INSTALLATION OF 11KV/440V COMPACT SUBSTATION

[1]Imran Patel, [2]Akshay Sawant, [3]Sumit Bondre, [4]Vinit kanase, [5]Bhimrao Asolkar

[1]Lecturer, [2]Student, [3]Student, [4]Student, [5]Student

[1]Department of Electrical, [2]Department of Electrical, [3]Department of Electrical, [4]Department of Electrical, [5]Department of Electrical

[1]SSPM'S College of Engineering, India, [2]SSPM'S College of Engineering, India, [3]SSPM'S College of Engineering, India, [4]SSPM'S College of Engineering India, [4]SSPM'S College of Engineering, India

Abstract: Energy that is been generated at the generation station is transmitted to the load areas which are at far away from it. Energy generated is step up and transmitted and it is step down gradually depending on varies stages. So this every stepping down stage has a substation. So these substations are usually out door conventional substation. So here we will discuss about a distribution substation which is a prefabricated substation or a substation which is enclosed in metal enclosure. This concept has been developed taking in consideration drawback of outer door substation. So this CSS has 4 separate compartments for HT compartment, RMU unit, transformer compartment and lv compartment they are highly customizable. It is of much in metro cities and it is future of substation with benefits such as safety, low maintenance, easy monitoring, controllability etc.

***Keywords*- Ring Main unit (RMU), Compact substation (CSS), Air Circuit Breaker (ACB), Hermitically Sealed Transformer.**

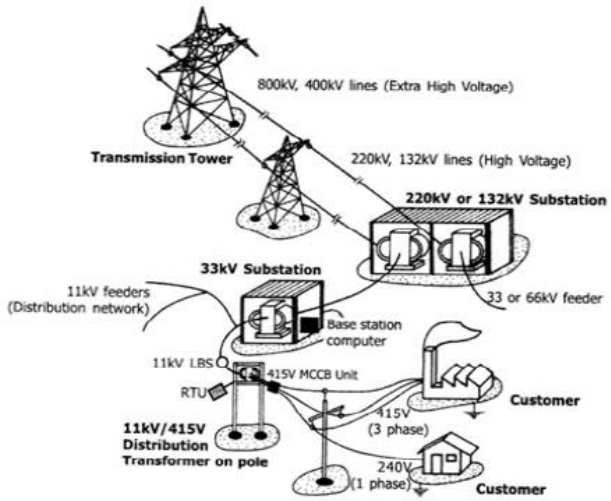
I.INTRODUCTION

As in growth of electrical engineering the power generation is important, also power transmission, distribution and utilization makes the power system complete. Generating and supplying the power electric to the user is the aim of the electrical power system. An electrical substation is a part of the electrical installation that includes the terminations of the transmission or distribution lines and switchgear, and which may also include transformers. The substation also typically includes all the necessary devices for control and protection. Depending on the function performed, it can be defined as a transforming, conversion, transmission or distribution substation. A MV/LV transformer electrical substation consists, therefore, of the set of devices dedicated to the transformation of the voltage supplied by the distribution network at medium voltage (e.g. 20 kV), into voltage values suitable for the power supply of the low voltage lines (e.g. 400 V).

The increase in electricity demand and difficulties with obtaining land for new developments introduces the challenge of building new compact substations with higher voltage ratings on existing sites. The adoption of compact Substations (CSS) permits a significant reduction in substation area. However, the growing concern of climate change makes this option less attractive because of the known greenhouse effect of SF6. The replacement of SF6 with other insulating gases that have lower environmental impact is ongoing but not yet commercially available. The aim of this research is to evaluate the possible reduction in size of transmission substations using air-insulated designs.

Electrical substations can also be divided into public and private substations. Public substations: these belong to the electricity distribution company and supply private users in single phase or three-phase alternating current (typical voltage values for the two types of power supply could be 230V and 400 V). They are in turn divided into urban or rural substations, consisting of a single small power transformer. Urban substations are usually built in brick, whereas rural ones are often installed externally directly on the MV pylon. Private substations: these can often be considered as terminal type substations, i.e. substations where the MV line ends at the installation point of the substation itself. They are owned by the User and can supply both civil users (schools, hospitals, etc.) and industrial users with supply from the public MV grid. The user must make available to the distributing company a special room, accessible to the staff of the company, in which the equipment for which the distribution company is responsible will be installed. There can be various design solutions, although in recent times the use of prefabricated substations is increasingly widespread.

Compact substation are been designed keeping an eye on problems faced in present systems. With a constant development and research over a few years in all aspects has led to tremendous improvement in compact substation. With increasing cost of land and shortage of land in few of the metro cities has led us towards designing more and more compact substation. As this substation have a lot of benefits over the existing conventional substation they are likely to be in more and more demand by end users whether it be public or private sector. Reliability, safety, capability to transport, preassembled components are few of the reasons why they are being considered over conventional substations.



II.METHODOLOGY

The fig.2 represents elementary diagram for the conventional substation, which is a pole mounted substaion. From evaluation of elctrical engineerig or electrical system there are only pole mounted or open space substaions. With change in time this convetional substation are being less benficial. To overcome the disavantages of convwtional substation this concept of prefabricated compact substation(CSS) has come into existance. In convetional distribution substation it consist of pin type insulator, ab swtch, distribution transformer, circuit breaker, lightning arrester, MV cable,LV cable, earthing. All this components are placed on H-Pole or permanent concrete foundation without control of working environment.

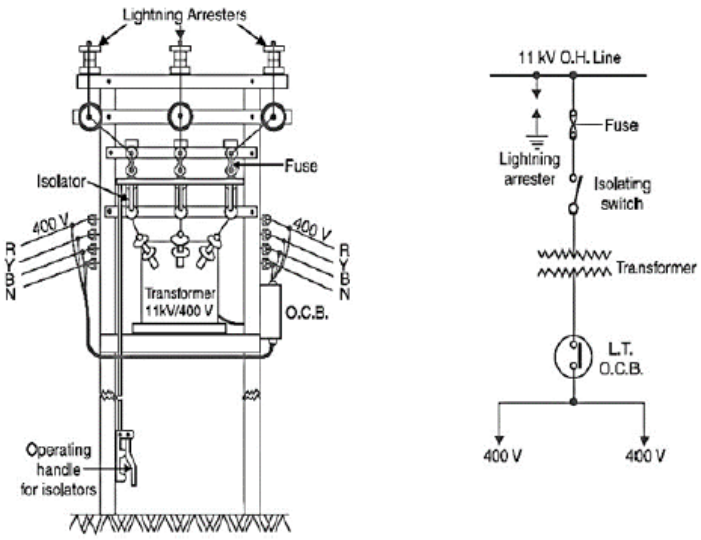


Fig 2.1 Layout and Single Line Diagram Of Pole Mounted Distribution Substation

Issues while working with conventional substaion-

1. As it is accessible to any one it reduces the human saftey.
2. Mechanical strength and stability decreases over time due to change in atmospheric condition .
3. Due anavilability of open space at centre of load it will be difficult to do such installation.
4. Monitoring and maintaince of such substation become difficult due to its wide spread.
5. There is no safety during event of fire, normal operation.
6. This systems can be tampard which is disadvantage on utility side.

III.DESIGN PARAMETERS

3.1 Prefabricated Canopy for CSS

As in the previous case of conventional substation we have seen the disadvantage that there is no control over working environment. So to overcome this metal box is been prepared. This pre-fabricated metal canopy adopts the current domestic leading technology, the shell generally adopts the galvanized steel plates, the frame uses standard container material and production craft, as good antiseptic performance which provides a better life. Equipment operation is not affected by natural climatic environment and external pollution, and it can ensure normal operation in harsh environments from -40° C to +50°C. Along with this prefabricated compact substation adopts the advanced designing idea, so appearance is beautiful and the size is optimized to be of same capacity power substation.

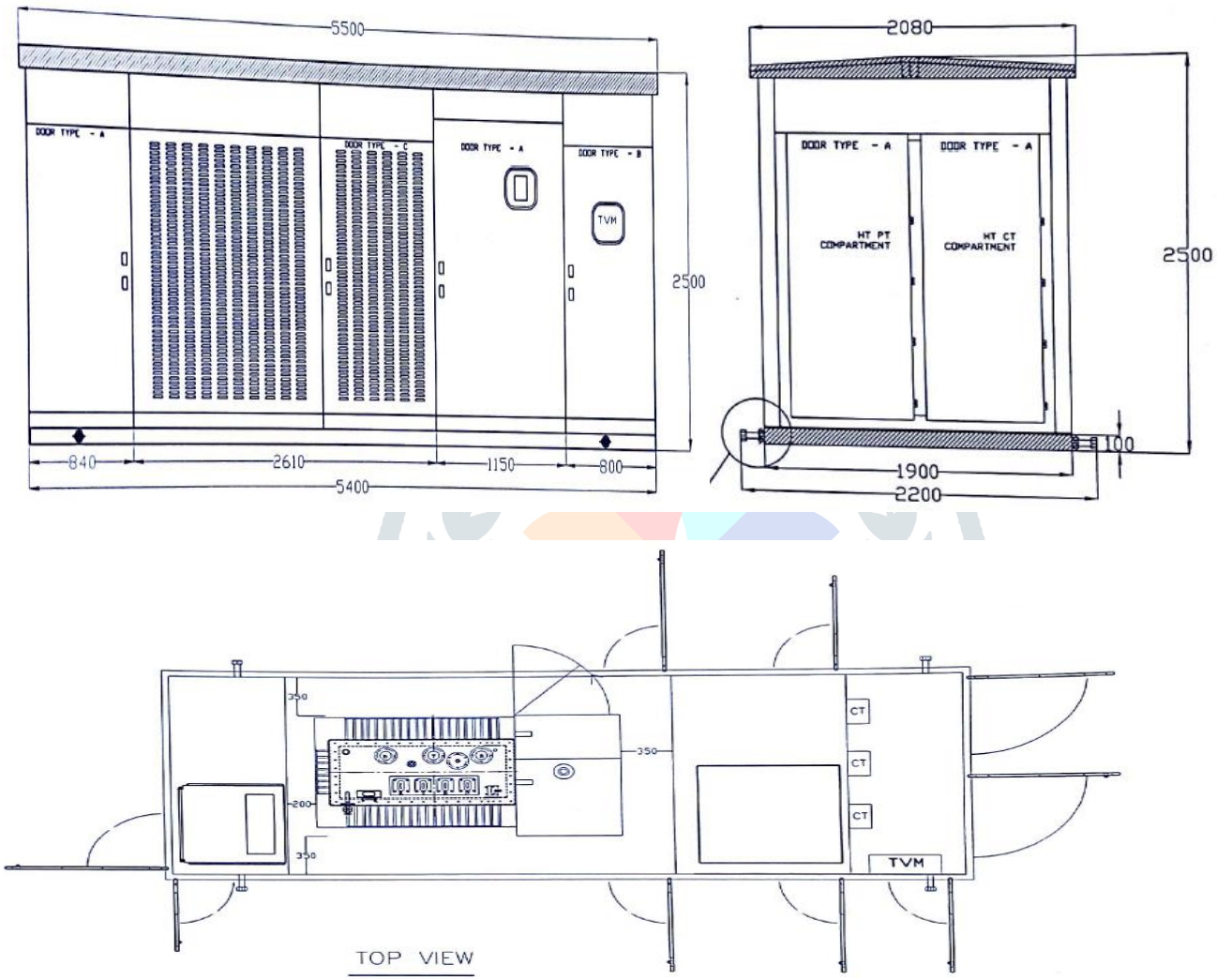


Fig 3.1 LHS view, Top view, Front View of Compact Substation

So we now see few of the benefits that this prefabricated canopy provides.

3.1.1 Reduced footprint and transportability

Modular unit substations are engineered to use as little space as possible while meeting a project's unique needs. The entire solution fits on a platform, making transportation and space requirements manageable. Structural base allows for assembled units to be lifted and transported, and easily relocated. This base also provides protection for interconnection power and control cabling and can be designed for on-board oil containment. If a mobile unit is required for fast deployment, the equipment can be mounted on a trailer base.

3.1.2 Enhanced safety and environmental benefits

A traditional overhead-fed substation often requires protective security features such as fencing to reduce potential exposure to exposed live parts. Here a pre-fabricated enclosure gives an extra benefit as all the component are able to lock from outside and only the authorized people can access the compartments. Arrangements are made such that this enclosure is breathable. So that with change in outer atmospheric temperature the inner temperature can be controlled.

3.1.3 Flexibility

An expandable design allows for a variety of equipment configurations to meet the requirements of various applications. To meet future needs, these modules can be quickly and easily connected together to form larger, more complex substations. Because modular solutions are often much more compact than traditional unit substations, multiple units may be applied without the need for dramatic investment in real estate. Additionally, multiple skid assemblies can be configured to meet physical space constraints when systems are expanded. This modular approach can help a company defer the cost of large system improvement projects by quickly allowing the addition of temporary power capacity, with the ability to support multiple projects across different locations over time.

3.1.4 Reduced Construction Time

Construction time required for this enclosure is quite less as compared to that of conventional ones. As this type of enclosure are manufactured away from actual site and in industry quality is improved as things are cross checked. And if they are to be manufactured in bulk it becomes of more ease.

3.1.5 Highly Customizable

In this enclosure arrangements can be done even after its been manufacture. Variations can be done based on selection of components. Whole unit has a high access from all the side. There is no need to open the metering compartments as the energy meters can be accessed from outside.

IV.PROPOSED SYSTEM

This system is design to overcome disadvantages of conventional substation. Here we are designing a 11kv to 440v 3phase 3 wired and 400kva distribution substation which is enclosed in in metal enclosure. As we know that this distribution substation they have to be placed at centre of the load. As it is to be placed at centre of load there may be chances that people may contact with it so taking all the safety measures in consideration for both the humans as well as the actual system safety. While designing this the major consideration or major precaution or what Electricity Board is concerned with is that is metering cubical should be sealed properly as the energy meters should stay un tampered. This system is divided into four compartments namely

1. HT Incoming compartment
2. RMU Unit
3. Transformer Compartment
4. LV Compartment

Now we will go through the whole system compartment wise in detail.

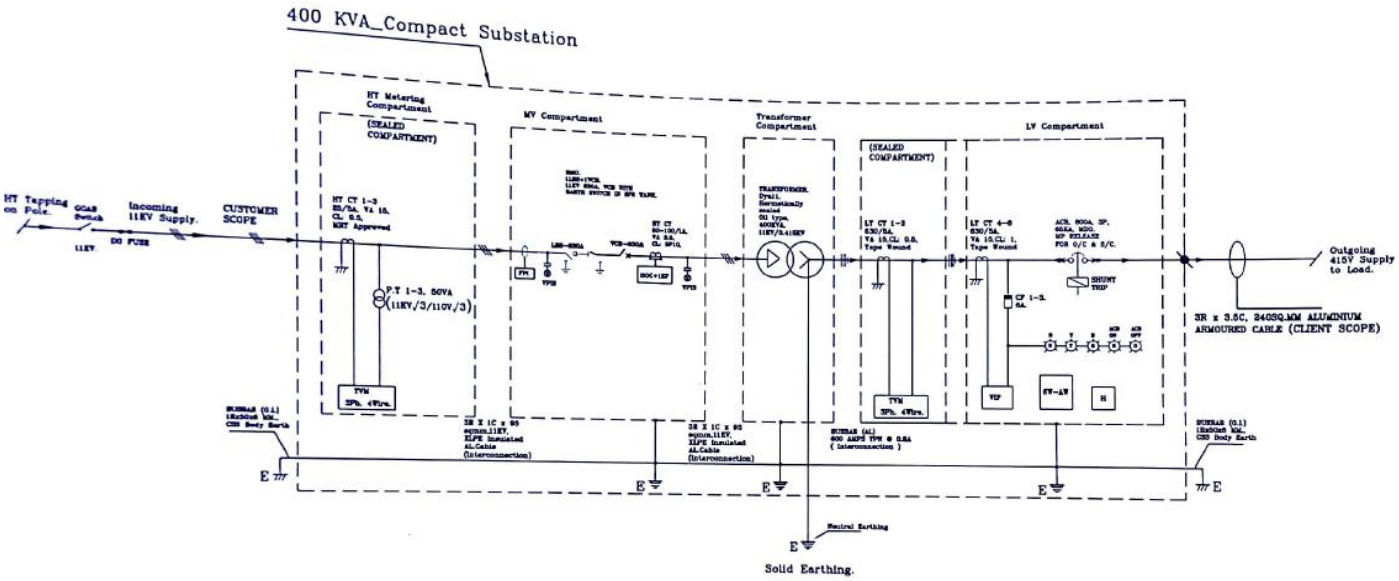
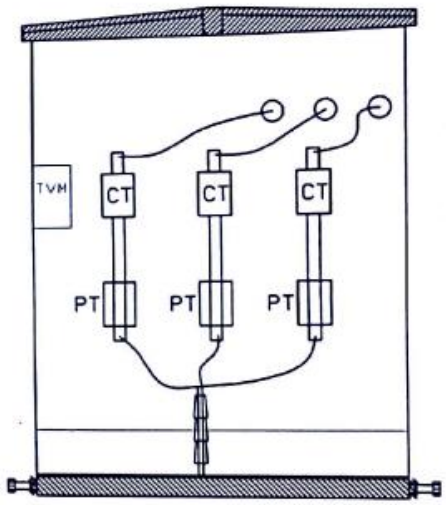


Fig 4.1 single line diagram of 11kv/440v substation

4.1 HT incoming compartment

This compartment is on the supply side from where the supply from the utility or electricity board comes. Here it's a 11kv supply that's comes into this compartment from the underground cables 3 cables from bottom termination. These incoming cables are lugged and then connected to the PT. Here the PT is (11KV/3 110v/3 50 VA). Above PT's CT's are been placed this PT's and CT's are connected using a busbar. Size of busbar is (80 * 10 MM) for phase and (80*5 MM) for neutral. Material used is for this busbar is aluminum.

Secondary terminals of PT's are been looped together and earth. While the second terminal is connected to the energy meter. Next are the CT's who have their incoming from PT's. CT's are of (11KV 25A/5A 15KVA and class 0.8). And the secondary side the outgoing is given to the RMU. Before that secondary terminals of CT's S1 S2 are given to the trivector meter. This compartment is locked from inside it has triple locking system this compartment can only be opened by electricity board. As resin cast CT and PT are used to avoid the moisture problem space heater is used which has thermostat to sense the temperature. Door limit switch is connected to a led bulb so that on opening of the compartment door the light bulb glows on.



4.2 Basic front view of HT compartment

4.2 RMU UNIT

Rmu unit is basically a switchgear unit on the ht side and before the transformer. Rmu unit consist of sf6 circuit breaker. A **Ring Main Unit (RMU)** is a totally sealed, gas-insulated compact switchgear unit. The primary switching devices can be either switch disconnectors or fused switch disconnectors or circuit breakers. In case a circuit breaker is the switching device, it is also equipped with protective relaying, either with a very basic self-powered type or a more advanced one with communication capabilities. The increase in rated voltage is handled by an increase in the insulating gas pressure**.** The figure above shows a typical RMU configuration where load disconnectors are the switching devices for the incoming cable feeders and circuit breaker works as the switching device for distribution transformer feeder. Three-position design // Closing, Opening and Earthling

All of the switching devices are of three-position design, having the possibility to close or open or earth the feeder in question.

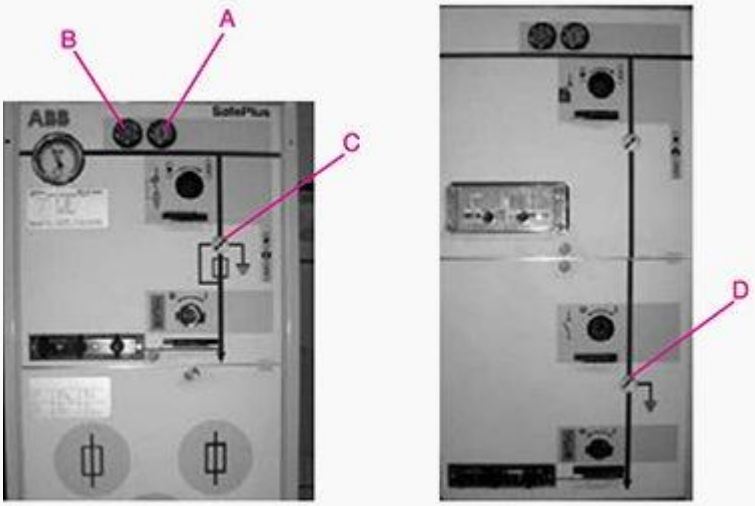


Fig:4.3 All switches can be operated with the included operating handle

Closing

Closing the moving contact assembly is manipulated by means of a fast-acting operating mechanism. Outside these manipulations, no energy is stored. For the circuit breaker and the fuse-switch combination, the opening mechanism is charged in the same movement as the closing of the contacts.

Fig: 4.4 Turn the operating handle clockwise to charge the close/open spring. Then push the green button. (A)

Opening

Opening of the switch is carried out using the same fast-acting mechanism, manipulated in the opposite direction. For the circuit breaker and fuse-switch combination, opening is actuated by:

- A pushbutton
- A fault.

Fig 4.5 Close earthing switch by turning operating handle clockwise.

4.3 TRANSFORMER UNIT

As this is a distribution substation here the voltage is being step down from 11kv to 440 v. and for this purpose oil immersed transformer is being used. This transformer is hermetically sealed oil immersed type. Also it's a 400va transformer having vector group DY. Hermetically sealed transformer is a transformer design which has no conservator. Here the dielectric insulating fluid in the transformer tank is completely sealed and is in zero contact to the atmosphere. The design avoids air in the transformer tank thereby avoiding slugging and oxidation of the dielectric fluid.

Hermetically sealed transformers are totally maintenance free and are particularly suited for use in exposed outdoor environments such as moisture, salt or dust laden atmospheres. They are used extensively in chemical plants, oil and gas terminals where poor accessibility makes regular maintenance impracticable. Transformers immersed in synthetic coolants are suitable for use indoors with adequate ventilation or near to the load center where oil would not be considered environmentally acceptable.

This transformer unit has a safety door which is called as transformer guard. To maintain the transformer compartment temperature space heater and exhaust fan are been used. Low temperature will create moisture effect on the transformer as well as the electronic components of on load tap changer. So as the temperature decreases thermostat will sense the temperature and it will give a signal to the space heater which will heat the inner atmosphere. Similarly when the temperature increases the thermostat will sense temp above 40 degree and after this exhaust fan are turned on. Doors are designed such that there is flow of air in and out of compartment.

On load tap changer is been provided with transformer it operates both manually and automatically. The transformer which is not disconnected from the main supply when the tap setting is to be changed such type of transformer in known as on-load tap changing transformer. The tap setting arrangement is mainly used for changing the turn ratio of the transformer to regulate the system voltage while the transformer is delivering the load. The main feature of an on-load tap changer is that during its operation the main circuit of the switch should not be opened. Thus, no part of the switch should get the short circuit.

4.4 LV COMPARTMENT

This compartment in on load side and the last compartment. Out coming from the secondary of transformer which is the step downed voltage of 44o v comes into this compartment using 4 bus bars. On the bus bars CTS are been placed who's output is given to the VIF meter where the voltage current and frequency are been denoted for per phase. Further this 440v is passed through an air circuit breaker which is (440v 800a) breaker.

This compartment again has a energy meter cubical which is been sealed so that no one will access it and tampering of meter can be avoided. Above the metering cubical are the indications for oil temperature alarm and breaker indication. Beside it a hutor is been placed which will give a hooting sound after the circuit breaker operates.

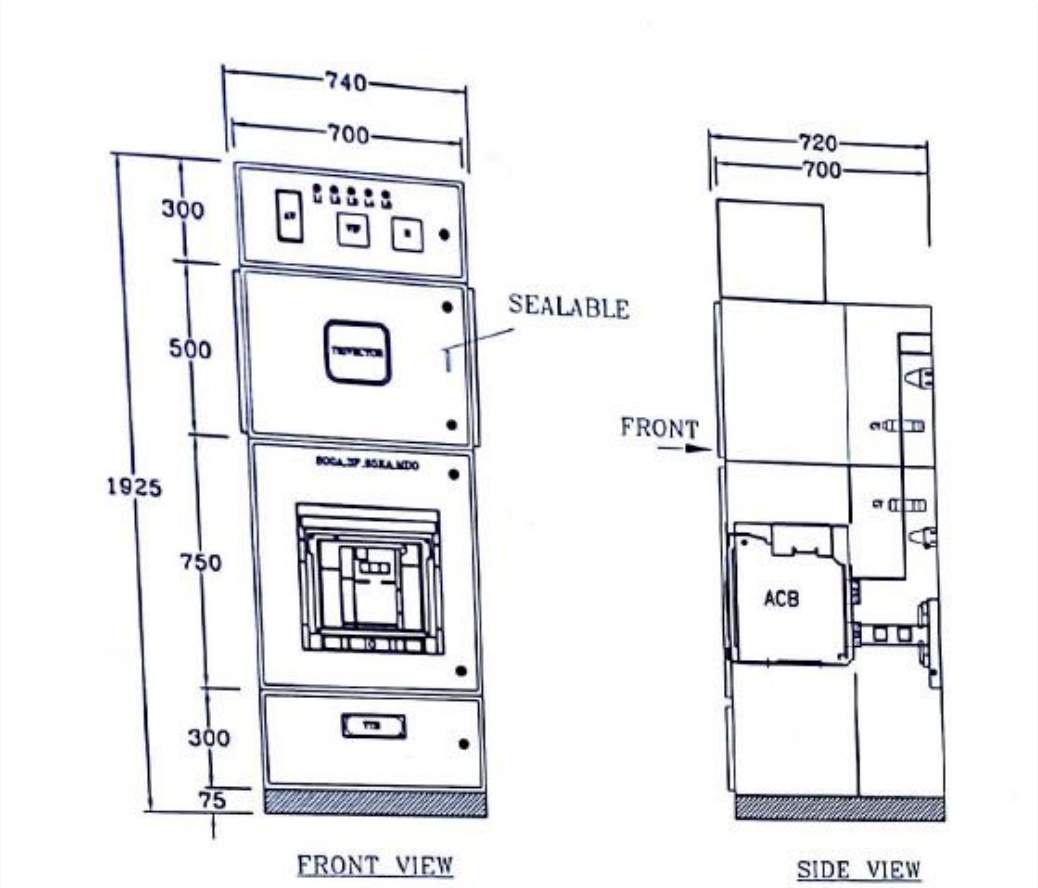


Fig 4.6 Side and front view of lv compartment.

V.CONCLUSION

Here a compact substation is being developed to overcome the existing problems with the conventional substation. Compact substation increases the safety it can be transported from one place to other. Also it can be placed in basement of buildings reducing the space problem and can be placed in the centre of load. Also maintenance cost is be reduced to large amount. Also GSM based monitoring system for transformer and billing systems can be added to this making it more effective use of OLTP maintains the smooth operation and no voltage fluctuations.

REFERENCES

1. The Electrical Engineering Handbook Series Series Editor Richard C. Dorf University of California, Davis
2. Transformer design principles By Robert M.Del Vecchio, Bertrand Poulin
3. Protection of Industrial Power Systems Second Edition By T. Davies
4. Power Supply Cookbook Second Edition By Marty Brown