applicability of modern tools for high voltage ohl maintenance: an assesment of common to modern technology

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Figure 2.

ABSTRACT

The Live Working methods on overhead lines are definitely modern and effectual maintenance techniques. Basically there exist no confines for Live Maintenance. Each project is analysed besides, in most circumstances, a technical resolution is established. In Live Working conferences and symposium most documents are denoting to practical solutions for resolving some maintenance difficulties. Theoretical approach remains also vital and the specialists are searching for new guideline for this field. Nevertheless, the foundation is the exhibition of novel solutions. Therefore, it means that most companies are attempting to develop and improve those technologies. Others are apprehensive about working live in medium or low voltages. At the same time others are apprehensive about working live within sub-stations. However, Live Maintenance began on overhead lines besides working on higher voltage overhead lines appears to be the icon of Live Maintenance fields. That is why much efforts are prepared in this region for safety expansion besides developing of innovative tools. Lastly, we can get complete results for higher voltage Live Line conservation. The study will present actual plus possible workings in Live technologies for revamping OHLs. From shared practices to up-to-date new technologies (counting robots) each Live technique should be encompassed in maintenance towards avoiding the de-energizing of the line. Besides, new technologies and tools industrialized in the sphere are also taken into consideration. In conclusion, nearly all maintenance workings can be done minus de-energizing the line.

**Keywords**: Live Maintenance; High Voltage Overhead Lines; Safety; De-energize

# EXECUTIVE SUMMARY

The live working technique on overhead lines are obviously a new technique and effective and efficient maintenance methods for high voltages. In the past there were many arguments and discussions for using the live loads rather than the dead loads in terms of economical values and technical difficulties. But these discussions have ended up with the conclusion of live maintenance remains superior from every point of opinion to de-energised methods. Some utilities or countries are sceptical plus are rescheduling the presentations for this type of works. Numerous queries are still asked regarding Live Maintenance. Are there technological limitations? Are there bigger risks for the grid? Are there bigger safety risks? Are there economic constraints? In common and basically there is no common methods for live maintenance (García et al., 2016). In Live Working conferences and symposia most researches are denoting to practical resolution for answering some maintenance difficulties. Theoretical approach remains also vital and the specialists are searching for new directive for this area. However the basis remains the exhibition of novel solutions (Singh et al., 2013).

So, there are lot of corporations are attempting to develop and improve the high voltage overhead maintenance technologies to make life easier. Some of them are concerned regarding working live in medium or low voltages. Others are apprehensive about working live within substations (Pouliot et al., 2015). Nevertheless, Live Maintenance began on overhead lines besides working on higher voltage overhead lines appears to be the icon of Live Maintenance fields. That is why several efforts are prepared in this space for safety enhancement besides developing of novel tools. Lastly, we can get complete resolutions for higher voltage Live Line preservation. All maintenance workings can be completed live besides we are attempting to display the state of skill of these tools, beginning from whatever we are capable of doing and bestowing what the rest are undertaking. As much as we are conversant of (Song et al., 2014).

Recent developments in new technologies and materials have delivered transmission utilities plus operators with numerous options for improve designs, more effective operation besides preservation of their resources.

High temperature – low sag - conductors (HTLS) are prepared of distinct alloys plus can be applied at temperatures amounting to 210°C. Such conductors are capable of carrying more electric current compared to standard conductors with a tolerable temperature between 80 - 90°C. The novel materials restrict the conductor and sag to pull towards preventing respective minimalize adaptions of towers comprising prevent substitutes by greater towers. HTLS conductors remain applied in re-conducting for the upping of prevailing lines and for novel lines. Often they are “tailor made” for a venture and ever venture must be explored on a case-to-case base. The picture displays the correlation amongst capacity (Amperes) plus conductor temperature. Therefore, the greater the temperature, the further Amperes can be accepted – however also higher harms (Miller et al., 2017).

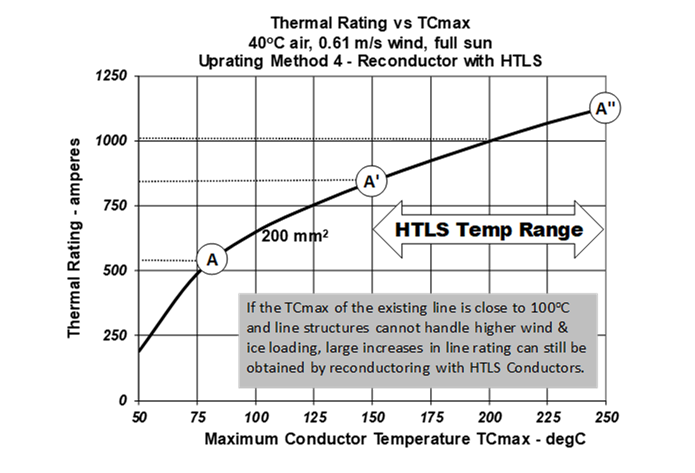


Figure 1: increase of capability (amperes) liable on the conductor temperature for a particular project. Source: CIGRE publication 763 „Conductors for the increasing of prevailing overhead lines “

# INTRODUCTION

## Research Background

An overhead line (OHL) or overhead wire is utilized to communicate electrical energy to electric trains, streetcars or cable cars. An overhead line comprises at least one wire arranged over rail tracks (or rails, especially in passages), raised to a high electrical potential by association with feeder stations at customary stretches. Live-line working, otherwise called hotline maintenance, remains the support of electrical hardware, regularly working at high voltage, while the electricity is on or off condition. Despite the fact that this is riskier for chipping away at electrical gear with the force off, live-line support procedures are utilized in the electric force circulation industry to maintain a strategic distance from the disturbance and high monetary expenses of killing capacity to clients to perform fundamental intermittent maintenance on diffusion lines plus other hardware. The principal procedures for live-line working were created in the early long stretches of the twentieth century, besides both hardware and work techniques were later advanced to manage progressively higher voltages. During the 1960s, strategies were created in the research facility to empower field labourers to come towards direct connection with higher voltage lines. Such techniques can be used to empower non-toxic work at the most elevated transmission voltages.

This chapter will talk about the basic terminologies along with their significance in today’s life. Furthermore, this will shed some light on live working techniques or methods on Overhead liveliness (OHL), and modern tools for OHL maintenance. This chapter will discuss some important aspects of the current study such as research background, research problem, aims and objectives, and contribution of the study.

## Problem Statement

The Live Working methods/methods on overhead lines (OHLs) are unquestionably the modern and proficient maintenance techniques. Basically there are no restrictions for Live Maintenance. Each undertaking is investigated and by and large a specialized arrangement is established. In Live Working gathering and symposia supreme papers are alluding to functional answers for taking care of some maintenance issues. Hypothetical (theoretical) methodology is additionally significant and the professionals are searching for new guideline for this field. Be that as it may, the premise is the introduction of new arrangements. It implies that a ton of organizations are attempting to improve and build up those advancements. Some of them are worried about working live in medium or low voltages. Others (Shu et al., 2007) are worried about working live within substations. However, Live Maintenance began on overhead lines and dealing with high voltage overhead lines is by all accounts the sovereign of Live Maintenance areas. That is the reason a ton of endeavours are done around there for security improvement and creating of new instruments. At long last we can discover total answers for high voltage Live Line maintenance.

To sidestep the need to close down electrical organizations for maintenance administrations, it is obligatory to create protected and pragmatic methods that would permit nonstop electrical force supply, subsequently diminishing the dangers and limiting the expenses for the transmission and dissemination organizations. Live-line maintenance is an exhaustive answer for confine blackouts and breakdowns significantly by efficient execution of condition observing and preventive maintenance plans with fitting utilization of HR and apparatus. With this high time issue of high voltage use in OHLs, this investigation will give a superior and justifiable perspective for the organizations to create improved systems. This will assist the cycle with being more productive and precise. Alongside this, the current will likewise be useful for the researchers to direct their separate investigations for a similar region of premium.

Transmission lines have become an indispensable of our settings, moving through an impressive variety of ecosystems, terrains and climates, leaving enduring pictures. At least partly responsible for this ubiquity is their longevity. In the 1960s and 70s, many of the main networks currently in operation were designed, with lines completed at the turn of the era not unusual. Many utilities running and owning high-voltage transmission lines face the same forms of maintenance issues due to the comparatively old era of these systems

At the lead of transmission line research plus development are sustaining reliability, expanding the useful life of cables, growing electrical energy transmission capacities, preventing failures, and ensuring worker plus public safety. Wood crossarms are of specific concern since they are generally very climate sensitive. Similarly, environment issues are at the center of the structural reliability of towers, as atmospheric weathering affects the steel galvanization.

## Objectives

The primary objective of the study is to evaluate the applicability of the modern tools such as Cembre stockist, 3M electricals, Insulators and etc for the high voltage OHL (Overhead Lines) maintenance. This study will drive from common to modern and advanced technology in the same. The objectives of the study are to:

1. To assess the applicability of advanced and modern tools regarding high voltage overhead lines (OHLs).
2. To examine the live working techniques in recent times along with their advancements to analyse the maintenance works on OHLs with respect to condition monitoring.
3. To examine the modern tools for OHLs including robotics maintenance.

## Significant of the study

This study will be significance as it will provide an understanding of the concept of operating voltage power conductor.

This study is significance in understanding the applicability of modern tools for high voltage OHL maintenance.

# LITERATURE REVIEW

## Introduction

This section offers an overview of recent and previous studies on the same or almost relevant topics including some subsections of it. This study also assesses and discusses integrative knowledge and strategies to develop a better understanding of the modern tools for the maintenance of OHLs with high voltage. The literature review, in the present study, talks about the consequences of using modern and traditional tools for the high voltage overhead lines and their maintenance. Specifically, in the live working techniques or methods, the management provides facilitated and good maintenance along with enormous equipped devices in order to carry out the appropriate method and processes. The live working techniques have been very beneficial and helpful in order to raise the safety measures and standards, and also eliminate the organizational errors that occur in the workplace. The medication errors and the cost efficiency of equipment are also reduced with the help of this technique. This technique is not only beneficial and effective to the healthcare agencies but is also essential for other service sectors in order to reduce errors and enhance work quality.

The current literature review consists of the following sections. This chapter is aimed at reviewing the existing stock of literature for the purpose of understanding concepts, trends, prevailing issues, and challenges in the concerned area of research. The chapter is divided into 4 sub-sections including the present section. The first five sections navigate through the background of the study by a general introduction to the concepts and then getting specific information on the research study. Later on, the research gap that is identified after reviewing this literature critically will be explained. Further, the variables identified that will be addressed in the study are represented using a conceptual framework. Finally, the hypotheses that the study will be formulated.

Minor, semi-autonomous robots advantage distribution line preservation and inspection procedures. Using remotely run robotic devices lessens the difficulties of line work by letting technicians to examine the lines besides performing preservation from a harmless distance (Toussaint et al., 2009). The necessity for simply installable devices for short periods is challenging due to the power line employees needing to use operative apparatuses for the maintenance of the power line components, comprising dampers and splices (Aracil et al., 2002). In the area of power line review, different techniques have been applied to conduct the line review. Though there has been exploration into the effectiveness of operated helicopters plus unmanned aerial cars, focus here stands on mounting robotic devices (Luque-Vega et al., 2014; Dong et al., 2012; Jaensch et al., 1998). Mounting robots employ the current lines for maintenance, wandering down the line whereas relaxing on it or compressed or otherwise linked towards it. These kind of devices offer superior solution in their review approaches because of their vicinity towards the line plus more meticulous motion. It also allows application of a broader variety of devices and other checking devices besides a probability of repair and maintenance actions performed by the robotic device itself. Through the maintenance and inspection of overhead power lines together with robotic devices, power firms are capable of managing their properties with larger effectiveness and in techniques impossible minus the devices. Exertion on such devices began over two centuries ago, compelled by well-being factors, access towards remote and problematic areas besides increasing operational effectiveness. The robotic devices also can be applied to assess the line for imperfections such as degradation, mechanical or corrosion damage (Katrasnik et al., 2010). Exact applications comprise checking firmness connexions for mechanical dilapidation via measuring resistance, sensing corrosion in the steel core of aluminium conductor steel reinforced cable or applying infrared imaging towards detecting possible flaws in power line gears (Barbosa and Nallin, 2014; Montambault and Pouliot, 2003). Video plus still images composed by line robots of components not observable from the ground can be employed to confirm faults spotted by other techniques. Collecting visual info to assess at a harmless distance from live lines plus archiving the data advantage inspection employees (Toussaint et al., 2009).

## Live working techniques: Introduction, history and current status

Live Working strategies or techniques on OHL (overhead lines) remain doubtlessly very modern just as proficient techniques for the maintenance. There was a great deal of conversation about the upsides of Live Working contrasted with dead techniques, concerning prudent and specialized angles. Despite the fact that all the examinations inferred that live maintenance is better from all perspectives than de-energized strategies, a few nations or utilities are doubtful and are deferring the applications for this sort of work (Oltean, Fagarasan, and Brabete, 2014). A ton of inquiries are as yet raised regarding Live Maintenance. They comprised, are there greater dangers for the framework? Are there innovative constraints? Are there prudent requirements? Are there greater dangers? Basically there are no restrictions for Live Maintenance. Each task is examined and much of the time a specialized arrangement is instituted. In Live Working meetings and symposia, most documents are alluding to viable answers for taking care of some maintenance issues.

Hypothetical methodology is likewise significant and the specialists are searching for new guideline for this meadow. Be that as it may, the premise is the introduction of new arrangements. It implies that a great deal of organizations is attempting to improve and build up those advancements. Some of them are worried regarding working live within medium or low voltages. Others are worried about working within substations. In any case, Live Maintenance began on overhead lines besides dealing with higher voltage overhead lines is by all accounts the sovereign of Live Maintenance areas. That is the reason a great deal of endeavours is done around there for well-being improvement and creating of new apparatuses. At long last it tends to be said that the total answers for higher voltage Live Line maintenance is currently accessible. Every maintenance works should be possible Live and organizations are attempting to show the condition of specialty of these advancements, beginning from what they can do and introducing what others are doing. As much as these organizations are educated regarding.

The live maintenance movement began in Romania when the preparation of a working group from IRE Sibiu in the year 1979 at Berlin Neuenhagen (previous German Democratic Republic). Somewhere in the range of 1982 and 1985 the guidance of five groups for live maintenance action occurred at Sibiu. The previous SUCREE Firm - Sibiu (these days RETRASIB) fabricated a bunch of devices for this gift of the novel groups and to finish their apparatus collections for live maintenance. Somewhere amid 1982 and 1994, fifty-eight live maintenance advancements for all-voltages besides all higher voltage portions of overhead lines were created and tried. Beginning with 2001, the live maintenance action was occupied by the newly established Society Smart S.A., the Maintenance auxiliary of Romanian Transmission National Company Transelectrica. These days the Live Maintenance advancements have a steady improvement in Smart. We are utilizing a wide scope of instruments, fabricated by Gennan, Romanian, French (EDF), USA (Chance), Poland (Arcon, Hubix), Brasil (Ritz) organizations.

This subsection will further talk about the modern and advanced live working techniques including live-line working methods. This will also highlight the country wise live work practices, challenges and opportunities. In addition, this will explain the safety and securities provided for the same. Increasing grid-iron connectivity is escorted by various aspects viz. extensive variation in cohort as well as heaps on daily/periodic basis, feast of the grid geologically, multi trend flow of power, exposed access, unscheduled interchange (UI) besides the necessity for economic notice. Therefore, it is demanding reliable plus secure grid-iron with constant quality supply of power. Extra plus ultra-high voltage transmission lines have been advanced internationally and are effectively being activated in developed countries. Recent trends within Indian transmission situation are progressing to establish 765 KV lines towards strengthening its transmission infrastructure. Enormous expansion of inter-nation transmission system stands under way to supply towards the transmission necessity of innovative generation projects. Existence of rising worldwide electricity consumption – growth in population Grid strive towards maximizing supplies, minimizing energy losses besides keeping costs down via energy efficiency plus continuous R&D agendas. Grid encounters these energy requirements with a packed range of services and solutions for long-distance transmission at voltages ranging up to 1200Kv. Transferring electricity at higher voltage and extra high voltages lessens the portion of energy lost to opposition, which differs liable on the precise conductors, the present flowing, plus the extent of the transmission line.

## Maintenance Works on Overhead Lines (OHLs) based on Condition Monitoring

Overhead lines (OHLs) is meant to produce uncontrolled potential voltages, which is also used for maintenance strategy. OHL must be maintained to form the bases of having reliability in calculations, with an aim of keeping high reliability for commercial network simulations. Maintenance of OHLs is required to evaluate and understand changes relating to intensity in maintenance for every transmission line. Switching off OHLs may work, however, this may have a significant effect on the power flow, stability, as well as reliability (Milun, 2017). The overhead line comprises conductor, tower foundations, insulators, tower structures, fittings, auxiliary facilities, grounding devices, and environs. The monitoring machineries for all items of overhead lines remain being developed plus successfully applied. Numerous items (including insulators, fittings and conductors) can be constantly examined online (Snyders, Ferguson, Enslin, & Reichmeider, 2010). Though the circumstances of foundations, auxiliary facilities, tower structures, and environs still basically depend on human ‘s checks, numerous hand-carrying tools can be used during inspection excursions (Lovrencic, Brezavscek, Pantos, & Gomiscek, 2017). Essentially, aerial reviews have been utilized widely in efficacies. The inspection and monitoring of individual stuffs of overhead lines can offer useful information concerning the condition of dissimilar portions of the overhead line. Numerous Live line maintenance workings were completed utilizing Live technologies from insulators spare to complex amends workings were on 400kV plus 220kV OHL (Chance, and Hubbell Power System, 2004). Novel technologies were established in the previous period, including insulator replacement, mounting of observing systems, growing of line arresters and many more. Live Line Maintenance involves of Emergency Restoration Systems (ERS), Live Line insulator washing and Hotline maintenance currently. In India, the Live Line Maintenance Technique obtained in 1958 plus Hot Line Training Center for voltage heights up to 400kV presented in NPTI, Bangalore.

Increasing grid-iron connectivity is escorted by various aspects viz. extensive variation in cohort as well as heaps on daily/periodic basis, feast of the grid geologically, multi trend flow of power, exposed access, unscheduled interchange (UI) besides the necessity for economic notice. Therefore, it is demanding reliable plus secure grid-iron with constant quality supply of power (Mawle, Pirate, and Burade, 2015). Extra plus ultra-high voltage transmission lines have been advanced internationally and are effectively being activated in developed countries. Recent trends within Indian transmission situation are progressing to establish 765 KV lines towards strengthening its transmission infrastructure. Enormous expansion of inter-nation transmission system stands under way to supply towards the transmission necessity of innovative generation projects. Existence of rising worldwide electricity consumption – growth in population Grid strive towards maximizing supplies, minimizing energy losses besides keeping costs down via energy efficiency plus continuous R&D agendas (Arnaiz, Konde, and Alarcon, 2013). Grid encounters these energy requirements with a packed range of services and solutions for long-distance transmission at voltages ranging up to 1200Kv. Transferring electricity at higher voltage and extra high voltages lessens the portion of energy lost to opposition, which differs liable on the precise conductors, the present flowing, plus the extent of the transmission

Since the power production’s early times, the detachments over which electrical power stands spread have been constantly increasing laterally with structure voltage levels. It has led towards a significant rise in the quantity of deferment insulators in usage on power lines. Insulation remains largely accountable for the functioning performance of the transmission line. Harmless design needs a desiccated flashover of the insulator cording of 3 to 5 times the minimal operating voltage besides a leakage pathway nearly twice the incursion distance. The design performs are altered for special instances such as chemical laden air, fog, or dust. Many countries apply strings of pin and cap insulators, occasionally entitled discs, for backing the overhead power lines conductors. The insulator mortar, of either porcelain or glass, is fixed via cement to a metal pin plus a metal cap. The shed remains sized and shaped to attain a higher electric strength through its surface. Besides, the defective charges are much complex for the 400 kV lines (typically 22-unit suspension string) compared to the 275 kV lines (typically 16-unit suspension string); for mostly similar sites, the highest let-down charges are for lines closer to the sea. Furthermost defective elements are at the higher voltage end of the string; within the vilest instance, one third of the conductor end elements are faulty. Transmission line conductors remain the most significant and the utmost expensive constituents of EHV lines; however, they are, vulnerable to ageing. One of the key reasons restraining their lifetime remains unavoidable wind prompted Aeolian vibrations. Numerous important lines within several nations are now getting to an era where the mechanical well-being tends to inadmissibly low morals, a state which remains very often tiny understood. Furthermore, due to the swelling use of novel kinds of conductors (such as, AAAC, new materials, new ACSR stranding, Alumoweld ACAR,) where long-term design understanding does not occur, serious conductor failures and fatigue occur, triggering increasing anxiety. Other line condition evaluation work has now been done on the British Transmission System. The goal is to evaluate the state of overhead lines through non-invasive methods. The main difficulties that have been reflected are the crashes in ceramic insulators plus broken conductor parts. Similar difficulties have also been discovered in overhead lines within other countries.

The degree of the cracked insulator difficult has been progressively recognised since the 1970s, with the acknowledgement that mechanical influences of protection have weakened. The insulator comes towards the end of its waged life either when it flops mechanically, sparks over at unsatisfactorily high occurrences or gives signal of weakening to a state likely to lessen its issue of care in service. All the insulators are exaggerated to some range by thermal, mechanical and impact ablation from weathering besides electro-thermal reasons, torsion and flexure, ionic motion, cement growth and corrosion. Looms has concluded that the pin and cap disc porcelain insulators remain mainly smashed by corrosion, cycling, and cement growth. Cyclic loading stands a known source of material let-down since it encourages both development of micro-cracks openly and allows entry of water into every kind of surface flaw.

## From inspection to robotic maintenance on overhead Lines (OHLs)

Electrical cable inspection (power-line inspection) plus maintenance rehearses are developing as changing business sector guidelines, essentially expanded line stacking and framework accessibility prerequisites put focus on lattice proprietors to enhance. Electrical cable examination and maintenance as of now profit by advancements in versatile mechanical technology. Mechanical technology is accordingly making its presentation in that field. As essential resources, power line networks should stay dependable and accessible. These days, framework proprietors are being constrained to create imaginative instruments and techniques to perform maintenance and assessment on their empowered circuits. Accordingly, interest in electrical cable automated devices has expanded significantly in the course of recent years (Pouliot, and Montambault, 2009). Another class of utilization robots is arising, focusing on live-line maintenance on transmission frameworks (Chan, 2003). Created at Hydro-Québec's exploration foundation, Line Scout Technology (Monotimbral, and Poulet, 2006) is one of the main advancements here of applied advanced mechanics, as it has been effectively conveyed in the ground for live-line teleoperated investigation and maintenance (Wang, 2006). Depicted in past papers as a model innovation, Line Scout has now grown up as a solid instrument for linemen. As of late outfitted with three programmable pan-and-tilt camera (PPTC) components, it has become portion of an improved teleoperation system and an incredible visual examination instrument. Basic visual assessment errands were at first performed. Such assignments require not many cameras and are of extraordinary incentive in social occasion data on the state of line segments. Taking estimations, supplanting line segments and other perplexing, handy undertakings required driving the plan further. On account of its secluded plan, the versatile stage can be tailored with a mechanical arm (LineArm) explicitly intended to chip away at stimulated circuits (Zhu et al., 2006).

This subsection will first describe the inspection along with the types of the same. Afterwards, this will include the development and evolution of the inspection to the robotics and management. This will include the live-line work and OHLs maintenance.

## Research Gap

As long as each presented workings are likely to be completed live it can be reflected that there exists no maintenance effort on OHL that can’t be completed in Live Working technologies. Other works comprise a complex design and preparation, however, considering economic aids in most circumstances the Live Maintenance remains a better method to prepare it. In Romania, even if the Live technologies began then stopped at higher Voltage levels, we are exasperating permanently to grow novel technologies. The employment of Live Maintenance in High Voltage remains a new objective, but until now the supply companies appear to be not concerned in this technique due to the danger of human and the time consuming with complex costs. The present study will provide actual and probable works in the Live technologies for restoring OHLs. From joint practices to up-to-date new technologies (counting robots) all Live techniques should be encompassed in maintenance towards avoiding the de-energizing of the line. Similarly, new technologies and tools developed in the domain are taken into serious consideration. Lastly, almost every maintenance works may be done minus de-energizing the line. Therefore, this paper discloses the significance of Live - Line Maintenance Techniques for Malaysian grid. Maintenance tactic of overhead lines centred on monitoring data offers actual information concerning fault quantified the severity of maintenance of each line, situation, location, and reason thereon. Therefore, maintain continuous distribution to consumers via avoiding interruption because of the maintenance. So, the maintenance technology openly saves equipment, improves the service quality and its associated neighbouring. Live work remains extremely unsafe for untrained employees and particularly it is openly affecting human being’s life. Before doing (Live line Maintenance Techniques) LLMT numerous technological study must be done including the electrical effect on employees near the T/L, expansion of live-line services, assurance of safety, the practical guidelines of live-line work plus safe technique of live-line labour. Hence it remains proposed that Live Line Maintenance Technique using Bare Hand Method is most suitable and technically suited for overhead transmission line

There have been various studies talking about the overhead line in many perspectives but the current study will only take the specific high voltage OHLs and conduct the study of the same basis. In this research study, we will be analysing the problem associated with the current OHL maintenance system and will develop and suggest how the so-called modern tools and techniques can be implemented to make the maintenance easier. The study and its findings will become a helpful source for them to conduct their studies in a logical and systematic manner.

# RESEARCH METHODOLOGY

## Introduction

The main drive of this chapter remains to provide a methodology of the research paper with the help of a mixed research approach including quantitative and qualitative approaches. In broad, there exist three techniques of live-line working which assist employees avoid the substantial hazards of living line working. Besides, in various methods, they all help to prevent present flowing from the live apparatus through the employee. There exist two elementary Live Line methods for High Voltage (HV) work, which in business terminology are known as ‘Bare-hand and Hot stick’ methods: Using hot-stick techniques, direct human interaction with live mechanisms is evaded. Line workers use apparatuses fastened to protected fibre glass rods to do the work, and continuously keep themselves at a harmless distance from the live workings

Live Line Tool or Hot stick.

Rubber Glove or Insulating Gloves.

Bare hand or Potential.

De-energised or Unearthed or

## Research Paradigm

Paradigm may be measured as the gathering of problems, variables, and concepts, related towards the research methodology of the study, comprising research approaches besides combined instruments. It can also be clarified as the outline of the values and assumptions. This paradigm targets at mounting a much improved concept plus exploring the proofs connected to the sensations. A research paradigm stands further distributed into deductive, positivism, inductive and interpretivism research paradigm.

The positivism approach refers to the formal proposition of a researcher. It specifies the dependent variables, independent variables, their relationship and also ensures that these variables cater to the rules of empirical testing and the rules of formal logic (Yanow and Schwartz-Shea, 2015). Interpretivism approach remains related to a multi-layered plus complex reality, besides this practicality is constructed via the skills and suppositions of the persons (Clarke, 2009). The deductive approach is in contrast with the inductive approach. The deductive approach is more inclined towards scientific observations in which the researcher goes through a review of pre-established theories and objectives and then examines the hypothesis developed from them (Clarke, 2009). The inductive approach does not involve ignoring theories when expressing the objectives and questions of the research. The paradigm aims to cause the meanings and sense from the set of data collected to identify patterns to establish a theory (Yanow & Schwartz-Shea, 2015).

***Chosen research paradigm***

The study taken up is conducted in order to understand the applicability of modern tools for high voltage overhead lines. Thus, in order to achieve the results for the chosen study positivistic paradigm will be panned out that will assist the scholar to achieve the goals of the study. The positivist approach remains reinforced by quantitative data gathered by the researcher to get anticipated results.

## Research Approach

Research is about aggregating the relevant knowledge and attestation, etc., but research is the technique of collecting data, analyzing with the assistance of appropriate methods and interpreting the collected data to get the final result and discussion. The research follows a systematic process to define the goals of the study plus ethical alignment of data and evaluating the results with the existing studies. Research approaches provide a complete proposal with essential methods and suitable strategies (Bowling, 2009). Research is distributed into two portions according to the research problem identification. Therefore, the research method can be distributed into two units’ Quantitative research method plus Qualitative research method. A qualitative research method is an independent and a widespread research method which outcomes in some kind of a finding (Jackson, 2015). In this research method, a researcher targets towards explaining a social sensation from the viewpoint of the contributors chosen for the drive of investigation. The quantitative research, as the name submits, pacts with quantities besides examining the connection between the distinct variables. In a quantitative technique, an experimentation is designed smearing the statistical and numerical approach plus required data remains collected via surveys conducted amid various respondents. The quantitative research approach is more or less related to the perceptions well-defined by science (Taylor, 2010).

Highly skilled proficient manpower needed for live lines scheduled maintenance activities including spacer dampers, replacement of insulator, hardware and thus avoiding outages. PGCILs are applying a wide variety of Tools produced by Brazil (Ritz) and USA (Chance) companies.

Maintenance within a transmission firm ought to be planned, performed and well-ordered with the purposes of: -

* Improving maintenance expenses
* Guaranteeing higher levels of resources availability
* Prolonging assets life
* Certifying an acceptable quality of distribution
* Ensuring the protection of employees plus the public, - Contributing towards the long-term practicality of the firm - Lessen the damage towards agricultural flora because the maintenance can be scheduled considering the flora period.

The following operative facts are reflected during the live line maintenance:

* Auto reclose tool on the line that is worked on remain inhibited towards eliminating switching over-voltages.
* Live work isn’t performed when lightning or thunder activity is existing due to the TO V's.
* Successions capacitor banks are avoided as they have been found to contain an impact of p.u. overvoltage alongside the line during line errors and switching.
* Closing resistors are commonly applied on EHV circuit breakers to diminish p.u. switching over-voltages.
* Where precise ethics for variables have not been single-minded by measurement plus/or replication, the

***Chosen research approach***

To discourse the objective of this study, the research applied both the research methods that are Quantitative and comprising the grouping of both primary and secondary sources. The qualitative data supports and helps the quantitative data for their analysis and result formulation.

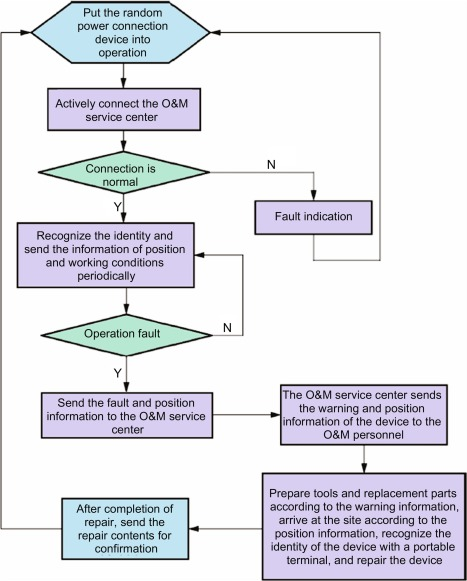


Figure 2.

As per the above flow chart we can understand that, how an overhead maintenance line can be maintained and identified the faults. Also, it can be explained by the following steps.

Detection of emergent conductor damage within the early phases protects not only unpredicted outages but also substantial money and time devoted towards widespread line repair. A marginally scratched conductor expenses less to renovate than a cracked conductor; thus, timely detecting of line wear may prevent high fee repairs. PLP commends that a strategy for constant line assessments be established, comprising follow-through assessments. A respectable routine to be followed in making check-ups plus repairs follows. Relevant line data remains important and supportive in determining the source of the difficulties and subsequently the counteractive repairs. The following info should be acquired and documented, if possible:

1. The tame of the line, date of installation and kind of construction.

2. Conductor scope of phase wires, stranding and neutral wire.

3. Line direction, dominant winds besides nature of terrain.

4. Size and type of insulator (through catalog quantity if possible) utilized towards supporting phase wires, besides diameter of the secondary spool.

5. Moveable hardware (insulators, nuts, braces, pins, etc.).

6. Nature of tie (hardness and size) plus Armor rod.

7. State of the wire (worn or broken) besides where the impairment is situated with reverence to the insulator.

8. State of the Armor rods with apparel related in per cent via its diameter.

9. State of insulator.

10. Recount data via phase (centre, road, neutral or field).

11. Record any uncommon observations (such as chipped insulators, broken ground wires, etc.).

12. Eliminate at least a set of ancient rods to regulate the state of the conductor under the rods.

13. Determine temperature, span length, sag, and tension.

14. Check one dual arm pole plus at least solitary dead-end edifice (the end for exhaustion breaks outer the dead-end fastens). It is moral practice to create specific cyphers on the above arguments to be sure that no phase is ignored. Research Design

**The research Design**

The research design remains the overall setup or framework of the research which stands combined to carry out the study systematically and logically. It aids as the draft to collect, quota and scrutinize the data. The research design may also be well-defined as an outline of the research that will integrate the collection, assessment, and examination of data. Besides, it is measured to be the widespread strategy that remains followed by the scholar to pool the diverse aspects linked to or comparable to the study logically and rationally. It has been fashioned to guarantee that research problem has been faced adequately plus to find the respond towards the research queries. The research design or study describes what kind of study is this. Besides, research design remains further distributed into sub-sections including Exploratory research design, Descriptive research design Explanatory research design, and Experimental research design (Salkind, 2010).

***Chosen research design***

The chosen technique for the study remains Explanatory and Descriptive research designs to conduct the whole study logically and efficiently. Grounded on the earlier studies alongside the point of opinions of persons on the subjects, the explanatory method helped the investigator to obtain a deep understanding into the present topic and grow some new conceptions for the similar. The novel concepts and ideas will assist future investigators to carry out their studies logically and systematically, centred on these principles they may also advance their unique ideas. Since, the subject for the present study remains very much exceptional and *not* that much of documents are presented so the descriptive method helped the investigator to improve study and comprehend the concepts besides developing some innovative ones. The descriptive method also backed the quantitative and qualitative data.

## Data Collection Method

Data collection remains a crucial plus authoritative aspect of any exploration study. The general research approaches used in the research are developed on the foundation of data composed by the investigator. Data gathered from different cradles act as a key component through which research method is simplified. Data may be collected via two main methods that are the primary and secondary methods, both of which play an essential role in gathering the objectives and aims of the research (Maxwell, 2012). Primary data collection remains the most important way of collecting the required info using several methods. In this kind of data collection method, the researcher to meet the research objective collects raw data which stands later analysed (Miller, Birch, Mauthner, & Jessop, 2012). Secondary data collection methods contain a vast range of proof which is gathered from many diverse secondary sources. This method focuses on accruing the data for collecting a comprehensive knowledge of the subject under consideration (Padgett, 2016). Besides, the secondary info is collected through numerous essays, books, websites linked to educational concepts reports, and publications which are applicable to the current study.

***Chosen data collection method***

The recent study applies both the methods, primary plus secondary data collection techniques to collect the applicable data for the research. The secondary data remains gathered with the assistance of previous and old papers based on the same area of interest. Secondary data collection methods contain a massive array of proof that is gathered from many diverse secondary sources. The research will offer a thorough analysis towards all applicable literature created by other researchers to find their results and obtain the response to the query of present research. Furthermore, in order to collect primary data for the present study, a set of open-ended questionnaires was distributed among the respondents of the current study for data collection. These surveys will contain a mixture of closed-ended questions which include the multiple-choice questions in which the respondents or participants were required to indicate the extent to which they agreed or disagreed. The checklist type multiple questions were also included in that with the chosen answer of the respondents. Furthermore, a semi-structured interview was also conducted to ensure the usage of both the data collection techniques. The respondent was, however, initially provided with an interview guide that was distributed through hand delivery by the researcher. This is to guide the study in areas and issues that were still under investigation for the proposed study. After all the interviews are duly filled, the researcher personally collects them from the respondents for analysis processes.

## Sampling Technique and Population

According to Taherdoost (2016), to respond all the doubts and queries of the research, the researcher is supposed to be capable of collecting data from every aspect and case, hence the need for sample miscellany is critical and important. The study populace or study populace is the group or entire set of resources from which the study sample is selected and tested for further study. Sampling technique is done in systematic order, the following are steps for sampling techniques. According to Taherdoost (2016), to respond all the doubts and questions of the research, an investigator is supposed to be capable of collecting data from every aspect and case, hence the need for sample miscellany is critical and important.

The research populace or study populace is the group or entire set of resources from which the research sample is selected and tested for supplementary study. Since the researcher has neither time to conduct the study with each case nor resources to examine and analyse. In order to carry out the study efficiently and logically, the researcher applies the sampling technique in order to reduce the number of cases. Sampling technique is done in systematic order, the following are steps for sampling techniques, start with defining a specific or target population to move smoothly in your study with no disturbance. Sampling frame selection remains the next phase in this, it includes analyzing plus selecting a confident frame entailing of all the necessary samples in which study desires to be completed Sampling technique choice and selection for further study. In general, these are divided into two parts such as non-random or Non-probability sampling plus Probability or the random sampling.

***Chosen sampling technique***

The present study will make use of probability sampling methods in order to get the anticipated and appropriate results. The selected population for study will be live-line working people or workers. Sampling technique used for qualitative data is non-probability purposive sampling and that for quantitative data is simple random sampling. The proposed study seeks to adopt the simple random sampling technique because it ensures that all the members of the target population have an equal opportunity of being nominated. Therefore, the response from the study participants were significant for the achievement of the study objectives as well as in addressing and answering the research questions. Chosen population for the current study will be live working people or workers, experiencing these things.

## Ethical Consideration

This part of the research will consider the ethical considerations should be followed when we design the OHL in terms of safety of ours and others. This part examines dangers that might be available during overhead line maintenance processes also presents protective apparatus designed towards creating a barrier amongst linemen besides high voltage lines and equipment, besides reviews protection performs that will help guarantee a safe working environment. Therefore, ethics is entrenched in the earlier Greek philosophical question of moral lifetime and it denotes to an agreed of values that can disapprovingly change previous considerations about actions and alternatives. Research ethics has the necessities on work, the preservation of dignity of issues besides the publication of the info in the research study. Ethical consideration remains the most critical and important piece of any research study (Fotrousi, Seyff, and Borstler, 2017). The safety and protection of human topics is significant through the presentation of appropriate ethical philosophies in any study or research. In quantitative and qualitative, both the lessons, ethical thoughts have a noteworthy resonance due to the in-depth behavior of the research process. The main drive of ethical concerns gets much more still while conducting surveys or interviews with endangered sets of participants (Arifin and Roshaidi, 2018). Research comprising humans is characteristically sensitive concerning ethical norms and aspects. Human being interrelating with technology as a portion of a study in research suggests a set of doubts, which makes the investigator take further moral considerations.

The worries are due to the unforeseen, unanticipated and unpredictable nature of technology. Therefore, ethical consideration remains the most critical and important segment of any research study. The safety and protection of human topics are important via the use of suitable ethical values in any study or research. In qualitative and quantitative, both the studies, ethical considerations have a significant resonance because of the in-depth behavior of the research process. The main drive of the ethical issues obtains much more silent when conducting surveys or interview with endangered sets of participants (Binti and Siti, 2018). Research participants or respondents should not be exposed to any harm or challenge and their confidentiality must be prioritized. However, there should be an appropriate level of confidentiality. A novel technology, for instance using a device for data collection, brands the research uncontainable for humans and therefore might have sudden effects on human beings plus the environment. So, studies combining technology and humans have specific ethical encounters that an investigator has to compact with (Fotrousi, Seyff, and Burster, 2017).

# EXPECTED RESULTS

## Introduction

This chapter will be analysing the expected level of new technologies and modern tools will be using for the overhead high voltage live lines maintenance works. Transmission lines have developed to a basic of our settings – they navigate an incredible array of terrains, environments, and climates, leaving permanent images. Their permanency is at least partly accountable for this outcome (Shu et al., 2007). Several major systems presently in service were constructed in the 1960 and 1970, with lines mounted at the turn of the era not unusual. Due to the comparatively old era of these constructions, most values owning and functioning high-voltage transmission lines meet the same kinds of maintenance difficulties. Maintaining consistency, extending the beneficial lifespan of lines, growing electrical energy transmission abilities, preventing failures, besides ensuring employee plus public safety are at the front of transmission line development and research. Wood crossarms remain one of the specific worry as they are classically quite complex to climate. Similarly, climatic issues are at the soul of the physical integrity of turrets, as atmospheric weathering impacts the galvanization of steel (Bodger and Woudberg, 1994).

## Expected results from the research and analysis

To deal with this issues, prominent utilities are investigative the economic effect of these difficulties and re-examining their planning plus operations performs. Many are similarly heavily included in the formation of equipment defence standards and controlling guidelines within the ultimate aim of diminishing the combined price of supply besides using of electricity via achieving a highest degree of transmission dependability.

To enable these determinations, CEA Technologies Inc. (CEATI) has prepared a Transmission Lines Asset Management Interest Group (TLAMIG), bringing together all electrical conveniences globally to exchange info plus to promote technology growth with the objective of adjusting the supervision of transmission line structure assets.

The Transmission Lines Asset Management Interest Group is presently financing several important projects, comprising,

* Vegetation Management in Rights of Way
* Protective Coating Maintenance Strategy for the Above-Ground Portion of Galvanized Steel Transmission Towers
* Condition Assessment Methodology for H-Frame Transmission Line Wood Crossarms

(Kulkarni et al., 2012)

## Condition Assessment Methodology for H-Frame Transmission Line

Condition Assessment Methodology for H-Frame Transmission Line Wood Crossarms

One of the weakest relations within the transmission grid remains the wood cross arm. These constructions have been applied for over a decade to back electric transmission lines. In-service cross arms are endlessly exposed towards a wide array of moisture and temperature conditions. Rainwater frame-up may root the wood towards losing much of its physical strength. Currently, the quantitative techniques for assessing the remaining power life of in-service wood cross arms are under-developed. This ambiguity may lead towards premature replacement and late feat on those cross arms necessitating maintenance. Besides, it is probable that because of this, utilities would be misdirecting funds (Aggarwal et al., 2000).

The periodic review and the replacement of wood cross arms remains necessary towards ensuring the dependability of electric provision to customers. Though, it is hard to evaluate the structural reliability of wood cross arms from the ground, detonating that, to create a qualitative evaluation, it is frequently necessary to carry out aerial inspections. Applying these visual evaluations, conditions may be graded based on a scale of 1 to 5. The method is though very subjective besides quantifying the outstanding strength plus service life of cross arms is problematic.

The second stage of this venture will comprise both a qualitative evaluation of the accessible inspection apparatuses for shaping the state and outstanding service life of towers besides a tower coating examination program. Moreover, the examination program will evaluate the application features of each kind of paint, physical assets of every coating, and the erosion resistance of every coating plus the weathering conflict of coated squares.

In the third stage, cost scrutiny software towards determining the exact charge of a tower coating venture will be established (Cameron et al., 1998). The software will consider many essential variables within its control, comprising environmental standards, travel and preparation charges, paint price, the number of required coating applications, and work costs besides drying times. The software will help utilities in handling their assets and funds management activities.

## New Technologies and Materials for Overhead Lines

With the recent advancement in new materials as well as technologies, they have provided transmission utilities as well as operators with various available options such as efficiency in operations, excellent designs, and maintenance of their assets. Additionally, existence of high temperature with low sag conductors, presents special allows that can be applied with temperatures of up to 20o C. Such conductors always carry more electric current as compared to the standard conductors which comprises of an allowable temperature of 80 to 90o C (Mawle, 2015). The new materials has a limitation on the sag, and conductor can pull with the aim of preventing respective reduced adaptations. Ideally, temperature is increased with reference to respective conductor temperature for a specific project.

When it comes to the results relating to the Dynamic Line Rating (DLR), it provides an indication of actual temperature of a conductor in comparison with the actual environmental parameters used in calculating the permissible maximum electric load. It is important to note that the higher the ambient temperature, the lower the permissible electric load (Piana et al 2018). Additionally, the higher the wind speed, the higher the rate of permissible electric load. Understandably, the principle governing dynamic line rating is based on the fact that the high wind as well as low temperature that promote higher permissible current within the conductors.

**4.5. Environmental Aspects of Overheads Lines and Maintenance.**

Overhead Line as well as Environmental Issues together with their interactions has been under consideration with Cigre for several years. The issues addressed have spanned from permit procedures, environmental impact analysis, and consultative issues relating to methodologies for overhead lines projects to environmental impacts mitigations. Other environmental aspects considered include land use, construction as well as maintenance. Ideally, a far-reaching empirical knowledge presents results based on the types of environmental effects electrical transmission projects. Such results have been also expressed in different studies, which include environmental reviews and impacts assessment. Most of the knowledge based environmental aspects relating to the power transmissions have been depicted in the proceedings on the ongoing various meetings relating to the topic (Oltean et al., 2014).

Additionally, the results literature on the characterization of transmission line impacts based on different aspects. The first aspect is land use changes, which presents construction as well as operations of transmission lines, which can amount to a considerable land use changes in the transmission processes. Moreover, most of the industrial and commercial uses are always not compatible with the requirements, which are geared towards ensuring that transmissions are kept right-of way. Regarding international electricity grid interconnections which may provide significant benefits based on the avoided emissions of international air pollutants. Concerning the first form of emissions, relates to greenhouse gases which leads to climatic change. Secondly is emission of gases as well as particles that recent research affirms that they can be transported of substantial distances along the oceans.

Undoubtedly, the amount of electricity available to the end users are based on 4 fundamental parameters which include operational efficiency, distribution efficiency, installed capacity, and distribution network. Operational efficiency can be measured via plant utilization metrics which include plant load factors or plant availability. Similarly, transmission as well as distribution efficiency is mostly measured via AT&C system reliability metrics (Mawle,et al., 2015). Uniform reach as well as distribution of the network warrants that all segments within the population, has access to electricity. In urban areas, infrastructures such as RMU’s and SCADA out to be put in place in the identified towns that has a population of over 4lakhs and input energy of 350MU, which Is considered to be part of R-ADRP. Based on the results obtained in different researches, analysis of the underlying factors are helpful in understanding strengths, weaknesses, threats, and opportunities in the adopted strategy. Additionally,

**Transmission Scenario**

With the application of technologies such as increasing of the voltage levels, that is 765kV AC, +/-800kV HVDC and reduction of the ROW requirements, among others enhances the transfer capacity, thus preventing the spreading of the disturbances. Additionally, conservation of right-of-way (ROW) minimizes impacts in terms of natural resources, coordinated development of cost effective transmissions corridor as well as the transfer requirements are the major areas of concern as far as the transmission voltage is concerned.

In obtaining the expected results, insulation testing is applied to obtain information on voltage distribution across the insulation strings in designing of future power transmission lines. . Ideally, the working principle of the enhanced device is based on the automatic measurement as well as recording of electric string across the insulation string, which decreases tremendously besides internally shorted simulations. Additionally, the tester is set across the string whereas the insulators are counted and configured automatically. In this case, the information’s that is obtained from the test conducted from the tests of up to 200 strings can be kept in the device to be transferred later in the host computer for interpretation purposes (Pianna et al., 2014). Additionally, the server software is solely responsible in transferring of data between the central unit that is on the tower, as well as the server within the transformer station. This is also bestowed in the calculation of the prospective temperature on the graphical interface using three colour code.

**ACTUAL RESULTS**

The current modern transmission and distribution of electricity has a low investment opposed to what is expected to maintain the current reliability and capacity hence this means that the new technology has not been utilizes effectively. In many countries the current system of local automatic controls which is over headed by people at control centres is not to adequately able to foresee possible blackout (Larsen, 2016). Modern communication of using technology can be effective since it can help to diagnose problems before they come. Additionally, this will help to safe on cost and maximize power supply. New technology have not been adequately used this is because in most countries there are many challenges facing the grid and there are few policy and regulation in this sector.

Moreover, there have been a lot of noise and there is need to do a noise assessment on night this is because at night residual noise is generally lower and the source where the sound is coming from. Any noise should be compared to any residual noise that should be measured at the receiver when the noise source is not working. Additionally, many countries have under supply capacity of overhead line connection. The table below shows different countries current connectivity with respect to the proposed connectivity

|  |  |  |  |
| --- | --- | --- | --- |
| Interconnected countries | Power carrying capacity of proposed interconnectors | Combined system pick demand | Capacity of proposed interconnectors as a percentage of peak demand |
| Ireland-North Ireland | 1500 MW | 6311 MW | 23.8% |
| Norway-Sweden | 2 X 720 MW | 49643 MW | 2.9% |
| France-Spain | 2 X1000 MW | 145625 MW | 1.4% |

Table 1

Furthermore, the current electrochemical devices in use are slow and cannot act quickly to handle rapid transmission. Therefore a good transmission and distribution system is needed in order to prevent overload and instability. From the results it can be seen that power deployment has been limited. Additionally, the technology has been underutilized, for instance when a fault occurs the state of the line may not be certain the crew safety the line cannot be worked on until it can be proven it’s safe. In the technology is well utilize there can be an immediate response to work on this cables. In many countries there is large amount of aging power transmission equipment which results to possible power failure.

In many countries in Europe over the world over 98% of Overhead line (OHL) on Extra High voltage (EHV 315kv to 500kv) electricity transmission distribution in Europe is of HVAC OHL building. For comparing reasons the extent of 380kv /400kv connectivity in seven European countries is shown in a table below.

|  |  |  |  |
| --- | --- | --- | --- |
| Countries | OHL km | Underground cables | % cable |
| Belgium | 1335 | 0 | 0.00% |
| France | 21361 | 3 | 0.01% |
| Germany | 20237 | 70 | 0.34% |
| Great Britain | 11979 | 229 | 0.91% |
| Ireland | 439 | 0 | 0.00% |
| Netherlands | 2061 | 31 | 1.43% |
| Portugal | 2236 | 0 | 0.00% |

Table 2

Additionally, many governments have not promoted investment in electricity transmission infrastructure and therefore they have not facilitated for efficient competition and safeguard of security of supply. Furthermore, transmission system operators have not efficiently managed their networks. Moreover, there have been a lot of power transmission failure resulting to a blackout that happens in Overhead lines (OHL). For instance in Europe and in USA. In many countries most Overhead Lines were built many years ago and are based on old technology, but there have been significant increase in demand of electricity therefore there is need to grow the capacity in order to make sure that there is power reliability

Undoutbfully, in the near future work would be online monitoring data, using a reliability analysis and this will require the development of high voltage intelligence equipment. This will help in renovating and maintaining of electric generation sector and national grid development. There is need to use sensing in fault detection and monitoring since this will help in high power electrical installation. Additionally, there have been so many deaths where by data shows that most of people who die are electrical workers. According to Alassi et al., (2019) deployment of new technologies can economic advantages in different countries annually. The technology should be the one that focuses on more accurate measures and electricity projection operating condition. Additionally, the technology to be adopted should be flexible and dynamic control of electric transmission system which will help to optimize transmission and distribution of electricity using the existing assets in operation.

Additionally, the statistics shows that the average duration for a 400kv/275kv/ 220kv OHL circuit would be out of service when faulty is somehow of an equivalent UGC circuit and take less than two days in the case of OHL and around 25 days for cases of 400kv UGC. The table below summarizes this.

|  |  |  |
| --- | --- | --- |
| OHL AND UGC | Projected fault rate for interconnector | Average time to repair |
| UGC | 1 fault per annum | 25 days |
| EIRGRID | 1 fault per every 20 years | 2 days |

Table 3 Source cigre technical bronchure

Furthermore, the technologies options complement building of new lines, the technology options can help to safe on cost and capacity to be introduced by new technology. Also when a given country invest in technology in the overhead line they will be able to provide temporary solution to current challenges such as construction of new lines or during transmission outage. Moreover, many technology are applicable to large power system. Additionally, there is need to make sure that there is a systematic maintenance intervention all damages, old parts as well as support devices which need to be replaced with new devices and making sure that the technology is maintained as well as safety and sustainability.

CONCLUSION

This study on review of numerous techniques on Transmission Line Maintenance plus Line monitoring positioned in many countries by the administration utilities besides many private organizations. Efforts made towards highlighting the current maintenance methods and advanced progress of maintenance technology centered on predictive monitoring and maintenance of line for coming perspective. The paper also displays factors touching on maintenance methods with the progressive development technology, development and research since its start. Profits of maintenance technology include; Maintenance Technology with Smart Grid (SG) technology offers features like maintaining solidity of the structure, rise in transmission capability, improving distribution quality, development in general performance and many more. Remodeling the energy state of the international marketplace. It also expands other performances such as architecture with fast data exchange, advanced communication, advanced management, and protocol (Oltean et al., 2014). Environmental Benefits include: - The decrease in losses by an enlarged availability results within savings in cohort and lower releases of polluting gases in the atmosphere. Similarly, live-line working processes and methods are particularly designed towards dealing with environmental concerns, like the fitting of bird aerospace diverters plus thus the replacement of spacers, insulators, and other fittings that produce noise. Furthermore, this technology contains a quality to advance performance of additional technologies including Wide Area Monitoring (WAM) and Flexible AC Transmission System (FACTS) in rural and urban area.

Overhead high-voltage lines are usually used as power transmission and the strategy of remotely operated switch gears mounted directly reduces the visual impact, vulnerability of the system to weather adversity. Various techniques are used to improve transmission lines for audible noise impact by considering the combination of switchgear action. Notably, sound emission data are fed as input into sound software to evaluate the noise alleged by the people. High and ultra- high -voltage infrastructure are the electrical networks for the increase in capacity, efficiency, and transmission distance. This provides essential functionality intended for adaptive capacity, damage limitation, and recovery speed in the power supply network.

Additionally, innovative installation of switchgear on the framework holds the conductor that permits a decrease of land use, visual intrusion, and power outages. However, the drivers to advance electric lines are enhanced on control, the capacity to operate, reliability, variation to diverse energy sources, and determination on switchgear performance. The infrastructure requires maintenance intervention for damages and devices that needs support for technology safety. Technical benefits are attained from the replacement of remote control and installed devices. Besides, a broad-band noise level increases the distance that remarks to an additional attenuation effect to the noise-causing a high-voltage lines.

REFERENCES

Al-Aqeeli, R., & Habiballah, I. (2020). Live Line Maintenance of Transmission Lines: A.

Arnaiz, A., Konde, E., & Alarcón, J. (2013). Continuous improvement on information and on-line maintenance technologies for increased cost-effectiveness. *Procedia CIRP,* 11, 193-198.

AGGARWAL, R., JOHNS, A., JAYASINGHE, J. & SU, W. J. E. P. S. R. 2000. An overview of the condition monitoring of overhead lines. 53, 15-22.

Bazeley, P. and Jackson, K., 2013. Qualitative data analysis with NVivo: SAGE publications.

Beryozkina, S. (2019). Evaluation study of potential use of advanced conductors in transmission line projects. *Energies*, *12*(5), 822.

Binti Mohd Arifin, Siti Roshaidai. (2018). Ethical Considerations in Qualitative Study.

BODGER, P. S. & WOUDBERG, J. J. J. I. J. O. E. E. E. 1994. High voltage live-line maintenance laboratory. 31, 195-205.

Bowling, A. (2009). The psychometric properties of the older people's quality of life questionnaire, compared with the CASP-19 and the WHOQOL-OLD. Current Gerontology and Geriatrics Research, 2009.

CAMERON, G., BODGER, P., WOUDBERG, J. J. I. P.-G., TRANSMISSION & DISTRIBUTION 1998. Incomplete Faraday cage effect of helicopters used in platform live-line maintenance. 145, 145-148.

Chan, J. (2003). Transport devices for overhead conductors: State of the art review and promising technology. *EPRI report*, *1001999*.

Chance, Hubbell Power System,(2004), ―Ease of EHV live-line maintenance by design, Zs. Bertalan, Z. Csedo, Z. A. Tamus Member, IEEE, ‖ Social Welfare and Live Line Maintenance‖.

Clarke, C. (2009). Paths between positivism and interpretivism: An appraisal of Hay's via media. Politics, 29(1), 28-36.

Fotrousi, F., Seyff, N., & Borstler, J. (2017). *Ethical Considerations in Research on User Feedback. 2017 IEEE 25th International Requirements Engineering Conference Workshops (REW).*

GARCÍA, A. A., BOBADILLA, I. G., FIGUEROA, G. A., RAMÍREZ, M. P. & ROMÁN, J. M. J. V. R. 2016. Virtual reality training system for maintenance and operation of high-voltage overhead power lines. 20, 27-40.

Jackson, S., (2015). Research methods and statistics: A critical thinking approach. s.l.:Cengage Learning.

KULKARNI, G., GANDHARE, W. J. A. I. J. O. E. & ENGINEERING, P. 2012. Proximity effects of high voltage transmission lines on humans. 3, 28-32.

Larsen, P. H. (2016). A method to estimate the costs and benefits of undergrounding electricity transmission and distribution lines. *Energy Economics*, *60*, 47-61.

Lovrencic, V., Brezavscek, A., Pantos, M., & Gomiscek, B. (2017). Contribution of live working to the quality, safety, efectiveness and efficiency of the maintenance processes.

Lugschitz, H., Yamakawa, T., & Kieloch, Z. (2020). Overhead Lines. In *Electricity Supply Systems of the Future* (pp. 185-212). Springer, Cham.

Mawle, P. P., Porate, K. B., & Burade, P. G. (2015). Over Head Transmission Lines Live Line Maintenance Techniques Based on Condition Monitoring in Indian Power Scenario. *INTERNATIONAL JOURNAL OF SCIENCE, SPIRITUALITY, BUSINESS AND TECHNOLOGY (IJSSBT)*, *3*(2).

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41). Sage publications.

Miller, T., Birch, M., Mauthner, M. & Jessop, J., (2012). Ethics in qualitative research. s.l.:Sage.

MILLER, R., ABBASI, F. & MOHAMMADPOUR, J. J. I. R. A. I. J. 2017. Power line robotic device for overhead line inspection and maintenance.

Montambault, S., & Pouliot, N. (2006, October). LineScout technology: Development of an inspection robot capable of clearing obstacles while operating on a live line. In *ESMO 2006-2006 IEEE 11th International Conference on Transmission & Distribution Construction, Operation and Live-Line Maintenance*. IEEE.

Oates, B.J., 2016. *Researching information systems and computing*. Sage.

Oltean, M. N., Fagarasan, T., & Brabete, D. L. (2014, May). Complete solutions for LW maintenance of high voltage OHL. In *2014 11th International Conference on Live Maintenance (ICOLIM)* (pp. 1-6). IEEE.

POULIOT, N., RICHARD, P.-L., MONTAMBAULT, S. J. I. P. & JOURNAL, E. T. S. 2015. LineScout technology opens the way to robotic inspection and maintenance of high-voltage power lines. 2, 1-11.

Padgett, D. K. (2016). *Qualitative methods in social work research* (Vol. 36). Sage Publications.

Salkind, N. J. (Ed.). (2010). *Encyclopedia of research design* (Vol. 1). Sage.

AGGARWAL, R., JOHNS, A., JAYASINGHE, J. & SU, W. J. E. P. S. R. 2000. An overview of the condition monitoring of overhead lines. 53, 15-22.

BODGER, P. S. & WOUDBERG, J. J. J. I. J. O. E. E. E. 1994. High voltage live-line maintenance laboratory. 31, 195-205.

CAMERON, G., BODGER, P., WOUDBERG, J. J. I. P.-G., TRANSMISSION & DISTRIBUTION 1998. Incomplete Faraday cage effect of helicopters used in platform live-line maintenance. 145, 145-148.

GARCÍA, A. A., BOBADILLA, I. G., FIGUEROA, G. A., RAMÍREZ, M. P. & ROMÁN, J. M. J. V. R. 2016. Virtual reality training system for maintenance and operation of high-voltage overhead power lines. 20, 27-40.

KULKARNI, G., GANDHARE, W. J. A. I. J. O. E. & ENGINEERING, P. 2012. Proximity effects of high voltage transmission lines on humans. 3, 28-32.

MILLER, R., ABBASI, F. & MOHAMMADPOUR, J. J. I. R. A. I. J. 2017. Power line robotic device for overhead line inspection and maintenance.

POULIOT, N., RICHARD, P.-L., MONTAMBAULT, S. J. I. P. & JOURNAL, E. T. S. 2015. LineScout technology opens the way to robotic inspection and maintenance of high-voltage power lines. 2, 1-11.

SHU, Y.-B., HU, Y. & LI, X. J. G. J. H. V. E. 2007. Maintenance and live working technology for ultra high voltage transmission line. 33, 1-5.

SINGH, J., GANDHI, K., KAPOOR, M., DWIVEDI, A. J. M. I. J. O. E. & ENGINEERING, I. 2013. New approaches for live wire maintenance of transmission lines. 3, 67-71.

SONG, Y., WANG, H. & ZHANG, J. J. I. T. O. P. D. 2014. A vision-based broken strand detection method for a power-line maintenance robot. 29, 2154-2161.

Snyders, A. J., Ferguson, J., Enslin, J. H. R., & Reichmeider, P. P. (2010, July). Avoiding costly plant shutdowns by employing specialized live technologies and safe practices. In *IEEE PES General Meeting* (pp. 1-6). IEEE.

Taherdoost, H. (2016). Sampling methods in research methodology; how to choose a sampling technique for research. *How to Choose a Sampling Technique for Research (April 10, 2016)*.

Taylor, P. C. (2010). Transformative educational research for culturally inclusive teaching. Keynote address delivered at the 7th International Conference on Intercultural Competence, Khabarovsk, Far East Russia.

Wang, L., et al, (2006), “Development and Control of an Autonomously Obstacle-Navigation Inspection Robot for Extra-High Voltage Power Transmission Lines”, SICE-ICASE International Joint Conference.

Wiek, A. and Lang, D.J., 2016. Transformational sustainability research methodology. In *Sustainability science* (pp. 31-41). Springer, Dordrecht.

Zhu, X., Wang, H., Fang, L., Zhao, M., & Zhou, J. (2006, October). Dual arms running control method of inspection robot based on obliquitous sensor. In *2006 IEEE/RSJ International Conference on Intelligent Robots and Systems* (pp. 5273-5278). IEEE.

AGGARWAL, R., JOHNS, A., JAYASINGHE, J. & SU, W. J. E. P. S. R. 2000. An overview of the condition monitoring of overhead lines. 53**,** 15-22.

BODGER, P. S. & WOUDBERG, J. J. J. I. J. O. E. E. E. 1994. High voltage live-line maintenance laboratory. 31**,** 195-205.

CAMERON, G., BODGER, P., WOUDBERG, J. J. I. P.-G., TRANSMISSION & DISTRIBUTION 1998. Incomplete Faraday cage effect of helicopters used in platform live-line maintenance. 145**,** 145-148.

GARCÍA, A. A., BOBADILLA, I. G., FIGUEROA, G. A., RAMÍREZ, M. P. & ROMÁN, J. M. J. V. R. 2016. Virtual reality training system for maintenance and operation of high-voltage overhead power lines. 20**,** 27-40.

KULKARNI, G., GANDHARE, W. J. A. I. J. O. E. & ENGINEERING, P. 2012. Proximity effects of high voltage transmission lines on humans. 3**,** 28-32.

MILLER, R., ABBASI, F. & MOHAMMADPOUR, J. J. I. R. A. I. J. 2017. Power line robotic device for overhead line inspection and maintenance.

POULIOT, N., RICHARD, P.-L., MONTAMBAULT, S. J. I. P. & JOURNAL, E. T. S. 2015. LineScout technology opens the way to robotic inspection and maintenance of high-voltage power lines. 2**,** 1-11.

SHU, Y.-B., HU, Y. & LI, X. J. G. J. H. V. E. 2007. Maintenance and live working technology for ultra high voltage transmission line. 33**,** 1-5.

SINGH, J., GANDHI, K., KAPOOR, M., DWIVEDI, A. J. M. I. J. O. E. & ENGINEERING, I. 2013. New approaches for live wire maintenance of transmission lines. 3**,** 67-71.

SONG, Y., WANG, H. & ZHANG, J. J. I. T. O. P. D. 2014. A vision-based broken strand detection method for a power-line maintenance robot. 29**,** 2154-2161.

Piana, E. A., Bignucolo, F., Donini, A., & Spezie, R. (2018). Maintenance of a high-voltage overhead transmission line: Sustainability and noise impact assessment. *Sustainability*, *10*(2), 491.

Oltean, M. N., Fagarasan, T., & Brabete, D. L. (2014, May). Complete solutions for LW maintenance of high voltage OHL. In *2014 11th International Conference on Live Maintenance (ICOLIM)* (pp. 1-6). IEEE.

Milun, D. (2017). Hazards and protective measures at work on 20 kV line in close vicinity to parallel 220 kV line. *CIRED-Open Access Proceedings Journal*, *2017*(1), 682-685.

**Sample Questionnaire**

**Please complete the follow and answer this questionnaire**

1. What do you understand by Overhead lines (OHLs)? Please explain briefly

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1. Dou you think OHLs can cause any hazards? If yes please explain how

* Yes
* No

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1. What are the power lines, and how powerful are they?

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1. Do you think whether new technologies and materials for overhead lines are sustainable? If yes, please explain

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1. What is condition assessment methodology for H-Frame Transmission Line?

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1. What do you understand about applicability of advanced and modern tools relating to high voltage overhead lines?

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