Learn To Interpret Single Line Diagram (SLD)

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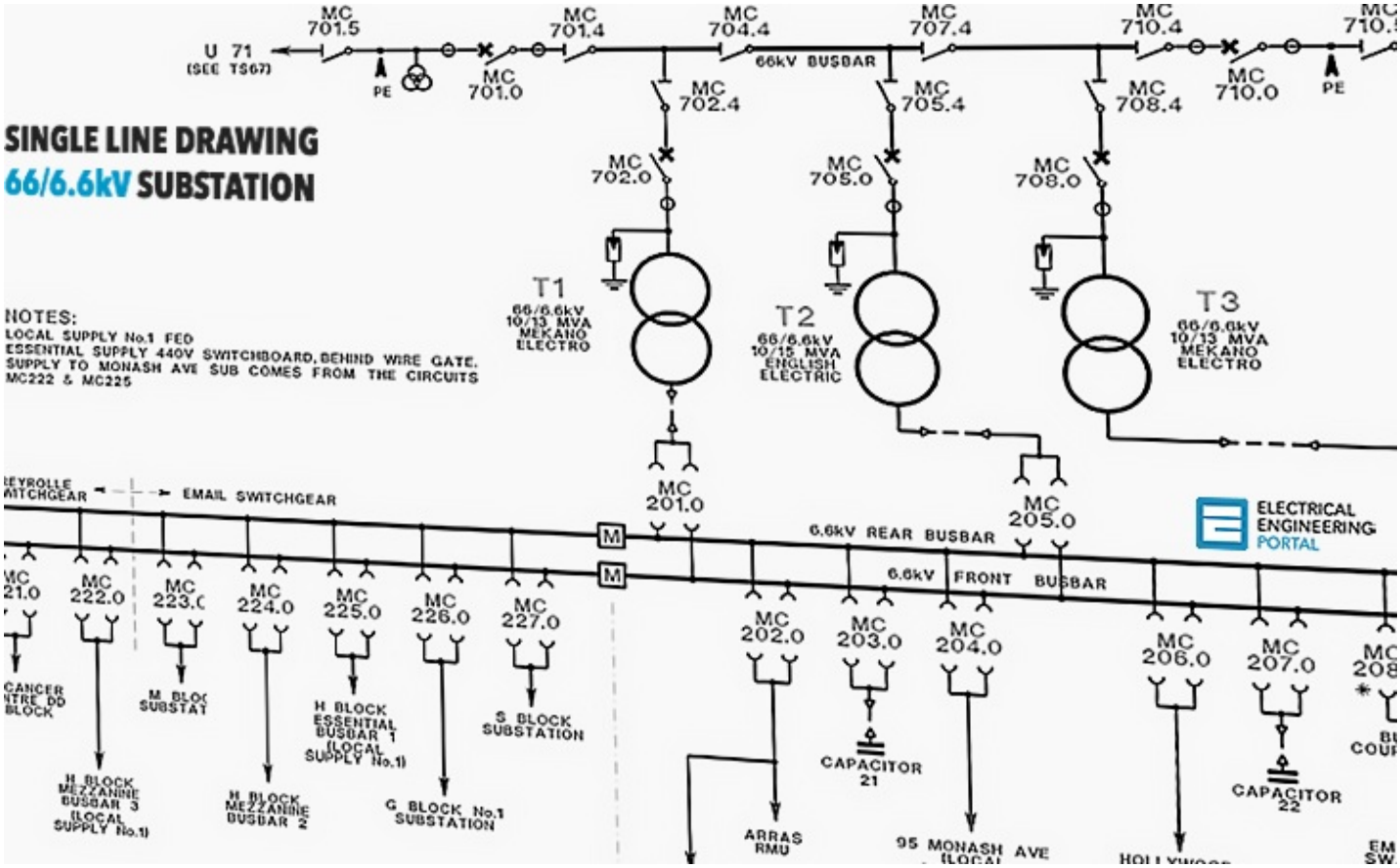


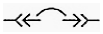
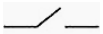
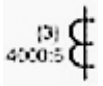
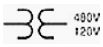
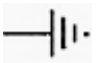
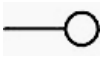
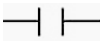
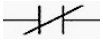
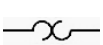
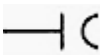
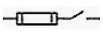
Single line diagram (SLD)

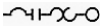
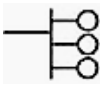
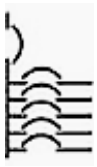
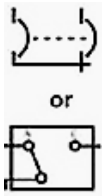
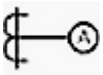
We usually depict the electrical distribution system by a graphic representation called a **single line diagram (SLD)**. A single line can show all or part of a system. It is very versatile and comprehensive because it can depict very simple DC circuits, or a very complicated three-phase system.

We use **universally accepted electrical symbols** to represent the different electrical components and their relationship within a circuit or system. To interpret SLDs you first need to be familiar with the electrical symbols. This chart shows the most frequently used symbols.

Learn To Interpret Single Line Diagram - SLD (on photo: An example of 66/6.6kV power substation single line diagram)

Individual electrical symbols		
Symbol	Identification	Explanation
	Transformer	Represents a variety of transformers from liquid filled to dry types. Additional information is normally printed next to symbol indicating winding connections, primary /secondary voltages and KVA or MVA ratings.
	Removable or drawout circuit breaker	Normally represents a MV drawout circuit breaker 5kV and above.

	Future removable or drawout circuit breaker position	Represents a structure equipped to accept circuit breaker in the future, commonly known as provisions.
	Non-drawout circuit breaker	Represents a fixed mounted low voltage circuit breaker.
	Removable or drawout circuit breaker	Represents a drawout low voltage circuit breaker.
	Disconnect switch	Represents a switch in low or medium/high voltage applications (open position shown)
	Fuse	Represents low voltage and power fuses.
	Bus duct	Represents low and medium/high voltage bus duct.
	Current transformer	Represents current transformers mounted in assembled equipment. A ratio of 4000A to 5A shown.
	Potential or voltage transformer	Represents potential transformers usually mounted in assembled equipment. A ratio of 480V to 120V shown.
	Ground (earth)	Represents a grounding (earthing) point
	Battery	Represents a battery in an equipment package
	Motor	Represents a motor and is also shown with an “M” inside the circle. Additional motor information is commonly printed next to symbol, such as horsepower, RPM and voltage.
	Normally open (NO) contact	Can represent a single contact or single pole switch in the open position for motor control
	Normally closed (NC) contact	Can represent a single contact or single pole switch in the closed position for motor control
	Indicating light	The letter inside circle indicates the color. The color red is indicated.
	Overload relay	Protects a motor should an overload condition develop.
	Capacitor	Represents a variety of capacitors.
	Ammeter	A letter is usually shown to designate the meter type (A = ammeter, V = voltmeter, etc.)
	Instantaneous overcurrent protective relay	The device number designates the relay type (50 = instantaneous overcurrent, 59 = overvoltage, 86 = lockout, etc.)
	Emergency generator	The symbol is frequently shown in conjuction with a transfer switch.
	Fused disconnect switch	The symbol is a combination of a fuse and disconnect switch with the switch in the open position.

	Low voltage motor control	The symbol is a combination of a normally open contact (switch), overload relay, motor and disconnect device.
	Medium voltage motor starter	The symbol is a combination of a drawout fuse, normally open contact (switch) and motor.
	Meter center	A series of circle symbols representing meters usually mounted in a common enclosure.
	Load center or panelboard	One circuit breaker representing a main device and other circuit breakers representing feeder circuits usually in a common enclosure.
	Transfer switch	• Circuit breaker type transfer switch • Non-circuit breaker type transfer switch
	Current transformer with connected ammeter	The instrument connected could be a different instrument or several different instruments identified by the letter.
	Protective relays connected to current transformer	Device numbers indicate types of relays connected, such as: • 67 – Directional overcurrent • 51 – Time overcurrent

Simple electrical circuit

Now, that you are familiar with electrical symbol, let's look at how they are used in interpreting single line diagrams. Below is a **simple electrical circuit**.

You can tell by the symbols that this single line diagram has three resistors and a battery. The electricity flows from the negative side of the battery through the resistors to the positive side of the battery.

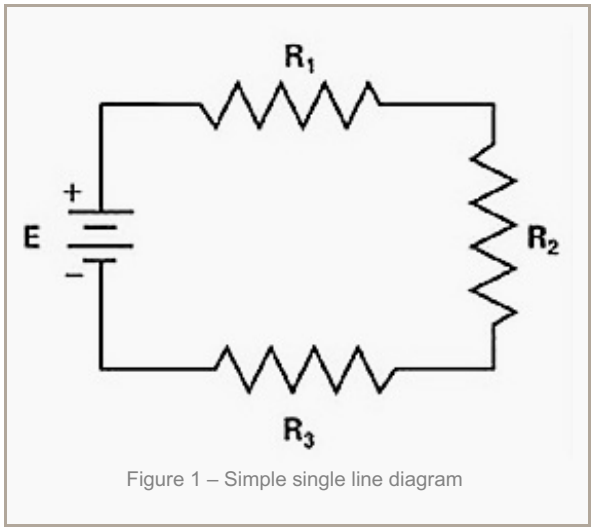


Figure 1 – Simple single line diagram

Industrial single line diagram

Now, lets go through a industrial single line diagram. When interpreting a single line diagram, you should always start at the top **where the highest voltage is** and work your way down to the lowest voltage. This helps to keep the voltages and their paths straight.

To explain this easier, we have divided the single line into three sections.

Area A //

Starting at the top, you will notice that a transformer is feeding power to the whole system. The transformer steps the voltage down from 35kV to 15kV, as indicated by the numbers next to the transformer symbol. Once the voltage has been stepped down, a drawout circuit breaker (**a1**) is encountered.

> *Do you*

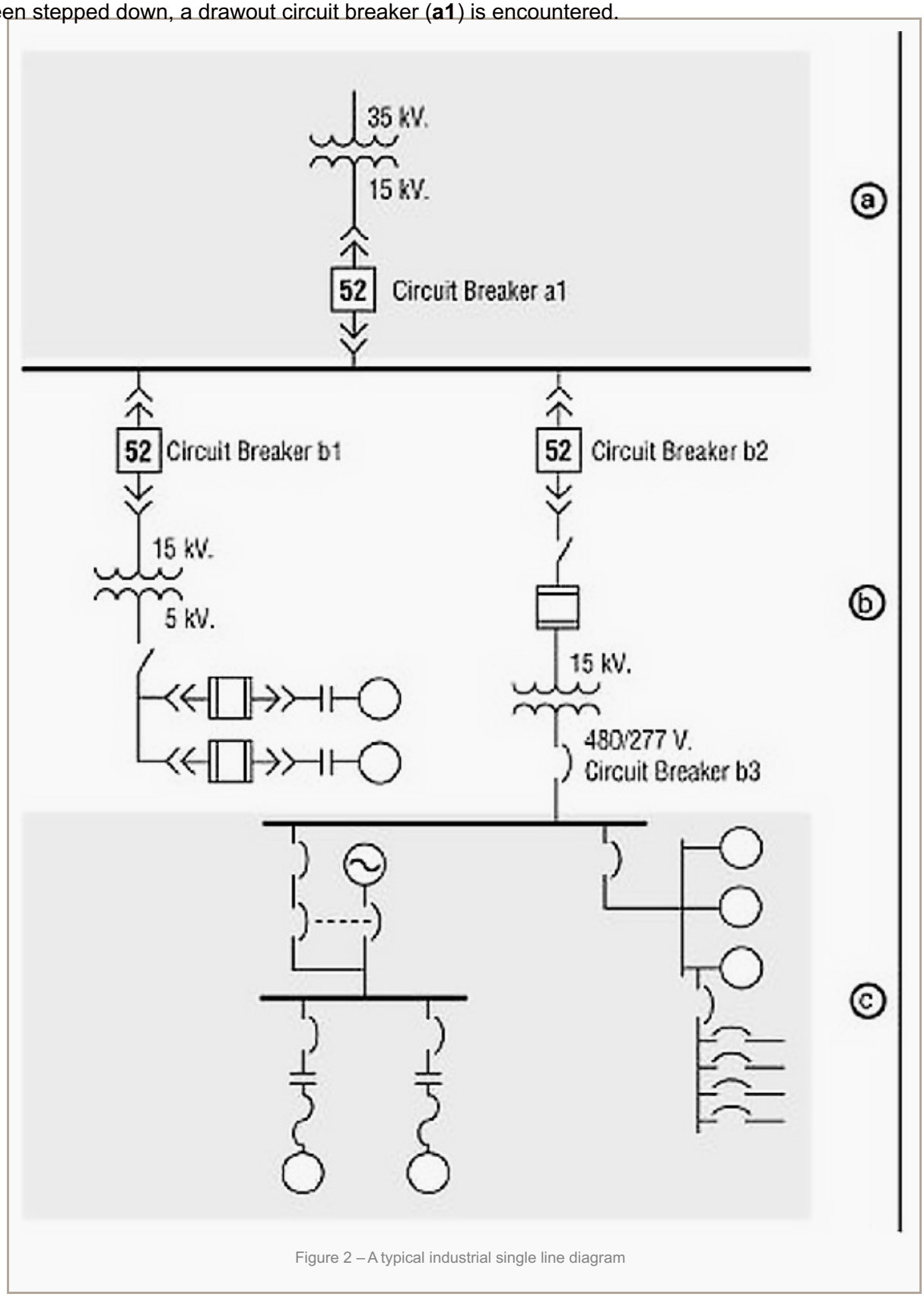


Figure 2 – A typical industrial single line diagram

> *recognize **the drawout circuit breaker** symbol?*

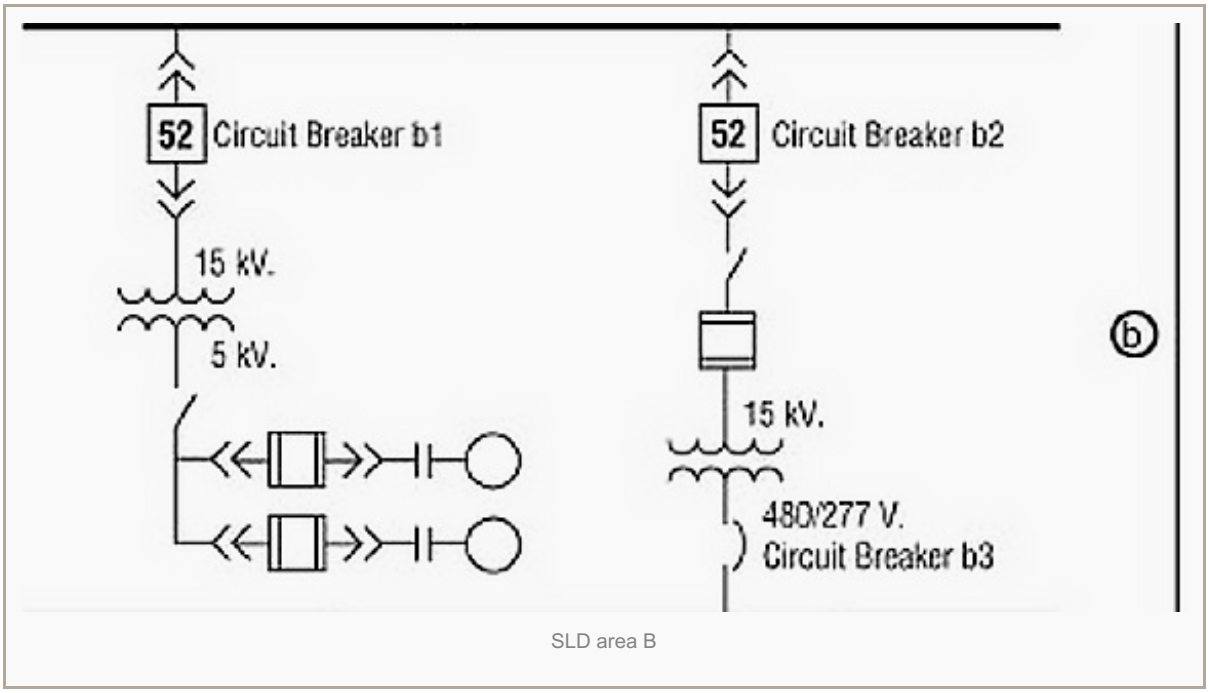
You can assume this circuit breaker can handle **15kV**, since it is attached to the 15kV side of the transformer, and nothing different is indicated on the single line diagram. Following the drawout circuit breaker (**a1**) from the transformer, it is attached to a heavier, horizontal line.

This horizontal line represents an **electrical bus**, which is a means used to get electricity to other areas or

circuits.

Area B //

You will notice that **two more drawout circuit breakers (b1 and b2)** are attached to the bus and feed other circuits, which are at 15kV, since there has been no indication of voltage change in the system. Attached to the drawout circuit breaker (**b1**), a step-down transformer is used to take the voltage in that area of the system from 15kV down to 5kV.



SLD area B

On the 5kV side of this transformer, a **disconnect switch** is shown. The disconnect is used to connect or isolate the equipment below it from the transformer. The equipment below the disconnect is at **5kV**, since nothing indicates the contrary.

> *Do you recognize the equipment attached to the lower side of the disconnect switch as being* ***two medium-voltage motor starters****?*

A number of starters could be connected depending upon the particular system requirements. Now locate the second drawout circuit breaker (**b2**). This circuit breaker is attached to a fused disconnect switch and it is connected to a step-down transformer. Notice that all the equipment below the transformer is now considered low voltage equipment, because the voltage has been stepped down to a level of **600 volts or lower**.

The last piece of electrical equipment in the middle portion of the diagram is another circuit breaker (**b3**). This time, however, the circuit breaker is a **fixed low voltage circuit breaker**, as indicated by the symbol.

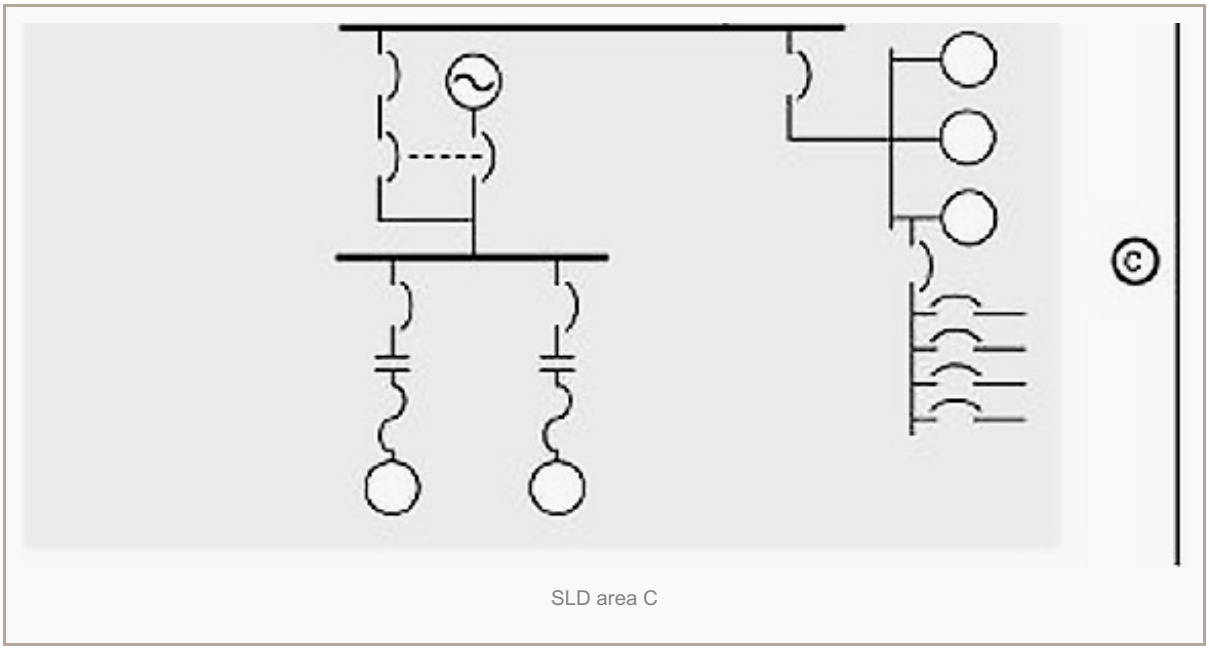
Moving to the bottom area of the single line diagram, notice that the circuit breaker (b3) in the middle is connected to the bus in the bottom portion.

Area C //

To the bottom left and connected to the bus is another fixed circuit breaker. Look carefully at the next grouping of symbols.

> *Do you recognize the automatic transfer switch symbol?*

Also, notice that a circle symbol which represents an **emergency generator** is attached to the automatic transfer switch. This area of the single line diagram tells us that it is important for the equipment connected below the automatic transfer switch to keep running, even if power from the bus is lost. You can tell from the single line diagram that the automatic transfer switch would connect the emergency generator into the circuit to keep equipment running, if power from the bus were lost.



SLD area C

A low-voltage motor control circuit is attached to the automatic transfer switch through a low-voltage bus. **Make sure you recognize these symbols.** Although we do not know the exact function of the low voltage motor control in this circuit, it is obvious that it is important to keep the equipment up and running. A written specification would normally provide the details of the application.

On the right side of the third area there is another fixed circuit breaker connected to the bus. It is attached to a **meter center**, as indicated by the **symbol formed by three circles**. This indicates that the electric company is using these meters to keep track of power consumed by the equipment below the meter center.

Below the meter center is a load center or panelboard that is feeding a number of smaller circuits. This could represent a load center in a building that feeds power to the lights, air conditioning, heat and any other electrical equipment connected to the building.

Few more words //

This over-simplified analysis of a single line diagram gives you an idea of the kind of story such diagrams tell about **electrical system connections and equipment**.

Just keep in mind that although some single line diagrams may appear overwhelming by virtue of their size and the wide variety of equipment represented, they can all be analyzed using the same step-by-step method.

***Reference** // Fundamentals of Electrical Distribution by EATON*