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**A THESIS REPORT
ON
Study On Protection and Control System of Electrical Substation**

Submitted To

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This thesis has been submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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Approval Letter

This Project/internship titled “**Study On Protection and Control System of Electrical Substation**”, submitted by Md. Mostafa Kamal ID: 141-33-130 to the Department of Electrical & Electronic Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on July, 2019.

Board of Examiners:

Declaration

I thus declared this thesis based on the results found by myself. The work materials found by other researchers are referred to by reference. To achieve the degree, this thesis is submitted to Electrical and electronics engineering Department of Daffodil International University. This thesis has not been fully submitted for any degree prior to the degree.

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Abstract

An electrical substation is a helper station of a power age, transmission, and dispersal system where voltage is changed from high to low or the switch using transformers. At first, the substation was related to only one power station where the generator was housed and where reinforcements of that power station. A transmission substation interfaces at any rate two transmission lines and A transport substation move control from the transmission structure to the dispersal game plan of a region. The substation, generally, contains at any rate one transformers and have trading, protection, and control gear. The huge limit performed by a substation is trading which is the partner and disconnecting of the transmission line to the structure. Confirmation device shields the system from the astounding condition. The controlling system controls the substation by various sort of controlling contraptions, for instance, electrical switch, PFI, M/C, move and others controlling device.

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Chapter 1: Introduction

1.1 Introduction:

An electric substation is a power age, an inactive transmission station and the spreading frame where the voltage changes from high to low or transformer rendering, switch is an electrical age, transmission and movement bit. Layers change voltage from high to low or change, or play any other game within other complex boundaries. Within the created station and the client, electrical power can be found in different volumes of different voltage levels. A substation can be used to convert transformers into transit volts between voltage and low transmission voltages or to convert interconnections of two mixed transmission voltages.

An electric substation is an energy age, transmission, and division system which is an auxiliary station where the voltage changes from high to low or using transformer. Control and Protection System A subdivision, transmission, distribution of a public activity is expected to continue running properly.

First, the substation was related to only one power station where the generator was kept and where the power station was reinforced. In an event a control subdivision interface is removed from the control of two domain transition lines and a transport substrate transmission structure from a domain's isolated plan. Public, generally, is associated with a transformer and has trading, protection and control gear. The trading limit which is carried out by a substation is the trade and structure which is isolated in transmission lines. The system shields from the amazing status of the confirmation device. Controlling system controls the substriction by various types of control contracts, for example, electrical switch, PFI, M / C, transfer and other device controls.

Chapter 2: Substation

2.1 Electrical Substation:



Fig2.1: Electrical substation

An electric substation is a power age, transmission and distribution system assistant station where the voltage changes from high to low or using a transformer substation, the switch is an electrical age, a bit of infection and movement. Substations voltage changes from high to bottom or changes or changes to one of the other complex limitations. Within the created stations and the client, the electrical energy can be of course through a couple of different voltage levels. A substation transformer can combine to change the voltage level in the higher transmission voltage and low flow voltages or interconnections of two separate transmission voltages.

An electric substance is an energy age, transmission, and division system which is an auxiliary station where the voltage changes from high to low or using transformer. Controlling and protection systems continue to operate as a subjection, transmission, distribution, as expected, to continue a critical activity.

First, the substation was related to only one power station where the generator was kept and where the power station was reinforced. A transmission substrate transfers two transmission lines at a rate and a transport is always transferred from the structure of a domain to the division of a domain. The substation, generally, contains in any event one transformers and have trading, protection, and control gear. The critical limit performed by a substation is trading which is the partner and segregating of the transmission line tan electrical substation is an auxiliary station of a power age,

transmission, and movement structure where voltage is changed from high to low or the turnaround using transformers. Electric power may travel through a couple of substations between making a plant and client and may be changed in voltage in a couple of stages. A substation that has a phase up transformer extends the voltage while reducing the current, while a phase-down transformer decreases the voltage while growing the current for nearby and business allotment. The word substation begins from the days before the flow system transformed into a network. The principle substations were related with only one power station where the generator was housed and were assistants of that Power Station. The system. Affirmation device shields the structure from the amazing condition. The controlling system controls the substation by various sort of controlling devices, for instance, electrical switch, PFI, M/C, move and others controlling contraption.

2.2 Elements of a substation:

Substations all around contain on any occasion one transformers and have exchanged confirmation and control hardware. In a massive substation, circuit breakers are utilized to interfere with any short circuits or over-load streams that may happen on the system. More minor dispersal stations may utilize reclose circuit breakers or wires for affirmation of branch circuits. Substations don't (if all else fails) have generators, despite the manner in which that a power plant may have a substation close-by. A customary substation will contain line end structures, high voltage switchgear, in any occasion, one power transformers, low voltage switchgear, flood confirmation, controls, developing an (earthling) framework, and metering. Different gadgets, for example, control factor revision capacitors and voltage controllers may in like way be orchestrated at a substation.

Substations might be remotely in fenced seclude locales, underground, or organized explicitly reason structures. Raised structures may have indoor substations. Indoor substations are generally found in urban locales to reduce the change from the transformers, for reasons of appearance, or to shield switchgear from the preposterous condition or sully conditions.

Where a substation has a metallic fence, it must be fittingly grounded (UK: earthed) to shield individuals from high voltages that may happen during a deficiency in the transmission framework. Earth issues at a substation can cause ground potential move at the flaw an area. Streams spilling on the planet's surface during an issue can make metal things have an overall unexpected voltage conversely with the ground under an individual's feet; this touch potential shows the danger of electric paralyze.

2.3 Transmission substation:

No rate of transmission in an infection relates to two transmission lines. In most cases all transmission lines have a comparable voltage. In this case, the substance consists of a high-voltage switch that separates the lines for related or maintenance. A transmission station can be transformed into two transmission voltages or tools, for example, directly organize the ability.

Transmission elements can go from simple to complex. Despite the circuit breaks of some "circuit stations", the car can be incomplete in spite of some circuit breaks. Most transmission elements can contain a variety of voltage levels and a giant area (some parts of land / hectares) with confirmation and control gear (capacitor, rice, switch, breaker, voltage and current transformer).

2.4 Distribution substation:



Fig2.2: Distribution substation

A transportation subscription in Canada's Scarborough, Ontario, Canada is a home-like disguised, garage, walk-in front and a profit in front of the greenhouse and the fountain. A notice undeniably seen "front gateway"

A Transportation Subscription Transmission Structure to move from control to the action division of a region. It is highly unlikely to use a great deal to off-off high-voltage-needed transmission control computing interface to control clients; Therefore, for mortgages of the catch-masked station, the mortgage reduces the value of a standard, which is a split of devotion for the sake of travel, usually on either occasion, in two transmissions or sub-transmission lines. Data voltage may be for example, 115 KV, or whatever the basic of the zones. The yield is different feeders.

The transferred voltage is usually based on the medium voltage position, position of 2.4 and 33 KV degree and the distribution of zone utility groups.

On the street side street (or in a city, down the street) feeders and at the end of time the client controls the scattering transformers on or near the premises. In addition to changing the voltage, the flow subservation function limits the flaws in the transmission or distribution systems. Prolonged circuits (several kilometers / mile), despite the voltage regulation line can be presented along the line, may have the motivation behind voltage regulation of the spreading material.

2.5 Layout of a substation:



Fig2.3: Tottenham Substation set in wild parkland in North London

The underlying layer of a substation configuration orchestration is a linear film arrangement that shows a trading and confirmation strategy, line of supply, and unchanged framework for dynamic feeders or transmission lines. Through a variety of electrical utilities, this is a common practice station to create a single line outline with titles (lines, switches, circuit breakers, and transformers).

Moving towards the line is a refinement switch frequently and has an electric switch. At the ceremony, the line will not have both; All that can be seen with a switch or an electric switch. A qualification change is used to give isolation because it cannot be weighted at present. An electrical switch is used as a protection contraption to meddle with inadequacy streams normally and may be used to turn stacks on and off. Where a colossal defect flow courses through the electrical switch this may be perceived utilizing stream transformers. Countless the present transformer yields may be used to 'trip' the electrical switch realizing a unit of the load given by the electrical change from the continuing point. This hopes to separate the weakness point from the rest of the structure and empower the rest of the system to continue working with inconsequential impact. The two switches

and circuit breakers may be worked locally (inside the substation) or remotely from a supervisory control center.

Chapter 3: Switchgear

3.1 Switchgear:

The term switchgear, used in association with the electric power structure, or system, insinuates the mix of electrical isolates, wires or possibly circuit breakers used to withdraw electrical apparatus. Switchgear is used both to de-engage apparatus to empower work to be done and to clear accuse downstream.



Fig3.1:High voltage switchgear



Fig3.2: A section of a large switchgear panel, in this case, used to control on-board casino boat power generation.



Fig3.3: Hybrid switchgear

The most dependable central power stations used direct open cutting edge switches, mounted on securing sheets of marble or asbestos. Power levels and voltages immediately raised, making open physically worked changes too hazardous to even consider evening consider utilizing for something other than separation of a de-strengthened circuit. Oil-filled apparatus allowed round fragment imperativeness to be contained and safely controlled. By the mid-twentieth century, a switchgear line-up would be a metal-encased structure with electrically-worked trading parts, using oil circuit breakers. Today, oil-filled rigging has for the most part been displaced by means of air-effect, vacuum, or SF₆ equipment, allowing huge streams and power levels to be safely compelled through customized apparatus uniting automated controls, affirmation, metering, and exchanges.

3.2 Switchgear in Substations:

Consistently switchgear in substations is arranged on both the high voltage and the low voltage side of gigantic power transformers. The switchgear arranged on the low voltage side of the transformers in assignment type substations by and by is generally arranged in what is known as a Power Distribution Center (PDC). Inside this structure are normally more diminutive, medium-voltage (~15kV) circuit breakers continuing the transport system. Furthermore, contained inside these

Power Control Centers are various exchanges, meters, and other correspondence equipment mulling over keen control of the substation.

For mechanical applications, a transformer and switchgear line-up may be participated in one cabin, called a unit substation.

3.3 Functions of switchgear:

A confirmation among the central elements of switchgear, which is the barrier to short-circuiting and overloaded loaded transmission streams while running the organization in irrelevant circuits. Switchby creates obstacles in circuits from power supply. Switcher is used to rebuild the system by empowering multiple sources to sustain another store.

Chapter 4: Transformer

4.1 Transformer:

A transistor is a compression that starts with a circuit and is then connected through electrical connectors. The main circuit makes a variable current (basic) a variable alluring field. The next circuit of this variable detection field (intelligent) is starting a variable voltage. This effect is called confession of shares.

If a heap is related to the consideration circuit, an electric charge will flush the booster in front of the transformer and then remove the essentiality starting with a circuit. Based on a standard transformer's voltage VS, it is scaled from a basic VP with the amount of wire bends in its specific winding:

With reasonable assurance of change amounts, a transformer enables to keep a pivting voltage in motion - making it more than NP - or lessening it. Transformers are the best electric machines without any doubt, an immense unit ready to move 99.75% of their production data efficiency. Transformers measure a ton of transplus-coupling transformers, measuring a ton of tons used to attach parts of the national energy to large units protected in a power speaker. Regardless of the size of the structure, all the work is done with relatively central models.



Fig4.1: Three-phase pole-mounted step-down transformer

4.2 Basic principles:

The transformer relies upon two norms: directly off the bat, that an electric stream can convey an appealing field (electromagnetism) what's more that, a changing alluring field inside a twist of wire

activates a voltage over the completion of the circle (electromagnetic acknowledgment). By changing the current in the basic circle, it changes the nature of its appealing field; since the changing alluring field connects into the discretionary twist, a voltage is induced over the assistant flawless development down transformer showing appealing movement in the middle. Improved transformer design appears to the other side. A present experiencing the fundamental circle makes an appealing field. The fundamental and discretionary circles are collapsed over a focal point of uncommonly high alluring permeability, for instance, iron; this ensures an enormous bit of the appealing field lines conveyed by the basic current is inside the iron and experience the helper twist similarly as the basic circle.

4.3 Ideal power equation:

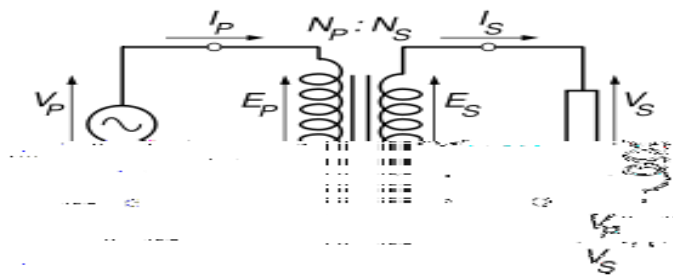


Fig4.2: The ideal transformer as a circuit element

If the second coil is connected to the load which lets the current flow flow, the electric circuit is passed from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; All incoming energy is converted into magnetic fields and secondary circuits from primary circuits. When this condition is met, the incoming electrical power is equal to getting outgoing.

$$P_{\text{incoming}} = I_P V_P = P_{\text{outgoing}} = I_S V_S$$

Giving the ideal transformer equation

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$

giving the ideal transformer equation

If the voltage is increased ($V_S > V_P$), then the current factor is reduced by the same factor (bottom step) ($I_S < I_P$). Transformers are skilled so this formula is a reasonable approximation. The obstruction of one circuit is changed by the square of the horizontal. For example, if there is an obstruction on the zodiac loop terminals, then it seems to be an essential circuit for the interference of this relationship, the target is that the ZP of the necessary circuits seems to be optional.

4.4 Detailed operation:

The above consistent illustrations reject those reasonable references to reasonable, obviously, the fundamental presentations required for the development of an alluring field in the middle and the duties of the field for the present due to the consideration circuit. A standard transformer model typically expects the central point of the opposite reverse with two ventilations, except for zero interruptions. On the right when the voltage is connected to the basic air, little current streams are progressing near the greedy circuits in the interior. To change, current current polarizing current is named; Since the ideal focus depends on zero reversal, charging is irregular, but still need to create an interesting field. Variable striking fields instigates an electromotive power (EMF) on each winding. Since there is no barrier to perfect winding, they do not have any associated voltage drop, thus, approximately equivalent VP and VS voltages in transformer terminals are equal to EMF. The essential EMF, which is running against the essential voltage, is often referred to as "back eMF". For this reason, the law of lencing reveals that the acceptance of the IMF will be reliably with the final goal that it will contribute to the development of an attractive field.

4.5 Practical considerations:

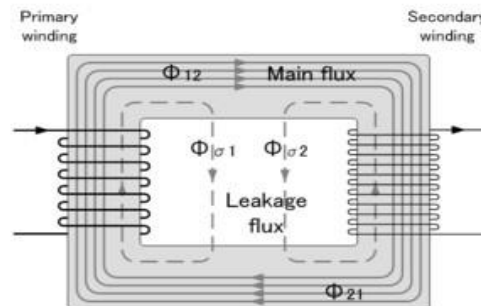


Fig4.3: Leakage flux of a transformer

The perfect transformer model hopes to connect every turn of each turn with all the speed created by the necessary speed connections. Actually speaking, some speed navigates the way that windings go out. [9] This transition is known as spelage speed and generally results in spell-inductance results in composite transformer winding. [8] Leakage results in electricity and then released from the electricity supply area. This is simply not a power lag (see "misfortunes," below), but as a result of the low voltage guidelines, the negligence of the auxiliary voltage is particularly heavily loaded in relation to the validity. [9] Generally low spillage according to the transformer is intended for loyalty purposes.

4.6 Energy losses:

A perfect transformer will be a lucky misadventure and 100% will be productive. Among the Commons transformers, the lamp is spread over winding, center, and integrated structures. Larger transformers are usually productive, and those who evaluate electricity for transport, they are more effective than 98% of a rule. Transformers analyzing supercomputing winding of 99.85% skillful, while exponentially unfortunate, the expansion of expertise in the annual investment funding with the large number of stacked transformers is slightly notable. Misfortune of the transformers is undoubtedly broken down in the name of unfortunate weakness and interesting circuits called iron misery. Transformers are unfortunate:

Winding resistance

Current flowing through the windings causes resistive warming of the conductors. At higher frequencies, skin impact and nearness impact make extra winding opposition and misfortunes.

Hysteresis losses

Each time the attractive field is turned around, a modest quantity of vitality is lost because of hysteresis inside the center. For a given center material, the misfortune is relative to the recurrence and is a component of the pinnacle motion thickness to which it is subjected. [17]

Eddy currents

Ferromagnetic materials are likewise great conductors, and a strong center produced using such a material additionally establishes a solitary short-circuited turn all through its whole length. Vortex flows, along these lines, a circle inside the center in a plane ordinary to the transition and are in

charge of resistive warming of the center material. The vortex current misfortune is an unpredictable capacity of the square of supply recurrence and the backward square of the material thickness. [17]

Magnetostriction

Attractive transition in a ferromagnetic material, for example, the center, makes it physically extend and contract somewhat with each cycle of the attractive field, an impact known as magnetostriction. This delivers the humming sound generally connected with transformers, [5] and thus, causes misfortunes because of frictional warming in powerless centers.

Mechanical losses

In addition to magnetic synthesis, the alternative magnetic field creates disadvantages of electromagnetic forces between primary and secondary windings. These brilliant vibrations in this metallic metal, add buzzing words, and eat the energy of a small amount.

Stray losses

The leakage itself is damaged, because the energy supplied by its magnetic field supplies the next half-cycle. However, any leakage flak eddy curve that prevents the nearby conveyor material such as the transformer's support framework will increase and the heat will be converted.

4.7 Autotransformer:



Fig4.4:Main article: Autotransformer

An autotransformer has only a singular winding with two end terminals, notwithstanding a third at a transitional tap point. The fundamental voltage is associated transversely more than two of the

terminals, and the discretionary voltage is taken from one of these and the third terminal. The fundamental and helper circuits, consequently, share different windings turns for all intents and purpose. [21] Since the volts-per-turn is the equal in the two windings, every development a voltage in the degree to its number of turns. An adaptable autotransformer is made by revealing some bit of the winding twists and making the assistant relationship through a sliding brush, giving a variable turns extent.

4.7.1 Instrument transformers:



Fig4.5: Current transformers, designed to be looped around conductors

A present transformer is an estimation device proposed to give current in its discretionary circle with respect to the present spilling in its quintessence. Current transformers are conventionally used in metering and protective giving off, where they support the shielded estimation of tremendous streams. The present transformer limits estimation and control equipment from the high voltages routinely presents on the circuit being evaluated.

4.8 Windings:

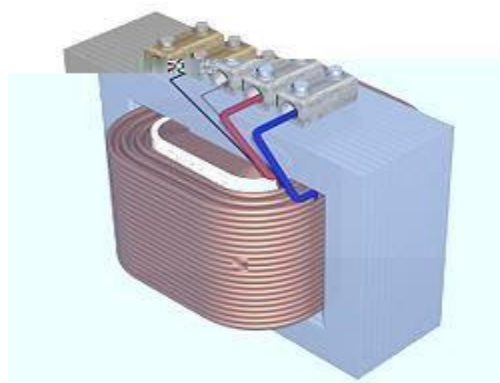


Fig4.8: Windings are usually arranged concentrically to minimize flux leakage

Slice see through transformer windings. White: encasing. Green winding: Grain situated silicon steel. Dark: Primary twisting made of without oxygen copper. Red: Secondary winding. Upper left: Toroidal transformer. Right: C-center, however, E-center would be comparable. The dark windings are made of film. Top: Equally low capacitance between all finishes of the two windings. Since most centers are in any event tolerably conductive they additionally need protection. Base: Lowest capacitance for one finish of the optional twisting required for low-control high-voltage transformers. Base left: Reduction of spillage inductance would prompt increment of capacitance.

High-recurrence transformers working during the tens to several kilohertz regularly have windings made of meshed Litz wire to limit the skin-impact and closeness impact misfortunes. Huge power transformers utilize various stranded conductors too since even at low power frequencies non-uniform appropriation of current would somehow or another exist in high-current windings. Each strand is independently protected, and the strands are organized so that at specific focuses in the twisting, or all through the entire twisting, each segment possesses diverse relative positions in the total conductor. The transposition levels the present streaming in each strand of the conductor and diminishes swirl current misfortunes in the winding itself. The stranded conductor is likewise more adaptable than a strong conductor of comparable size, supporting assembling.

For sign transformers, the windings might be orchestrated in a manner to limit spillage inductance and stray capacitance to improve high-recurrence reaction. This should be possible by part up to each loop into segments, and those areas put in layers between the segments of the other winding.

This is known as a stacked sort or interleaved winding.



Fig4.8.1: Three-phase oil-cooled transformer with cover cut away. The oil reservoir is visible at the top.

Radiative fins aid the dissipation of heat.

Chapter 5: PROTECTION DEVICE FUSE (ELECTRICAL)

5.1 Fuse (electrical):



Fig5.1: 200A Industrial fuse. 80 kA breaking capacity

In gadgets and electrical designing, a breaker (short for fusible connection) is a sort of overcurrent security gadget. Its fundamental part is a metal wire or strip that melts when such a large number of current streams, which breaks the circuit wherein it is associated, along these lines shielding the circuit's different segments from harm because of intemperate current. A useful wire was one of the basic highlights of Thomas Edison's electrical power circulation framework. Circuits (and other overcurrent gadgets) are a basic piece of a power dissemination framework to counteract fire or harm. At the point when a lot of current courses through a wire, it might overheat and be harmed or even begin a flame. Wiring guidelines give the most extreme rating of wire for assurance of a specific circuit. Neighborhood experts will join national wiring guidelines as a feature of the law. Wires are chosen to permit entry of typical flows yet to rapidly intrude on a short out or over-burden condition.

5.2 Lucas type fuses:

Lucas type circuits are utilized in old English made or collected autos. The physical length of this kind of breaker is either 1" or 1.25" with cone-shaped finishes. Lucas type intertwines as a rule utilize a similar shading coding for the appraised current. Lucas circuits have three evaluations; the

nonstop present they are intended to convey, the momentary current at which they will combine, and the ceaseless current at which they will intertwine too. The figure found on Lucas breakers is the consistent melting current which is double the ceaseless amp rating that the framework ought to utilize; this can be a wellspring of disarray when supplanting Lucas wires with non-Lucas wires.

5.3 Markings:



Fig5.2: A sample of the many markings that can be found on a fuse.

Surface Mount Breakers on 8 mm tape. Each wire estimates 1.6 mm x 0.79 mm and has no markings. Most breakers are set apart on the body, or end tops to markings demonstrate their evaluations. Surface mount innovation "chip type" wires include practically no markings making distinguishing proof troublesome.

When supplanting a circuit, it is essential to translate these markings effectively as breakers that may appear to be identical, could be intended for altogether different applications. Breaker markings. Will for the most part pass on the accompanying data;

Ampere rating of the fuse

- Voltage rating of the fuse
- Time-current characteristic ie. element speed
- Approvals
- Manufacturer / Part Number / Series
- Breaking capacity

5.4 Bosch type:

Bosch type fuse (used in older cars) Bosch type fuse is used in older (often European) automobiles. Physical dimensions of this type include the 6x25 mm cone end. Bosch type fuse generally use the same color coding for rated current. DIN value 72581/1

Color	Ampere
Yellow	5A
White	8A
Red	16A
Blue	25A

5.5.1 High voltage fuses:

Wires are used on power structures up to 115,000 volts air conditioning. High-voltage wires are used to verify instrument transformers used for power metering, or for little power transformers where the expense of an electrical switch isn't legitimized. For example, in assignment structures, a power breaker may be used to guarantee a transformer serving 1-3 houses. An electrical switch at 115 kV may cost up to fivefold the measure of as a lot of force wires, so the ensuing saving can be an enormous number of dollars. Shaft mounted scattering transformers are about continually guaranteed by a fusible example, which can have the breaker segment displaced using live-line bolster instruments.

Tremendous power wires use fusible segments made of silver, copper or tin to give unfaltering and obvious execution. High voltage launch wires envelop the fusible association with gas-creating substances, for instance, boric destructive. Right when the breaker blows, heat from the bend causes the boric destructive to create gigantic volumes of gases. The related high weight (routinely more noticeable than 100 atmospheres) and cooling gases rapidly drench (stifle) the resulting twist. The hot gases are then hazardously expelled out of the end(s) of the breaker. Another one of a kind High Cracking Limit (HRC) wires envelop at any rate one parallel related fusible associations with an imperativeness holding material, consistently silicon dioxide sand. Right when the fusible association blows, the sand acclimatizes essentialness from the round portion, rapidly stifling it, making a fake fulgurate at the same time.

5.5.2 British plug fuse:



Fig5.5.2: 20 mm 200 ma glass cartridge fuse used inside equipment and 1 inch 13 A ceramic British plug fuse.

The BS 1363 13 A attachment has a BS 1362 cartridge inside. This permits the utilization of 30 A/32 A (30 A was the first size; 32 A is the nearest European orchestrated size) attachment circuits securely. So as to keep link sizes sensible, these are normally wired in ring mains. It additionally gives better insurance to little machines with meager flex as an assortment of circuit evaluations (1 A, 2 A, 3 A, 5 A, 7 A, 10 A 13 A with 3, 5 and 13 being the most widely recognized) are accessible and a reasonable wire ought to be fitted to permit the ordinary working current while securing the apparatus and its rope just as conceivable. With certain heaps, it is entirely expected to utilize a somewhat higher appraised intertwine than the typical working current. For instance, on 500 W halogen floodlights, it is entirely expected to utilize a 5 A breaker despite the fact that a 3 A would convey the ordinary working current. This is on the grounds that incandescent lamps draw a huge flood of current at switch on as their chilly obstruction is far lower than their opposition at working temperature.

In most other wiring rehearses, the wires in an adaptable string are viewed as ensured by the branch circuit over the present gadget, typically appraised at around 15 amperes, so an attachment mounted breaker isn't utilized. Little electronic mechanical assembly frequently incorporates a circuit holder on or in the gear, to ensure inward parts as it were.

5.5.3 Thermal fuses:

A "warm circuit" is routinely found in purchaser gear, for instance, coffee makers or hair dryers or transformers driving little customer contraptions. They contain a fusible, temperature unstable compound which holds a spring contact instrument commonly shut. Exactly when the enveloping temperature gets unnecessarily high, the amalgam disintegrates and allows the spring contact instrument to break the circuit. The contraption can be used to prevent a fire in a hair dryer for example, by evacuating the power supply to the radiator segments when the breeze stream is meddled (for instance the blower motor stops or the air confirmation ends up being incidentally blocked). Warm wires are a 'one-shot', non-reset table device which must be displaced once they have been started.

Chapter 6: Lightning Rod

6.1 Lightning Rod:

A lightning bar (USA) or lightning conductor (UK) is a solitary part in a lightning assurance framework. Notwithstanding poles set at standard interims on the most noteworthy parts of a structure, a lightning assurance framework ordinarily incorporates a housetop system of transmitters, different conductive ways from the rooftop to the ground, holding associations with metallic articles inside the structure and an establishing system. The real housetop lightning pole is a metal strip or bar, normally of copper or aluminum. Lightning assurance frameworks are introduced on structures, trees, landmarks, connects, and even water vessels to shield from lightning harm. Singular lightning poles are now and then called finials, air terminals or strike end gadgets. The US Patent Office names "Lightning defenders" in Class 174 (Power: conductors and separators), Subclass 2 (Lightning defenders) and Subclass 3 (Bars).

6.2 Structure protectors:



Fig6.1: An example of a standard, pointed-tip air terminal

Scene appropriate for motivation behind clarification Speaks to Master Kelvin's "decreased" territory of the locale; Surface concentric with the Earth to such an extent that the amounts put away over it and under it are equivalent; Expanding on a site of intemperate electrostatic charge thickness; Expanding on a site of low electrostatic charge thickness.

6.3 Lightning diversion:

Traditional lightning poles are associated by means of a low-obstruction wire or link to the earth or water beneath, where the charge might be securely dispersed. Preoccupation is a misnomer; present day frameworks block the charge that ends on a structure and conveys it to the ground. The redirection hypothesis expresses that the lightning bar ensures a structure absolutely on the grounds

that it is grounded, and subsequently a lightning strike that happens to connect to the defender will be occupied around the structure and "earthed" through an establishing link or conductor. There is some vulnerability with respect to why a lightning strike may specially connect to a lightning defender; the main supposition that will be that the air close to the defender winds up ionized and along these lines conductive because of the extreme electric field. Different producers make these cases.

6.4 Lightning arresters:

In telecommunication and communication, a lightning arrester is set where wires enter a structure, averting harm to electronic instruments inside and guaranteeing the wellbeing of people close them. Lightning arresters likewise called flood defenders are gadgets that are associated between each electrical conduit in a power and correspondences frameworks and the Earth. These give a short out to the ground that is hindered by a non-conductor, over which lightning bounces. Its motivation is to confine the ascent in voltage when correspondence or electrical cable is struck by lightning.

6.5 Electric power system lightning protection:

High-pressure electrical cables convey a lighter conduit (some of the time called a 'pilot' or 'shield') wire over the fundamental power conveyors. This conductor is grounded at different focuses alongside the connection or protected from the pinnacle structures by little covers that are effectively bounced by lightning voltages. The last permits the pilot wire to be utilized for correspondences purposes, or to convey current for airplane leeway lights.

Electrical substations may have a snare of grounded wires covering the entire plant.

6.6 Lightning conductors and grounding precautions:



Fig6.2: Example of a grounding system that failed during a lightning strike resulting in a fire.

In a perfect world, the underground piece of the get together ought to dwell in a zone of high ground conductivity. On the off chance that the underground link can oppose consumption well, it tends to be shrouded in salt to improve its electrical association with the ground. While the electrical opposition of the lightning conveyor between the air terminal and the Earth is unsettling, the inductive reactance of the conduit could be progressively significant. Hence, the down conductor course is kept short, and any bends have an enormous range. On the off chance that these measures are not taken, lightning current may bend over an impediment, resistive or responsive, that it experiences in the conductor. At any rate, the circular segment current will harm the lightning transmitter and can without much of a stretch locate another conductive way, for example, building wiring or pipes and cause fires or different calamities. Establishing frameworks without low resistively to the ground can in any case be successful in shielding a structure from lightning harm. At the point when ground soil has poor conductivity, is exceptionally shallow, or nonexistent, an establishing framework can be increased by including ground bars, counterpoise (ground ring) conductor, or potentially link radials anticipating far from the structure. These increases, while still not diminishing the opposition of the framework in certain cases, will permit the dissemination of the lightning into the earth without harm to the structure.

6.7 Lightning protection system:

A lightning assurance framework is a framework that shields a structure from harm because of lightning strikes, either through securely leading the strike to the ground, or keeping the structure from being struck. Most lightning security frameworks are made out of a system of lightning bars, metallic link conduits, and ground anodes intended to give a low impedance way to the lightning to go through towards the ground.

6.8 Grounding Electrodes:

Legitimate establishing of a lightning insurance framework is basic for the security of a structure. Inability to give adequate establishing could result in the harm or loss of property and lives. The most well-known techniques for establishing a lightning security framework incorporate ground poles, ground plates, Ufer grounds or a ground ring (counterpoise).[12] In poor establishing conditions, for example, rough soil or shallow topsoil, extra establishing measures ought to be taken to guarantee satisfactory establishing for the framework.

6.9 Radioactive Rod Systems:

Radioactive pole frameworks' principle separating highlight from conventional Franklin type frameworks is the utilization of radioactive materials in the lightning bars. The hypothesis behind this is the radioactive properties of the bars can ionize the air around the pole adequately to improve the probability of that pole being struck, as opposed to the structure itself. This, as a result, would expand the zone of insurance given by the lightning pole. Lamentably, the viability of radioactive lightning has been demonstrated to be not as much as that of normal lightning poles as the radioactive materials are just ready to ionize the air around the lightning pole for a short separation that doesn't emphatically influence the opportunity of being struck.

Chapter 7: Control System (Circuit Breaker)

7.1 Circuit breaker:

The prologue to this article may not enough outline its substance. To conform to Wikipedia's lead segment rules, it ought to be extended to give an open review of the article's key focuses.



Fig7.1: Two pole miniature circuit breaker

An electrical switch is a thusly worked electrical change proposed to shield an electrical circuit from damage achieved by over-weight or short out. Rather than a wire, which works once and a while later should be replaced, an electrical switch can be reset (either physically or subsequently) to proceed with the run of the mill action. Circuit breakers are made in varying sizes, from little contraptions that guarantee an individual nuclear family machine up to enormous switchgear expected to verify high voltage circuits empowering an entire city.

An early sort of electrical switch was delineated by Edison in an 1879 patent application, in spite of the way that his business control allocation system used wires. [1] Its inspiration was to shield lighting circuit wiring from accidental short circuits and over-loads.

7.2 Operation:

All circuit breakers have normal highlights in their activity, in spite of the fact that subtleties shift significantly relying upon the voltage class, current rating, and kind of the electrical switch.

The electrical switch must identify a deficiency condition; in low-voltage circuit breakers, this is typically done inside the breaker nook. Circuit breakers for huge flows or high voltages are generally organized with

pilot gadgets to detect a deficiency current and to work the trek opening component. The trek solenoid that discharges the lock is generally invigorated by a different battery, albeit some high-voltage circuit breakers are independent with current transformers, security transfers, and an interior control power source.

The electrical switch contacts must convey the heap flow without over the top warming, and should likewise withstand the warmth of the bend delivered when interfering with the circuit. Contacts are made of copper or copper compounds, silver combinations, and different materials. Administration life of the contacts is constrained by the disintegration due to interfering with the circular segment. Smaller than expected circuit breakers are generally disposed of when the contacts are worn, however, power circuit breakers and high-voltage circuit breakers have replaceable contacts.

7.3 Types of circuit breaker:



Fig7.3: Front board of a 1250 An air electrical switch made by ABB.

This low voltage power electrical switch can be pulled back from its lodging for adjusting. Outing attributes are configurable by means of Plunge switches on the front board. A wide range of groupings of circuit breakers can be made, in view of their highlights, for example, voltage class, development type, interfering with sort, and basic highlights.

7.4 Low voltage circuit breakers:

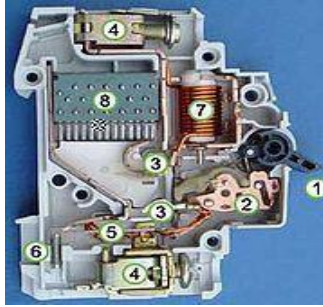


Fig7.4: Photo of inside of a circuit breaker

Low voltage (less than 1000V AC) types are common in domestic, commercial and industrial application, include:

- MCB (Small Circuit Breaker) - Not more than 100 degrees above current. Trip features are usually not regular. Thermal or heat-magnetic operation. The above mentioned breakers are in this category.
- MCCB (Sloping Case Circuit Breaker) - up to 1000 current temperature or heat-magnetic operation. The trip can last longer in the greater rating.
- Low voltage power circuit breakers can be mounted on LV switchboards or multi-layers of switch cabinets.

7.5 Magnetic circuit breaker:

Attractive circuit breakers utilize a solenoid (electromagnet) whose pulling power increments with the current. The electrical switch contacts are held shut by a hook. As the current in the solenoid increments past the rating of the electrical switch, the solenoid's force discharges the hook which at that point enables the contacts to open by spring activity. A few sorts of attractive breakers fuse a pressure driven time to defer highlight utilizing a gooey liquid. The center is limited by a spring until the current surpasses the breaker rating. During an over-burden, the speed of the solenoid movement is confined by the liquid. The postpone licenses brief current floods past typical running current for engine turning over, empowering hardware, and so forth. Short outflows give adequate solenoid power to discharge the lock paying little respect to center position subsequently bypassing the postpone include. Encompassing temperature influences the time delay, however, does not influence the present rating of an attractive breaker.

7.6 Common trip breakers:



Fig7.5: Three pole common trip breaker for supplying a three-phase device.

When providing a branch circuit with more than one live conductor, each live conductor must be secured by a breaker shaft. To guarantee that every single live conductor is hindered when any post trips, a "typical trek" breaker must be utilized. These may either contain a few stumbling instruments inside one case or for little breakers, may remotely integrate the posts by means of their working handles. Two shaft regular excursion breakers are normal on 120/240 volt frameworks where 240-volt loads (counting significant apparatuses or further circulation sheets) range the two live wires. Three-shaft normal trek breakers are regularly used to supply three-stage electric capacity to huge engines or further appropriation sheets.

7.7 Medium-voltage circuit breakers:

Medium-voltage circuit breakers appraised somewhere in the range of 1 and 72 kV might be collected into metal-encased switchgear line ups for indoor use or might be singular segments introduced outside in a substation. Medium-voltage circuit breakers can be ordered by the medium used to quench the curve:

- ➔ Vacuum electrical switch—With evaluated flow up to 3000 A, these breakers intrude on the flow by making and smothering the circular segment in a vacuum holder. These must be essentially connected for voltages up to around 35,000 V, which compares generally to the medium-voltage scope of intensity frameworks. Vacuum circuit breakers will, in general, have longer futures between update than do air circuit breakers.
- ➔ Air electrical switch—Appraised flow up to 10,000 A. Trek qualities are regularly completely customizable including configurable outing limits and deferrals. Typically, electronically controlled, however, a few models are chip controlled by means of a basic electronic trek unit. Frequently utilized for fundamental control appropriation in an enormous mechanical plant, where

the breakers are masterminded in draw-out fenced in areas for simplicity of the support. SF6 circuit breakers quench the circular segment in a chamber loaded up with sulfur hexafluoride gas.

Medium-voltage circuit breakers might be associated into the circuit by catapulted associations with transport bars or wires, particularly in open air switchyards. Medium-voltage circuit breakers in switchgear line-ups are regularly worked with drawn-out development, enabling the breaker to be evacuated without aggravating the power circuit associations, utilizing an engine worked or hand-turned system to isolate the breaker from its walled in area.

7.8 High-voltage circuit breakers:



Fig7.8: 400kV SF6 circuit breakers

Electric power transmission system is confirmed and limited by high-voltage breakers. The meaning of "high voltage" change is usually indicated by the ongoing Global Electro Specialist Commission (IEC), while electricity transmission is generally considered to be 72,500 V or higher. High voltage breaker works reliably solenoid-working, current identification protective transfer through current transformer. The insurance transfer plan in divisions can be confusing, protects the hardware, and can relocate from various types of additional burden or ground / soil problems.

High-voltage breakers are comprehensively ordered by the medium used to douse the circular segment.

- Bulk oil
- Minimum oil
- Air blast
- SF₆

Some of the manufacturers are ABB, AREVA, Cutler-Hammer (Eaton), Siemens, Toshiba, Schneider Electric and others.

Chapter 8: Switch

8.1 Switch:

The change is alluded to as a "door" when disconnected to the scientific structure. In the way of thinking of rationale, operational contentions are spoken to as rationale entryways. The utilization of electronic doors to capacity like an arrangement of rationale entryways is the major reason for the PC—for example, a PC is an arrangement of electronic switches which capacity as rationale doors.



Fig8.1: Three tactile switches. Major scale is inches.

8.2 Contacts

An electrical switch is a thusly worked electrical change expected to shield an electrical circuit from mischief realized by over-weight or short out. As opposed to a wire, which works once and subsequently should be replaced, an electrical switch can be reset (either physically or therefore) to proceed with the run of the mill movement. Circuit breakers are made in contrasting sizes, from little devices that guarantee an individual nuclear family machine up to tremendous switchgear planned to verify high voltage circuits empowering an entire city. An early sort of electrical switch was delineated by Edison in a 1879 patent application, in spite of the way that his business control allotment system used wires. [1] Its inspiration was to shield lighting circuit wiring from coincidental short-circuits and over-loads.



Fig8.2: A toggle switch in the "on" position.

Chapter 9: Relay

9.1 Relay:

A transfer is an electrical switch that opens and closes under the control of another electrical circuit. In the first structure, the switch is worked by an electromagnet to open or close one or numerous arrangements of contacts. It was created by Joseph Henry in 1835. Since a hand-off can control a yield circuit of higher power than the info circuit, it very well may be viewed as, in an expansive sense, a type of an electrical speaker

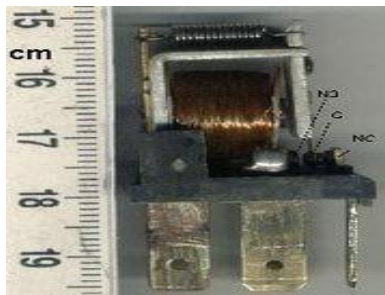


Fig9.1: Automotive style miniature relay

9.2 Operation:

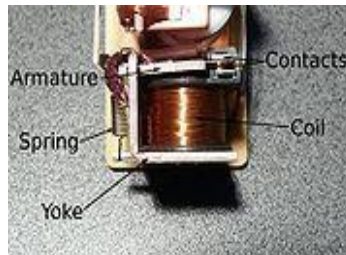


Fig9.2: Simple electromechanical electronics relay.

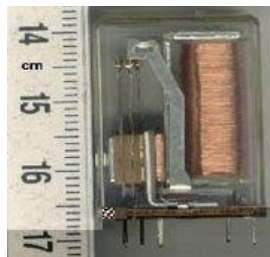


Fig9.3: Small relay as used in electronics

A basic electromagnetic hand-off, for example, the one taken from a vehicle in the primary picture, is an adjustment of an electromechanical solenoid. It comprises of a curl of wire encompassing a delicate iron center, an iron burden, which gives a low hesitance way to attractive transition, a moveable iron armature, and a set, or sets, of contacts; two in the hand-off envisioned. The armature is pivoted to the burden and precisely connected to a moving contact or contacts. It is held set up by a spring with the goal that when the transfer is de-stimulated there is an air hole in the attractive circuit. In this condition, one of the two arrangements of contacts in the transfer envisioned is shut, and the other set is open. Different transfers may have more or less arrangements of contacts relying upon their capacity. The transfer in the image additionally has a wire associating the armature to the burden. This guarantees progression of the circuit between the moving contacts on the armature, and the circuit track on the Printed Circuit Board (PCB) through the burden, which is welded to the PCB.

At the point when an electric flow is gone through the curl, the subsequent attractive field pulls in the armature and the ensuing development of the mobile contact or contacts either represents the moment of truth an association with a fixed contact. On the off chance that the arrangement of contacts was shut when the transfer was de-empowered, at that point the development opens the contacts and breaks the association and the other way around if the contacts were open. At the point when the current to the curl is turned off, the armature is returned by a power, around half as solid as the attractive power, to its casual position. As a rule, this power is given by a spring, yet gravity is additionally utilized normally in modern engine starters. Most transfers are made to work rapidly. In a low voltage application, this is to diminish commotion. In a high voltage or high current application, this is to lessen arcing.

9.3 Applications:

Relays are used:

- ➔ To control a high-voltage circuit with a low-voltage signal, as in certain sorts of modems or sound speakers,
- ➔ To control a high-current circuit with a low-current sign, as in the starter solenoid of a vehicle,
- ➔ To identify and disconnect blames on transmission and dissemination lines by opening and shutting circuit breakers (assurance transfers

Chapter 10: Overview Of A Typical Substation

10.1 Bhurulia dual source 33/11kv indoor substation, Gazipur

In this part, we examine the principal segments of Bhurulia dual source 33/11kv indoor substation where we visited as of late.



Fig 10.1: Bhurulia dual source 33/11kv indoor substation, Gazipur.

In the substation, there are two approaching feeders/source: Bhurulia 33kv and BOF 33kv. For each source, they use 33/11kv Transformers and every one of them 10MVA. The one-line graph of Bhurulia substation demonstrates the approaching and active feeders.

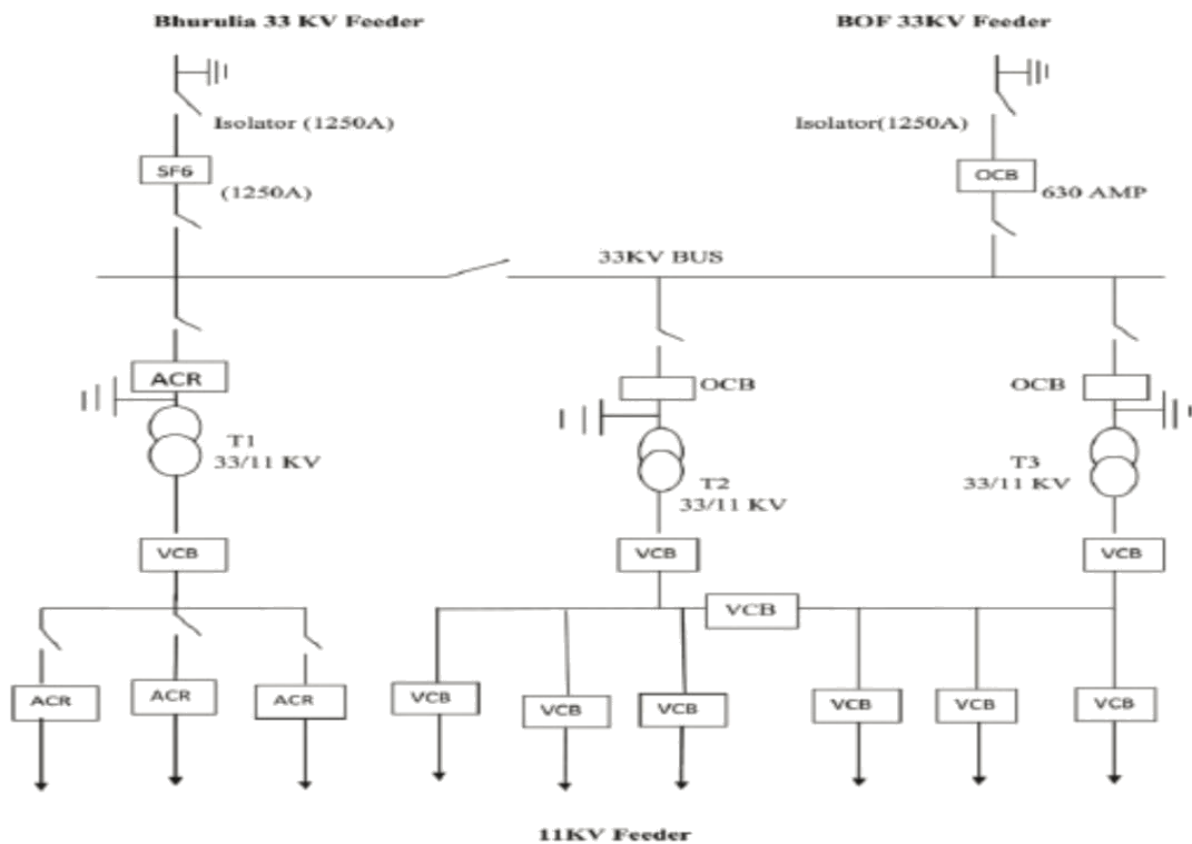


Fig 10.2: One line diagram of Bhurulia dual source 33/11kv indoor substation.

10.2 Lightning arrestor:

A lightning arrestor is a noteworthy guarded contraption presented in the substation similarly as on overhead transmission lines. As the name suggests it shields the electrical framework from the hurting effects of lightning. An aiding arrestor has two terminals high voltage terminal and one ground terminal. The high voltage terminal is regularly connected with the overhead line or to the equipment to be guaranteed. The ground terminal is related through a method for low insurance from the beginning. Between the high voltage and ground terminal, there is either air or material of high restriction. This material shields the common electrical power from being redirected to the ground. At any rate when lightning strikes it has especially high current, and simply this high current can

cross the region of high resistance, hence possessing the strike away. The Bhurulia substation uses a 36kv lightning arrester.



Fig 10.3: Lightning Arrester

10.3 Insulators:

The overhead transmission lines and Bus-bars are bolstered on towers. Since the towers are at ground potential. The fixed must be protected with the pinnacle structures. Overhead line separators are utilized to electrically isolate the line channels from one another and from supporting structures. The most ordinarily utilized material for the assembling of separators is glass and porcelain. There are a few sorts of protectors (for example stick type, suspension type, strain type, post encasing, and so forth.) and their utilization in the sub-station will rely on the administration necessities.



Fig 10.4: Different types of insulator.

10.4 Isolators or Isolating switches:

In sub-stations, it is regularly wanted to separate a piece of the framework for general upkeep and fixes. This is practiced by a disconnecting switch or an isolator. An isolator is basically a blade switch and is intended to open a circuit under no heap. At the end of the day, isolator switches are worked just when the lines where they are associated convey no current. They additionally encourage the redistribution of burdens. The substation utilizes both 33kv and 11kv isolator.



Fig 10.5: Isolators.

10.5 Circuit Breaker:

An electrical switch is an exchanging gadget which can be worked physically and naturally for controlling and assurance of electrical power framework separately. The circuit breakers are utilized to break the circuit if any deficiency happens in any of the instrument. In the accompanying substation: Oil Circuit Breaker (33kv), SF6 Circuit Breaker (33kv) and Vacuum Circuit Breaker are utilized.



Fig 10.6: Oil, SF6 and Vacuum Circuit Breaker.

10.6 Bus-bars:

They resemble an electrical intersection where power is gathered from approaching transmission lines and after that redistributed to the active transmission line. All the significant hardware in a substation are associated with the transport bars, subsequently, transport bar security is of utmost significance. On the off chance that any deficiency happens on the transport bar, at that point, all other hardware in a substation associated with it may get influenced and consequently, they should get stumbled as quickly as time permits. A substation can have more than one transport bar housed in it. There are a few transport bar plans that can be utilized in a substation. The decision of a specific plan relies on different factors, for example, framework voltage, the situation of sub-

station, level of unwavering quality, cost, and so on. The Bhurulia substation has 33kv Bus-bar in the indoor segment and another is 11kv Bus-bar in open air area (work in the procedure).



Fig 10.7: 33kv Bus-Bar (marked with arrow)

10.7 Instrument Transformer:

Instrument transformers are utilized to venture down the current or voltage to quantifiable qualities. They give institutionalized, useable degrees of momentum or voltage in an assortment of intensity checking and estimation applications. Both current and voltage instrument transformers are intended to have unsurprising attributes of over-burdens. The appropriate task of overcurrent insurance transfers necessitates that present transformers give an anticipated change proportion notwithstanding during a short out. These are further classified into two types which are discussed below.

- Current Transformer
- Potential Transformer

10.7.1 Current Transformer:

The Current Transformer is a sort of venture up transformer, ventures down the current to a known proportion. The essential of this transformer comprises at least one turns of thick wire associated in arrangement with the line. The auxiliary comprises of an enormous number of turns of fine wire and gives current to the estimating instruments and transfers a present which is a steady portion of the current in the line. Let a present transformer appraised at 100/5 An is associated in the line to gauge current. On the off chance that the current in the line is 100 An, at that point current in the auxiliary will be 5A. In Bhurulia substation 33kv CT proportion of 600:5A, 300:5A, 1000:5A, and so on are utilized.



Fig 10.8: Current Transformer.

10.7.2 Potential Transformer:

It is basically a stage down transformer and ventures down the voltage to a known proportion. The essential of this transformer comprises of countless turns of fine wire associated over the line. The auxiliary twisting comprises of a couple of turns and it gives voltage to estimating instruments and transfers a voltage which is a known portion of the line voltage. Let a potential transformer appraised at 66kV/110V is associated with an electrical cable. On the off chance that the line voltage is 66kV, at that point, the voltage over the auxiliary will be 110 V. In Bhurulia Substation 33kv/. The 10kv potential is utilized.



Fig 10.9: Potential Transformer.

10.8 Power transformers:

During transmission and dissemination of power, one needs to increment or decline its voltage to guarantee appropriate transmission and dispersion with the least power misfortune. This work is accomplished with the assistance of intensity transformers. A power transformer is utilized in a sub-station to venture up or venture down the voltage. A stage up transformer ventures up the voltage or builds the voltage. It is additionally now and then alluded to as a transmission transformer. It is utilized to venture up age voltage to a high incentive for transmission of electric power.



Fig 10.10: Power Transformer.

A stage down transformer ventures down the voltage or diminishes the voltage. It is likewise now and again alluded to as Distribution transformer. It is utilized to venture down the voltage from High voltage level to Low voltage Level. Aside from at the producing station, all the ensuing substations use venture down transformers to bit by bit lessen the voltage of the electric supply lastly convey it at use voltage. Bhurulia Substation utilizes three-stage 33kv/11kv strides down transformers. Every one is 10MVA. There is an extra Transformer known as station transformer for interior supply which is 33kv/400v.

Discussions:

We have examined the principal of Electrical substation, its working framework, transmission, dissemination, control and assurance and how to support. It is a backup station of a power age and dispersion where voltage is changed from high to low or the turnaround utilizing transformers. Substation associated with the power station. Substation, for the most part, contains more transformers and have exchanged, security and control gear. The substation is, for the most part, used to adequate voltage conveyed to the shopper. For example, local location, business zone, and modern territory, and so forth.

Recommendations:

1. Substation should be located in a free and open space.
2. Government should have provided skilled technical person for operation and maintenance.
3. Man power should be trained up in the technical institution locally and also in abroad to increase their technical efficiency and required capability.

Conclusions:

Substation encourages us to convey the Electricity to the end client for example private, business territory and modern region. So we need to screen all the framework to decrease the transmission misfortune, support cost, and framework misfortune. These misfortunes can be diminished by utilizing present-day innovation and gifted specialized individual. In the event that we can do this, at that point we can give greater power to our national voracity, load-concealing can limit step by step and can supply greater power to our modern segment for an irregular generation. The predictable power supply can evacuate every one of the snags of our national development. So we need to give more consideration to its creation, transmission, and appropriation of Electrical substation.

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