Department of Electrical and Electronic Engineering (EEE)
Faculty of Engineering (FE)
American International University- Bangladesh (AIUB)

Laboratory Report

Power System Protection Laboratory

Section: D Semester: Summer 2020-21

Experiment No.: 01

Experiment Title: Familiarization with different kinds of Insulators, Fuses and Miniature circuit breakers.

Date of Experiment: 27-5-2021 **Date of Submission: 29-6-2021**

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Marking Rubrics for Laboratory Report (to be filled by Faculty)

Objectives	Unsatisfactory (1)	Good (2-3)	Excellent (4-5)	Marks
Experimental circuit diagrams with list of apparatus	Unable to specify necessary list of equipment and procedures	Able to partially specify necessary list of equipment and procedures	Able to fully specify necessary list of equipment and procedures	
Experimental Results	Very few measurements results are presented in this report.	The report presents only important experimental results.	All the required measurements are being taken during lab and indicated in the report.	
Simulation circuits with corresponding results	Simulation circuits and results are not included in this report properly.	Few simulation results are included in this report.	All the simulation circuits are included in this report with appropriate results.	
Comparison between experimental and simulation results	Cannot summarize or compare findings to expected results	Summarize finding in an incomplete way	Summarize finding in a complete & specific way	
Discussion/Report questions	Cannot reach meaningful conclusions from experimental data	Can extract most of the accurate data. Answers to the report questions are partially correct.	Can extract all relevant conclusion with appropriate answer to the report questions.	
Overall Report format	Report is not prepared as per the instruction.	Report format is satisfactory with few missing sections.	Report is prepared as per the instructions having all mandatory sections.	
Comments	Assessed by (Name, Sign, and Date)		Total (out of 30):	

Title: Familiarization with different kinds of Insulators, Fuses and Miniature circuit breakers.

Introduction: Electrical power system operates at various level ranging from 0.4KV to 400KV or even more electrical apparatus may be enclosed or open. For operating that equipment always need some protection device to protect. there might be various types of faults occur by operating those devices. To avoid those abnormalities for the safety of equipment's and human personnel which may be endangered due to exposure to live parts under faulty condition, protection systems are used. They either isolate the fault of de-energize the device.

Theory: The different types of insulators, fuses, miniature circuit breakers, lightning arresters are discussed in detail.

Insulator: An electrical insulator is a material in which electric current does not flow freely. The atoms of the insulator have tightly bound electrons which cannot readily move. Other materials, semiconductors and conductors conduct electric current more easily.

- Pin-type insulators
- Line post insulators
- Suspension insulators
- Strain insulators
- Shackle insulators
- Post insulators
- Cap and pin insulators
- Stay insulators

Pin-type insulators:

These insulators are used for the transmission and distribution of electric power at voltages up to 33 kV. A single-pin insulator is deployed to transmit voltages up to 11 kV but higher voltages require two-, three- or four-piece pin insulators. Pin-type insulators are secured with steel or lead bolts onto transmission poles and generally used for straight-running transmission lines. However, beyond voltages of 33 kV, these types of insulators become bulky and uneconomical.

Fig: Pin type Insulator

Line post insulators:

Line post insulators are used in medium voltage overhead distribution lines for the purpose of fixing conductors to tower bodies. They are used in distribution systems within cities and are commonly installed on metal, concrete and wooden structures to horizontally or vertically support line conductors. These insulators can also be used to support high voltage conductor jumpers or leads.

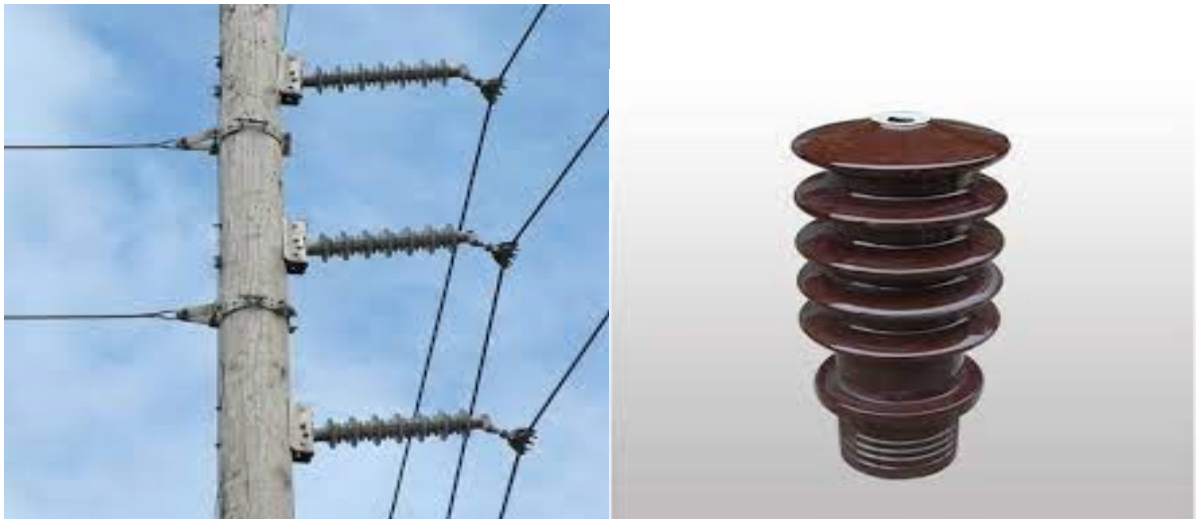

Fig: Line post insulators

Suspension insulators:

Suspension-type insulators, which consist of a number of porcelain discs connected by metal links in the form of a string, are deployed for higher voltages. The conductor is suspended at the bottom end of the string and the other end is secured to the cross-arm of the tower. Each unit or disc is designed for low voltage, usually 11 kV, and the appropriate number of discs, depending on the working voltage, are connected in a series. Suspension-type insulators are generally used with steel towers. As the conductors run below the earthed cross-arm of the tower, this arrangement provides partial protection from lightning.

Fig: Suspension insulators

Strain insulators:

These insulators are designed for handling mechanical stresses at angle positions where there is a change in the direction of the line or at the termination point of the line. In the case of high voltage lines that have longer spans and greater mechanical loading, suspension insulator strings are arranged in a horizontal position, and these are referred to as strain insulators. However, in situations when a single string is not sufficient for taking the load, two or more strings can be deployed in parallel for higher conductor tensions.

Fig: Strain insulators

Shackle insulators

Shackle or spool insulators are generally deployed in low voltage distribution networks, and can be used in horizontal or vertical positions. Like strain-type insulators, they are also deployed on sharp curves, end poles and section poles.

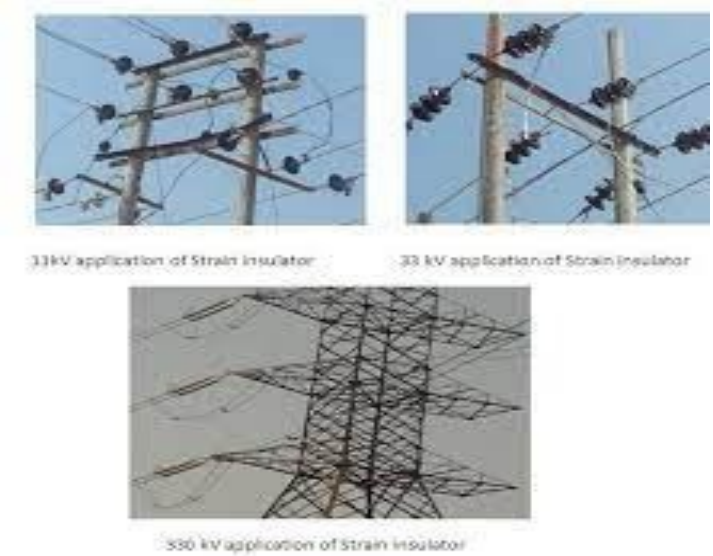

Fig: Shackle insulators

Post insulators:

Post insulators are similar to pin-type insulators but they are more suitable for higher voltage applications. These insulators can be mounted on supporting structures, both horizontally and vertically.

Fig: Post insulators

Cap and pin insulators:

Cap and pin insulators are generally deployed on overhead T&D lines to evacuate bulk power over long distances. They are also used for substation busbar high-level strained connections.

Fig: Cap and pin insulators

Stay insulators:

Stay insulators, also called egg insulators, are primarily used to prevent stay wires from getting energized from accidentally broken live wires. Hence, they function to provide insulation between stay clamps and transmission poles.

Fig: Stay insulators

Hollow insulators:

Hollow insulators are employed by substation equipment manufacturers to house post-type current transformers, voltage transformers, cable bushings, circuit breaker supports with central operating rods and interrupting chamber assemblies, isolator supports, etc. However, such insulators need to be of high mechanical strength as they are used in applications that are subject to sudden pressures, like circuit breakers or surge arresters.

Fig: Hollow insulators

Fuses: A fuse is an electric /electronic or mechanical device**,** which is used to protect circuits from over current, overload and make sure the protection of the circuit. The working principle of a fuse is based on the "Heating effect of Current" i.e., Whenever a short circuit, over current or mismatched load connection occurs, then the thin wire inside the fuse melts because of the heat generated by the heavy current flowing through it. Therefore, it disconnects the power supply from the connected system. In normal operation of the circuit, fuse wire is just a very low resistance component and does not affect the normal operation of the system connected to the power supply.

Fig: Fuse

Semi-enclosed or Re-wire able fuse: Semi-enclosed, rewireable fuses consist of a ceramic or plastic carrier that slots into the fuse board or consumer unit and suspends a strand of fuse wire between two screwed terminals. Turn all the power off at the consumer unit. Replace the fuse wire by loosening the two terminals and removing the old broken wires.

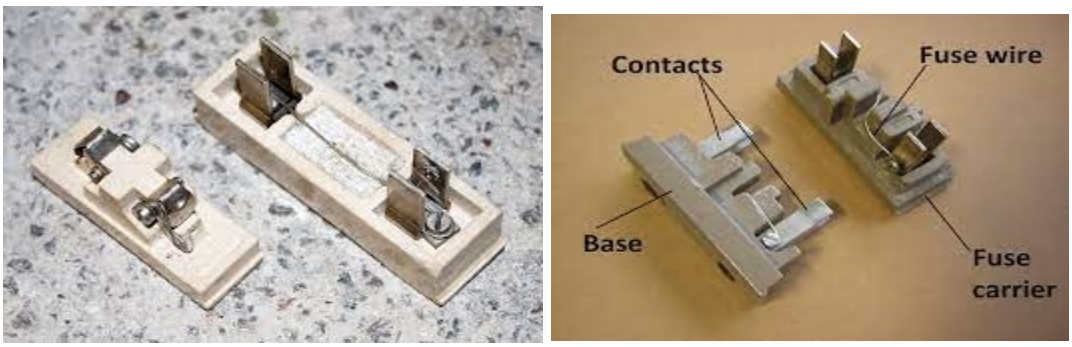

Fig: Re wire able fuse

Dropout fuse: Drop Out Fuses are protection devices that protect networks and equipment from current surges and overloads. An overcurrent will melt the fuse element in the carrier disconnecting the line or equipment. They also provide network isolation points when manually operated with a hot stick.

Fig: Dropout fuse

HRC (High Rupturing Capacity): HRC fuse is one kind of fuse, where the fuse wire carries a short circuit current in a set period. If the fault occurs in the circuit, then it blows off. The HRC fuse is made with glass otherwise some other kind of chemical compound.

Fig: HRC

Lightning Arrestor: A lightning arrester is a device used on electric power transmission and telecommunication systems to protect the insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrester has a high-voltage terminal and a ground terminal.

Fig: Lightning Arrestor

Miniature Circuit Breaker (MCB): A Miniature Circuit Breaker (MCB) is an automatically operated electrical switch used to protect low voltage electrical circuits from damage caused by excess current from an overload or short circuit. MCBs are typically rated up to a current up to 125 A, do not have adjustable trip characteristics, and can be thermal or thermal-magnetic in operation.

Fig: Miniature Circuit Breaker (MCB)

Report Question:

I. If we use PIN type insulator above 33 KV line
- Heavy weighted
- Too bulky
- Its size becomes large
- Costly and uneconomical

So, PIN type insulator is not used above 33 KV

II. In a fuse there have nothing but a thin wire. This wire cross section is depending on the current rating of the line. We know resistance is inversely proportional to the cross-section area. Fuse can protect the system from over load and short circuit current. We know heat is produce in conductor by the power les of I2R. So, the more current theow the fuse wires the more heat generate and after a certain time delay it could be burnt and the line will be disconnected. This is the time delayed operation of fuse.
On short circuit current, it could be the normal condition of current, it could be the normal condition of current and the system is protected from short circuit current.

III. Differences between MCB and CB:

MCB	CB
Miniature circuit breaker	Normal circuit breaker
It is used in LV system	It is used in HV system
Rupturing capacity is low	Rupturing capacity is high
Mechanism of MCB is tripping release	Mechanism of CB is tripping relay

Discussion: In this experiment, we have learnt all of the insulators, fuse and MCB. We saw all the equipment in the online demonstration and got the idea of their working theory. We also have the concept of low voltage insulators, fuses and fuse for high insulators. All the mages of the equipment are attached in report and some clarity is provided is this article. The aim of this experiment has been achieved.

Reference:

i) AIUB lab manual
ii) https://www.electricaltechnology.org/2014/11/fuse-types-of-fuses.html
iii) https://www.electroschematics.com/what-is-an-insulator/