Ohm- mtr	Density of Material	7.86 gms/cc
Specific heat of material	0.114 Cal/ gm/ 0 C	Max. Temp. of Bolted joint	500 0 C
Depth of Burial Mat	0.6-0.7 mtr	Soil Resistivity	100 Ohm- mtr
Duration of Fault Current	1 Sec	Type of Electrode	MS Flat (50 ×6 mm) (50x8 mm)
Human body Resistance	1000-1500 Ohm	Allowable Corrosion	1 % per annum for the 1st 12 yrs and 0.5 % for the next 12 yrs as per ISS 3043/1987
Current density of earth conductor	100A/mm2		

1. CONCLUSION: - This article has tried to cover the entire concept of safety consideration of both equipment and human beings. This can be finally concluded herein that in case of any eventuality, the final outcome depends on the flow of fault current to universal earth system within the quickest possible time. During this flow, there could be development of potentials at different points depending on the impendence path in the system. These potentials sometimes become intolerable and can hamper the safety of the operator. Hence a standardized, duly installed, effectively functioning, regularly checked, periodically inspected, adequately maintained and well-kept earthing system is the only choice for the safety of both people and equipment.
Understanding the role and use of EARTHING in our system can make ourselves and our system SAFETY.
Final Take away BE EARTHED BY GROUNDING is the SUMMERY of this article. Wishing you all to maintain the SAFETY practices to handle the most effective Electrical Energy for your service rather than your master.

Having 29 years of technical experience on various HT and EHT voltage level in the field of transmission sector. Specialization on the development techno-economical design of protection control schemes for system development and system planning. At present he is involved with various on-going projects on GIS, SAS and updated Remote SCADA control stations of OPTCL.
He has publication of around 103 technical papers in National and International arena and a regular contributor to the National journals like Electrical Mirror, Electrical India, CBIP journal and IEEMA journal. He has been awarded in various arena on National and International level. He has authored many technical books, the recent publications being TECHNICAL MIRROR Case Studies under Icon media Publication and in IEEMA JOURNAL as the series "Event and Eventualities".
He is also the coordinator of a Technical Electrical Engineers' Group named "SPARK- Ignited to share" with around 3200 members all across the nation with eminent and Senior Electrical Engineers of the country.

By P. K. Pattanaik
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OPTCL- Bhubaneswar

Enhancing Safety Through Centralized Monitoring & Control of Distribution Network

Abstract—SCALE or Safety, Care ,Agility, Learning, Ethics are the Values of TP Central Odisha Distribution Ltd (TPCODL) and Safety is one of the core values. In order to ensure Safe and Reliable Power Supply to its consumers, TPCODL has established "Power System Control Centre"(PSCC) .With the establishment and operationalization of PSCC from 16.6.2020 , PSCC is operating as a central agency for : (a) Control & Monitoring of 33 and 11 kV Network, (b) Institutionalization of a standard & uniform process of Permit To Work (PTW) across the license area , (c) migrating from the manual to remote operations of all 33 / 11 kV Substations in a phased manner, (d)coordination with Odisha Power Transmission Corporation Ltd (OPTCL) & State Load Dispatch Centre (SLDC) in due course of time , (e) day ahead scheduling of power, real time monitoring & control of power, (f) central data repository for network parameters and will carry out reliability analysis across various divisions /voltage levels and across the license area. It will compute and report various reliability indices for the utility that would be required for benchmarking, improving performance parameters and compliances.
Keywords—Power System Control Centre ,Permit To Work Safety ,Relaibility ,SCADA/DMS ,Three Way Communication,Sign Writing

I. BACKGROUND

As per Orissa Grid Code (OGC) Regulations 2015, Clause 2.5 outlines the role of Distribution License, as per the code one of the functions of the Distribution License is to establish Distribution System Operation & Control Centre. The clause if reproduced below:

"Establish Distribution System Operation & Control Centre (DSOCC) at a strategic location near the geographical center and load center of the Distribution Licensees' Area of Supply, having adequate communication facilities. The DSOCC shall be manned round the clock with the required staff during emergency periods. It shall take appropriate action in response to grid warnings as decided by the Distribution Licensee and convey suitable instructions to the operating staff. It shall take timely action in response to grid warnings as per standard instructions laid down by the Distribution Licensee in this regard and if necessary, issue appropriate instructions in addition, if a particular situation warrants. The SLDC / ALDC shall intimate the Distribution Licensee through DSOCC, regarding significant deviations of Understanding the role and use of EARTHING in our system can make ourselves and our system SAFETY.

Final Take away BE EARTHED BY GROUNDING is the SUMMERY of this article. Wishing you all to maintain the SAFETY practices to handle the most effective Electrical Energy for your service rather than your master.

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Final Take away BE EARTHED BY GROUNDING is the SUMMERY of this article. Wishing you all to maintain the SAFETY practices to handle the most effective Electrical Energy for your service rather than your master.

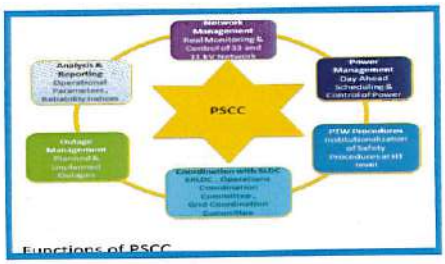
final schedules of State generators and CGS on overall merit order. The DSOCC shall undertake suitable load management and curtailment."

With the above statute and various other benefits in mind, Power System Control Centre (PSCC) was set up for TP Central Odisha Distribution Ltd (TPCODL)

Earlier there was no concept of PSCC and all network operations were carried out in a decentralized manner and an overall monitoring of the network would therefore be difficult . Further though there existed a process of Permit to Work (PTW), the practices followed across Divisions were not uniform. Monitoring of Operational parameters at a centralized level was not possible . All the 33 kV Incoming feeders to the 33 /11 kV Substations emanate from OPTCL Grids and all the coordination for planned /unplanned outages and switching operations pertaining to these feeders is coordinated between the concerned Sub Divisional Officer (SDO) and OPTCL Grid In this scenario a holistic view of the complete view of the 33 kV network at any point was not available.

Various functions envisaged from PSCC are

(a) Real Monitoring & Control of 33 and 11 kV Network
(b) Day Ahead Scheduling, Real Time Monitoring & Control of Power
(c) Planning & Outage Management
(d) Reliability Analysis & Reporting
(e) Voltage Control
(f) Institutionalization of Safety Procedures at HT level
(g) Coordination with State Load Dispatch Centre
(h) Contingency Planning
(i) Demand Estimation



I. VALUE CREATION WITH ESTABLISHMENT OF PSCC

Arising out of the functions enlisted above, various benefits will be accrued leading to Operational Excellence:

1.Ensure efficient & coordinated operations across the license area as envisaged by the Grid Code.

2. Will facilitate faster restoration in the event of a shutdown /breakdown with the help of remote operations through SCADA /DMS. As a result of this reliable and uninterrupted supply to the consumers at large is ensured.

3. Will ensure optimal loading, utilization of the network by effecting real time positions of switches in the network so as to ensure the minimal possible losses in the network.

4. Management of active and reactive power in the network to ensure voltage control and loading of the network.

5. Facility of contingency analysis on the network with real time network parameters and under various scenario for initiating corrective action in terms of network improvement schemes.

6. Institutionalization of uniform safety procedures across the license area for planned /unplanned outages including preventive and breakdown maintenance activities by developing Standard Operating Procedures, Operating Instructions, Permit to Work and Safety Tagging procedures. This will result in ensuring safety of personnel and equipment and consequently avoid any accidents to utility personnel and outsiders alike.

7. Near accurate Load forecasting for the utility on long term and short-term basis inclusive of day ahead forecasting and scheduling for better planning and power management ensuring the best power purchase cost.

8. With the availability of real time monitoring of power at various interface points in an integrated manner centrally at PSCC, real time balancing of injection and drawal of power by the utility is possible thereby ensuring Grid discipline and adherence to Grid Code. This will also ensure minimal deviation from the drawal schedule of power and thereby minimal deviation charges arising out of the applicable Deviation settlement mechanism.

9. PSCC will be the nodal point of contact for coordination with the State Load Dispatch Centre for efficient and coordinated operation of the Grid in terms of maintaining stable load ,voltage & frequency of the grid .Also PSCC would be responsible for implementing Load trimming schemes ,preferably with an automated and prioritized load shedding module for ensuring Grid stability at all times.

Various functions envisaged from PSCC are

(a) Real Monitoring & Control of 33 and 11 kV Network
(b) Day Ahead Scheduling, Real Time Monitoring & Control of Power
(c) Planning & Outage Management
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(h) Contingency Planning
(i) Demand Estimation

1. Will ensure optimal outage management for preventive and breakdown maintenance of the network equipment's for ensuring maximum system availability.

2. PSCC will be a central data repository for network parameters and will carry out reliability analysis across various zones /voltage levels and across the license area. It will compute and report various reliability indices for the utility that

would be required for benchmarking, improving performance parameters and further as a regulatory compliance for reporting.

3. Will be representing the utility in various Grid Coordination Committees i.e. Operation Coordination Committee, Protection Coordination committee etc. required as per the Grid Code for coordination with the State Transmission Utility. PSC will also serve as a coordinating point for implementing instructions of the SLDC during any system disturbances as a result of natural calamities or otherwise for maintaining Grid resilience.


24 x 7 PSCC in Operation

I. ACTUAL DEPLOYMENT OF PSCC

As of May 2021 ,PSCC has been fully deployed to monitor and control 52 number of 33 /11 kV Substations in the city of Bhubaneshwar and Cuttack .

This has been made possible by operationalization of Supervisory Control & Data Acquisition (SCADA) for all these stations. PSCC is manned 24 x 7 by Shift Engineers, With the SCADA in place real time monitoring and control of 33 /11 kV Substations in the twin cities of Bhubaneshwar & Cuttack is done ,a total of 261 ,11 kV feeders are directly being managed from PSCC , cumulatively about 300 MW of power . This is probably the first time that remote operations through SCADA have been deployed at this scale anywhere in Odisha.

1) STANDARD OPERATING PROCEDURES

Before initiating remote operations ,it was very much necessary that separate set of Standard Operating Procedures be framed ,documented and circulated as a reference document for all to adopt and follow. This was a paradigm shift in the operations that would now be carried out at the distribution level .

All the scenarios that would arise for any kind of tripping ,outages be it planned and unplanned have been envisaged and detailed .Special


TPCODL
TP CENTRAL ODISHA DISTRIBUTION LIMITED
Standard Operating Procedure (SOP)
For

Panels at the Stations has been carried out. Standard Sign Writing Document is published & Signwriting at all Remote Operated Stations in Bhubaneshwar and Cuttack has been completed.

11kV Feeder Panels Before Sign Writing
11kV Feeder Panels After Sign Writing

4) SYSTEM BASED PERMIT TO WORK SYSTEM

With the migration of 33 /11 kV Substations of Bhubaneshwar & Cuttack city to central remote control and monitoring through Power System Control Centre (PSCC), adoption & deployment of Safe Permit To Work (PTW) system has been the topmost priority.

At the inception PTW`s were being managed through a manual Excel based system. This involved a lot of procedural work is involved as well, it is a humongous task to manage and record such huge amount of entries for issuing and clearing PTW`s manually.


Training Sessions at 33 /11 kV Substations

In order to overcome this, PSCC with inhouse IT team has developed a complete web based PTW Management system "Suraksha Kavach"

PTW System -Suraksha Kavach

Through Suraksha Kavach, PSCC manages it's Permit to Work system efficiently. The following key aspects are addressed through this

1. Only pre-authorized personnel are eligible for working on lines/equipment's

2. Every work is identified by a unique code number. This is only shared with working personnel so that only they can clear the line/equipment by charging.

3. The unique code is autogenerated by Suraksha Kavach and SMS is sent directly to registered number

4. Division, Substation and Feeders are pre-mapped into the system. It automatically detects the number of consumers affected for any shutdown

At present, PSCC manages about 4000 operations remotely every month. This number is further expected to grow 5-7 times in near future.

With these prime aspects addressed, PSCC desk engineer focuses on ensuring safety adherence

and minimal supply interruption time to consumer. Additionally, Suraksha Kavach helps in data management and aids analysis by generating customized reports for monitoring operational efficiency.

Multiple checks and balances are built into the system so that during closing of PTW, if multiple number of outages/PTW`s are running on same feeder then, SURAKSHA KAVACH shows warning notification before closing of any PTW on that feeder.

5) VIRTUAL TAGGING IN SCADA

Virtual Tag in SCADA is a protection interlock that prevents any operation on tagged feeder

Various types Of Tag that can be used during remote operation through SCADA are Maintenance, Earthing, Work Permit, Information, Open Only ,Close Only ,Manned Operation.

Maintenance Tags' informs user of ongoing outages and avoids maloperation.

Tagging system in SCADA

6) COMMUNICATION PROTOCOL

Three-way communication is the best practice of communication and same has been adopted for all communication between the field and PSCC, the basic outline of three-way communication is as follows:

Alert before clearing equipment with multiple PTW`s

1) The sender states his message to the receiver

2)The receiver acknowledges the communication by repeating the critical information in the communication back to the sender, if the receiver did not understand the communication then he has to ask the sender for clarification.

3)The last step is the sender confirms the message is correctly understood by the receiver or if it is not understood the sender.

must indicate that the message is not understood, and three-way communication process has to start over. There is no room for errors due to improper or incorrect communication in the course of operations, which, therefore, has enhanced the Operational Safety manifold.

7) SCALING UP OF OPERATIONS

From the time that remote operations started and migrated from manual to parallel to remote operations ,the scale of operations being managed through PSCC has increased dramatically thus ensuring that all the operations carried out from PSCC are safe and all the works carried out on feeders controlled through PSCC are with a valid PTW .This has increased the Safety of the Equipment and personnel

CONCLUSION

With the initiation of Centralized Operations through PSCC for the 11 kV network in June 2020 ,TPCODL has come a long way in enhancing Safety manifold ,ensuring Operational Excellence ,improving Reliability ,brought about change from migration to totally manual operations to System based operations .Personnel operate almost all equipment of system remotely ,System to Aid in Decision making ,No physical proximity to the equipment's ,Third party overview of the system for better coordination ,Updated information of restoration work available centrally and can be passed on to consumers ,Realtime visibility of system parameters and ultimately, leading to Safe ,Faster operations and Delighted Consumer.

Authors

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Over 25 years of experience including Automation ,GIS, Network Planning ,Engineering ,Power Management, Regulatory Interface ,Grid & Distribution Operations at TPC , TPDDL and State Distribution Utility .Has been a member of working groups of Bureau of Indian Standards (BIS) for Transformers and Insulating Fluids . Has represented in various National and International forums with 26 Technical Papers publications

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Safety Zone Creation, A Path to Mission Zero Harm

A collaboration of technology and robust safety measures in electrical distribution system

Introduction

The new era has dawned rich with promises for providing a safe workplace and consumer safety at Odisha Discom. Every organization enthusiastically exploring fresh avenues and strategies for further enhancement of safety performance and germinate interesting in new approaches. To breed a path-breaking safety culture among the employees, adoption of robust safety measures and initiatives towards the aim "Mission Zero Harm" with a collaboration of new edge of technology are essential. There is a unique concept called "Safety Zone Creation" which to be practiced for establishing "Zero Harm" at workplace. Focus to be given towards hierarchy of risk control with help of technologies and following the electrical safety guidelines.

This article gives a detailed guide on "Safety Zone Creation" while working on electrical lines. The complete safety of workplace can be achieved by applying some of the safe practices, technologies and personal protective equipment. This Safety Zone is going to provide an assurance of zero harm to the workman during working in electrical installation.

Scope of application

Safety zone creation can be applicable in any electrical installation irrespective of Generation, Transmission and Distribution. It is effective for activities related any substation and electrical lines.

Purpose

To provide safe workplace and safe working environment for employees

Objective

Adherence to Organization's Safety Goal
Adherence to legal requirement
Conforming Employee Safety

Importance of "safety zone"

Electricity is very essential for our daily life and easy to use but if it's mishandled during operation and maintenance work, it can cause major injury and sometimes deadly fatal injury. The main objective of the safety zone creation is to establish the electrical maintenance work in such a manner that prior to work execution by following three basic electrical rules i.e.,

- Test & Isolate Before Touch,
- Ensure Job Safety while Working,
- Use PPE's (Personal Protective Equipment) Before Work.

In the transmission and distribution sector breakdown and planned shutdown is common for all but it's not that easy to execute the work. A minor mistake on isolation of live line can cost loss of life and damage of the equipment. We can execute the work without any injury or damage by creating a Safety Zone at the workplace. In our daily routine of operation it is necessary to follow the steps like taking a valid permit to work, workplace arrangement with required safety tools and PPE's, Implementation control measures by following the job safety analysis and focus on high-risk activities.

How to create a "safety zone" – Complete isolation prior to execute the work

The safety zone creation started with taking a valid work permit and engagement of authorized personal for the work. Prior to start of work, employees involved in the activity are required to be provided with the pre task briefing about the activity (Tool-Box Talk).In a proper planned manner isolation of the line to be done by using Lock Out and Tag Out procedure to avoid a unauthorized operation. Once the line is

isolated, it is required to be tested with a Neon tester (high voltage induction tester). After successful checking and confirming as the line is completely dead, it needs to be discharged with help of discharge rod and portable ground so stored energy if any can be routed to the ground and discharged fully to make an available a safe line for work. After isolation there might be a chance of back charge i.e. current follow from the user end as the consumer might be using Invertor, diesel generator and other means of supply, so isolation of the both the side of the line is very essential to create a safety zone.

In addition to above provisions in creating Safety Zone we must ensure using personal protective equipments (PPE) like Full Body Harness for fall protection, Correct rating of Rubber Hand gloves with respect to voltage level, Electrical Safety Shoes and Safety Helmet. All these activities requires strict supervision which will ensure compliance to the Safety norms at site.

Key benefits of creating "safety zone"

By adopting the safety zone creation, the benefits to the organization are very wide in range. It might not be visible on immediate basis but when the electrical incidents are prevented the tangible and intangible benefitsof incidents gives the cost optimization in operation and motivate employees towards adoption of safety culture.

A safe workplace not only protects employees from injury and illness, it can also lower injury/illness costs, reduce absenteeism, increase productivity and qualityand raise employee morale. In other words, safety is good for business, plus protecting workers is the right thing to do as every employee is very important for their family. It is the employer responsibility to provide a safe work zone with employee's active participation to follow the safety standards and defined guidelines for team effort towards making everyday injury free. "There is nothing important than a human life, so no compromise on safety zone creation"

Implementation of Permit to work (PTW)

The safety zone creation will not be possible without a permit to work system as it's is a formal system stating exactly what work is to be done, where, and when. A responsible person should assess the work and check safety at each stage. The person taking over the job signs the permit to show that he understood the risks and precautions. Considering the electrical distribution line and geographical distance ensuring permit to work can be followed from a single point of contact. For effective coordination Power System Control Center (PSCC) to be established for approval and issuing permit. It ensures deployment of authorized person for work, positive isolation conformation from the field and primary substation prior to the execution of the activity."You are step away from accident, if you are working without a valid work permit".

Use of Technologies like Neon tester, Discharge rod, Shorting clip, PPEs for Safe Zone creation

At our workplace integration of man and machine is very much required by using the technology which is ease of access to information, saves time, ease of mobility, better communication means, time &cost efficiency, reliable in use, provide protection level by avoiding direct contact along with improved techniques. The use of technology is very essential in the safety zone creation to save human life's, while creating the safety zone we can use safety tools like Neon tester, Discharge rod, Shorting clip, PPEs like induction safety helmet, electrical hand glove and electrical safety shoes, full body harness with pole garb arrestor with FRP ladder to ensure safe work execution. We can only able to use the technology in proper way when we are trained and competent to use it appropriate manner.As the machine has no brain we need to self-resilient and ensure every best possible thing to ensure 100 % positive isolation of

line prior to work. It very important to understand and establish a man and machine collaboration prior to work by checking the tools prior to use and ensuring it suitable for voltage in which we had planned to work. Safety zone creation can only be possible when we had right trained and competent personal to perform the activity, so training plays a very vital role for safety zone. It's a combined effort by the employer and employee to trained and understand the required safety practices, procedures and tools use information for putting the effort for creating a safe work environment.

Training for employees on Safe Zone creation

The workplace safety training is a process that aims to provide our workforce with knowledge and skills to perform their work in a way that is safe for them and their co-workers. In addition, an effective workplace safety plan includes instructions and guidelines to identify hazards, report them, and deal with incident prevention. Workplace safety training is as vital as workplace safety itself. It enables the employees to ensure a safe work environment with proper knowledge about the safety precautions. It also helps the employees to recognize safety hazards and correct them. It enables them to understand best safety practices and management expectations. Practice yard for Safety Zone can be created to provide practical demonstration about creation of Safety Zone and practice thereafter.

Let's come to be a part of the cultural transformation byadoption of safety zone creation

All of us have heard the term 'cultural transformation' off and on. In fact, the safety zone concept was designed with a primary purpose of bringing about a cultural transformation among employees and creating benchmark on safety practices. Introducing safety zone embarked all towards ushering in a positive culture to build up the safety competency of the workforce by making use to the safe work practices. Let's dwell on the word 'culture' in this issue and examine its relevance in today's context. It is importance to each individual to adopt it in daily routine of the workplace to enhance the safety performance. We believe the safety zone creation will definitely make very big impact on workplace by mitigating the risk and ensuring safety of employees and delivering the safe electricity to the consumers.

Operation and maintenance of electrical transmission and distribution (T&D) lines are at extremely high risk of electrocution. The result of inadvertent contact with T&D lines often is death or severe injury that involves damage to internal organs, musculoskeletal disorders, neurological damages and severe burns. The overall Odisha Generation, Transmission and Distribution sector had demonstrated that contact with overhead power lines has been the single largest cause of electrical fatalities over the last decade. To reduce this disproportionate injury rate, safety zone implement with collaboration of technology will help to injury prevention with the expected safety benefit by creating safe workplace with positive safety culture and safe behaviors towards work execution and treat electrical safety very seriously.

Hope that the articles are not only motivating, but also help in implementation of the good practices shared so that every workplace becomes a safe work environment for all.

Happy reading!

ZERO HARM

Mr. Milind Prabhakar Kulkarni
Chief Operation Services
Tata Power Southern, Odisha Distribution Ltd

MINIMIZATION OF ELECTRICAL ACCIDENTS CAN SAVE VALUABLE LIFE AND RESOURCES.

Nitrogen Injection Fire Prevention and Extinguishing System for Oil Filled Transformers

Abstract:Fire hazard in oil filled transformers is a matter of grave concern as during an internal fault in the transformer arc may occur and the transformer oil may catch fire. Transformer oil catching fire may result in rapid build-up of pressure inside transformer and can result in explosion. This fire / explosion hazard can lead to loss of valuable electrical assets and may also result in fatal or non-fatal accidents. Along with the loss of a capital asset, payment of compensation due to fatal or non-fatal accidents can severely dent the financials as well as the reputation of an organization. Several methods such as Water spray system, Water Mist system, CO2based firefighting system, Nitrogen Injection fire prevention system etc. can be employed to avoid or minimize the extent of damage in case of such electrical accidents. Out of all these methods, Nitrogen Injection fire prevention system (NIFPS) is the most accurate, reliable and effective method for fire prevention and fire extinction in oil filled transformers.

Introduction:

Different types of Transformers are used in power system. Commonly used power transformer is oil filled power transformer. In the oil filled power transformer oil act both as insulating and cooling media. In transformers, an internal fault resulting in an arc will cause fire. The fire may spread resulting from ignition of oil, causing explosion of tank, rupture of tank, core and winding and also burning the neighbouring equipment.

What is Fire?

Fire is an exothermic chemical reaction in which combustible material combines with oxygen in the atmosphere to give out heat and flame. But once fire has begun, the heat produced may often be sufficient to support or even accelerate the process. The materials involved in the combustion process may be in solid, liquid or gaseous state. They are also identified as two or three-dimensional.
Reasons for Fire in Oil Filled Transformers

Fire due to internal causes

Those faults that arise within in the transformer are called internal faults. These faults are very severe and there is always risk of fire. These fault can be:

- Line to ground fault or line to line fault on HV and LV external terminals.
- Line to ground or line to line fault on HV and LV windings.
- Short circuit between turns of HV and LV windings.
- Due to break down of insulation of lamination bolts etc., a poor electrical connection of conductors which causes arcing under oil.
- Coolant failure, which will cause a risk of temperature rise even below full load operation.
- Bad load sharing between transformers, in parallel, which can cause overheating due to circulating current.

Fire causes due to external causes: Faults which occur in other part of the system outside the transformer are called external faults.

- Bushing failure.
- OLTC fire.
- Spread of fire from surroundings.

All the above will cause internal break down of insulating material in the transformer and the resulting arc energy causes rapid rise of oil temperature. Due to rising of oil temperature the hot oil having exceeded the flash point temperature coming contact with oxygen from the external atmosphere, causes fire in the oil filled transformer.

Damages caused due to the fire in Oil filled Transformers

- Explosion of tank.
- Rupture of tank, Winding and core.
- Personnel injury.
- Neighbouring equipment's such as CT's, Lightning arrestors, power cables, marshalling box etc., catching fire.

Due to fire in the oil, temperature rises rapidly and it will exceed flash point temperature. Hence pressure in the transformer tank rises rapidly PRV acts or even in some cases tank rupture.

Origin of Fire Fighting System:

Extract From Indian Electricity Rules 1956. Where a substation or a switching station with apparatus having more than 2000 liters of oil is installed, whether indoor or outdoor, Provisions shall be made for extinguishing any fire which may occur.

- Govt. of Indiavide their Gazette notification dtd 24th sept.2010 has made it mandatory for transformers of 10MVA/above or with oil capacity more than 2000 lts shall be provided with fire fighting system .
- The transformer shall be protected by an automotive high velocity water spray system or by Carbon–dioxide (CO2) system or Nitrogen Injection Fire Prevention system. mandatory for transformers of 10MVA/above or with oil capacity more than 2000 lts shall be provided with fire fighting system .

- The transformer shall be protected by an automotive high velocity water spray system or by Carbon–dioxide (CO2) system or Nitrogen Injection Fire Prevention system.

Nitrogen Injection Fire Prevention System.

General description

It Consists of fire extinguishing cubicle near the transformer, control box in control room, fire detector on transformer tank top cover, specially designed non-return valve in conservator pipe between buchholtz relay and conservator tank, and signal box placed on transformer. Fire extinguishing cubicle is connected to transformer tank by pipes for oil drain and nitrogen injection. Cable connections are provided from signal box to Control box and from Control box to Fire Cubicle.

Nitrogen injection fire prevention and extinguishing system designed for oil filled transformer, shall prevent tank explosion and the fire during internal faults resulting in an arc after arc generation and also extinguish the external oil fires on transformer top cover due to tank explosion or external failures like bushing fires, due to OLTC fires and fire from surrounding equipment.

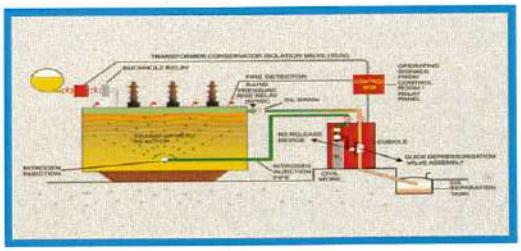
The system shall work on the principle of "DRAIN AND STIR" and on activation, shall drain a predetermine quantity of oil from the tank top through the outlet valve, to reduce the tank pressureand inject nitrogen gas at high pressure from the lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface, below flash point to extinguish the fire.

Conservator tank oil shall be isolated during tank explosion and oil fire, to prevent aggravation of oil fire. Transformer isolation shall be an essential precondition for activating the system. The system is also designed to operate manually, in case of failure of power source.

NIFPS System Components

- **Fire extinguishing cubicle:** With base frame and containing oil drain assembly, nitrogen cylinder, electromechanical control unit for oil drain and nitrogen release, pressure monitoring switch for backup protection for release of nitrogen, detectors necessary for monitoring system, flanges with gate / butterfly valves on top panel for connecting pipe connections from transformer, panel lighting etc.
- Control box: It is used for monitoring system operation, automatic control and remote operation, with alarms, indication light switches, push buttons, audio signals, fault detection suitable for tripping and signalling on station battery DC supply.
- **Pre-stressed non-return valve (PNRV):** Working mechanically on transformer oil flow rate, with proximity switch for remote alarm indication and with visual position indicator. PNRV setting for operation "Minimum 60 litres per minute".

v **Fire detectors:** The fire detector are of two types:
i) Linear Heat Detector (LHD) and
ii) Quartz Bulb.



The required number of fire detectors rated for 141 degC for heat sensing fitted on the top of the transformers.
Heat sensing temperature 141deg C
Heat sensing area 800 mm radius.

- **Signal box:** For terminating cable connections from PNRV and fire detectors.
- Signal box fixed on transformer side valve for terminating cable connections from fire detector and PNRV.

Operation

The system is provided with three modes of operation.
1. Automatic control for fire prevention and extinction.
2. Remote manual mode from control box
3. And local manual mode in the fire extinguishing cubicle.

Transformer isolation through master trip relay or circuit breaker shall be an essential requirement for system activation in automatic or remote control mode.

1.Automatic control

➢ **Operation under prevention mode**

During internal arching gases are generated resulting into pressuring the transformer tank. This leads to operation of differential relay, pressure relieve valve and/or buchholz relay and master trip (86) relay. On sensing these faults a predetermined quantity of oil from tank top is drained, which reduces the pressure in tank. Simultaneously conservator oil is isolated through pre-stressed non return valve and nitrogen gas starts injecting from lower side of the transformer tank to reduce temperature of oil surface.

➢ **Operation under Fire extinction mode**

During transformer fire, NRV operates and isolates the conservator oil to prevent further aggravation and spreading of fire. Before rupture of tank the pressure relieve valve and/or buchholz relay and master trip (86) relay operates due to pressurisation of transformer tank. Due to fire on transformer fire detector will operate and after receipt of these signals predetermined amount of oil will be drained. Simultaneously nitrogen gas starts injecting from lower side of the tank to reduce temperature of the top oil and extinguishes the fire.

2. Remote manual control

In case the system failed to operate in auto mode due to non-availability of any one signal, operator shall operate signal by breaking window glass and operating extinction release switch. Operation of master trip (86) relay is a requirement for this operation.

3. Local manual control

In case the system failed to operate in auto mode/remote manual mode due to non-availability of any one signal or failure of power supply, operator shall operate system manually from fire extinguishing cubicle and extinguishes the fire.

Fire extinction period

On commencement of N2 injection →Maximum 30 seconds
On system activation up to post cooling →Maximum 3 minute.

System activating signals

For Prevention: Differential relay trip + buchholz or pressure relief valve trip + master trip (86) relay operation / circuit breaker trip (Transformer isolation).
For Extinction: Fire detector operation + buchholz or pressure relief valve trip + master trip (86) relay operation / circuit breaker trip (Transformer isolation).

COMPARISON OF DIFFERENT FIRE PROTECTION SYSTEMS			
Function	NIFPS	Water Spray System	CO_2 System
Function	Fire Prevention and Fire Extinction	Fire Extinction	Fire Extinction
Installation Cost	Low	High	High
Location	Indoor and outdoor	Outdoor	Indoor
Hazard	Nil	Nil	Risk of suffocation
Space requirement	Small	High	High
Maintenance Cost	Low	High	Low

NIFPS System at Alumina Refinery, NALCO, Damanjodi

The NIFPS system has been successfully commissioned in MAR 2018at Alumina Refinery, NALCO, Damanjodi. It has been installed for 03 numbers of 6.3 MVA indoor transformers without water drainage facility.

a) Fire Extinguishing Cubicle

b) Transformer with associated piping and PNRV

c) Signal Box

d) Control cum Annunciation Box

Advantage of Nitrogen Injection & Drain Method of Fire Protection

- On activation, the system extinguish the Fire within seconds. It rapidly drains oil to prevent explosion and inject nitrogen to prevent and extinct fire.
- It prevents the Transformer from explosion. Once a fault signal is detected from the transformer the oil is drained within seconds in order to release pressure and to avoid explosion.
- The system is highly reliable and utilizes the principle of logic signal to prevent any improper or unnecessary activation of the system.
- The system is easy to install and maintain for both new and existing transformers.
- Nitrogen Gas is inert and does not react with transformer oil.
- It is completely Non-Toxic & Non-hazardous.
- It provides best cooling effect to the oil inside the Transformer.
- Forms insulating layer of N2 Blanket on top surface of the oil.
- Less Cost of Installation & Maintenance.
- Environment Friendly due to characteristic of nitrogen gas.
- Best System for the Areas of water Scarcity.

Conclusion

The 'Nitrogen injection & Drain method' to protect the Power Transformer from catching fire is the best method / technique suited for Indoor/Outdoor application because of its low maintenance requirement& with practically no recurring cost besideshaving high reliability of operation& is being satisfactorily adopted by many generation, transmission, distribution companies and various industries for minimization of fire hazard in oil filled transformers.

About the Contributor

The contributor has 13 years of experience of operation and maintenance in the field of Electrical power distribution, control and protection. He has been directly involved in conceptualization, engineering, procurement, retrofit and installation of NIFPS systems in 3nos of existing 6.3MVA 11/6.9KV oil filled transformers.

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IMPROVEMENT OF INSULATION RESISTANCE IN 50 MVA, 133 KV/33 POWER TRANSFORMER, MAKE: GEC, AT OUR 132 KV SUBSTAION

Abstract:
The Objective of this article was to improve the insulation resistance (IR) value of the 50 MVA transformer which was having very low IR value i,e about 60 to 100 Mega ohm. To improve the IR value, it was required to remove or to dry the moisture from the insulating materials of the transformer which are part of cores and coils. To improve the IR value of the Transformer at sub-station without sending the transformer to any outside workshop, we have utilized the Vacuum Drying Process of the transformer. In this process we have pushed the dry air (above its dew point) from a Dry Air Generator (whose dew point was -70 deg centigrade) into the transformer and vacuumed it next day at -760 mm Hg pressure and the process continued repeatedly for 10 days.

Introduction:
The 132 KV/33 KV, 50 MVA transformer is utilized for supplying power to two furnaces of capacity 10 MVA and 24 MVA. On preventive check of this transformer it was found that its IR value was 60 Mega Ohm which is very low for a 132 KV voltage system and might cause damage to the transformer. To avoid further damage to the transformer and subsequent detriment to auxillary equipment installed in sub-station, it was decided to improve the IR value of the transformer as a corrective measure for electrical safety to the transformer and other electrical apparatus installed in the Sub-Station.

Improvement Process:
A decision was taken to improve the IR value of the 50 MVA Transformer at sub-station without taking the transformer to any outside transformer repairing workshop. We have thought of various methods for improving the IR value like:

a) Simply heating the transformer body without oil, with pad heater
b) Low Frequency Heating (LFH) of the transformer
c) Vacuum Drying of the transformer by Dry nitrogen gas or by Dry air.

We have chosen the Vacuum Drying method, by using a Dry Air Generator because it was more economical and suitable to adopt the process by keeping the transformer on its own bay.

Process Description:
The whole process is described below:
1) Pre-testing of the transformer: After isolation of the transformer, we have done routine test like Ratio Test, magnetizing Current, Magnetic Balance, IR value measurement. Those tests were carried out to ensure the pre and post parameter measurement which should be same and should not raise any confusion after completion of Vacuum Drying process of the transformer.

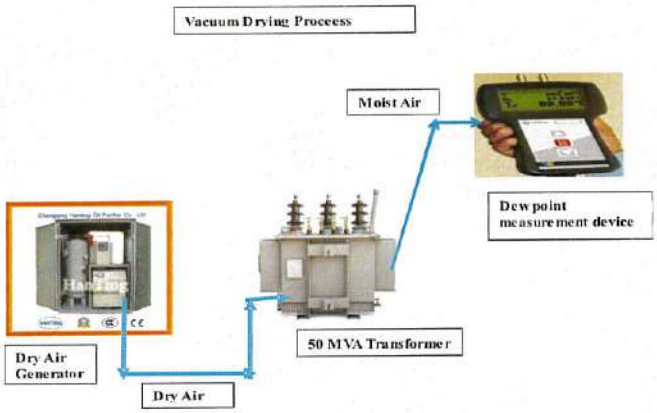
2) The measured IR value of the 50 MVA 132 KV / 33 KV transformer before oil was drained out.

	5 KV Meggar (Sl No 850098) (in Mega-Ohm)		5 KV Digital Meggar (500 volt to 5000 volt, Sl no—166343, Model KM2805 MK-1) (in Mega Ohm)	
	15 secs	60 secs	15 secs	60 secs
Primary-Earth	100	120	100.1	113
Primay-Secondary	102	140	106.2	136
Secondary- Earth	105	130	103	125

We have taken the IR value with two different IR value measurement device and found the IR values are approximately same. From the values it was concluded that IR value was not much healthy to energize the transformer at 132 KV voltage. Hence decision was taken to overhaul the complete transformer including the replacement of old oil with new oil.

3) The old oil was completely drained out from the transformer. The core and coil was washed with hot transformer oil (at 70 deg centigrade). New gaskets were replaced in top cover and in all the

flange. Required new oil seals and O-rings were replaced in Bushings. Air leak test was carried out by pushing dry air into the transformer at 0.25 Kg/sq cm pressure. The dew point of dry air was measured (Value -70 deg centigrade) at Air Generator point.
After pushing the dry air into the transformer, It was ensured that there is no air leakage from the transformer as air pressure inside the transformer was maintained constantly at 0.25 KG/sq cm for 24 hrs. After that Vacuum Drying process on the transformer was started.



4) Vacuum drying: The vacuum drying process was started on 22 Nov 2016 and it was completed on 30 Nov 2016. On 22 Nov 2016, The dew point inside the transformer was 4.92 deg centigrade and gradually dew point inside the transformer was reduced to -13.35 deg centigrade after continuing with vacuum drying process.
The reduction trend of dew point is shown as below:

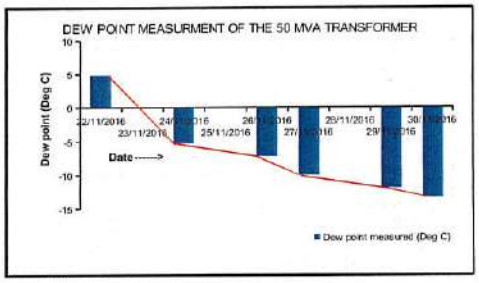
Dry Air Generator Specification: (N2-78 %, O2-21 %, Humidity: -50 to -70 Deg centigrade)
The reduction trend of Dew point is shown as below:

Dew Point Measurement inside the 50 MVA transformer

Date	Dew point measured (in Deg Centigrade)
22/11/16	4.92
24/1116	-5.3
26/11/16	-7.2
27/11/16	-10
29/11/16	-12
30/11/16	-13.35

The -ve sign of dew point measurement shows that the reduction of the moisture in the insulating material of the transformer and dryness inside the transformer is increased.

5) Oil filling and oil filtration: After the vacuum drying, new oil is pushed inside the transformer at 60 deg centigrade through filter machine and the transformer oil was filtered till the oil BDV was achieved to 85 KV @ gap of 2.5 mm. After that the oil was cooled down up to OTI 25 deg Centigrade and the final IR value was taken and the IR value was as below:



Conclusion:
After the whole process it was concluded that the IR value of the 50 MVA transformer was increased by 10 times to its previous value and this IR value was much suitable to energize the transformer at 132 KV voltage level. The process was started on 18 Nov 2016 and completed on 04 Dec 2016 (17 days). Thus, it took much less time compared to getting the same done at out side workshop. The productive days were saved and in time action on this transformer precluded further damage to it.

	5 KV Meggar (SI No 850098) (in Mega-Ohm)		5 KV Digital Meggar (500 volt to 5000 volt, SI no—166343, Model KM2805 MK-1) (in Mega Ohm)	
	15 secs	60 secs	15 secs	60 secs
Primary-Earth	1150	1400	1100	1400
Primay-Secondary	1000	1100	1050	1150
Secondary- Earth	800	1400	800	1450

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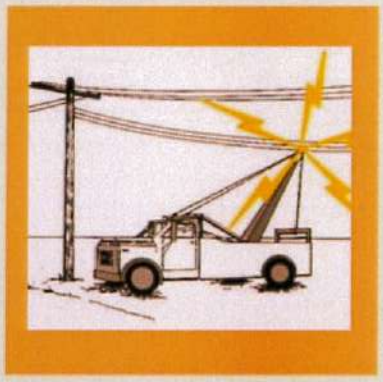
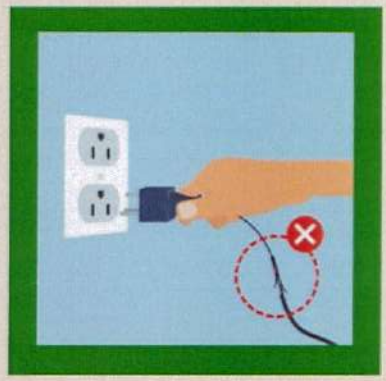


ALWAYS LOOK UP

OVERHEAD LINE CAN SHUT YOU OFF



REPLACE BROKEN CORD

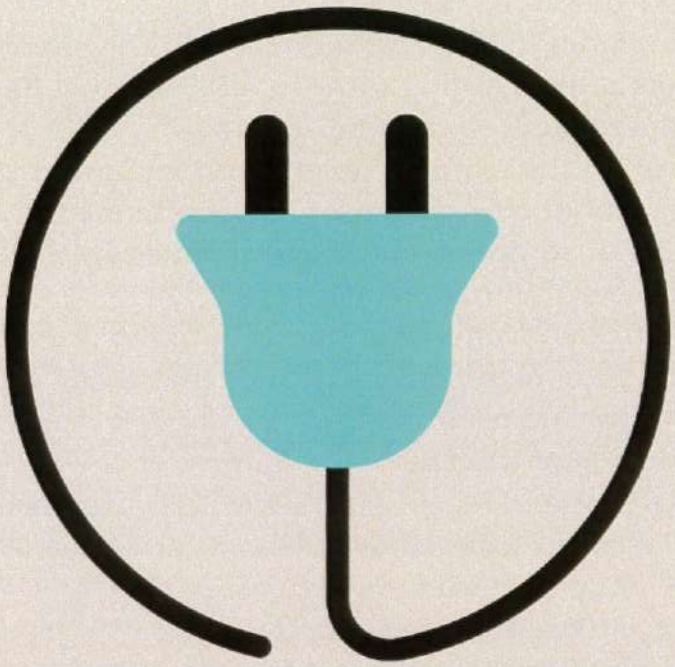
YOU MAY BE ELECTROCUTED

DO NOT OVERLOAD

THERE MAY BE FIRE

CALL AN ELECTRICIAN

DON'T DO BY YOUR SELF



Electrical Safety Practices

Electrical Safety Practices

- Ensure that apparatus is properly discharged before handling.
- Only designated person should be permitted to work on live electric.
- Employees should be provided efficient personal protective equipment complying BIS **standards or any relevant international standards;**
- Any crane or vehicle movement in the vicinity of supply lines should be monitored.
- Avoid any electrical contact with supply end and maintain sufficient clearance.
- Power should be tapped only from the designated sources as instructed.
- The panel board should be earthed.
- Provide signs or lights to warn personnel when the supply is energized.
- When using tools near electrical hazards, all tools must have a double insulated casing to prevent contact with energized parts.
- Cable should run to the required length with minimum joints.
- No live ends of a conductor should be left unattended.
- Do not let Electrical equipments to be suspended by the cords.
- Never leave holder without lamps or plugs.
- More attention to be given when power supplies serve more than one job, switching errors can result in energizing the wrong equipment, leading to possible hazards for the personnel.

One must Ensure every day whether:-

i. There are effective lockout/ tagout (LOTO) & Permit to work procedures in place;
ii. Employees are properly trained for safe work practices;
iii. Safety talks are done with workers regularly;
iv. Portable electrical tools are grounded;
v. ELCB/ RCD/Ground fault circuit interrupters and/or an assured equipment grounding program are in place for carrying out the assigned electrical work.

Planning:

- A single line diagram should be submitted to safety department for approval before execution of work & only after the approval of the single line diagram, the work should be executed.
- Only trained and authorized personnel should carry out any services or repair. Distribution Panels:
- Tapping should be done from maintenance panel only after prior written approval.
- All distribution panels should display current rating.
- All panels should be duly grounded to avoid ground fault current.
- Panels should be at least to an IP44 rating to avoid dust entry and protect from wet condition.
- Panels should be fitted with Ground Fault Current Interrupters (GFCI) to avoid fault currents.
- To avoid toppling, the base of the panels should be securely fixed to the ground.
- Prior to operation all power supply and protective devices should be checked.
- All electrical panels should be easily accessible & have a minimum statutory clearance.
- When not in use, electrical panel's doors should be closed and latched.

- Ensure that panel's surrounding is free from combustible and flammable materials. Electricity supply from panels to work area:
- All electrical cords and appliances must have apt weather protection.
- Male and female industrial sockets should be used for connections of cords and no joints should be made with PVC tapes.
- Do not attach Electrical cords to the building surfaces/ structures.
- Caps should be used in unused sockets to avoid direct contact and mechanical damage.
- Firm Mounting of Receptacles in their enclosures and it should not move when the plug is inserted.
- Double insulation should be ensured in cables to prevent from frying and possible mechanical damage.
- Cables running over the ground should be avoided if they pose a trip hazard or electrocution.
- Cables should be laid either underground or routed minimum above 4m from the ground level.
- The cable should be routed above the ground with the minimum height of 6m from the ground level where it is crossing the passage meant for vehicle movement, where underground laying is not possible.
- If the cables are laid underground, the cable route markings should be made with boards which should display the direction and the current rating.
- Electrical cords should be placed away from areas where they may be pinched and areas where they may pose a tripping or fire hazard (e.g., doorways, walkways, under carpet etc.)
- The post meant for cable support should be earthed duly.
- All extension boards should be minimum IP44 type
- Use of extension cord should be minimized
- When not in use, tools should be unplugged
- Whip a cord to unplug it
- Ensure that the cable must be secured inside the equipment by non-conducting faces so that it cannot slip.
- Electrical equipment that has grounded three pronged plugs should only be used.
- Do not attempt to remove by yourself, if a prong breaks off inside an outlet
- Do not remove the prongs of an electric plug. If plug prongs are missing, loose or bent replace the entire plug.
- Before entering into power supply or associated equipment enclosure, following precautions should be taken:-
- De-energisation of the equipment
- Open and lock out the main input circuit breaker, auxiliary power circuits should be checked.
- Discard damaged cords, cords that become hot or cords with exposed wiring.
- Power tools should be inspected for frayed power cords, broken plugs and cracked or broken housing electrical equipment should be unplugged before repairing or servicing it.
- The equipment must be ensured for inspection, testing and labelling.

Additional safe measures:

- We should stay at least 10 feet away from overhead power lines.
- Ensure proper illumination in all areas where electrical hazards are to be encountered and an emergency lighting system should be in place as well
- Never drill a wall or floor without checking for any concealed utility electrical system.
- Specialized personnel protective equipment and clothing should be provided to the personnel to work on energized line or equipment.

  The following safety features should be ensured while working with energized line/ equipment:
- Insulated tools to avoid shocks.
- Rubber gloves
- Shock resistance safety boots/ shoes.
- Safety glasses/ goggles.
- Flame resistance clothing if there exists any risk of an electric arc that could cause a fire.

Precaution to be taken while working with a hand tool:

- Residual current device (RCD) with 30mA sensitivity should be ensured in the operating circuit.
- Always wear hand gloves.
- Wear an electrical safety shoe while working with electricity.
- Stand on rubber mat while working.
- Work on live terminal boxes, panels etc. should be done by using only one hand to the extent possible. Touching of any conducting/ metal part with other hand should be avoided.
- Well insulated overall sheathed 3 or 4 core cables should be used.
- Joints in wires should be avoided.
- DO not use earth as neutral.
- Secure tight connections. A neutral disconnection stops the equipment but cause electrocution on touching the terminals (including the neutral terminal).
- The body of the equipment should be earthed using third core of the cable.
- Only flexible cable should be used to connect hand-tools (avoid single strand/ stiff wires). Use rubberised sheath/ sleeves near terminals and ends, to avoid cuts due to frequent twisting/ fatigue.
- Follow proper interconnection techniques- Plug a socket, terminal blocks, welding receptacles etc.
- Power supply for hand tools should be from centre tap earthed transformers.
- Use only flame proof equipment in classified areas.
- Follow permit system while doing maintenance/ repair. Earth the phase conductors, while working and use locks to prevent inadvertent 'switching on' during repairs.

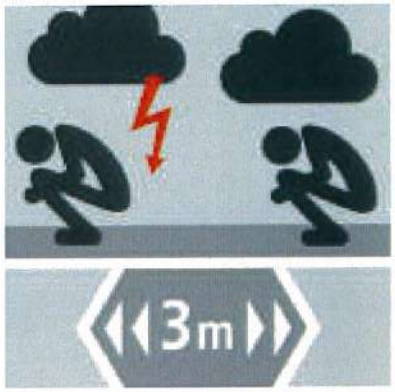
Precaution Against LIGHTNING

Take following measures in case of lightning:

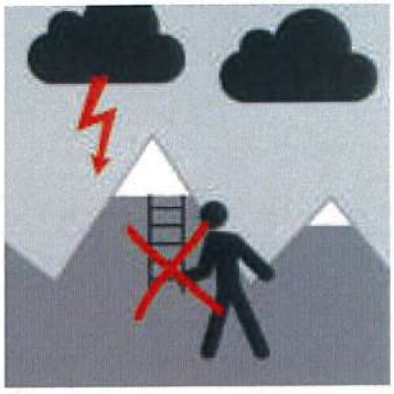
In Open Terrain:

Put your feet as close together as possible, wrap your arms around your legs and tuck your head in. Keep a distance of 3 m to the next person.

Avoid trees, groves, edges of the forest and wood poles of overhead lines. Keep a distance of 10 meter from all trees and limbs.



In the mountains:

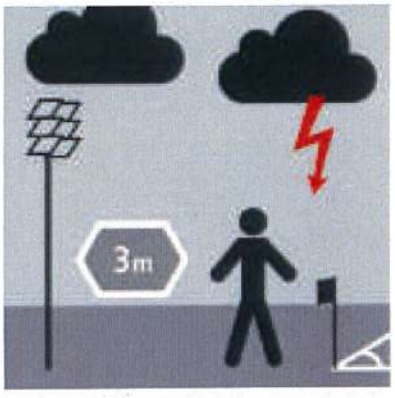


Keep off the peak, avoid being the highest point around.

Keep a distance of at least 3 meter from other people and metal objects such as hooks, ladders and ropes.

On a playing ground:

Be at least 3 m away from radio masts and flagpoles. Put down flags, umbrellas and golf clubs.

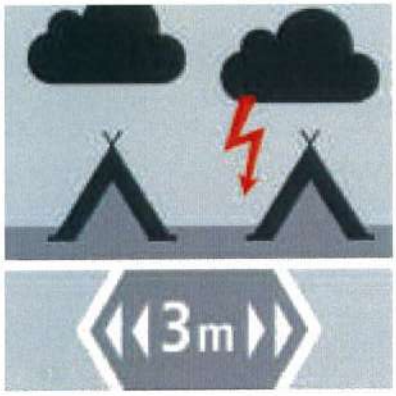


During fishing or hunting:

Lay down your fishing rod and seek shelter on land.

Hunters should immediately leave open tree stands at the first sign of lightning and thunder.

During camping:



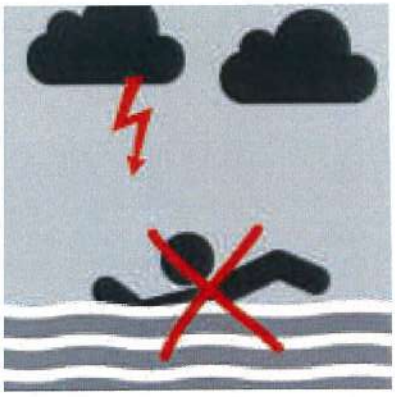
Never erect your tent directly next to poles or pylons, at the edge of the forest or next to isolated trees.

Use an insulating mattress and do not touch the tent poles during a thunderstorm.

Keep a distance of at least 3 m from other tents and caravans.

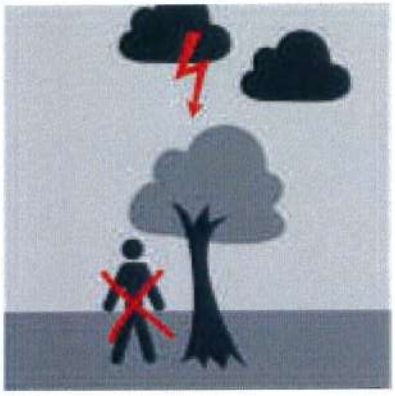
Crouch down in your tent on an insulating dry mattress.

In open water:



Leave the water right away and take cover at the first sign of lightning and thunder.

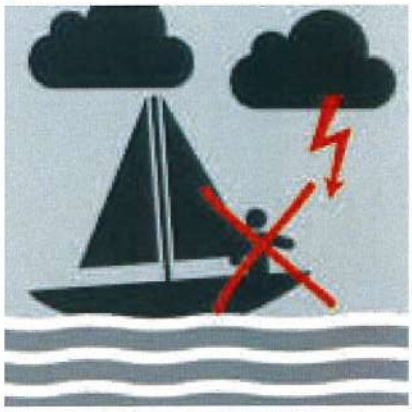
Under the Tree:



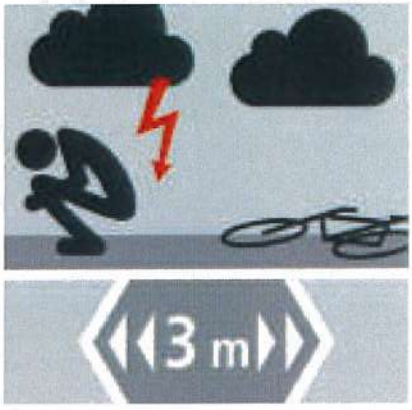
Avoid trees, grooves and edges of the forest and keep a distance of 10 meter from all trees and limbs.

On-board a boat:

Go into the boat, crouch down and do not touch the rig or any other metal objects.



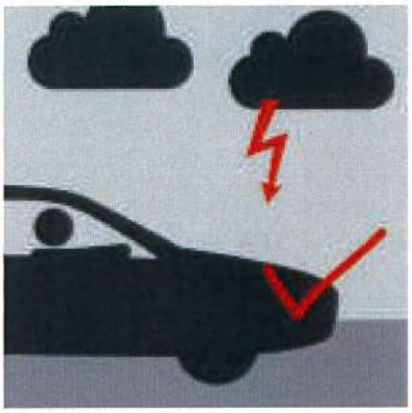
Riding a bicycle:



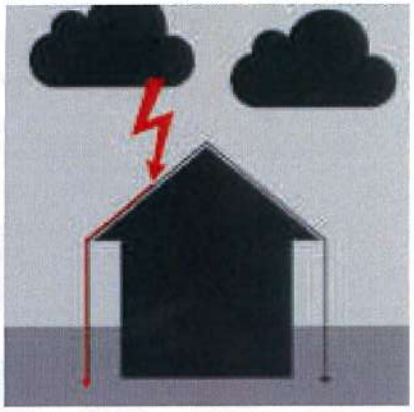
If on a bicycle or motorcycle, stop riding, seek shelter (for example under a bridge) or crouch down at a distance of at least 3 meter from your vehicle.

Inside a car:

In case of heavy rain or rolls of thunder, it is advisable to stop at the next possible place or wait until the thunderstorm has disappeared to avoid being blinded by the light and therefore lose control.



Indoors:



Adequate lightning protection system shall be installed.

Avoid using the following during thunderstorm:

- Watching TV
- Surfing the internet
- Talking over mobile/telephone
- Taking shower/bath

What to do if someone is struck by lightning

- Common injuries from being struck by lightning can be nerve and muscle paralysis, impaired eyesight and hearing as well as raised blood pressure.
- Try to calm the lightning victim if he/she is conscious. Softly talk to the victim until help arrives.
- If the victim is unconscious, put him/her in the recovery position. Check the victim's pulse and breathing. If the lightning victim has no pulse or heartbeat, lay him/her on his/her back and immediately begin cardiopulmonary resuscitation (heart massage and resuscitation). Do not stop until the victim starts to move, his/her chest begins to rise and fall or help arrives to take over.

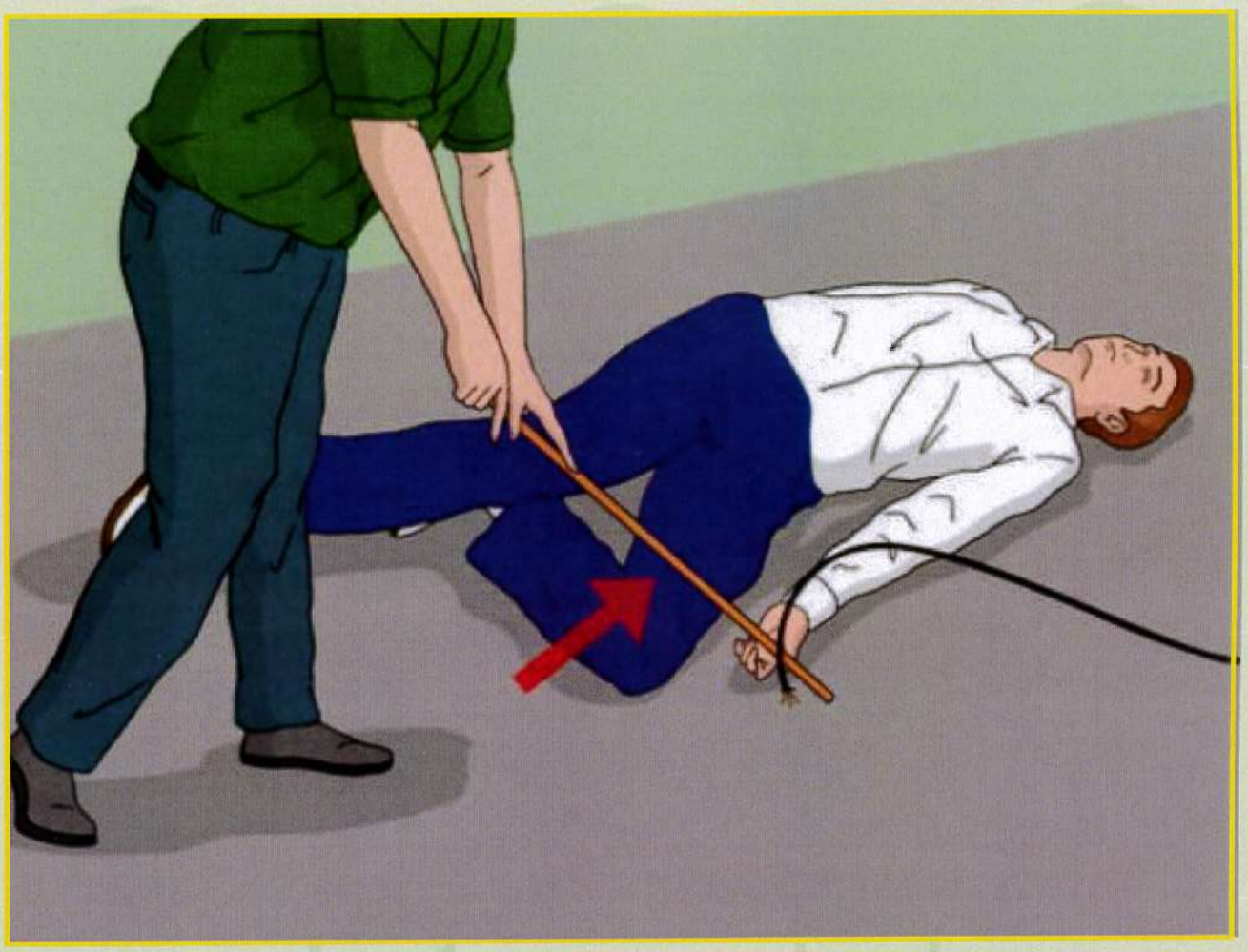
Recovery position

Heart Massage

Resuscitation

Don'ts...

- DO NOT renew a blown fuse, until the cause is identified and rectified.
- DO NOT close any switch unless you know why it was kept open.
- DO NOT Touch or tamper with any electrical equipment or conductor, unless you have made sure that it is DEAD and EARTHED.
- DO NOT Work on live circuit without the permission of the supervisor and make sure that all safety precaution have been taken and you are accompanied by a second person competent to render first aid.
- DO NOT disconnect earthing connection or by-pass safety gadgets installed on mains and apparatus.
- DO NOT open or close switch or fuse slowly or hesitantly and do it promptly.
- DO NOT touch an electrical system or circuit when your hands are wet.
- DO NOT use wires with poor insulation.
- DO NOT disconnect a plug by pulling flexile cable when the switch is on or off.
- DO NOT work on energised circuit without taking extra precautions, such as use of rubber gloves.
- DO NOT throw water on the electrical equipment in case of fire.
- DO NOT allow visitors and unauthorised persons to touch or handle electrical apparatus or come within the danger zone of high voltage apparatus.
- DO NOT test circuit with bare fingers.



Don't forget these Life saving elements !!!

ACCIDENT BRINGS TEARS..
SAFETY BRINGS CHEERS...

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