CHAPTER ONE

INTRODUCTION

1-1 Introduction:-

Electric power distribution is the portion of the power delivery infrastructure that takes the electricity from the highly meshed, high-voltage transmission circuits and delivers it to customers.

1-2Problem statement: -

The main problem on which the study is based is to address the problems of overhead lines represented in:

1- The voltage drop due to the presence of connections between the conductor lines, as well as due to the long distances between the load centers and the transformers.

2- The bridges are cut off and burnt due to looseness in the line.

3- The breakdown of insulators due to lightning strikes and weather factors.

4- A short circuit occurs as a result of tree movement in the tracks of the lines.

5- The lines poles fall as a result of strong winds.

6- Overhead line columns inside residential cities cause many traffic accidents as well as distort the city's view.

1-3 The goal of the Project:-

Introducing the underground cable system to the urban distribution networks.

Determine the appropriate type and section of the cable as well as determine the cable paths.

- Determine the number of transformers needed to operate the area, taking into account placing them in appropriate places to facilitate maintenance operations.

- Accurate distribution of loads and feeding elements.

- Set the appropriate connection system in this network, taking into account a future plan for extension as well as the total costs.

4.1 Methodology: -

In addition to the theoretical aspect of scientific research, there will be field work in which a study area is taken and the necessary calculations are made for it. A simulation program for the project will also be attached to the scientific research.

CHAPTER TWO

DISTRIBUTION NETWORKS

2-1Introduction:-

In this chapter, we dealt with a general concept of distribution networks of all kinds, in terms of the method of connection and extension, its components and the elements of the network's supply, and we will devote more attention to the ground cables.

2-2Electrical power distribution network: -

It is the one that receives electrical power and distributes it to consumers and it consists of a group of feeders that starts from a main transformer station and ends with distribution transformers that reduce the voltage to 110 V or 220 V.

2-2-1Benefits of distribution networks: -

1- Receiving the electrical power sent from the generation stations via transmission lines and distributing it to consumers.

2- The distribution is made on voltages commensurate with the purposes of consumption through substations to convert super-voltages (EHV) or high (H.V) into medium voltages (MV) or low voltages (LV).

3 - It represents the link between consumers and the National Authority for Electricity Distribution.

4- Through it, the distribution is usually in two phases: -

2-2-2Primary distribution:-

Voltage ranges from 33kv -6.6kv depending on the standard voltages used.

2-2-3Secondary distribution:-

On the use voltages where there are two systems 110/220 V or 380/220 V.

2-2-4 types of distribution networks:-

The distribution networks were divided into a group of types according to: -

1- Depending on the voltage used:-

In terms of efforts used, it was divided into:

1 / Medium voltage distribution networks.

It refers to the primary feeder network with a voltage that includes 11 kv, and through it the factories and major producers are fed

2 / Low voltage distribution networks.

Where the voltage is reduced from 11kv to 415v in order to feed residential areas.

2- According to the method of linking:-

It was divided into two types:

1-Radial system (radial): -

1-Primary distribution system:

Be on voltages ranging from kv66-kv33.

There are three main types of the first distribution system:

It is the simplest and most widespread distribution system and it consists of a group of independent elements that exit from the distribution station to feed each of them a specific area.

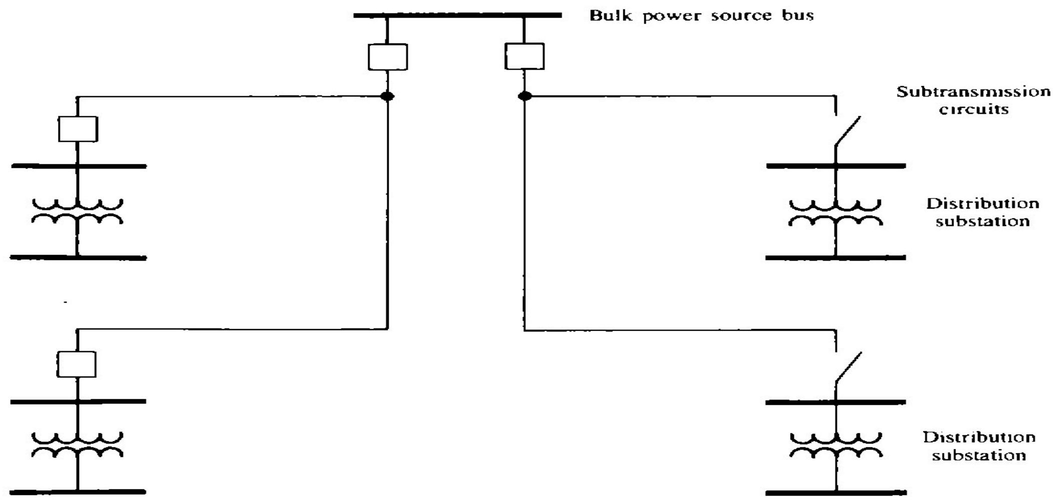

Fig.2-1.Radial system

Each circuit consists of the main feeder, which branches off branches that connect to the distribution transformers, and these branches are connected to the main feeder through fuses so that no errors in any of the feeders or (branches) cause a separation of the main feeder completely.

It has the advantage that in the event of a fault occurring in one of the branches and the fuse fails to work and the part in which the error occurred is not disconnected, the cutter at the beginning of the feeder will work, causing the entire feeder to be disconnected and also works to reduce the interruption in service by dividing the feeder into sections where it can be re- Feed the remote sections at the fault as quickly as possible by connecting them to the nearest feeder using emergency links.

2-Improved system from radial subtransmission:-

Improved system from radial subtransmission is introduced as shown in Fig.2b. in this system additional feeder is incorporated to allow relatively faster service restoration when faults occurs on the one of transmission circuits.

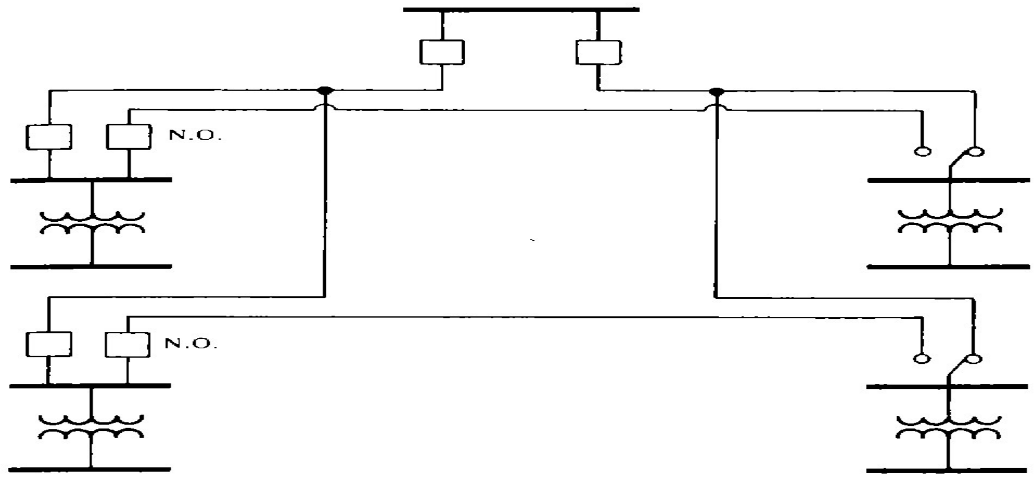

Fig.2-2.Improved Radial subtransmission system

3-loop subtransmission:-

Due to higher service reliability the subtransmission system is designed as loop circuits or multiple circuits forming a subtransmission grid or network as shown in Fig.2c. In this design a single circuit origination from a bulk power bus runs through a number of substation and returns to the sane bus.

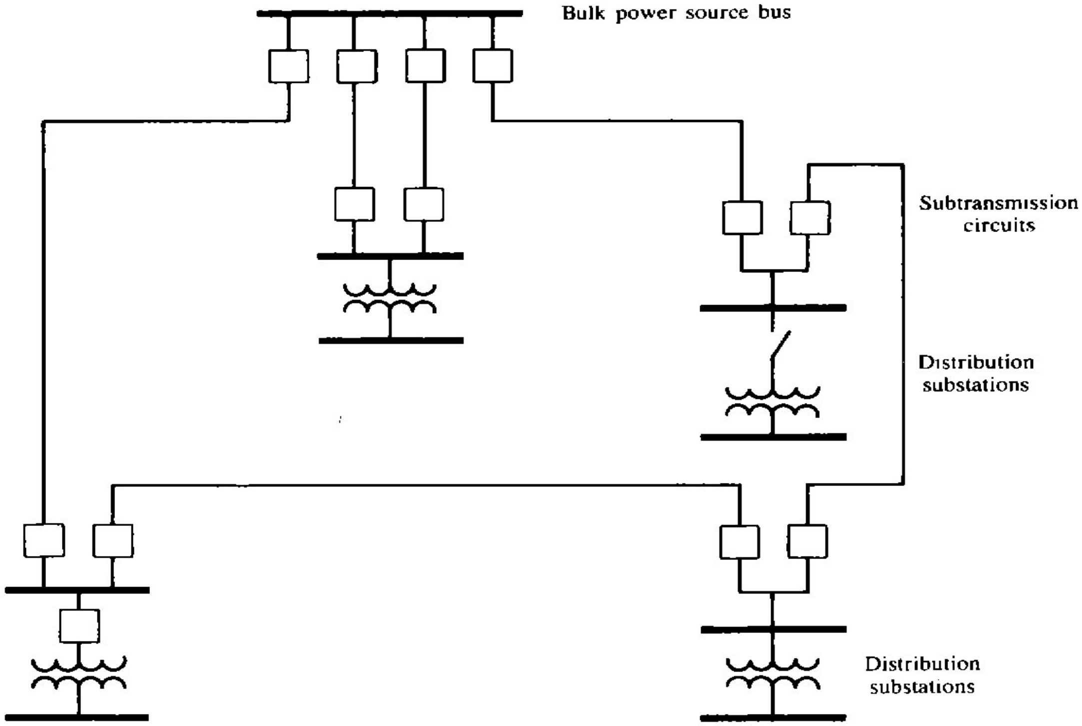

Fig.2-3. Loop subtransmission system

4-The network or grid subtransmission:-

The network or grid subtransmission has multiple circuits in order to produce interconnected substations. The design may have more than one bulk power source, therefore it has the greatest service reliability and it requires costly control of power flow and control system. This type is the most commonly used form of subtransmission.

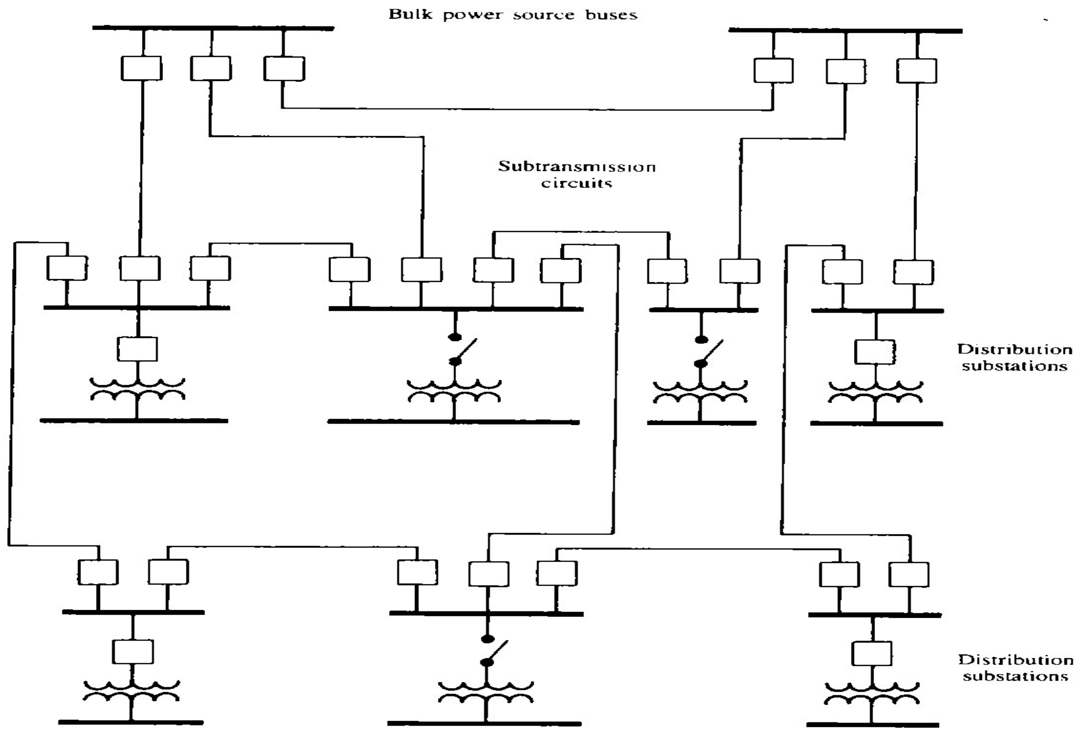

Fig.2-4. Network subtransmission system

2-3 Electrical distribution board: -

The function of the basic distribution panels is to control the locking and conduction of electrical current with the safe operation of any equipment or apparatus in addition to protecting people and property from harm, protection from overcurrent, as well as thermal effects resulting from operation or when malfunctions.

It is not just a metal box with the distribution rods on which the various cutters are installed with the aim of the cables coming out of the board. The location of the distribution board is chosen so that it is close to the load center in order to reduce the length of the cables.

The low voltage panels are divided into general panels and sub-distribution panels:

2-3-1Classification of Distribution Board:-

The panels are classified according to the shape into the following types:

1 - Open Frame Construction Distribution Boards:

It is a exposed panel that is accessed from all directions, so it is installed in closed places only to avoid electric shock.

2-Panels with construction:

It achieves protection from contact with electrified parts of the panel face, but does not do so from other interfaces, so it is installed indoors only.

3- Panels with cells:

These panels are closed on all sides, so it is permissible to install them in open operating areas.

4-Panels with retractable unit:

These units are built inside the panel cells and the cell can be divided into separate sections, each of which contains retractable units, so it is safe and easy during maintenance.

5- Box style units:

It consists of a group of boxes and contains equipment units such as distribution rods and contactors, and is used in places with harsh operating conditions.

It is noted when describing the electrical panels the use of what is known as Ip-Code, which is a number composed of x ,y.

The first number x ranges from 1 to 6 and gives a measure of the degree of protection of the panel against dust.

The number y ranges from 1 to 7 and gives a measure of the degree of protection of the panel against water.

2-3-2General notes on electrical boards: -

-The main distribution board shall be installed close to the building's power supply point, and the main feeders that supply the sub panels are branched from it.

-The bodies of all distribution panels must be earthed.

- It is preferable for each of the panel bars to be isolated with one of the colors (red - yellow - blue) so as not to cause errors in the distribution of the circuits.

-The panels should be provided with a chart or table drawing showing the load distribution inside the board. **:-**

The distribution transformer normally serves as the final

2-4 Transformers

A transformer efficiently converts electric power from one voltage level to another. A transformer is two sets of coils coupled together through a magnetic field. The magnetic field transfers all of the energy (except in an autotransformer). In an ideal transformer, the voltages on the input and the output are related by the turns ratio of the transformer.

$V1= N1 /N2. V1$

Where N 1 and N 2 are the number of turns and V 1 and V 2 are the voltage on windings 1 and 2 Distribution Transformers From a few kVA to a few MVA, distribution transformers convert primary voltage to low voltage that customers can use. In North America, 40 million distribution transformers are in service, and another one million are installed each year (Alexander Publications, 2001). The transformer connection determines the customer's voltages and grounding configuration. Distribution transformers are available in several standardized sizes as shown in Table 4.2. Most installations are single phase. The most common.

TABLE 4.2

Standard Distribution Transformer Sizes

Distribution Transformer Standard Ratings, Kva

Single phase	5, 10, 15, 25, 37.5, 50, 75, 100, 167, 250, 333, 500
Three phase	30, 45, 75, 112.5, 150, 225, 300, 500

Overhead transformer is the 25-kVA unit; Pad mounted transformers tend to be slightly larger where the 50-kVA unit is the most common. Distribution transformer impedances are rather low. Units under 50 kVA have impedances less than 2%. Three-phase underground transformers in the range of 750 to 2500 kVA normally have a 5.75% impedance as specified in (ANSI/IEEE C57.12.24-1988). Lower impedance transformers provide better voltage regulation and less voltage flicker for motor starting or other fluctuating loads. But lower impedance transformers increase fault currents on the secondary, and secondary faults impact the primary side more (deeper voltage sags and more fault current on the primary). Standards specify the insulation capabilities of distribution transformer windings (see Table 4.3). The low-frequency test is a power-frequency (60 Hz) test applied for one minute. The basic lightning impulse insulation level (BIL) is a fast impulse transient. The front-of-wave impulse levels are even shorter-duration impulses. The through-fault capability of distribution transformers is also given in IEEE C57.12.00-2000 (see Table 4.4). The duration in seconds of the short circuit capability is:

t=1250\I*I

Where

Is the symmetrical current in multiples of the normal base current from Table 4.4. Overhead and pad mounted transformer tanks are normally made of mild carbon steel. Corrosion is one of the main concerns, especially for anything on the ground or in the ground. Pad mounted transformers tend to corrode

Through-Fault Capability of Distribution Transformers

Single-Phase Rating, kVA	Three-Phase Rating, Kva	Withstand Capability in per Unit of Base Current (Symmetrical)
5–25	15–75	40
37.5–110	112.5–300	35

Source : IEEE Std. C57.12.00-2000, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

near the base (where moisture and dirt and other debris may collect). Submersible units, being highly susceptible to corrosion, are often stainless steel. Distribution transformers are (self cooled); they do not have extra cooling capability like power transformers. They only have one kVA rating. Because they are small and because customer peak loadings are relatively short duration, overhead and pad mounted distribution transformers have significant overload capability. Utilities regularly size them to have peak loads exceeding 150% of the nameplate rating. Transformers in underground vaults are often used in cities, especially for network transformers (feeding secondary grid networks). In this application, heat can be effectively dissipated (but not as well as with an overhead or pad mounted transformer). Subsurface transformers are installed in an enclosure just big enough to house the transformer with a grate covering the top. A "submersible" transformer is normally used, one which can be submerged in water for an extended period (ANSI/IEEE C57.12.80-1978). Heat is dissipated through the grate at the top. Dirt and debris in the enclosure can accelerate corrosion. Debris blocking the grates or vents can overheat the transformer. Direct-buried transformers have been attempted over the years. The main problems have been overheating and corrosion. In soils with high electrical and thermal resistivity, overheating is the main concern. In soils with low electrical and thermal resistivity, overheating is not as much of a concern, but corrosion becomes a problem. Thermal conductivity in a direct-buried transformer depends on the thermal conductivity of the soil. The buried transformer generates enough heat to dry out the surrounding soil; the dried soil shrinks and creates air gaps. These air gaps act as insulating layers that further trap heat in the transformer.

Single-Phase Transformers :

Single-phase transformers supply single-phase service; we can use two or three single-phase units in a variety of configurations to supply three-phase

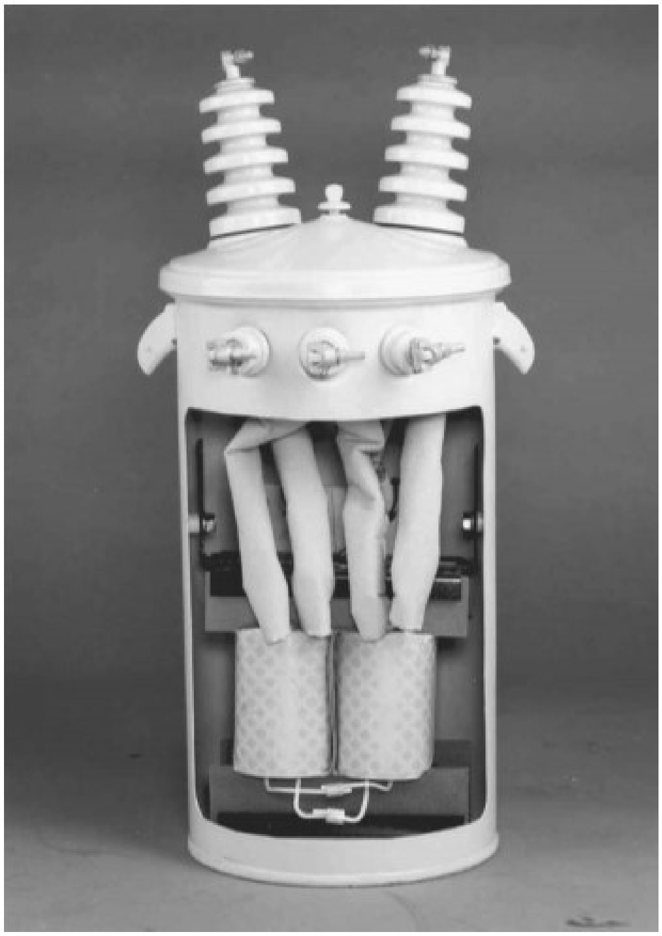

FIG.2-5. Single-phase distribution transformer. (Photo courtesy of ABB, Inc. With permission.)

service. A transformer’s nameplate gives the kVA ratings, the voltage ratings, percent impedance, polarity, weight, connection diagram, and cooling class. Figure 4.4 shows a cutaway view of a single-phase transformer. For a single-phase transformer supplying single-phase service, the loadfull current in amperes is

I=S kva\Vkv

2-5Control Equipment: -

2-5-1 contactors:

They are main poles capable of carrying a high current that are controlled by the control coil.

The contactor is provided with a number of auxiliary electrodes:

(n / o) It is open in the normal position as long as there is no signal in the contact coil, and then the main poles are also open, then automatically switches to the off position, once the contact coil is electrified and vice versa in the case of the second type (n / c)

The most important specifications of contactors: -

They are described according to several variables:

-Operating voltage and its value.

-Number and type of auxiliary electrodes.

-Rated current.

-Number of basic electrodes.

-The nature of pregnancy.

2-5-2Capacitors: -

It is installed on the common low voltage distribution rod to reduce the KVA of the structure generated by

Lower PF, lower overall transformer loads.

But improving the PF reduces the KVA passing in all the cables before the capacitors, so it will be tested by the same original KVA. To remedy this problem, the capacitors are moved and placed on the general boards of loads or placed directly at the loadsMaximum operating voltage, maximum measured voltage, and minimum operating current and travel time.

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2-5-3Circuit breakers:-

A circuit breaker is defined as a mechanical switch capable of connecting, carrying and disconnecting currents under normal operating conditions, as well as a time-limited connection and endurance of rip currents in abnormal operating conditions, such as a short circuit.

Cutter Parts: -

1-Moving touch:

And it shall be of a material that is well conductive to electricity and its function (with the fixed contact) is the direct connection between the terminals of the electrical source and the terminals of the load circuit.

2-Fixed touch:

Its function is common to the moving contactor and there are fixed sparks absorbing contacts corresponding to the moving sparks.

3- Mechanical part:

Its function is to control the movement of the moving contact by connecting or disconnecting it with the fixed contact.

4-Electrical part:

This part is only present in circuit breakers that can be operated electrically and its function is to give commands to disconnect and connect to the mechanical part.

5- Insulator between electrodes:

It is a special type of oil that acts as a barrier that prevents contact between the electrodes and thus prevents short circuits between them.

2-6Low Voltage circuit breakers:

Low voltage circuit breakers are divided into three types:

1-MCB called miniature circuit breaker.

2-MCCB is called a molded case circuit breaker.

3-GFCB, called Ground Fault Circuit Breaker.

2-6-1MCB: -

It is called a circuit breaker, and there are two models of it, one of which is used in three-sided extension circuits and the other type is used in single-sided circuits.

Fig.2-6.show some types of IMCB.

Among the most important characteristics of these cutters:

- The capacity of the switch ranges from 6 ampere to 125 ampere.

-Used in branch circuits such as lighting, sockets and household loads. There are many types of microcircuit breakers:

1- Type B micro-circuit breaker:

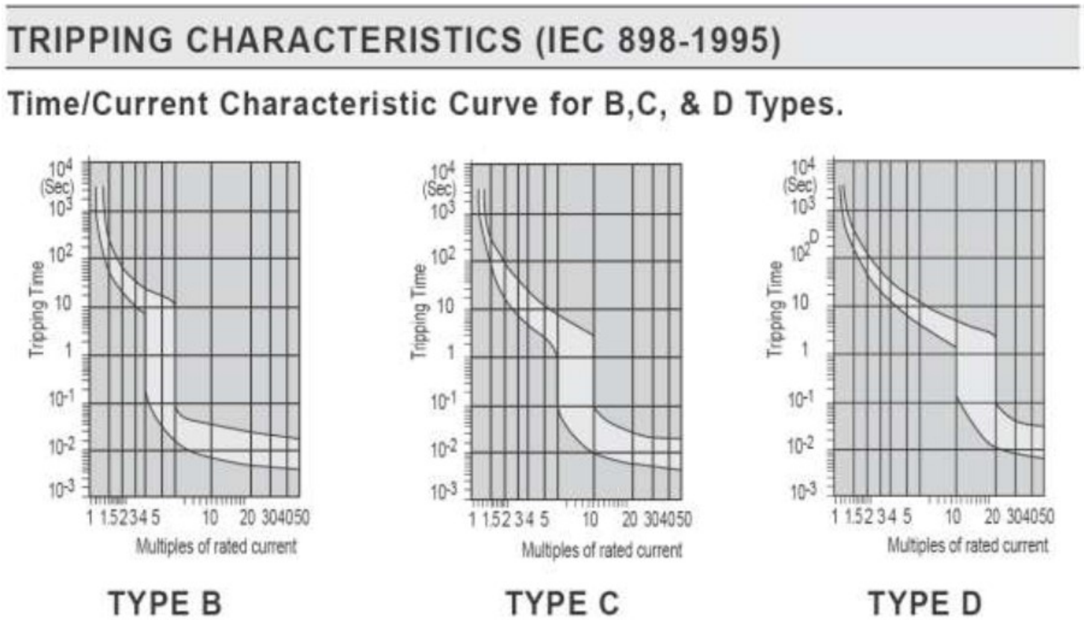
This circuit breaker is used in general circuits without impulse currents as well as for protection of glow circuits, and this circuit breaker operates simultaneously in the range of In3 to In5.

2- Type C micro cutter:

This circuit breaker is used to protect sub circuits with moderate to large impulse currents such as motor circuits and air conditioning units, and it operates in the range of 5In to In10.

3- Type D micro-circuit breaker:

This circuit breaker is used to protect sub-circuits that contain large impulse currents, such as circuits feeding to welding devices and containing transformers, and this circuit breaker operates simultaneously in the range from In10 to In20.



2-6-2MCCB:

It is called a circuit breaker to protect the supply circuits. This type is more complex in its structure than the first type and is characterized by its large size, which helps it to withstand and withstand high short currents. It is also characterized by high flexibility when adjusting the relationship between the separation time and the value of the fault current.

Fig.2-7.show some types ofMCCB

2-6-3GFCB:

This type is used to protect against the current leaking into the ground in electrical installations, as the idea of its work depends on comparing the value of the current entering the circuit with the value of the current leaving it. If a difference occurs between the two currents, this indicates the current leakage from the circuit.

Fig.2-8.show GFCB.

A special table for all cutouts:

Circuir Breaker Ratings																										
10	16	20	25	32	40	50	63	80	100	125	160	200	250	400	630	800	1000	1250	1600	2000	2500	3200	4000	5000	6300	CB (A)
MCB															ACB											
	MCCB																									

2-6-4Ratings for circuit breakers: -

1-Rated Voltage:

It is the voltage caused by the opening and closing capacitance of the circuit breaker (line voltage in the case of a three-phase system). This capacitance of the same circuit breaker may vary depending on the operating voltage value. The rated voltage is usually the maximum permissible operating voltage.

2-Rated Frequency: -

This is the frequency based on the design of the cutter and its various release springs.

3-Rated Insulation Voltage: -

Voltage is the standard voltage at which to design the dielectric parts of a breaker. It is mainly designated for low voltage circuit breakers due to its difference from the rated voltage, while in medium and high voltage circuit breakers its value is approximately the same as the rated voltage value.

4-Rated withstand voltage at power frequency: -

This voltage represents the effective value of the maximum voltage of its frequency (50 or 60 HZ) that the insulation can withstand, and it is a measure of the extent of the insulation tolerance of the transient voltages in the network. This voltage means for medium and high voltage circuit breakers and it is almost twice the rated voltage.

5-Rated Impulse Withstand Voltage: -

This voltage represents the maximum value of the impulse wave voltage that the insulation can withstand. It is a measure of the insulation tolerance of the transient voltages as a result of lightning strikes. It is usually between four to six times the rated voltage.

6-Rated Breaking Current: -

It is the effective value of the symmetric short current that the circuit breaker can separate. It represents the power factor in the network during the presence of the minors.

7-Rated current of shorter time: -

It represents the maximum effective value of the symmetric current that the breaker can withstand for a period of time ranging from one second for low voltage circuit breakers and from two seconds to three seconds for medium voltage circuit breakers. This current is considered a measure of the thermal endurance of the breaker under short conditions.

2-7Fuses:-

It is a device to protect the electrical circuits from increasing the current resulting from short circuits or overloads as a result of the melting of a fusible element when the current exceeds a specified value and within a suitable time.

2-7-1Fuse components: -

The fuse directly consists of four main parts, namely: -

1- Fuse element: -

It is made of a metal material of certain shapes and dimensions so that its melting is fast in relation to the rest of the components of the network and it is made with a material of silver, copper, aluminum, lead or some other alloy with a low melting temperature

2- Fuse link: -

Inside it is the smelting element and the materials used to extinguish the electric arc arising from its melting, in addition to other auxiliary parts.

3- Fuse contact tips: -

It is used to install the fuse in the circuit and connect it electrically to it.

4- The fuse base.

The working principle of the fuse: -

The working principle depends on the thermal effect of the electric current passing through it, as it melts at a certain current and cuts off the current. The fuse element is required to be made of good material and not to be consumed over time.

2-7-2Regulations:

1- The rated current of the fuse current rating (In): -

It is the largest current that passes through the fuse continuously without damaging the fuse, and the standard currents are

2 - 4-6-8-12- 16-20 - ---- 1250 A

2- Minor smelting stream: minimum fusing current: -

It is the smallest value of the current that makes the element fuse.

3- Fusing factor: -

It is the sum of the value of the rated fuse current over the value of the rated fuse current which is greater than one and is given by the following relationship: -

Smelter = This parameter is greater than one

4- Pre-Arcing Time:

It is the time between the start of the current sufficiently to cause the fuse to melt and the moment the electric arc begins.

5- Arcing time:

The time between the moment of the fuse being disconnected and the final separation of the circuit.

6- The working time of the fuse: -

It is the sum of two times, which are the time before the arc occurred and the time before the arc occurred, i.e. that:

The total time for the operation of the fuse = time before the arc occurs + time for the arc

2-7-3Fuse classification: -

Fuses are classified into many and varied types, and we will mention the main and important types, including:

Recycled fuses.

Cartridge fuses.

1- Recycled fuses:

They are fuses made in the form of rectangular rectangles from the Chinese, with two copper ends fixed together and connected together from the outside of the smelter with a thin conductor called a filament, and when the shortening occurs, the conductor is cut and the circuit separates.

Fig.2-9. showing the fuse being rewired

2- Cartridge fuses:

The melting element is inside a glass or ceramic tube, and this tube is filled with a fire-retardant material such as quartz.

There are two types of these fuses:

1-Cylindrical Cartridge Fuses:

They are cylindrical fuses with a ceramic section filled with silicon sand that extinguishes the electrical arc caused by shortening. These fuses have a melting factor of approximately 1.5.

Fig.2-10.showing cartridge.

2- Ejection Fuses:

It consists of a fuse element inside a tube and has an open end, and when the fuse element melts, the electric arc extends between the two ends of the fuse and as a result of the high temperature of this arc the tube material evaporates, which leads to the emission of a huge amount of gases that raises the pressure inside it, which works to extinguish the electric arc and prevent its re-ignition.

Fig.2-11.showing Ejection Fuses

3- Evacuated fuses:

Here, the idea of cutting the electric arc and not igniting it depends on the electrical insulation property of the vacuum. These fuses are characterized by their small size and quiet operation, so they are suitable for closed places.

Fig.2-12.showing evacuate fuses.

4-Cartridge fuses with release device:

This type is in the form of a cylinder or a rectangular parallelepiped, where the cylindrical type contains inside it a silicon powder that can withstand high values of shortness, and the other type contains a thin silver wire and is often provided with a malfunction indicator that indicates the occurrence of shortening.

They are HRC high cutting fuses


Fig.2-13 showing Cartridge fuses with release device.

Cartridge fuses in general have the following advantages:

1-Open circuits with high short current.

2-If the appropriate fuse is chosen for the department , the effect of aging is almost negligible.

3-Circuit separation speed.

4-High distinction of minor areas.

.5-Its con]st is lower compared to cutting devices of similar capacity.

2-8Cables: -

Ground cables are the second means of transmitting electric current after air wires .It is made of the same conductor material as copper or aluminum, but it has the advantage of covering these wires with a material called the insulator, this insulator gave us more freedom in that all the conductors were collected within one space, the insulator shirt is called, as the distance between the conductors and some of them is no longer it exceeds 5 cm, but in the air wires the distances between the conductors were large more than 58 cm and the next figure shows that.

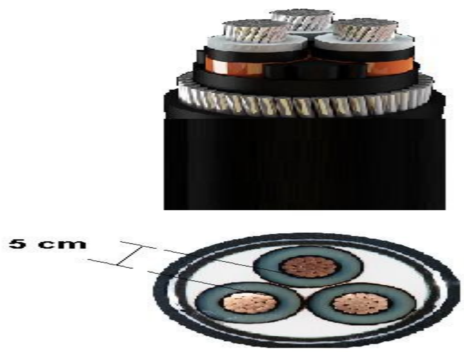


Fig.2-14. showing cable

2-8-1Cable components: -

1- Connector:

The conductor or the core is called a material that has a small resistance to passage the electric current through it easily, as the area of the conductor cross-section is proportional to the value of the current that is, the greater the cross sectional area of the conductor, it can withstand larger currents, and the conductor is surrounded by an insulating material that isolates it from the rest of the hearts and the conductor is made of materials that have the ability to conduct electricity, and those materials are aluminum and copper are the only two metals that are frequently used as electrical conductors.

2-Aluminum:

Aluminum is lightweight, silvery in color and can be easily shaped into any shape as it can be drawn

Shaped like wires and aluminum, it does not rust, and is resistant to corrosion by weather conditions or chemicals

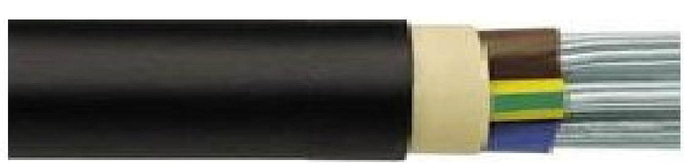


Fig.2-15. showing aluminum cable.

Aluminum is more ductile and malleable than copper, which means it is easier to draw into wires thin. As a result, steel reinforced aluminum wire is used in all electrical cables found in high voltage electrical power stations.

2-Copper: -

Copper is characterized by good conductivity, malleability and formability, as it does not crack when knocking, pressing or forming into unusual shapes. Copper can be formed cold or hot, and can be rolled into sheets with a thickness of less than 0.05 mm. Cold rolling changes the natural properties of copper, and increases its strength.

Fig.2-16. showing copper cable.

2- The conductor curtain (semiconductor material): -

It is a layer of thin semiconductor material that is placed around the conductor evenly and fills the spaces between surfaces the connector is to ensure the rotation of the conductor, meaning that there are no wires protruding from the conductor where excessive wires that cause insulation breakage and damage to the cable, which protect the conductor from electrical stress it regulates the electric field scattered around the heart as a result of the irregular matrix surface as well.

It prevents the formation of ionized gaps between the insulator and the conductor that cause the dielectric to weak and collapse.

3-Insulation:-

The insulator is one of the most important parts of the cable, where sometimes the cable is called the type of insulator used, whose thickness is proportional to the operating voltage, that is, the higher the voltage, the greater the thickness of the insulator, and it is required that it has a high electrical insulation intensity, as well as a long life span and resistance to high temperatures, where the quality of the insulation indicates the quality of the cable.

2-8-2The most important thermoplastics:

Used in the manufacture of insulators are**:**

1- PVC material

It is considered a thermoplastic that softens with heat, usually PVC material that can withstand a temperature of up to 50 ° C in normal operation and withstand up to 160 ° C in the event of shortening, and it is usually used as an insulator up to a voltage of 3 kV.

2- XPLE material

They are considered thermal solids that do not soften by heat until their combustion temperature and usually withstand up to 90 degrees Celsius in the case of normal operation and up to 250 degrees Celsius in case of shortening, and usually XLPE is used as an insulator for voltages above 3 kV

3-EPR Ethylene and propylene rubber.

4- Interior insulation curtains: -

Some problems may occur to the cable, which leads to its breakage as a result of some stress. This problem has been overcome by metal-shield cables by surrounding each core with metallic paper or copper tape.

5- Cable filling Materials:

In order for the cable to take a circular shape to it and also to prevent the conductors moving inside the jacket and friction with each other, which harms the insulator and its accessories and leads to its destruction and consequently the collapse of the cable completely. Therefore, the space between the insulated conductors inside the cable sleeve must be filled with materials called filler materials, where this material can be segments of Plastic or a flexible material such as polyvinyl chloride to give the cable a round shape.

6-Armoring:

They are wires or spiral strips of steel that are wrapped in a regular way around the cable throughout its length to protect the cable from possible damage to it. The reinforcement is either by a spiral strip around the cable of steel or heat treated aluminum or the reinforcement is done by metal wires wrapped in a spiral or parallel form regular around the cable, which increases Cable flexibility.

7-Jacket or Sheath:

It is used to protect and protect the conductors and the internal parts of the cable from moisture, water, heat, gases, or any chemical substances that the cable may be exposed to. It is also used as an electrical insulator over the wires or reinforcing tape of the cable and covers the cable in its entire length. This cover is called the protective cover of the cable and it is of materials resistant to conditions in which the cable can be used These materials are polyethylene and nylon.

2-8-3Cable Types:

There are many and varied cables to suit the operating conditions in which they will be working and can be classified

In many ways such as (number of cores - operating voltage - type of insulating material).

Types of cables in terms of usage voltage: -

Most of the standard specifications worldwide agree on the classification according to the voltage value according to the following: -

1 - Low voltage cables up to 1000 volts.

2 - Medium voltage cables after 1 k. P to 33 k. P.

3 - High voltage cables of 66 k. P to 880 kW P.

4 - ultra-high voltage cables greater than 880 kV. P to 558 k. P.

1- Low voltage cables from 1 volt to 1000 volts: -

Low voltage cables are used to transmit electricity in indoor distribution lines in public networks and industrial such as lighting systems, electric motors, and those cables work at a maximum voltage

About 1000 volts, these cables are made of simple raw materials such as polyvinyl chloride

Which can withstand temperatures up to 50 ° C in normal operation and withstand up to 160 PVC

Degrees Celsius and in short condition, PVC is usually used as insulation up to 3 kV.

2- Medium voltage cables from 1 kV to 33 kV: -

These cables are used to transmit power MV cables medium voltage electricity in distribution networks, starting from 3.3 kV to 33 kV, due to the high voltage or (XLPE) voltage and electric field around the conductors, so an insulator such as polyethylene is used using paper impregnated with oil to insulate between conductors and some of them, and of course those conductors are made of the material is copper or aluminum, and medium voltage cables can be either single-sided or triple-sided the faces are as in shape.

3- High voltage cables from 66 kV to 400 kV: -

Used to transmit electrical power at HV high voltage starting from voltage 66 kV up to 400 kV and this type of cable is similar in

Its composition is medium voltage cables, but the cable's resistance to electrical stress is technically these cables are used in the main circuits of transmission lines as well as for connecting stations some of them, especially inside cities, have cables, and these types of cables may be triple single-face or single-face cables, preferably single-face cables

Second: Types of cables in terms of the shape of the conductor: -

The conductor is the material through which the electric current is passed, so the cable core is made of good material conduction to electrical current, as that material must be characterized by a low resistance to electric current transmission this conductor is usually called a core.

1-Solid Conductors:

Solid conductors are used for cables of small sizes that operate on small currents.

It does not need to be highly flexible, and these cables are used in the control and lighting circuits of the stations.

Electrical and industrial installations and a solid conductor is the one that consists of one hair.

2-Stranded Conductors:

Stranded conductors consist of a number of filaments, so they are used under high loads and voltages the higher the currents of the same conductor cross-sectional area, to reduce the cortical phenomenon.

Third: Types of cables in terms of the number of conductors (number of sides of the cable):

It was divided according to the economic and technical criteria into:

1-Single core cable

One-core cable we mean by the word heart is the conductor, this type of cable contains

Only one conductor and this is the only type of cable that is used for both high voltages

The low and the difference are in the operating voltage of the cable which determines the type of use for it.

2-Multi-core cables:

They are cables that contain more than one conductor for easy connection and arrangement of these types:

Three-core cable -

This type of cable is used in high and medium voltage networks, as it does not need a line

Equalization also in the case of three-phase motors.

Multi-core cable

Quad-core cables are used to distribute electrical energy in a low-voltage network of less than 1000 volts, and those types of cables are distinguished by that the insulation takes colors that determine the type of face according to a specific system that fits with the standard specifications in global efforts and these colors are red, yellow, blue and black.

Fourth - types of cables in terms of type of insulation material:

1- Cables insulated with paper impregnated with oil (oil cables).

2- P. V. C - Cables insulated with Article (polyvinyl chloride):

It has excellent electrical properties at low voltages and low temperatures as well its price is cheap, it is always the first choice around the world and it ranges from voltage up to 3.3 KV, but its flaw its isolation is affected by temperature.

3-Insulated cables with cross-linked polyethylene (XPLE):

It is characterized by high moisture resistance, high temperature resistance, shortness and overloading. It is the hardest insulator, and therefore it does not often need a reinforcement process except when it is expected to be subjected to violent mechanical stresses, especially when buried in the ground.

4- Cables insulated with a rubbery polyethylene material (P.L.R):

Rubber is resistant to water but not oil and gasoline

Cable tables according to the British system: -

The table shows copper cables: -

CHAPTER TREE

METHODOLOGY

3-1Intoduction:-

In this chapter, the area on which the study is being conducted is defined, in addition to calculating the loads of the area in which the project is to be implemented, and then specifying the specifications of the elements required to complete the extension process for the network, taking into account the standards followed in the design of electrical distribution networks.

3-2 Study Area :-

The model of the neighborhood (Al-Jawhara, District 1), east of the Nile, was taken as an area for conducting the field study, as it consists of three hundred and ninety-five housing units, and each unit has one floor. The next figure showing study area.

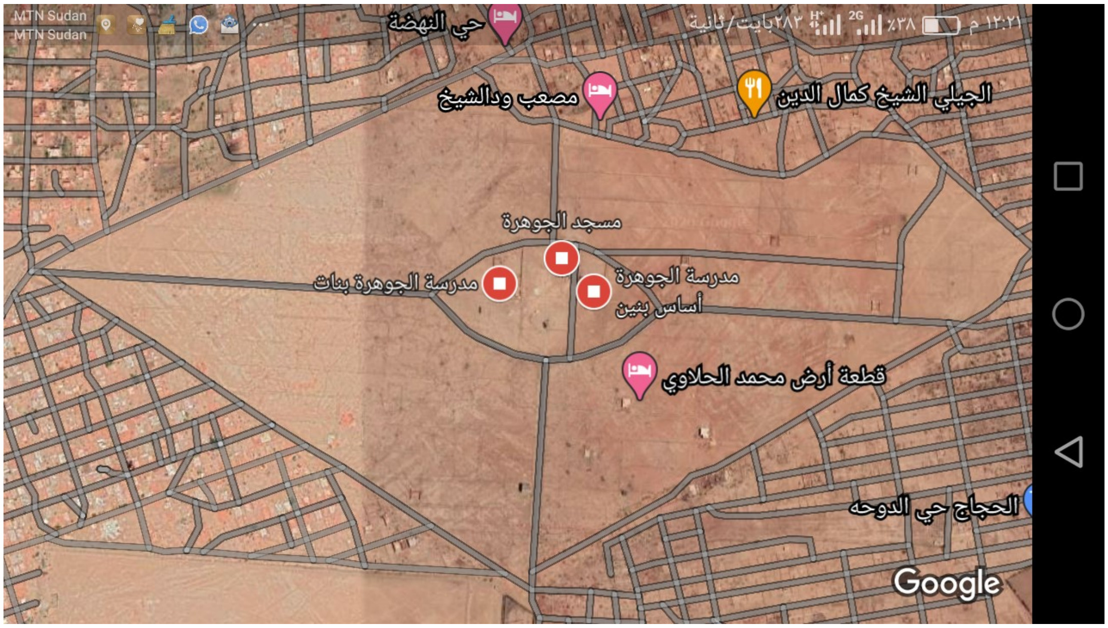


Fig.3-1. Showing study area.

3-3 Load calculations for the study area: -

When designing distribution networks, it is necessary to perform accurate calculations of the loads according to the standards used in the design process, represented in the parameters of the loads, namely: -

3-3-1 Demand Factor (KD)

The demand factor for the electrical system: It is the ratio between the maximum demand of the electrical system and the loads on the electrical system. The loads on the electrical system are the sum of the rated loads of all equipment and devices that feed into the electrical system. It must be noted that connecting the loads to the electrical system does not mean that all loads are working at the same time or during the same period of time, so the demand factor is always less than one.

The purpose of knowing the demand factor is to estimate the share of the total load connected and to be fed simultaneously.

3-3-2Coefficient of variation:

The coefficient of variance is the ratio between the sum of the maximum demand for each load of the loads and the maximum demand of the total load assuming that D1, D2, D3, …………… ..Dn are the maximum demand for the loads and DT is the maximum demand for the load.

Network extensions:

3-4Transformer:

The transformer is placed inside a room whose area is not less than one meter and it may differ according to the size of the transformer, preferably at a height of 60 cm from the surface of the ground. For ease of entry and exit of the maintenance team, the room must be well ventilated, and two ducts connected to the room must be opened to pass medium and low voltage cables

3-4-1Transformer earthing:

The transformer contains two types of grounding systems:

Protective grounding is by grounding the outer body of the transformer and the second type is system grounding

By grounding the break-even point as in the following figure

3-5 Cable:

The method of extending the cable depends on several factors, the most important of which is the nature of the project. Industrial projects are preferred with them, either the main networks in cities are buried directly in the ground because this is better in terms of the quality of the leakage of heat generated from the cables.

When burial in the ground, the following must be observed:

Burial depth is usually not less than 80 cm.

First a layer of fine sand 10 cm thick is placed, then the cable is extended directly over it.

Sand is added again over the cable after it has been extended until we reach a height of 20 cm from the depth of the burial.

Brick blocks are placed along the cable path as a guide.

We return the normal dirt that came out during drilling into the hole again to a distance of 20 cm from the edge of the drilling, then put a yellow tape at this depth.

In the event that more than one cable is placed inside the same trench, a ready-made separator must be taken into account to separate them along the path of the two cables and act as a barrier to fire.

When cutting the cable on any street, the cable must be placed inside the PVC pipe to further protect the cable from the mechanical stresses resulting crossing cars.

General notes on extension cables:

A single cable must not be placed inside a metal tube, because the current passing through it is accompanied by a magnetic field that causes an inductive current to form inside the pipe.

A fire barrier must be placed between the power cables and emergency cables if they are placed on one cable holder.

Telephone and other light-current cables should be located at least 30 cm from the power cable.

3-6Grounding System:

All electrical systems and safety instructions stipulate the necessity of a grounding system in buildings and facilities of all kinds in order to protect people and prevent electrical shock due to design or operational errors or weather factors or a breakdown of the protective insulation of current-carrying conductors.

3-6-1Grounding rod: -

It is an anti-decomposition copper rod ranging in length from 1 to 1.5 meters and is buried in earth by knocking and its resistance should not exceed 1 ohm.

3-6-2Grounding cable:

It is a copper wire with good conductivity of electricity that is connected between the grounding rod that is buried in the ground and the grounding bar of the main distribution board, then the sub-grounding wires are distributed to all the branch circuits according to the size of the main cable and then to the electrical appliances.

The types of grounding systems are: -

1- Protective grounding: -

It is the grounding of all metal parts of the electrical equipment which may occur

Direct contact between the human body and it, as these objects should not carry any electrical charge.

2 System grounding: -

The goal is that a part of the circuit such as the neutral point is grounded

It works to protect against touch voltage. As for low voltage networks, the neutral point is grounded

It works on not increasing the face voltage to a voltage that reaches the line voltage during a malfunction on any phase

Others.

Most common feeding source grounding systems: -

There are many methods of grounding the break-even point at the source of feed, the most important of which are: -

1- Solidly Earthling.

2- Grounding during Resistance Grounding.

3- Grounding during Reactance Grounding.

4- Isolated system.

1- Solidly Earthling:-

In this system the break-even point is directly connected to the grounding electrode and this system is characterized by that when a ground fault occurs, the voltage on the Faulty Phase does not exceed the normal voltage, and then there is no need for expensive insulators.

Distinguishing and detecting the fault is very easy in this system due to the high fault current compared to the normal current, but on the other hand it is necessary that the system (whether cables or CBs) bear the values of very high short currents expected to occur, meaning that its Rupture Capacity will be very expensive, and therefore Mostly this method is used with low effort only.

2- Grounding during Resistance Grounding:-

This is the most popular system, especially with electrical generators, where the resistance is placed directly connected to the neutral point or placed on the secondary side of the Earthing Transformer as in the figure

3-Grounding during reactance:

In it, Reactor is used between the grounding point and neutral, and the Reactance value is often chosen so that it reduces the fault current value by about 25-60% of the values of the highest short current in the Solidly Earthed state, and the reduction should not exceed more than that to avoid a severe rise in Break-even voltage value.

4- Isolated system:-

This system is safer because the fault current is absent because there is no path through which the fault current returns to the source, or in fact a very small current, as it will only leak through the stray capacitors of the device and its cables, the system is considered the most economical because its protection devices are less expensive than Those used with higher currents.

Methods for fastening the ground wire and metal objects: -

One of the most important steps in the grounding system is to ensure the quality of the connection between the grounding rod between the grounding cable and there are some methods used for the connection process, namely:-

1- Method of mechanical fastening by clamps or nails

2- Method of linking by pressing on a copper sleeve by a hydraulic press

3- Method of bonding by winding.

CAPTER FOURE

METODOLOGY OF STUDY AREA

4-1Study area:-

The following figure showing the study area by google maps application in east Nile.

Fig4-1 .Showing study area by google maps .

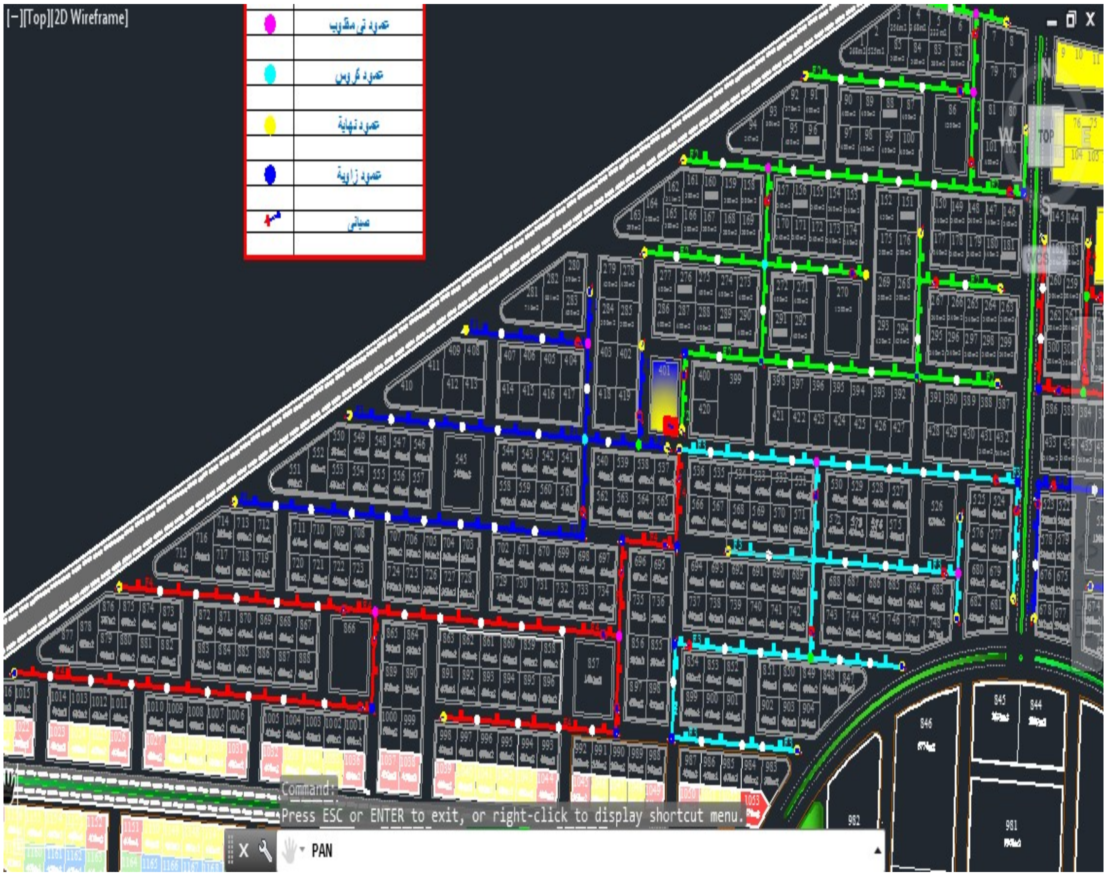


Fig4-1.Showing the study area and number of units.

In the above figure showing the number of apartments (395).

4-2 load calculations:

Total load per apartment = 7.583KW

Considering power factor (0.85)

Therefore, the apparent capacity of the apartment = 8.92KVA

Consumption of all residential units=3523.82KVA

Define elements for network design:

After performing the load calculations, we found that the design requirements for this neighborhood are as follows:

4-3Chose Transformers:

Since the transformer load ratio is 80%

The capacity of suitable transformer is
4404.825 KVA

Thus, we need two transformers of 2 MVA and 2.5 MVA

4-4 Circuit breakers:

Seven circuit breakers are specified for one transformer, one main and six branch circuit breakers.

Main cutter capacity:

$S = \sqrt{3} \times V \times I$.. ()

$$I_{load} = \frac{2\times10^{\wedge}6}{\sqrt{3}\times433} = 2666.74$$

From the circuit breaker rating tables, we find that a suitable circuit breaker suitable for this current is a circuit breaker of capacity 3200 A

Since the number of sub-feeders is six, so the sub-C.B stream is 444.46 A

From the breaker rating tables the suitable breaker capacity is 630 A.

4-5Cables:

The cable is determined based on the current required to feed the loads and the current coming out from the sub feeder is 444.84A

Thus, from the tables for the cables, the cross-sectional area of the cable for this current is 300 and it is of the type XLPE .

The following figure showing simulation for study and load flow about by cable and two transformer.

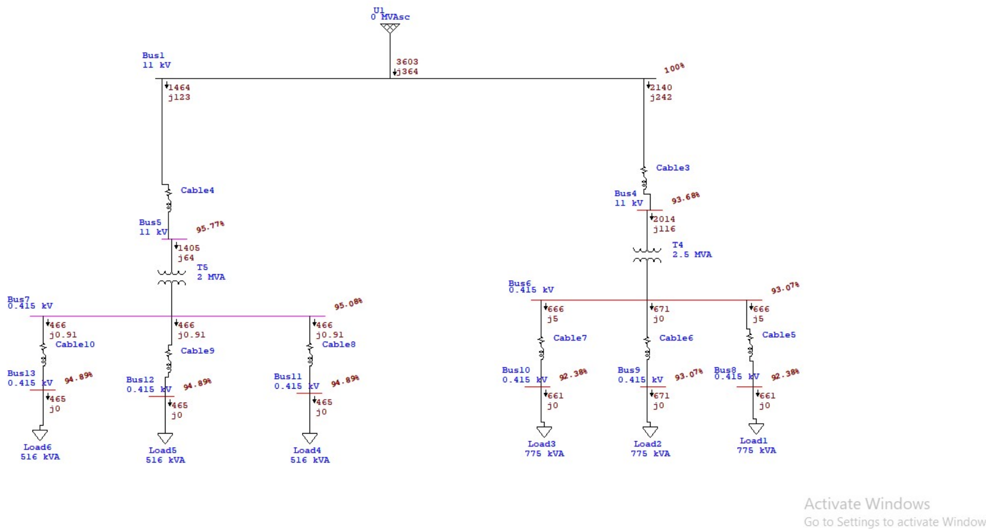


Fig4-2. Showing simulation for study by ETAP program.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5-1 Conclusion:-

After completing the design and analysis of the project, identifying all parts related to electrical distribution (secondary distribution), we learned how to deliver electrical energy to the consumer, as in the modern era, the correct and fair distribution of electricity technology and method at the level of the country is considered a reason for the growth and prosperity of societies, so it is necessary to focus on delivering Electricity to the consumer for the benefit to prevail.

The project is considered a simplified idea of how the calculations related to how electricity is distributed in neighborhoods and residential plans.

5-2Recommendations:

Researchers recommend the following:

1- We recommend the periodic follow-up and maintenance of electric power lines.

2- We recommend the use of modern methods of extensions within cities, represented by cables, due to the high security provided by these roads and to preserve the line from faults and weather factors.

3- Researchers in this field should study how to protect the distribution units and provide them with the latest protection and monitoring devices.

4- Researchers in this field should use programs such as ETAP for its benefit in reducing time, as well as reducing economic costs and obtaining results much closer to reality.

5-We recommend that electricity be delivered to regions and villages far from the sources of generation, thus achieving maximum benefit from electricity generation

5-3References:

_T.A Short Electric power distribution. Mehta & Rohit mehta principles of power system

_S.h Singh electric power generation transmission and distribution

_Theraga

_Electric power distribution system engineering by Turon gonen

دراسات في توليد ونقل و توزيع الطاقة الكهربية\ا.د محمود جيلاني\2019_

Table (1) shows demand transactions for loads:

Utility	Demand Factor

Residence load (<0.25kw)	1
Residence load (<0.5kw)	0.6
Residence load (>0.1kw)	0.5
Restaurant	0.7
Theatre	0.6
Hotel	0.5
School	0.55
Small Industry	0.6
Store	0.7
Motor Load (up to 10HP)	0.75
Motor Load (10HP to 20HP)	0.65
Motor load (20HP to 100)	0.55
Motor Load (Above 100HP)	0.5
Office,School	0.4
Hospital	0.5
Air port, Bank, shops ,	0.6
Restaurant,factory,	0.7
Work Shop,Factory(24hr shift)	0.8
Arc Furnace	0.9
Compressor	0.5
Hand tools	0.4
Inductance Furnace	0.8

Tabel(2)shows diversity Factor

Circuits Function	Diversity Factor in % (Ks)
Lighting	90%
Heating and air condition	80%
Socket – outlets	70%
For the most powerful motor	100%
For the second most powerful motor	75%
For all motors	80%

Cable tables according to the British system: -

Table(3) shows copper cables: -

الكبل	التيار	الممانعه	تيار القصر
25	105	0,8779	2,875
35	130	0,6371	4,025
50	160	0,4751	5,750
70	195	0,3365	8,050
95	235	0,2499	10,925
120	265	0,2053	13,800
150	295	0,1739	17,250
185	335	0,1481	21,275
240	380	0,1245	27,600
300	425	0,1106	34,500

Table (4) shows the aluminum cable:

الكبل	التيار	الممانعه	تيار القصر
25	80	1,4421	1,900
35	100	1,0492	2,660
50	125	0,7777	3,800
70	155	0,5423	5,320
95	185	0,3972	7,220
120	210	0,3183	9,120
150	235	0,2640	11,400
185	265	0,2166	14,060
240	305	0,1734	18,240
300	340	0,1472	22,800

.

Table (5) showing the loads of the house:

Number	Electrical appliance	The number	Consumption	TotalConsumption	Demand Factor	Diversity Factor	
1	air condition	3	0.25	0.75	0.75	1	0.57
2	Lighting	30	0.04	1.2	1	0.9	1.08
3	Fan	6	0.15	0.9	0.8	0.8	0.72
4	Iron	1	1	1	0.3	1	0.3

5	Blender	1	0.12	0.12	0.3	1	0.04
6	Oven	1	2	2	0.5	1	1
7	Refrigerat or	1	0.112	0.112	0.8	1	0.9
8	PC	1	0.04	0.04	0.8	1	0.03
9	boiler	1	2	2	0.4	1	0.8
10	Digital	2	0.4	0.8	0.8	1	0.64
11	Washer	1	0.375	0.375	0.3	1	0.11 3
12	water pump	1	0.25	0.25	0.3	1	0.75
13	TV	2	0.4	0.8	0.8	1	0.64