American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-10, Issue-03, pp-187-193
www.ajer.org
Research Paper Open Access

Electricity Safety Analysis on the Process of Replacing Find Insulator in Medium Voltage Network Pole Under Voltage Conditions

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ABSTRACT : *Work in 20 KV Voltage Condition is maintenance work carried out when the power is on or in a stressful condition, this type of work has a high potential hazard and endangers the safety of workers so that hazard identification is required in every work process. The purpose of this study is to identify the sources of potential hazards that exist in the workplace based on the four impacted classifications, namely the general public, technical personnel who do the work, installations and the environment. The data collection method uses primary data from interviews, while secondary data comes from documents and company records and is then analyzed descriptively. The preliminary results of this study can be concluded that the sources of the hazard at working in 20 KV Voltage Condition are falling objects, flash over, injured, falling, hot temperatures, aluminum ladders and bulkhead ladders that are not properly installed, and the presence of stressful conditions on each conductor. And for the recomendations for the implementation of work in 20 KV voltage condition are to require every technician to comply with the SOP (Standard Operating Procedure), use complete Personal Protective Equipment (PPE) and must be careful when carrying out work and socialization to the surrounding community.*

KEYWORDS: *Hazard Identification, Work In Voltage, Electricity Safety, Find Insulator.*

Date of Submission: 14-03-2021 Date of acceptance: 28-03-2021

I. INTRODUCTION

Electricity is one of the means needed by the community to improve their welfare. Electrical energy is used to support people's daily activities, starting as lighting, driving force, heating, and others. The development of increasingly advanced technology at this time resulted in the use of many electrical resources to support a better life. The electric power distribution system is supported by adequate distribution equipment. In normal conditions the distribution system is energized by working currents and voltages so that it affects the performance of existing equipment. The distribution equipment is equipment that is sensitive to disturbances, both from internal (internal) factors and external (external) factors.

The working conditions of distribution equipment such as insulators, conductors, transformers and connections in overhead lines are very prone to interference and damage caused by load currents. Load currents can cause losses and increase the temperature of the distribution system equipment, thereby reducing the efficiency and lifespan of existing equipment [1]. In addition to disturbing load currents, damage to distribution equipment can also be caused by sparks (flashover) that arise due to the gap between phases which affects the equipment on the 20 KV Medium Voltage Air Line distribution network to heat.

To increase the reliability of the distribution system and minimize any disruptions, maintenance is required. Routine maintenance and maintenance of distribution network equipment aims to overcome the reduction in efficiency and damage so that the equipment can work properly according to its function.

In terms of maintenance and maintenance of the network carried out by the electricity supply company with a system without voltage (blackout), it is a vital problem experienced by consumers and electricity companies because it can reduce service continuity. The electricity supply for customers is hampered and they cannot carry out the production process optimally because electricity is not distributed. The losses experienced by the electricity company are enormous because of the blackout resulting in a large amount of electrical energy being lost and cannot be sold to consumers. The solution to suppress blackouts is to increase the SAIDI (System

Averange Interruption Duration Index) and SAIFI (System Averange Interruption Frecuency Index), the power company maintains a 20 KV Medium Voltage distribution network with a hot line maintenance system [2].

Work in voltage condition has a high risk of danger, both risks to work safety, public safety, installation safety and environmental safety. In the explanation of Indonesian Law No. 30 Year 2009, it is stated that, "Besides being useful, electric power can also be dangerous. Therefore, in order to better ensure general safety, work safety, installation security, and the preservation of environmental functions in the supply of electricity and the utilization of electric power, electric power installations must use electrical equipment and equipment that meet the equipment standards in the electricity sector" [3].

The implementation of electricity safety is important for electricity business entities to minimize the risk of electricity accidents (general public accidents, work accidents, installation accidents and pollution and / or environmental damage) in every electricity activity. Occupational safety and health are important aspects in controlling all risks that exist in company operations [4]. The activities in the implementation of the production process in an industry can cause a potential risk of work accidents [5]. In addition, Law Number 32 of 2009 Environmental Protection and Management article 1 paragraph 2 is a systematic and integrated effort to conserve environmental functions and prevent environmental pollution and / or damage which includes planning, utilization, control, maintenance, supervision and law enforcement [6].

To realize an effective and efficient electricity safety at work in voltage, it is necessary to analyze the safety of electricity work to prevent unwanted occurrences and to eliminate potential hazards. For this reason, the authors are interested in analyzing the safety of electricity at work under stressful conditions, especially in the maintenance of electricity distribution networks, namely the process of replacing pedestal insulators on medium voltage grid poles in a stressed state.

The formulation of the problem in this research is what are the potential hazards that can occur at work in voltage by using the electricity safety analysis method in The Medium Voltage Network Maintenance Team at X city, while the specific objective is to analyze the potential hazards in the installation of the R phase pedestal insulator on the medium voltage grid pole in a voltage state using the direct touch method.

II. RESEARCH METHODOLOGY

The research method used in this study is a type of qualitative research with the aim of analyzing the potential hazards of electricity activities by using the electricity safety analysis method. This research is divided into 5 stages, namely preliminary, data collection, data processing, analysis and discussion as well as conclusions and suggestions. The research method flow chart can be seen in Figure 1.

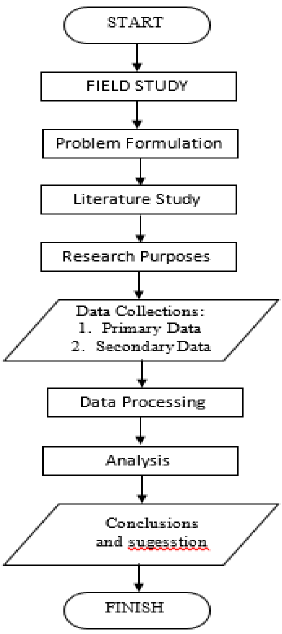

Fig.1. Research Diagram

A. Introduction Stage

The preliminary stage is carried out to obtain general information. In the introductory stage, there are 5 steps:

1. Field Study

The first step in this research is to make observations to get a picture of the actual condition of the object to be studied. This will be very useful for researchers because it can provide a clear picture of their research. From the results of this field study, researchers can find out the problems that occur at the company.

2. Problem Formulation
   At this stage it is the beginning of conducting research, where the scope of the problem described is the problem of electricity safety at work in voltage condition at The Medium Voltage Network Maintenance Team at X city. Potential hazards at work in voltage condition are analyzed in order to prevent unwanted events from occurring and to eliminate potential hazards.
3. Literature Study
   Literature study is used to study theory and science related to the problem to be studied. Sources of literature come from books, journals, and studies of previous research which include theories on electricity safety, Job Safety Analysis (JSA) and Electricity Safety Analysis.
4. Research purposes
   The purpose of this research is to identify, analyze and provide recommendations for improvements.

B. Data Collection Stage

The data collection stage includes observation and interviews. This data will be input at the data processing stage. After obtaining the required data, data processing is carried out using the relevant methods according to the problems at hand. The method used is electricity safety analysis.

The following are the stages of data processing carried out:

1. Choose a job to be analyzed
   To start the electricity safety analysis process, it begins with selecting a job or task that needs to be evaluated. Choosing a job to analyze may sound simple, but it can be an important consideration when you have limited time and resources to analyze all stages of the job process. Basically, almost any type of work requires a safety analysis. However, there are several factors that need to be considered in determining work priorities that must be analyzed first, including:
   a. The job with the highest accident rate
   b. Work that has the potential to cause serious and deadly injury, even for jobs for which there is no previous accident history
   c. Work where one minor negligence of the worker can result in a fatal accident or serious injury
   d. Every new job or job that has undergone a change in work processes and procedures
   e. The work is quite complex and requires written instructions.
   The various factors above can help in determining what jobs should be prioritized and must be analyzed first.
2. Detail the steps of the job from start to completion of work
   In order to carry out a proper and thorough electrical safety analysis, each job must be specified. These steps are not only specific to a particular job, but also specific to a particular work area. If the work area changes but the type of work is the same, still the steps of the job need to change too. It is important to avoid detailing the work too narrowly (in detail) or too broadly. Generally, each job contains no more than 10 tasks. If it turns out that the tasks on the safety analysis exceed this number, consider dividing the work into two or more phases separately.
3. Identification of Potential Hazards / Impacts
   Any potential hazards / impacts should be identified as soon as possible after the observation and details of each work step have been completed. If one or more work steps need to be repeated, it is best to do them immediately, if possible. Identification of potential hazards / impacts is the most important part in carrying out an electricity safety analysis. Here are some things you can consider when identifying hazards:
   a. The cause of the previous accident (if any)
   b. Other jobs located near the work area
   c. Regulations or regulations related to the work to be carried out
   d. Manufacturer instructions in operating work equipment.
4. Determine control / preventive measures
   Each potential hazard / impact that has been previously identified requires control. These controls describe how you will eliminate hazards in the work area or how you will significantly reduce your risk of injury. The hazard control hierarchy is a tool commonly used to develop occupational hazard control measures. The National Institute for Occupational Safety and Health (NIOSH) divides five hierarchies of hazard control in the workplace, including:
   a. Elimination - eliminating or minimizing harm
   b. Substitution - replacing hazardous tools, machines, or other materials to become less dangerous

c. Engineering - isolating, installing additional ventilation systems, modifying tools, machines or workplaces to make them safer
d. Administrative controls - procedures, rules, training, duration of work, K3 signs, K3 posters, labels, etc.
e. Personal protective equipment (PPE).

C. Analysis and Conclusion Stage

The research data that has been processed is then analyzed, interpreted and used as a guide in making improvements. The improvement proposal is a general recommendation that can be applied in all types of accidents that occur. At this stage the results of the writing will be concluded. This conclusion covers the objectives achieved in writing the report. This section also discusses recommendations as suggestions for implementation.

Fig.2. Installation of pedestal isolators in a stressed state Using the Direct Touch Method (source: www.pdkb.id)

III. RESULT AND DISCUSSION

The electricity safety analysis is carried out in the following stages:

1. Determine the type of work to be analyzed
   In this study, the type of job of replacing the phase R pedestal insulator with direct touch method. The observations made were when the work was carried out on 17 November 2020 in City X. This work was carried out by The Medium Voltage Network Maintenance Team at X city, with as many as 7 workers consisting of 1 team leader, 1 K3 supervisor and 5 PDKB technicians.
2. Break down the job into basic steps
   In the process of replacing the Phase R fulcrum insulator, the direct touch method consists of 10 stages according to the Standard Operating Procedure used. The stages are as follows: preparation of materials and equipment, followed by installing a no voltage detector and protector. And next is to remove the Pin Type Insulator Cover on Phase R and untie the tie wire and move the conductor to the cross arm. Then replace the Phase R fulcrum insulator and return the conductor to the insulator trench. After that tie the conductor with tie wire and close the Phase R insulator with the Pin Type insulator cover, which is then followed by removing the conductor cover, insulating type pins on both sides and insulating blanket on the cross arm and removing the no voltage detector. And ends with restoring equipment and materials.
3. Identifying potential hazards in each job
4. Controlling danger

The results of the identification of potential hazards /impacts and control of electricity hazards for electricity safety analysis in terms of the safety of the general public are as in table 1

Table 1. The Results of Electricity Safety Analysis for General Public Safety in the Installation of R-Phase Insulators with Direct Touch Method

No	Job Steps	Potential Hazards for the General Public Safety	Control Measures
1	Preparation of Materials and Equipment	• Hit by a sharp object	• Installation of barricades / safety lines and information boards
2	Installing No Voltage Detector and Protector	• Equipment fell	• Installation of barricades / safety lines and information boards
3	Removing Pin Type Insulator Cover on Phase R	• Equipment fell	• Installation of barricades / safety lines and information boards
4	Unfasten the tie wire and move the	• Flash over	• Installation of barricades / safety lines and

	conductor to the cross arm		information boards
5	Replacing the phase R pedestal insulator	• Isolator falls	• Installation of barricades / safety lines and information boards
6	Returns the conductor to the insulator trench	• Linesman slips	• Installation of barricades / safety lines and information boards
7	Tie the conductor with tie wire	• Flash over	• Installation of barricades / safety lines and information boards
8	Menutup isolator Phasa R dengan Pin Type isolator cover	• Equipment fell	• Installation of barricades / safety lines and information boards
9	Melepas conductor cover, pin isolator type pada kedua sisi dan insulating blanket pada cross arm dan melepas no voltage detector	• Equipment fell	• Installation of barricades / safety lines and information boards
10	Mengembalikan peralatan dan material	• Stuck work equipment	• Installation of barricades / safety lines and information boards

The results of the identification of potential hazards / impacts and control of electricity hazards for the analysis of electricity safety in terms of work safety are as in table 2.

Table 2. Results of the Analysis of Electricity Safety for Worker Safety in the Installation of the R Phase R Insulator with the Direct Touch Method

No	Job Steps	Potential Hazards for the Worker Safety	Control Measures
1	Preparation of Materials and Equipment	• Hands scratched by sharp objects • Slipped • Hit by a sharp object	• Wear cotton gloves • Pay attention to the placement of equipment and materials in a safe place
2	Installing No Voltage Detector and Protector	• Stung by tension • Equipment fell	• Make sure the PPE is installed properly • Make sure to install correctly
3	Removing Pin Type Insulator Cover on Phase R	• Stung by tension • Equipment fell	• Make sure the equipment is removed properly • Make sure the area of the closest tension has been installed protector perfectly
4	Unfasten the tie wire and move the conductor to the cross arm	• Gloves are leaking • Stung by tension • Flash over	• Fit to open the bonds using combination pliers • Roll the ties when untying • Make sure the cross arm is completely closed • Ensure that the conductor cover is properly connected to the line hose
5	Replacing the phase R pedestal insulator	• Hands pinched • Isolator falls • Gloves are torn	• Take care when removing or installing insulators • Make sure the insulator is bonded to the fabric slink • Hold the insulator by its intact parts
6	Returns the conductor to the insulator trench	• Linesman slips • Loose conductor	• Ensure an ergonomic working position • Hold the conductor firmly by the lineman
7	Tie the conductor with tie wire	• Gloves are leaking • Stung by tension • Flash over	• Make sure the tie wire ends are not sharp • Roll the ties while tying the knots • Make sure the cros arm is closed completely
8	Closing the R phase insulator with the Pin Type insulator cover	• Equipment fell • Stung by tension	• Make sure to install correctly • Make sure the area of the closest voltage has been installed protector perfectly
9	Removing the conductor cover, insulator type pins on both sides and the insulating blanket on the cross arm and removing the no voltage detector	• Equipment fell • Stung by tension	• Make sure to install correctly • Make sure the protector that is removed starts from the position furthest from the linesman
10	Return of equipment and materials	• Hands scratched by sharp objects • Slipped • Stuck work equipment	• Wear cotton gloves • Ensure gradual return of equipment and materials • Take care in returning work equipment

The results of the identification of potential hazards / impacts and control of electricity hazards for the analysis of electricity safety in terms of installation safety are as shown in table 3.

Table 3.The Results of Electricity Safety Analysis for Installation Safety in the Installation of R Phase R Insulators with Direct Touch Method

No	Job Steps	Potential Hazards to Installations Safety	Control Measures
1	Preparation of Materials and Equipment	There is no potential hazards	There is no potential hazards
2	Installing No Voltage Detector and Protector	• The lift man touches the conductor and there is a leak to the grounding and flash over	• Installation of local grounding • Coordination with the Distribution Control Area Unit in anticipation of trip protection
3	Removing Pin Type Insulator Cover on Phase R	• The lift man touches the conductor and there is a leak to the grounding and flash over	• Installation of local grounding • Coordination with the Distribution Control Area Unit in anticipation of trip protection
4	Unfasten the tie wire and move the conductor to the cross arm	• The lift man touches the conductor and there is a leak to the grounding and flash over • The conductor touches the cross arm and flashes over	• Installation of local grounding • Coordination with the Distribution Control Area Unit in anticipation of trip protection
5	Replacing the phase R pedestal insulator	• The lift man touches the conductor and there is a leak to the grounding and flash over	• Installation of local grounding • Coordination with the Distribution Control Area Unit in anticipation of trip protection
6	Returns the conductor to the insulator trench	• The lift man touches the conductor and there is a leak to the grounding and flash over • The conductor touches the cross arm and flashes over	• Installation of local grounding • Coordination with the Distribution Control Area Unit in anticipation of trip protection
7	Tie the conductor with tie wire	• The lift man touches the conductor and there is a leak to the grounding and flash over	• Installation of local grounding
8	Closing the R phase insulator with the Pin Type insulator cover	• The conductor touches the cross arm and flashes over	• Coordination with the Distribution Control Area Unit in anticipation of trip protection
9	Removing the conductor cover, insulator type pins on both sides and the insulating blanket on the cross arm and removing the no voltage detector	• The lift man touches the conductor and there is a leak to the grounding and flash over	• Installation of local grounding
10	Return of equipment and materials	The conductor touches the cross arm and flashes over	Coordination with the Distribution Control Area Unit in anticipation of trip protection

And the results of the identification of potential hazards / impacts and control of electricity hazards for the analysis of electricity safety in terms of environmental safety are as shown in table 4.

Tabel 4. Results of the Analysis of Electricity Safety for Environmental Safety in the Installation of R-Phase Insulator with Direct Touch Method

No	Job Steps	Potential Hazards to Environmental Safety	Control Measures
1	Preparation of Materials and Equipment	There is no potential hazards	There is no
2	Installing No Voltage Detector and Protector	There is no potential hazards	There is no
3	Removing Pin Type Insulator Cover on Phase R	There is no potential hazards	There is no
4	Unfasten the tie wire and move the conductor to the cross arm	There is no potential hazards	There is no
5	Replacing the phase R pedestal insulator	There is no potential hazards	There is no
6	Returns the conductor to the insulator trench	There is no potential hazards	There is no
7	Tie the conductor with tie wire	There is no potential hazards	There is no
8	Closing the R phase insulator with the Pin Type insulator cover	There is no potential hazards	There is no
9	Removing the conductor cover, insulator type pins on both sides and the insulating blanket on the cross arm and removing the no voltage detector	There is no potential hazards	There is no
10	Return of equipment and materials	There is no potential hazards	There is no

IV. CONCLUSION

Electrical safety in the process of replacing a pedestal insulator on a medium voltage grid pole in a high voltage state has a considerable potential hazard. Therefore, after analyzing and controlling control measures based on four classifications to the General Public, technical personnel who carry out the installation of pedestal isolators, installations and the environment, and it is found that the effect on environmental safety in the installation of pedestal isolators does not have a potential hazard to the environment. no control measures required.

After seeing the potential hazards that can occur and analysis for the control measures of these potential hazards, the recommended recommendation is the cooperation of all parties involved both from agencies, workers and the community where there is a need for socialization and education to understand the potential hazards that can occur and how to control them. potential hazards and for workers to comply with the Standard Operating Procedure latest, calibrated and complete personal protective equipment.

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Agus Yulianto, et. al. "Electricity Safety Analysis on the Process of Replacing Find Insulator in Medium Voltage Network Pole Under Voltage Conditions."*American Journal of Engineering Research (AJER)*, vol. 10(3), 2021, pp. 187-193.