INTRENSHIP REPORT
ON

FUNDAMENTALS OF TRANSFORMER MAKING AND SWITCHGEAR ASSEMBLING

BY

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Faculty of Science and Engineering

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Approved By

Academic Advisors

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Approval Letter

To whom it may concern

This is to certify that Salah Uddin Ahmed, Tanmoy Sarker, Md. Abu Talha, Sultan Mahmhud, Faisal Alam Hemel and Rakesh Chandra Ghosh having student ID 2006-1-80-007, 2006-1-80-008, 2006-1-80-010, 2006-1-80-011, 2006-1-80-012 and 2006-1-80-017 respectively have successfully completed the project work that was assigned to them as part of the internship program. We really feel proud to know about the proposal and select our organization for internship opportunities. We will arrange all kinds of possible support from our side to make the internship program successful.

07/10/2010

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POWERMANN
SUBSTATION & GENERATORS
URS ISO 9001 : 2000 Certified Company

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We are also very grateful to all of our teachers for their encouragement and cooperation throughout our Internship and academic life.

At last we were grateful to our parents for their encouragement and patience.

Executive Summary

his report is written on the basic of substation that is divided into two parts. One is transformer and nother one is switchgear. In this report we focus on various machines which are used for ansformer making and switchgear assembling. A transformer is a device that can transfer energy rom one circuit to another by electromagnetic induction. To make a transformer, one hundred and ourteen different tasks were held and we were part of it. Basically a transformer has two coils: LT low tension) coil and HT (high tension) coil.

LT coil is mainly made of copper strip wire and this wire is imported by the company from India, Japan and Singapore. Number of turns of LT coil depends on transformer power (KVA). LT coil is directly connected to the load. This is called secondary side also.

HT coil is made by two types of copper wires, one is bear copper and the one is super enable. Bear copper is not insulated, so insulation is required but super enable is insulated. In most of the cases, bear copper is used to make transformers because sometimes super enable's insulation breaks down. If the insulation breaks then the total transformer falls down. HT side is called primary side also. Two types of coil are used, spiral and disc type of coil. Spiral coil is used for (50-1000) KVA and disc coil is used for above 1000 KVA. If the disc type of coil is used then the cost becomes higher, but it has some advantages like long longevity, high insulation and cooling system is better than spiral coil.

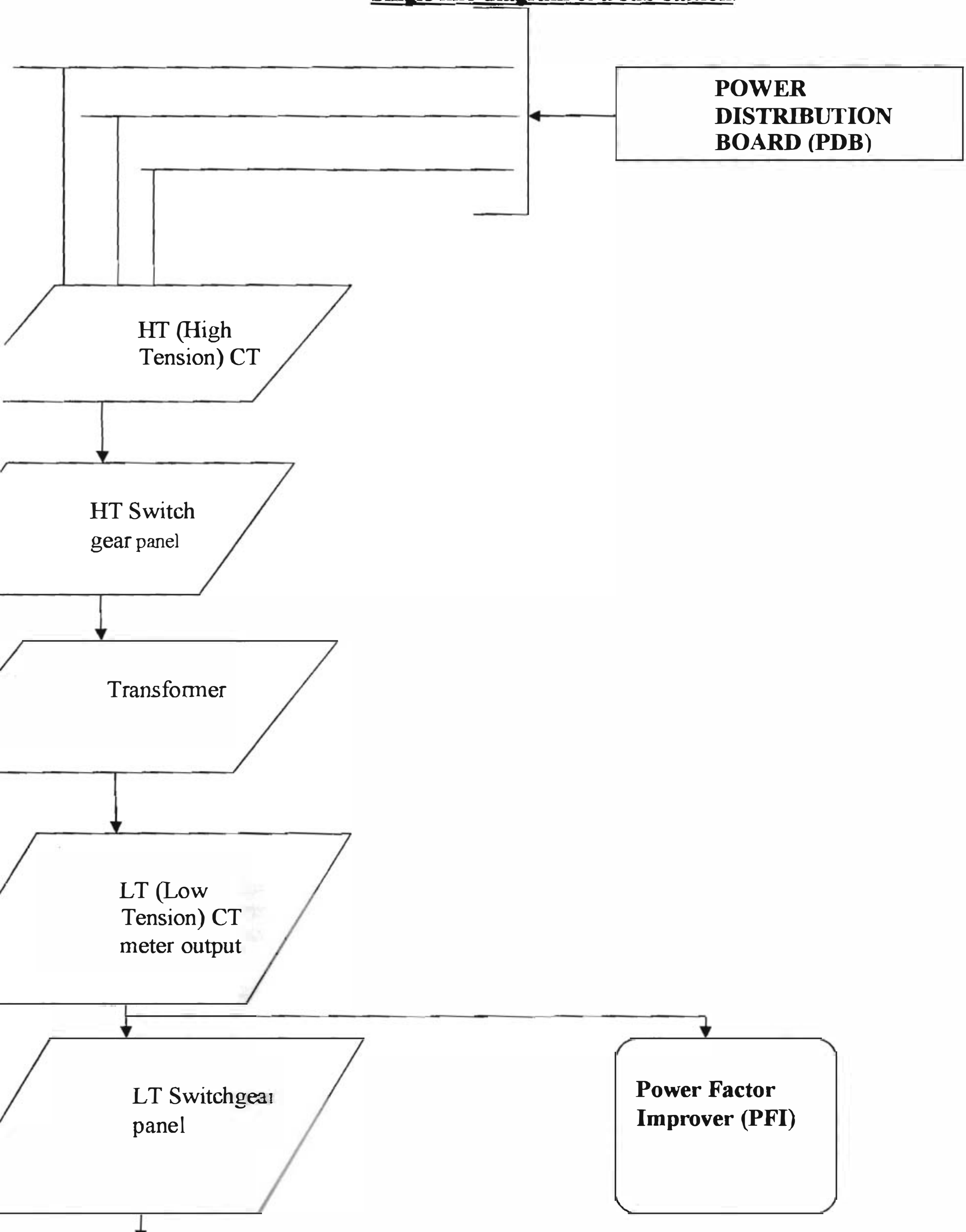
If the fault is occurred in primary side then only the primary side coil destroys but if fault is occurred in secondary side then both of the coils destroyed.

Silicon steel is used for transformer core and it is imported from Germany, Korea and Japan. Main advantage of silicon steel is it produces maximum electric field. 45 degree angle was maintained when cutting corner and diameter of the silicon steel core. Good silicon sheet thickness should be 0.20 to 0.30 mm.

Double paper coating (DPC) is used for copper insulation. Here also used burnish, black paper, page board, ampere tube and so on

When we worked in the Powermann we got the opportunity to see the entire task of making a transformer and switchgear and we completed all of the work successfully. We tried our best to learn and know everything from honorable persons of the Powermann.

Single line diagram of a sub-station.



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1. INTRODUCTION

1.1 Company Profile:

POWERMANN®
SUBSTATION & GENERATORS

URS UKAS

ISO 9001 : 2000 Certifited Company

a) Foundation:

Powermann Bangladesh Limited started manufacturing of Distribution Transformer in the year 2001 with a strong team of Transformer and Switchgear background. Powermann offer customer's complete substation and transformer is one of its key item on which the company has achieved a mile-stone on quality. Due to this the company has earned a good faith from more than thousands of Private entrepreneur and Government policy maker. Eventually the company started manufacturing of Power Transformers and keeping good example by making up to 5MVA, 33KV system. Now this manufacturing setup is ready to make up to 10/14MVA. The factory is one of the largest independent manufacturing unit for manufacturing of high-quality, custom solutions for power systems for big or small Industrial units, Commercial complexes and Government utilities. Powermann transformer factory is now one of the resourceful Engineering Setup on 20,000 SFT shaded area under 100,000 SFT land with good quality manpower, machineries and test laboratories. We have made a good team work with Overseas Transformer Experts with our local experiences of more than 20 years and highly motivated some local Professors and Engineers. This is what engineers call as TEAM POWERMANN. Though transformers are designed according to international standards and on requirements of valued customers comprising the recognized standards of IEC-76, BS-71, ANSI 57,12, VDE 0532. Powermann is developing its continuous improvement in design and using the modern production technique with latest technology and experience. Hence the most of the technological innovations is being found to come from QC Circle in Powermann Factory.

b) Management:

- CHAIRMAN: Engr. Kazi Maruf Ahmed
- MANAGING DIRECTOR: Engr. Utpal Kumar Das
- DIRECTOR: Engr. M .M. Hassan Mamoon
- DIRECTOR: Engr. Abu Mohammed Yousuf

- DIRECTOR: Engr. Arup Ratan Chowdhury

c) Philosophy:

The management philosophy of the Powermann Bangladesh Ltd is "to produce high-quality Engineering that create a positive impression and satisfy customer by applying the local technologies we have developed throughout our history with the aim of contribution to a more affluent way of life". Taking advantage of our Engineering expertise thus acquired, Powermann will continue to create impact and offer satisfaction in local markets; earn the unwavering confidence and respect of customers; enter in to global markets and ensure long-term growth; and continuously enhance corporate value well into the future. In order to enhance corporate value in this way. We consider it essential that the company cultivate a youthful corporate climate and willingness to new challenge and implement innovations; adopt an equitable personnel evaluation system that encourages employees to demonstrate their abilities as much as possible; and gain a thorough understanding of global environment protection and compliance.

d) Quality Policy:

As a consistent guarantee of the highest quality, Powermann has achieved ISO 9001: 2000 certificate in the year 2004 for all its range of transformers and other products. This certification is done by United Registrar of Systems Ltd., Uk and marked UKAS Quality Management. Regular internal & external quality audits ensure full and continuous conformity with these International standards. The same United Registrar is also maintaining the regular audits. Powermann is also started working on environmental issues. They have implemented 5S, QC Circle and TQM with fulfilled practices of dynamic work culture. In all the area of factory and offices (Head office and Branch offices) entire work-culture is maintained as per 5S (SEIRI, SEITON, SEISO, SEIKETSU, SHITSUKE) and QC Circle is bringing the talent floor field level to top level.

e) Ten Spirits of Powermann

- Working hard and aiming high.
- Serving and devoting to through Customers.
- Working with unity and solidarity.
- Co-operation in a friendly way with colleagues and clients.
- Developing through reforms.
- Seeking truth from facts.
- Depending upon fairness and honour.
- Always abiding by laws and regulations.
- Making contribution to the nation by developing industry.
- "Raise voice of customer".

1.2 Objective of the Internship

- To represent the transformer and switchgear of Powermann Bangladesh ltd.
- To elaborate the process of making a transformer and establishment of a switchgear
- To present basic mechanism of transformer and switchgear.
- To introduce some main equipment used to make transformer.

1.3 Scope and Methodology

This report is completely representing the basic making process of a transformer and establishment of switchgear. It also contains the electrical and non-electrical equipment description which is needed to make a transformer and switchgear assembling.

This report is written on the basic of two ways information collection, one is talking and discussing with technicians and employee and personal observation and another resource is company web site and manuals.

2. FUNDAMENTALS OF A TRANSFORMER

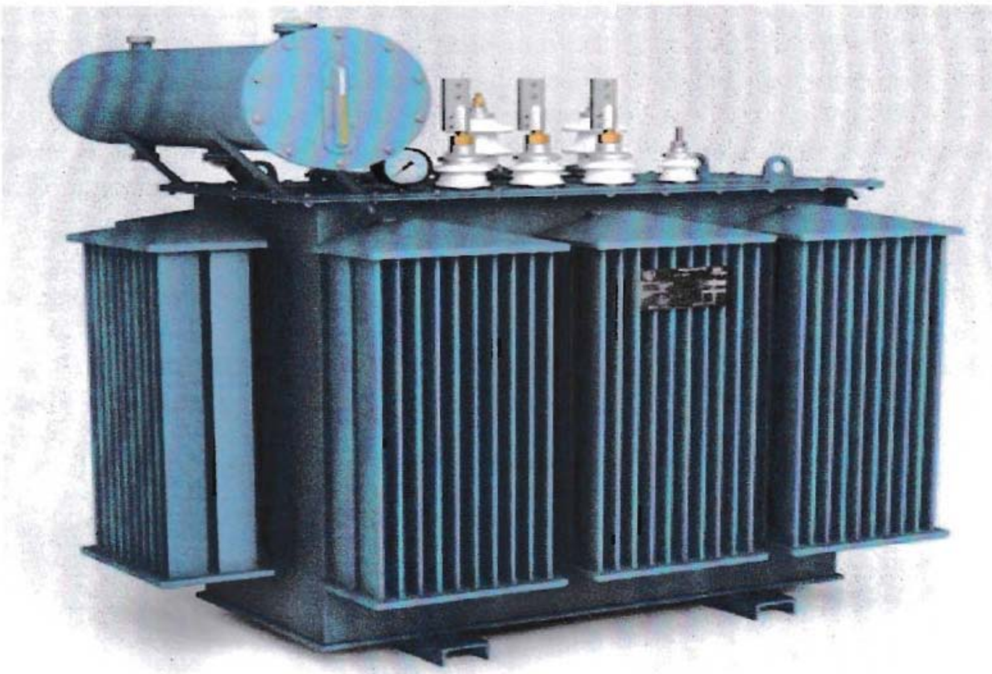

Figure 1: Transformer

The transformer is one of the most reliable pieces of electrical distribution equipment (figure: 1). It has no moving parts, requires minimal maintenance, and is capable of withstanding overloads, surges, faults, and physical abuse that may damage or destroy other items in the circuit. Often, the electrical event that burns up a motor, opens a circuit breaker, or blows a fuse has a subtle effect on the transformer. Although the transformer may continue to operate as before, repeat occurrences of such damaging electrical events, or lack of even minimal maintenance can greatly accelerate the eventual failure of the transformer. The fact that a transformer continues to operate satisfactorily in spite of neglect and abuse is a testament to its durability. However, this durability is no excuse for not providing the proper care. Most of the effects of aging, faults, or abuse can be detected and corrected by a comprehensive maintenance, inspection, and testing program.

2.1.1 Operation:

The transformer operates by applying an alternative voltage to the primary winding. As the voltage increases, it creates a strong magnetic field with varying magnetic lines of force (flux lines) that cut across the secondary windings. When these flux lines cut across a conductor, a current is induced in that conductor. As the magnitude of the current in the primary increases, the growing flux lines cut across the secondary winding, and a potential is induced in that winding. This inductive liking and accompanying energy transfer between the two windings is the basis of the transformer's operation (figure: 01). The magnetic lines of flux grow and expand into the area around the winding as the current increases in the primary. To direct these lines of flux towards the secondary, various core materials are used. Magnetic lines of force, much like electrical currents, tend to take the path of least resistance. The opposition to the passage of flux lines through a material is called reluctance, a characteristics that is similar to resistance in an electrical circuit. When a piece of iron is placed in a magnetic field, the lines of force tend to take the path of least resistance (reluctance), and flow through the iron instead of through the surrounding air. It can be said that the air has a greater reluctance than the iron. By using iron as a core material, more of the flux lines can be directed from the primary winding to the secondary winding; this increases the transformer's efficiency.

2.1.2 Winding, current and voltage ratios:

If the primary and secondary have the same number of turns, the voltage induced into the secondary will be the same as the voltage impressed on the primary (figure: 2).

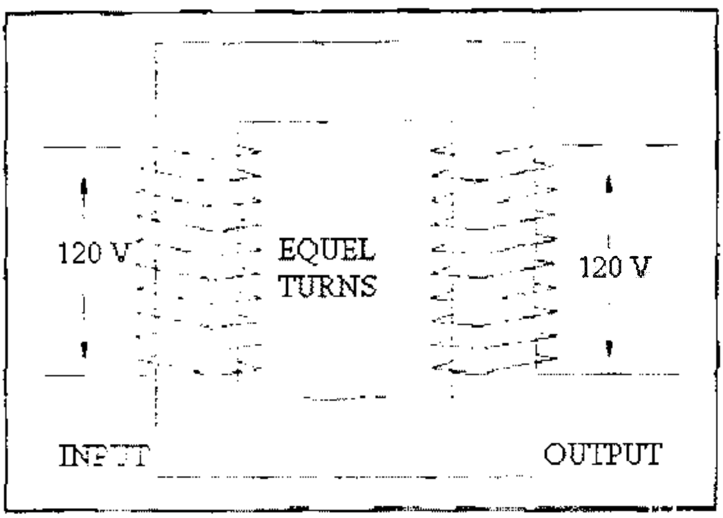

Figure 2: Transformer equal turns ratio

If the primary has more turns than the secondary then the voltage induced in the secondary windings will be stepped down in the same ratio as the number of turns in the two windings. If the primary voltage is 120 volts, and there are 100 turns in the primary and 10 turns in the secondary, then the secondary voltage will be 12 volts. This would be termed a "step down" transformer as shown in (figure: 3).

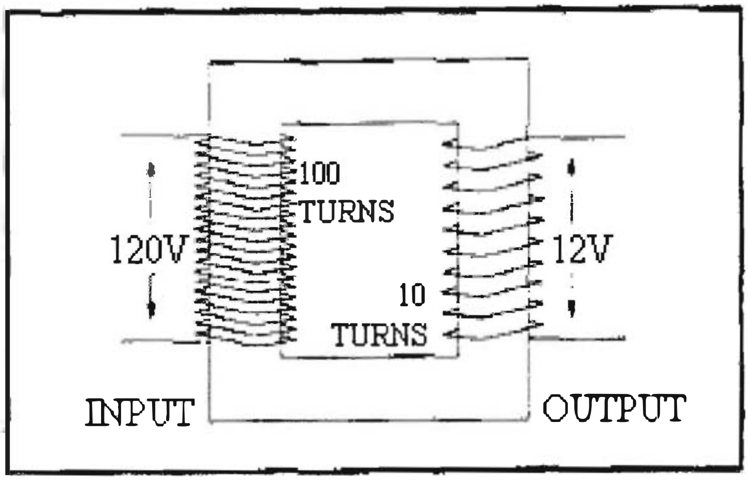

Figure 3: Transformer 10: 1 ratio

A "step up" transformer would have more turns on the secondary than on the primary, and the reverse voltage relationship would hold true. If the voltage on the primary is 120 volts, and there are 10 turns in the primary and 100 turns in the secondary, then the secondary voltage would be 1200 volts. The relationship between the number of turns on the primary and secondary and the input and output a voltage on a step up transformer is shown in (figure: 4).

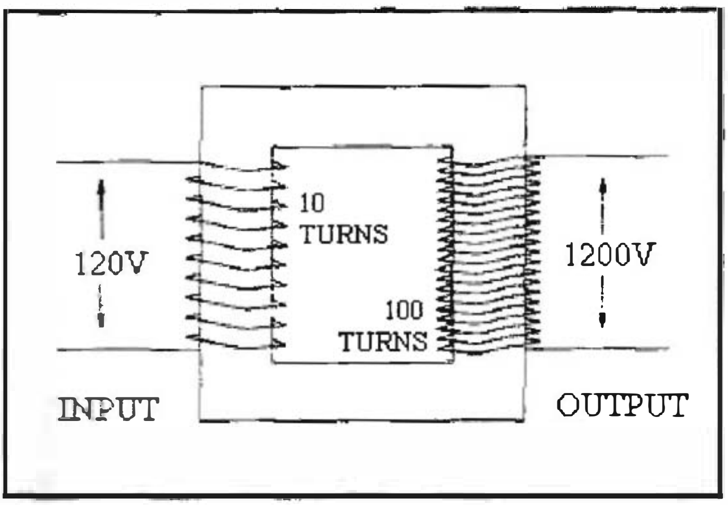

Figure 4: Transformer 1:10 turns ratio

Transformers are used to adjust voltages and currents to the level required for specific applications. A transformer does not create power, and therefore ignoring losses, the power into the transformer must equal the power out of the transformer. This means that, according to the previous voltage equations, if the voltage is stepped up, the current must be stepped down.

The amount of power that a transformer can handle is limited by the size of the winding conductors and by the corresponding amount of heat they will product when current is applied. This heat is caused by losses, which results in a difference between the Input and output power. Because of these losses and because they are a function of the impedance rather than pure resistance, transformers are rated not in terms of power (Watts), but in terms of KVA. The output voltage is multiplied by the output current to obtain volt-amps; the k designation represents thousands.

2.1.3 Induction law

The voltage induced across the secondary coil may be calculated from Faraday's law of induction, which states that:

$$V_S = N_S \frac{\mathrm{d}\Phi}{\mathrm{d}t}$$

Where V_S is the instantaneous voltage, N_S is the number of turns in the secondary coil and Φ equals the magnetic flux through one turn of the coil. If the turns of the coil are oriented perpendicular to the magnetic field lines, the flux is the product of the magnetic flux density B and the area A through which it cuts. The area is constant, being equal to the cross-sectional area of the transformer core, whereas the magnetic field varies with time according to the excitation of the primary. Since the same magnetic flux passes through both the primary and secondary coils in an ideal transformer, the instantaneous voltage across the primary winding equals

$$V_P = N_P \frac{\mathrm{d}\Phi}{\mathrm{d}t}$$

Taking the ratio of the two equations for V_S and V_P gives the basic equation for stepping up or stepping down the voltage

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

2.1.4 Ideal power equation:

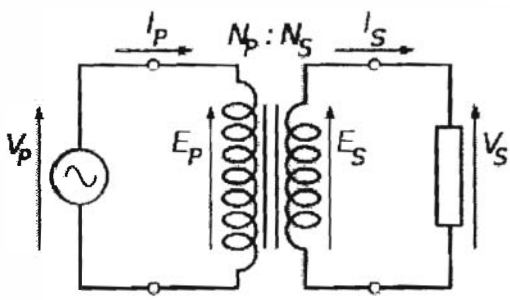

Figure 5: The ideal transformer as a circuit element

If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; all the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the incoming electric power must equal the outgoing power.

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

Giving the ideal transformer equation,

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

Transformers normally have high efficiency, so this formula is a reasonable approximation.

If the voltage is increased, then the current is decreased by the same factor. The impedance in one circuit is transformed by the square of the turn's ratio. For example, if an impedance Z_S is attached across the terminals of the secondary coil, it appears to the primary circuit to have an impedance of $Z_S\left(\frac{N_P}{N_S}\right)^2$. This relationship is reciprocal, so that the impedance Z_P of the primary circuit appears to the secondary to be $Z_P\left(\frac{N_S}{N_P}\right)^2$.

2.1.5 Effect of frequency:

Transformer universal EMF equation:

If the flux in the core is purely sinusoidal, the relationship for either winding between its rms voltage E_{rms} of the winding and the supply frequency f, number of turns N, core cross sectional area a and peak magnetic flux density B is given by the universal EMF equation,

$$E_{rms} = \frac{2\pi f N a B_{peak}}{\sqrt{2}} \approx 4.44 f N a B$$

If the flux does not contain even harmonics, the following equation can be used for halh-cycle average voltage E_{avg} of any waveshap.

$$E_{avg} = 4 f N a B_{peak}$$

The time-derivative term in Faraday's Law shows that the flux in the core is the integral with respect to time of the applied voltage. An ideal transformer would work with direct-current excitation, with the core flux increasing linearly with time. In practice, the flux would rise to the point where magnetic saturation of the core occurs, causing a huge increase in the magnetizing current and overheating the transformer. All practical transformers must therefore operate with alternating current. The EMF of a transformer at a given flux density increases with frequency. By operating at higher frequencies, transformers can be physically more compact because a given core is able to transfer more power without reaching saturation and fewer turns are needed to achieve the same impedance. However, properties such as core loss and conductor skin effect also increase with frequency. As such, the transformers used to step down the high over-head line voltages are much heavier for the same power rating than those designed only for the higher frequencies.

Operation of a transformer at its designed voltage but at a higher frequency than intended will lead to reduced magnetizing current; at lower frequency, the magnetizing current will increase. Operation of a transformer at other than its design frequency may require assessment of voltages, losses, and cooling to establish if safe operation is practical

2.1.6 Energy losses:

An ideal transformer would have no energy losses, and would be 100% efficient. In practical transformers energy is dissipated in the windings, core, and surrounding structures. Larger transformers are generally more efficient, and those rated for electricity distribution usually perform better than 98%.

Experimental transformers using superconducting windings achieve efficiencies of 99.85%. The increase in efficiency from about 98 to 99.85% can save considerable energy, and hence money. Losses in transformers vary with load current and may be expressed as no-load or full-load loss. Winding resistance dominates load losses, whereas hysteresis and eddy current losses contribute to over 99% of the no-load loss. The no-load loss can be significant, so that even an ideal transformer constitutes a drain on the electrical supply and a running cost; designing transformers for lower loss requires a larger core, good-quality silicon steel, for the core and thicker wire, increasing initial cost, so that there is a trade-off between initial cost and running cost.

Transformer losses are divided into losses in the windings, termed copper loss, and those in the magnetic circuit, termed iron loss. Losses in the transformer arise from:

Winding resistance
Current flowing through the windings causes resistive heating of the conductors. At higher frequencies, skin effects create additional winding resistance and losses.

Hysteresis losses
Each time the magnetic field is reversed, a small amount of energy is lost due to hysteresis within the core. For a given core material, the loss is proportional to the frequency and is a function of the peak flux density.

Eddy currents
Ferromagnetic materials are also good conductor and a core made from such a material also constitutes a single short-circuited turn throughout its entire length. Eddy current therefore circulate within the core in a plane normal to the flux, and are responsible for resistive heating of the core material. The eddy current loss is a complex function of the square of supply frequency and Inverse Square of the material thickness. Eddy current losses can be reduced by making the core of a stack of plates electrically insulated from each other.

Magnetostriction
Magnetic flux in a ferromagnetic material, such as the core, causes it to physically expand and contract slightly with each cycle of the magnetic field, an effect known as magnetostriction. This produces the buzzing sound commonly associated with transformers and can cause losses due to frictional heating.

Mechanical losses
In addition to magnetostriction, the alternating magnetic field causes fluctuating forces between the primary and secondary windings. These vibrations within nearby metalwork, adding to the buzzing noise and consuming a small amount of power.

Stray losses
Leakage inductance is by itself largely lossless, since energy supplied to its magnetic fields is returned to the supply with the next half-cycle. However, any leakage flux that intercepts nearby conductive materials such as the transformer's support structure will give rise to eddy currents and be converted to heat. There are also radioactive losses due to the oscillating magnetic field, but these are usually small.

2.1.7 Dot convention:

It is common in transformer schematic symbols for there to be a dot at the end of each coil within a transformer, particularly for transformers with multiple primary and secondary windings. The dots indicate the direction of each winding relative to the others. Voltages at the dot end of each winding are in phase; current flowing into the dot end of a primary coil will result in current flowing out of the dot end of a secondary coil

2.1.8 Equivalent circuit:

The physical limitations of the practical transformer may be brought together as an equivalent circuit model (Figure 6) built around an ideal lossless transformer. Power loss in the windings is current-dependent and is represented as in-series resistances R_P and R_S. Flux leakage results in a fraction of the applied voltage dropped without contributing to the mutual coupling, and thus can be modeled as reactance's of each leakage inductance X_P and X_S in series with the perfectly coupled region.

Iron losses (core losses) are caused mostly by hysteresis and eddy current effects in the core and are proportional to the square of the core flux for operation at a given frequency. Since the core flux is proportional to the applied voltage, the iron loss can be represented by a resistance R_C in parallel with the ideal transformer.

A core with finite permeability requires a magnetizing current I_M to maintain the mutual flux in the core. The magnetizing current is in phase with the flux; saturation effects cause the relationship between the two to be non-linear, but for simplicity this effect tends to be ignored in most circuit equivalents. With a sinusoidal supply, the core flux lags the induced EMF by 90° and this effect can be modeled as a magnetizing reactance X_M in parallel with the core loss component. R_C and X_M are sometimes together termed the magnetizing branch of the model. If the secondary winding is made open-circuit, the current I_0 taken by the magnetizing branch represents the transformer's no-load current. The secondary impedance R_S and X_S is frequently moved to the primary side after multiplying the components by the impedance scaling factor $(N_P/N_S)^2$.

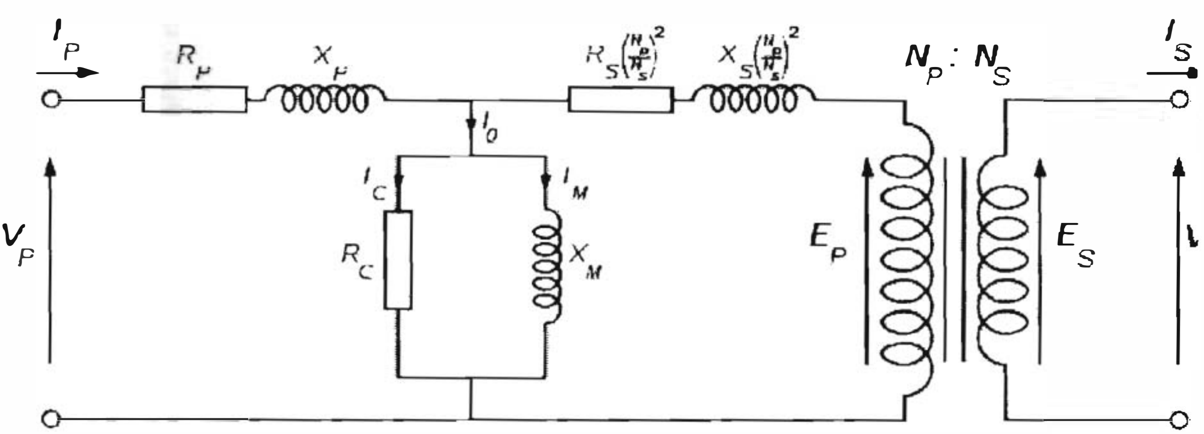

Figure 6: Transformer equivalent circuit, with secondary impedances referred to the primary side

The parameters of equivalent circuit of a transformer can be calculated from the results of two transformer tests: open circuit test and short circuit test.

2.2.1 Scope

Substation transformers can range from the size of a garbage can to the size of a small house; they can be equipped with a wide array of gauges, bushings, and other types of auxiliary equipment. The basic operating concepts, however, are common to all transformers. An understanding of these basic concepts, along with the application of common sense maintenance practices that apply to other technical fields, will provide the basis for a comprehensive program of inspections, maintenance, and testing. These activities will increase the transformer's service lie and help to make the transformer's operation both safe and trouble-free.

2.2.2 Maintenance and testing

Heat and contamination are the two greatest enemies to the transformer's operation. Heat will break down the solid insulation and accelerate the chemical reactions that take place when the oil is contaminated. All transformers require a cooling method and it is important to ensure that the transformer has proper cooling. Proper cooling usually involves cleaning the cooling surfaces, maximizing ventilation, and monitoring loads to ensure the transformer is not producing excess heat.

a. Contamination is detrimental to the transformer, both inside and out. The importance of basic cleanliness and general housekeeping becomes evident when long-term service life is considered. Dirt builds up and grease deposits severely limit the cooling abilities of radiators and tank surfaces. Terminal and insulation surfaces are especially susceptible to dirt and grease build up. Such buildup will usually affect test results. The transformer's general condition should be noted during any activity, and every effort should be made to maintain its integrity during all operations.

b. The oil in the transformer should be kept as pure as possible. Dirt and moisture will start chemical reactions in the oil that lower both its electrical strength and its cooling capability. Contamination should be the primary concern any time the transformer must be opened. Most transformer oil is contaminated to some degree before it leaves the refinery. It is important to determine how contaminated the oil is and how fast it is degenerating. Determining the degree of contamination is accomplished by sampling and analyzing the oil on a regular basis.

c. Although maintenance and work practices are designed to extend the transformer's life, it is inevitable that the transformer will eventually deteriorate to the point that it fails or must be replaced. Transformer testing allows this aging process to be quantified and tracked, to help predict replacement intervals and avoid failures. Historical test data is valuable for determining damage to the transformer after a fault or failure has occurred elsewhere in the circuit. By comparing test data taken after the fault to previous test data, damage to the transformer can be determined.

2.2.3 Safety

Safety is of primary concern when working around a transformer. The substation transformer is usually the highest voltage item in a facility's electrical distribution system. The higher voltages found at the transformer deserve the respect and complete attention of anyone working in the area. A 13.8 kV system will arc to gro nd over 2 to 3 in. However, to extinguish that same arc will require a separation of 18 in. Therefore, working around energized conductors is not recommended for anyone but the qualified professional. The best way to ensure safety when working aro nd high voltage apparatus is to make absolutely certain that it is de-energized.

a. Although inspections and sampling can usually be performed while the transformer is in service, all other service and testing functions will require that the transformer is de-energized and locked out. This means that a thorough understanding of the transformer's circuit and the disconnecting methods should be reviewed before any work is performed.

b. A properly installed transformer will usually have a means for disconnecting both the primary and the secondary sides; ensure that they are opened before any work is performed. Both disconnects should be opened because it is possible for generator or induced power to back feed into the secondary and step up into the primary. After verifying that the circuit is de-energized at the source, the area where the work is to be performed should be checked for voltage with a "hot stick" or some other voltage indicating device.

c. It is also important to ensure that the circuit stays de-energized ntil the work is completed. This is especially important when the work area is not in plain view of the disconnect. Red or orange lock-out tags should be applied to all breakers and disconnects that will be opened for a service procedure. The tags should be highly visible, and as many people as possible should be made aware of their presence before the work begins.

d. Some switches are equipped with physical locking devices (a hasp or latch). This is the best method for locking out a switch. The person performing the work should keep the key at all times, and tags should still be applied in case other keys exist.

e. After verifying that all circuits are de-energized, grounds should be connected between all items that could have a different potential. This means that all conductors, hoses, ladders and other equipment should be grounded to the tank and that the tank's connection to ground should be verified before beginning any work on the transformer. Static charges can be created by many maintenance activities, including cleaning and filtering. The transformer's inherent ability to step up voltages and currents can create lethal quantities of electricity.

f. The inductive capabilities of the transformer should also be considered when working on a de-energized unit that is close to other conductors or devices that are energized. A de-energized transformer can be affected by these energized items, and dangerous currents or voltages can be induced in the adjacent windings

g. Most electrical measurements require the application of a potential, and these potentials can be stored, multiplied, and discharged at the wrong time if the proper precautions are not taken. Care should be taken during the tests to ensure that no one comes in contact with the transformer while it is being tested. Set up safety barriers, or appoint safety personnel to secure remote test areas. After a test is completed, grounds should be left on the tested item for twice the duration of the test, preferably longer.

h. Once the operation of the transformer is understood, especially its inherent ability to multiply voltages and currents, then safety practices can be applied and modified for the type of operation or test that is being performed. It is also recommended that anyone working on transformers receive regular training in basic first aid, CPR, and resuscitation.

2.2.4 Nameplate data

The transformer nameplate contains most of the important information that will be needed in the field. The nameplate should never be removed from the transformer and should always be kept clean and legible. Although other information can be provided, industry standards require that the following information be displayed on the nameplate of all power transformers:

a. Serial number: The serial number is required any time the manufacturer must be contacted for information or parts. It should be recorded on all transformer inspections and tests.

b. Class: The class, as discussed in paragraph 4-1, will indicate the transformer's cooling requirements and increased load capability.

c. The KVA rating: The KVA rating, as opposed to the power output, is a true indication of the current carrying capacity of the transformer. KVA ratings for the various cooling classes should be displayed. For three phase transformers, the KVA rating is the sum of the power in all three legs.

d. Voltage rating: The voltage rating should be given for the primary and secondary, and for all tap positions.

e. Temperature rise: The temperature rise is the allowable temperature change from ambient that the transformer can undergo without incurring damage.

f. Polarity (single phase) The polarity is important when the transformer is to be paralleled or used in conjunction with other transformers.
g. Phasor diagrams: Phasor diagrams will be provided for both the primary and the secondary coils. Phasor diagrams indicate the order in which the three phases will reach their peak voltages, and also the angular displacement (rotation) between the primary and secondary.

h. Connection diagram: The connection diagram will indicate the connections of the various windings, and the winding connections necessary for the various tap voltages.

i. Percent impedance: The impedance percent is the vector sum of the transformer's resistance and reactance expressed in percent. It is the ratio of the voltage required to circulate rated current in the corresponding winding, to the rated voltage of that winding. With the secondary terminals shorted, a very small voltage is required on the primary to circulate rated current on the secondary. The impedance is defined by the ratio of the applied voltage to the rated voltage of the winding. If, with the secondary terminals shorted, 138 volts are required on the primary to produce rated current flow in the secondary, and if the primary is rated at 13,800 volts, then the impedance is 1 percent. The impedance affects the amount of current flowing through the transformer during short circuit or fault conditions.

j. Impulse level: The impulse level is the crest value of the impulse voltage the transformer is required to withstand without failure. The impulse level is designed to simulate a lightning strike or voltage surge condition. The impulse level is a withstand rating for extremely short duration surge voltages. Liquid-filled transformers have an inherently higher BIL rating than dry-type transformers of the same KVA rating.

k. Weight: The weight should be expressed for the various parts and the total. Knowledge of the weight is important when moving or untanking the transformer.

l. Insulating fluid: The type of insulating fluid is important when additional fluid must be added or when unserviceable fluid must be disposed of. Different insulating fluids should never be mixed. The number of gallons, both for the main tank, and for the various compartments should also be noted.

m. Instruction reference: This reference will indicate the manufacturer's publication number for the transformer instruction manual.

3 DETAILS OF INTERNSHIP WORK

On the first day of our internship, our supervisor discussed about the overall summery of the industry. We knew there are two parts of substation. The first one is transformer and the second one is switchgear. For making transformer, this company is fully self-independent but switchgear is assembled here using many imported equipments.

3.1 Manufacturing Transformer

The manufacturing processes of a transformer consist of six different sections. We have visited one section per day with a specialist. In every section, we have observed the working principle and sometimes got hands on experience. Now we are discussing about these sections.

3.1.1 Coil Section

There are two types of coil for high and low tension side of a transformer. Now we will discuss about HT coil, LT coil and disk coil.

HT coil:

Our supervisor said that Copper wire should be prepared from carbon and dust free sandpaper. Then it is made straight, which is free from bend. After that coil is insulated in several layers by DPC (double paper coated) paper using HT DPC machine (Figure: 7). A solid cylindrical forma of predetermined diameter and length is used. Finally, the coils are made in number of layers by HT coil machine (Figure: 8). The starting and finishing leads of each coil are terminated on both sides of the coil. In this part we worked practically and got help from workers.

Figure 7: DPC Machine

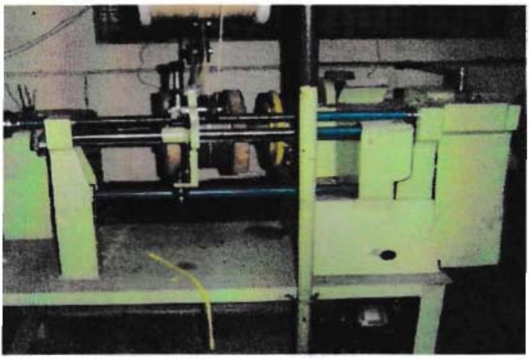

Figure 8: HT coil machine

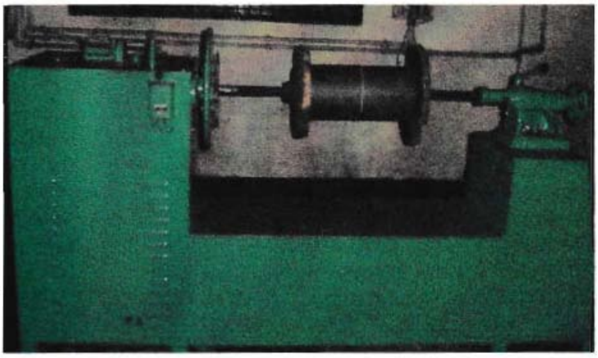

Figure 9: LT coil machine

LT coil:
From our supervisor, we have learned that for making LT coil the copper strip should be prepared from carbon and dust free sandpaper. Then it is made bend free using LT DPC machine (Figure: 9) insulated. Later a wooden cylindrical forma is being used. Finally, the coil is made into several layers depending on transformer power.

Disc coil (For high power transformer):
Disk coil is used in transformer when the range of power is above 2000KVA. During our internship, we saw the making of disk coil for 2.5MVA transformer. There are three expert diploma engineers who make disk coils. They explained, for making disk coil only copper strip is used and it is made dust free by using sand paper. Using DPC paper it is insulated. A large wooden forma is used to make a coil. Its size is pre calculated from transformer power. Starting and ending points of the coil are bended separately.

3.1.2 Core Section

The main material of core section is silicon steel sheet which is imported from India. Core is imported as a shape of rill (Figure: 10).

Figure 10: Rill (silicon steel sheet)

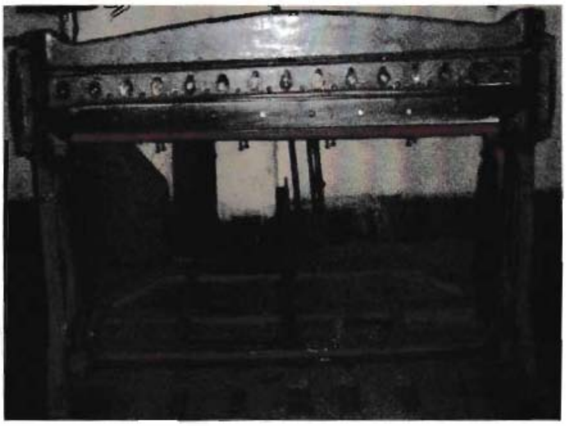

Figure 11: Big piece cutting machine

Figure 12: Small piece cutting machine

Figure 13: Corner cutting machine

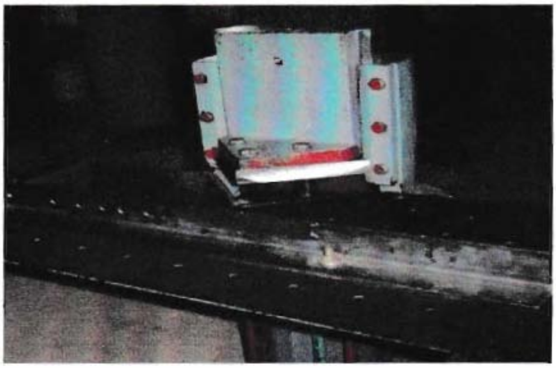

Figure 14: Benoze cutting machine

Using big piece machine (Figure: 11), silicon sheet is cut from rill to make big pieces. Then we made small pieces from big pieces using small piece machine (Figure: 12). Corner is cut of the both side of the small piece sheet using corner cut machine (Figure: 13). Corner angle is 45 degree and we tried to cut 45 degree angle. Make benoze shape using die machine (Figure: 14). Finally transformer core is assembled manually by silicon sheet (Figure: 15). Actually in this section, we have worked practically.

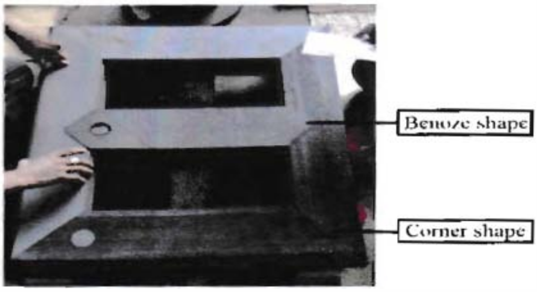

Figure 15: Core assembling

3.1.3 Tank Section

In this section we only observed because this section is totally worker biased. The body of transformer is made in this section. The raw materials of this section are steel and MS sheet. Through the head of tank section we ascertained that at first the Megger test is performed to know the quality of tank.

Figure 16: Sharing and cutting machine

Figure 17: Spot welding machine

Figure 18: Sem welding

Then Cutting of ms sheet using sharing machine (Figure: 16). After that the workers bend the sheet using Hydraulic pressure brake if necessary. Power press is used to make the shape. Then Spot welding machine (Figure: 17) is used to make the two radiator sheet. Using sem welding (Figure: 18) two radiator sheets are attached. Finally, it is set in transformer body.

3.1.4 Lathe Section

For fittings transformer needs some equipments such as Nut and bolt, Tie rod, Core bolt, Suspension rod, HT and LT rod, Die rod for using machine, HT cap, LT flans, Panja (using in HT panel phase). The raw materials of this section are copper brush, aluminum casting, iron and silver. These types of equipments are prepared by Lathe and grinding machine (Figure: 19). This section is also workers biased.

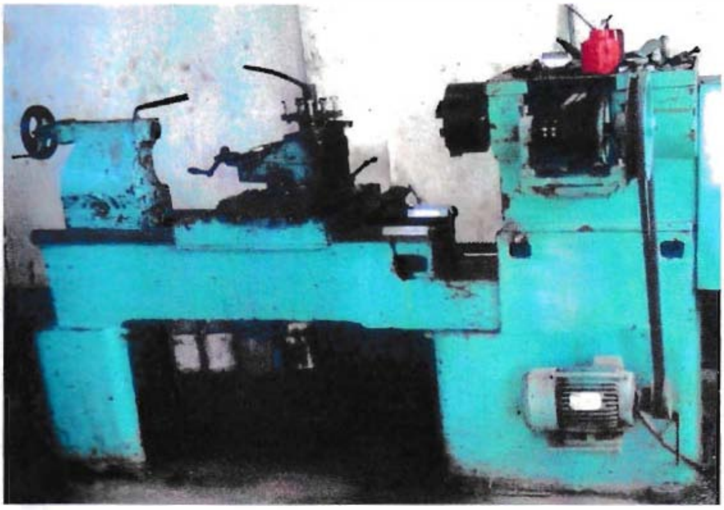

Figure 19: Lathe machine

3.1.5 Paint Section

The raw materials of this section are N.F chemical (for disgracing) (250mg N.F +2000 liter water), Astofic (3kg +2000 liter water), Phosphate, Siemens gray, Liquid color, Powder color and Red oxide (putting). We knew from the main painter that there are some precautions like Hand gloves, mask, Apron.

Figure 20: Paint section

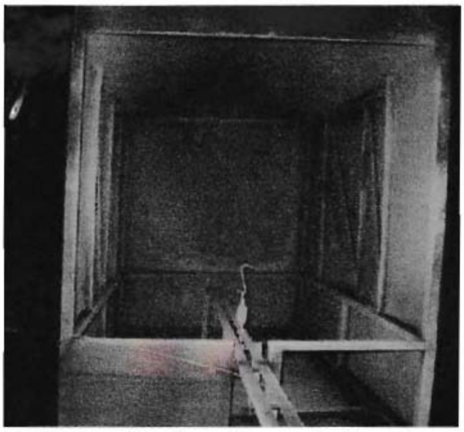

Figure 21: Powder painting box

Then we observed the whole working steps of painting section (Figure: 20). At first, oil is removed from a box using N.F chemical. Then the cleaning of box is done normally by chipping/grinding, and washing using water. The outside surface of the tank is short blasted to achieve a very fine and smooth finish. After cleaning the tanks, a coat of hot oil resistance paint is applied on the internal surface of the tank. The outside surface is painted with a coat of Red Oxide primer and subsequently with one coat of enamel paint as per customer's requirement. Using phosphate chemical to give a gray color. For removing phosphate bad smell phosbon is used. Then box is inserted in the heat chamber. Finally spray with Siemens gray in powder painting box (Figure: 21) again is inserted in the heat chamber and heating with 220 ^{0} C temperature for fifteen minutes.

3.1.6 Nickel Section

In nickel section, we have worked practically and the steps are done by us. At first, oil is removed from box using N.F chemical. The cleaning of box is done normally by chipping/grinding. And then it is sinked in strophic acid and then it is washed in water. Galvanizing process (Figure: 22) was done. Then seven color (Figure: 23) is used to color the material. After that it is inserted in nitric acid. Finally washing it by using fresh water and then dry it by gun heater which is shown in (Figure: 24)

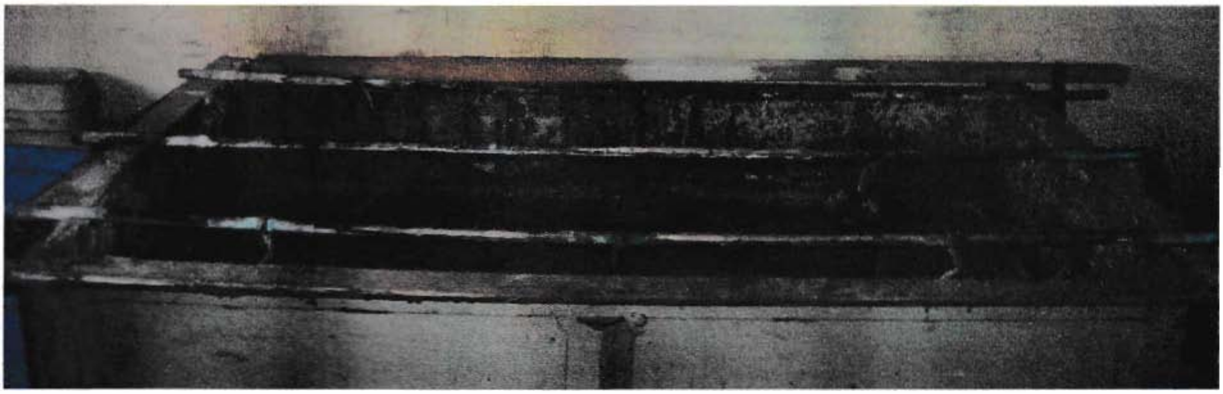

Figure 22: Galvanizing process

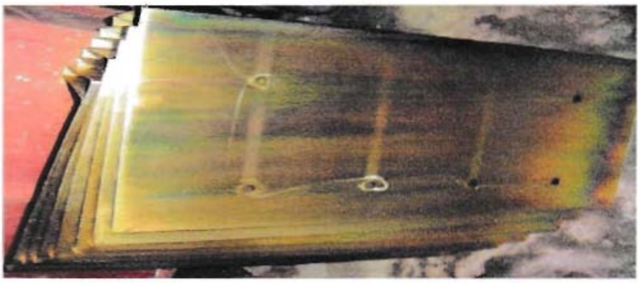

Figure 23: After seven color

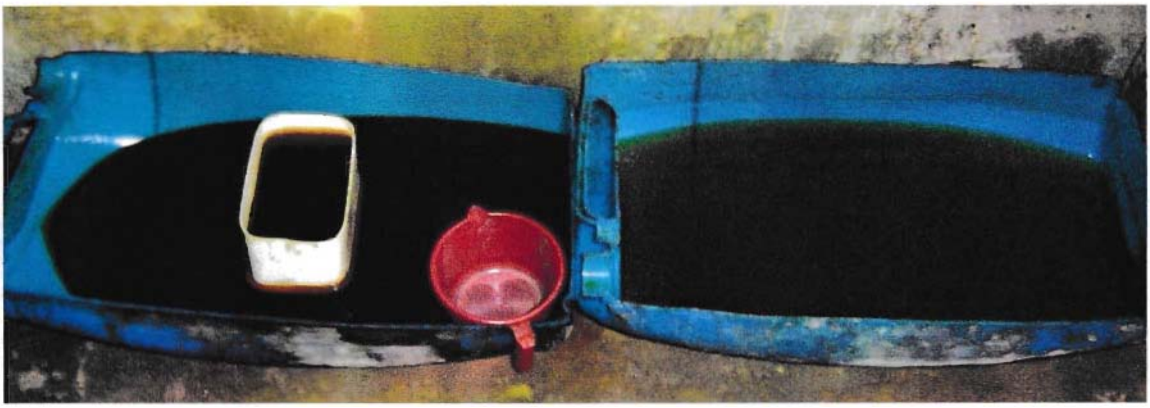

Figure 24: Seven color & water

3.1.7 Assembly Section

This is last section of transformer manufacturing. Here, we passed two days to learn the details about this section. This section is much important for fabrication of transformer. In this section, supervisor and other engineers helped us.

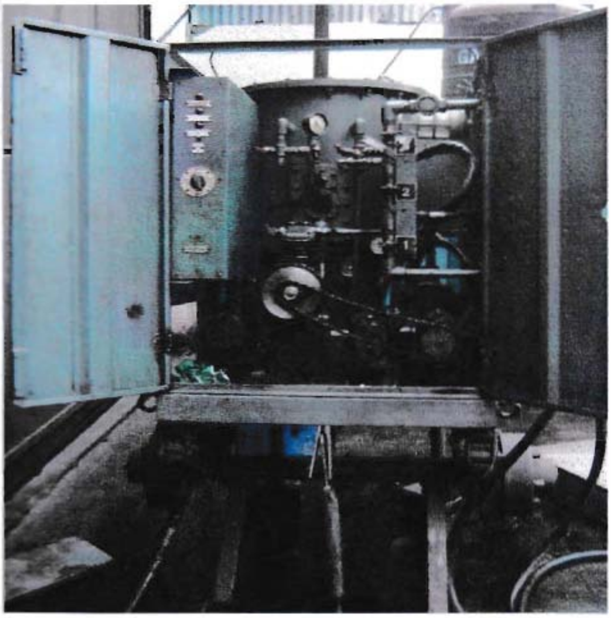

Figure 25: centrifugal machine

The working steps of this section which we observed that the components produced in the coil winding and core assembly stages are then taken into core-coil assembly stage. The core assembly is vertically placed with the foot plate touching the ground. Then the top repression of the core is removed. The limbs of the core are tightly wrapped with cotton tape and then varnished. Cylinder made of insulating press board/ pressphan paper is wrapped on all the three limbs. Low Voltage Coil is placed on the insulated core limbs. Insulating block of specified thickness and number are placed both at the top and bottom of the L.V. Coil. Cylinder made out of corrugated paper or plain cylinder with oil ducts are provided over L.V. Coil. H.V. Coils are placed over the cylinder. Gap between each section of H.V. Coils including top & bottom clearances is maintained with the help of oil ducts, as per the design/drawings. The Top Yoke is refilled. Top core frame including core bolts and tie rods are fixed in position. Primary and secondary windings (Figure: 26) are connected as per the requirements. Phase barrier between H.V. phases are placed as per requirement. Connections to the tape changer (Figure: 27) are made (2.5 percent plus and minus). By using centrifugal machine (Figure: 25) to oil warm up and moisture finally, the component is placed in the heating chamber. Then megger tested and tank up it. Fill the tank with moisture free oil and intake it. Transformer is given to test section.

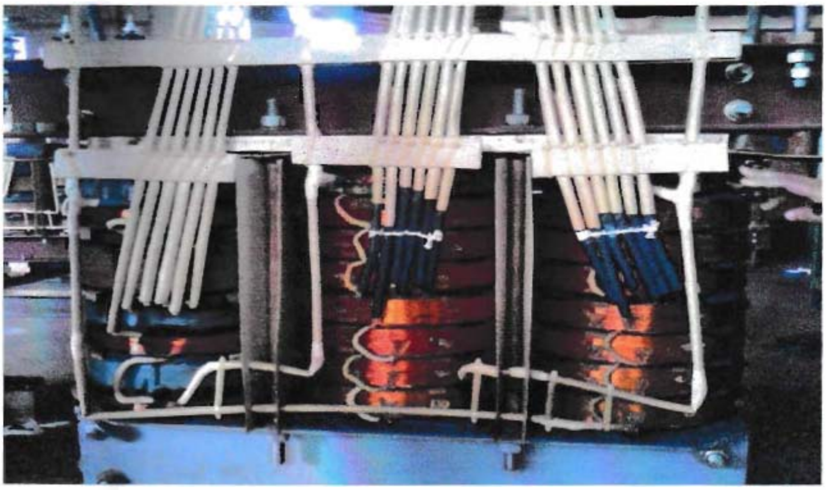

Figure 26: Delta connection

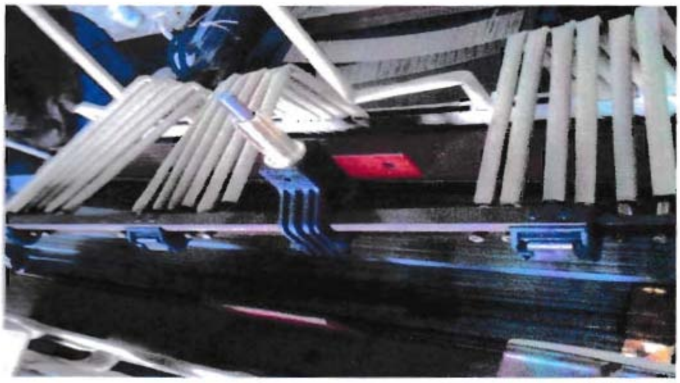

Figure 27: Tap changer

Finishing:

1 Fittings and accessories as per customer's specification and drawing are checked.
2 Air Pressure test is subjected to avoid any leakage and seepage on all transformer.
3 Transformers are filled with oil up to the minimum level marking, wherever necessary.
4 Loose accessories like, earthing terminals, bimetallic connectors; dial type thermometers are also checked for proper fittings.

3.2 QUALITY ASSURANCE DURING MANUFACTURING

Sourcing:

Punching raw materials required for manufacturing of transformer from reputed suppliers only. Most of Powermann's suppliers are also ISO certified, strict testing is done on all of the raw materials during receiving before MRR in their factory. Brass metal parts are checked on receiving stage for dimensions, tensile strength and resistance. COMEM, KAWASAKI, WE IDMANN, HYRAX, ORIENTAL is major brand of sourcing.

Magnetic Core:

The core is built with laminations of high grade grain- oriented silicon steel. The special cutting and stacking methods result in low no-load losses and noise levels. The stacked core is reinforced with bandages or with studs, treated with a layer of glue (which contributes to the low noise level) and finally with a layer of point (to protect against corrosion).

Winding:

Circular type and rectangular type windings are respectively used for relatively large or small type of transformers. Axial and radial ducts of the winding allow the liquid insulation for cooling. It caucuses uniform heat dissipation due to losses. The round conductor windings consist of individually wound coil sections connected in series to produce phase winding. Powermann uses high grade imported copper for LT winding and export quality super enamel from Gazi Wires for HT winding.

Tap Changer:

The tap changer made of high quality homogeneous insulation board or synthetic resin mould, is mounted below oil level for changing the connections of taps in primary windings.

Insulation:

Insulation papers and press boards of high quality from Wiedmann, Switzerland are used for all powermann brand transformers. The moisture content of the insulation paper is very minimum. The careful drying system removes almost all moisture from the insulation structure and finally from a complete transformer.

Service Condition:
Altitude: Up to 1000m above sea level ambient air temperatures up to 45°C.

Limits of Temperature Rise:
Above and ambient $40^{0}C$ for the windings not exceeding 60°C for the top oil.

Transformer Oil:
Transformer oil is procured from reputed manufacturers. On receipt of oil it is tested from resistivity, dielectric dissipation factor (Tan Delta), acidity, flash point, pour point, breaks down voltage and interfacial tension as per BIS & IEC. Powermann has got complete in house testing facilities for conductance of these tests. Transformer oil after filling in transformer is again tested for these tests as per BIS & IEC.

HT and LT coils:
HT and LT coils are checked for inner diameter, outer diameter, axial length, number of turns and resistance. Completed core coil assembly is checked for clearances, ratio and resistance.

Core Assembly:
Completed core assembly is checked for dimensions, air gapes and weight. Random testing is done for no load loss by putting LT coil only.

Core Coil Assembly:
Completed core assembly is checked for clearance ratio and resistance.

Bushing:
High voltage and low voltage bushing are of wet process porcelain manufactured by BISF in Bangladesh or imported from reputed manufacturer with terminals suitable for copper conductors. Both HV and LV sides are terminated with bare bushing. All the bushing is top mounted, but side mounted bushing can be provided on request.

Cable Sealing Box:
Both HV and LV bushing can be terminated in cable sealing boxes, manufactured in accordance with BS 2562 on top care. Normally distribution transformer bushings are kept top mounted without sealing.

Tanks & Radiators:
Radiator plant of powermann is the best equipped one in the country with proper press machines, seam, mig & tig welding facilities. Pressed steel radiators are tested for dimensions and leakages. Pressure tests are performed to check the leakage. After the welding process all the tanks are chemically processed in order to remove all traces of grease, rust, welding slag and other impurities. Complete tanks are tested for dimension and leakage tests.

Tanking:
Core coil assembly after drying is checked for desired insulation levels. Tested assembly is boxed up in tank and electrical clearances are checked.

Painting:

Tank is painted by a zinc riches primer coat and two finishing coats as required by the customer. Powder coated radiator is also available on request.

Accessories:
H.V bushing with terminal connectors, LV Bushing with terminal connectors, Tap chargers, Conservator tank (only for the conservator type), Lifting-Lug, Thermometer (for three phase transformer) silica gel breather for the conservator type, pressed steel radiator, name plate with connection diagram, oil level indictor, oil drain plug, earthing terminal, Buchholz relay, gate valve.

Routine test:
Powermann test laboratory is approved by BSTI, Electrical lisencing authority of energy ministry and BUET. All test instruments are kept calibrated. Though all tests and checks are done during the production process and completed transformer following routine tests are conducted. Every types of test had observed practically by us.

I. Insulation Resistance test
II. Induces over voltage test
III. Separate source voltage withstand test
   1. HV High voltage test
   2. LV High voltage test
IV. Turn ratio test. polarity and phase relationship test
V. HV and LV resistance test
VI. No load current and no load loss measurement test
VII. Load losses test at rated current and frequency
VIII. Percentage impedance
IX. Core insulation test
X. Insulation oil test
XI. Function of tape changer test

3.3 Switchgear

Powermann Bangladesh Limited has long history in improving and updating the engineering in switchgear technology. The switchgear division of the company is itself a complete unit with knowledge, experience, skills as well as machineries, machining facilities and test equipment. Their fabrication unit is one of the equipped plant with power shearing machine, modern hydraulic and power operated Bus bar bending, Punching & Cutting machines, hydraulic and power operated sheet bending machines, sem welding, mig welding, tig welding with all kind of tooling facilities. Powermann fabricated panels and boxes are most modern in facilities and uses. Powermann made EUROBOX is one of the latest distribution boxes which are equivalent to any imported quality distribution boards.

3.3.1 Quality

QC circle of switchgear division is bringing very good innovations and adding values to their products. 5S (SEIRI, SEITON, SEISO, SEIKETSU, SHITSUKE) is fully implemented here as the management has declared that Powermann factory is a 5S-Zone. ISO 9001:2000 is fully practiced to ensure. The clients of Powermann get guaranty in Transformer. Guaranty period is 18 months. Powermann also give 18 months warranty which covered any product of country.

3.3.2 General standards

1. Degree of Protection: DIN 40050/IEC-Publ.529 IP40
2. Dimension: DIN 41s488 Sheet 2
3. Routing Test of Breakers: IEC 60056
4. Routing Test of Panel along with the Breakers: IEC 60298
5. Indoor / Outdoor Compartment: IEC 60298
6. Clearance of Air and skate module Distance: DIN VDE 0660, part 500(TTA) And IEC- Pubi.439-1, DIN VDE 0160, part 100.
7. Dry Power of Capacitor(Insulating Gas filled): IEC 70

Approved by

1. BSTI, PWD, BUET, MATS,
2. Chief Electrical inspector, BPDB,
3. DESA, DESCO, REB

Certification

ISO 9001:2000(International Organization for Standardization)

3.3.3 Switchgear Products

We have just observed the switchgear panel. In his panel, all the equipments are imported from outside. After importing equipments, these are assembled in this panel. So products of switchgear panel are:

1. HT switchgear
2. LT switchgear
3. PFI
4. Control Panel
5. ATS
6. HT Metering Panel
7. LT Metering Panel
8. Change Over Switch
9. Change Over Switch

3.3.4.1 Painting

This section is same as transformer's painting section. All the panels of HT switch gear, LT switch gear, PFI plant and Distribution board are powder coated. Powermann also have High Quality Electroplating Plant for nickeling and seven colors.

3.3.4.2 Machines (Bend m/c)

Figure 28: Bending machine

A latest modern Hydraulic Press machine (Figure: 28) is used for bending, cutting and holing bus bar parallels according to measurement. We have practical experience with this machine.

3.3.5 Main feature of Panel

The main feature of this panel is mainly assembled.

3.3.5.1 Construction

1. **Metal frame:** MS Sheet.
2. **Paint:** Powder coating (siemens gray) at high temperature
3. **Bus bar:** Required rating hard drawn copper bus bar
4. **Cable:** BRB or Eastern NYY Cable, 600/1000Volts (Black)

Specification: Plain annealed copper conductor, PVC Insulated and PVC Sheathed Single cable. Suitable use for indoors, outdoors, underground and water for continuous permissible service voltage of 720/1200V.

3.3.5.2 Testing

Test Before Assembly		Test After Assembly	
1.	Circuit Breaker	1.	Wiring test
2.	CT Test	2.	Performance test
3.	Ammeter performance	3.	Continuity test
4.	Volt meter performance	4.	Insulation Resistance test
5.	Insulator	5.	Final Check up

Table 1: For LT Switchgear

Test Before Assembly		Test After Assembly	
1.	VCB/LBS/SF6/MOCB	1.	Wiring test
2.	CT Test	2.	Overall Performance test
3.	PT Test	3.	Continuity test
4.	IDMT Relay Test	4.	Insulation Resistance test
5.	Ammeter Test	5.	Final Check up
6.	Volt meter Test		
7.	Insulator Test		

Table 2: For HT Switchgear

Test Before Assembly		Test After Assembly	
1.	Capacitor	1.	Wiring test
2.	Magnetic Contactor	2.	Overall Performance test
3.	Reactive Power Controller(Relay)	3.	Continuity test
4.	Fuse	4.	Insulation Resistance test
5.	Insulator Test	5.	Final Check up

Table 3: For Power Factor Improvement (PFI) Plant

All testing are examined in factory testing lab which is directly monitored by quality controller and we have done this test practically.

3.3.5.3 LT switchgear

In this section we have only observed the connection given by the experts (Figure: 29).

Figure 29: LT panel

Basic function

- Controlling or Switching
- Protection (Over Load, Short circuit, or any Electrical Fault)
- Status reading (current, voltage, frequency)
- Power distribution

Connection

Conductor entry from top and bottom:

Type	Standard
Rated operating Voltage(V)	up to 660V,50-Hz
Rated Current(A)	up to 7200A

Table 4: Technical specification Electrical

Components	Standard
circuit breakers	up to 6300A
DOL Contactor starters	up to 400 A
A Contactor type reversers	up to 400A
Contactor type star-delta starters	up to 700A

Table 5: Rated current of components

SL no.	Equipment	Brand	Country of origin
1.	ACB	ABB	Italy
2.	ACB	Merlin Gerin	France
3.	MCCB/ MCB	ABB	Italy
4.	MCCB/ MCB	Merlin Gerin	Merlin Gerin
5.	MCCB/ MCB	Hausmann	Germany
6.	MCCB/ MCB	Siemens	Germany
7.	CT	Rise sun	...
8.	Ammeter(Analog)	Rise sun	……..
9.	Voltmeter(Analog)	Rise sun	……….
10.	Ammeter(Digital)	Inter	Turkey
11.	Voltmeter(Digital)	Inter	Turkey
12.	Digital multi functional meter	Rish master	India
13.	Copper Bus bar	……………..	……….

Table 6: Equipment Standard

Note: Powermann provides Lt Switchgear according to client's choice and mainly brand equipment.

3.3.5.4 HT switchgear

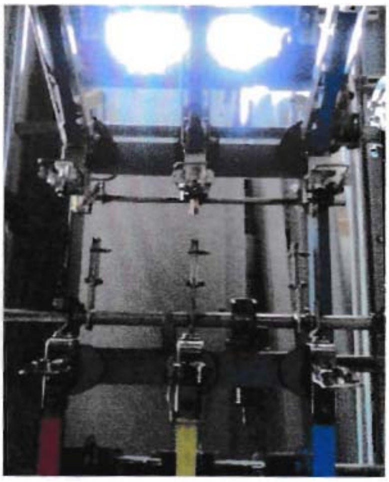

Figure 30: HT panel

Figure 31: Potential transformer

The VCB, MOCB, LBS, SF6 circuit breaker and the switchboards are of optimized design for Bangladeshi supply condition and ambient. The breaker and switchboard is of compact design, sturdy construction and simple in operation with a proven motorized spring operated mechanism.

This design ensures ease of operation, low cost maintenance and higher longevity. Powermann are also using very high quality ring main unit (RMU) suitable for highly populated city like Dhaka for multiple feeders in incoming and outgoing.

Powermann HT Panels (Figure: 30) are equipped with Built-in mechanical interlocks for safety and the breaker compartment is so designed, that it ensures the inter changeability with the identical circuit breakers. The cubical design of 12KV, 25KV, and 1250A is also compatible with their SF6 and Minimum Oil Circuit Breakers (MOCB). The panels are fully compartmentalized and extensible on both sides, consisting of bus bar chamber with adequate air clearances, PT compartment (Figure: 31), CT (Figure: 32) and cable termination compartment, breaker compartment and metering chamber.

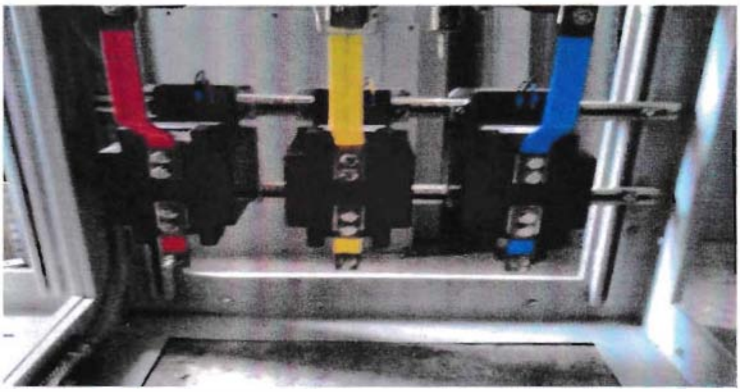

Figure 32: CT (Current transformer)

The purpose of HT Switchgear

High Tension Switchgear comprises the units designed for rated voltage of 12KV, 33KV current range 400A to 1250A. Switchgear insulation designed to withstand rated voltage is also subjected to over voltage due to lightning and breaker operation transients.

Type of HT Switchgear

FIXED TYPE

VCB/LBS/SF6 breaker is suitable for use in cubicle switchgear units. Such breaker is fixed to a switchgear or floor by bolting its base with it. If requested, fixed mounting SF6 Breaker/VCB/LBS's may be provided with wheels which will make its movement easier.
Connections between the breaker and incoming as well as outgoing bus bars are made directly and kept fixed.

DRAW-OUT TYPE

VCB/SF6 breaker is mounted on a cradle. The complete unit may be provided with a shutter of front cover. This SF6 Breaker /VCB along with the cradle can be easily installed inside a switchgear compartment without any need of mechanical adjustment.

Technical specification

Specification of HT Switchgear	VCB	VCB	LBS	SF6	SF6
	PNN10	PNN20	PNN21	PNN30	PNN31
Rated voltage	12KV	12 KV	33 KV	12 KV	33 KV
Rated Current	630A-1250A	630A	800A-1250A	630A	1250A
Short Time Current Rating for 3 sec.	20 KA	18.1 KA	20 KA	20 KA	20 KA
Basic Impulse Level	75 KV	50 KV	50 KV	75 KV	75 KV
Making Current	50 KA	50 KA	50 KA	50 KA	50 KA

Table 7: Technical specification

SL no.	Equipment	Brand	Country of Origin
1.	LBS	F&G	Germany
2.	VCB	ABB	Italy/ Germany
3.	VCB	Merlin Gerin	Merlin Gerin
4.	CT	Siemens	Germany
5.	PT	Siemens	Germany
6.	IDMT Relay	Omron	Japan
7.	IDMT Relay	GEPA	Turkey
8.	Ammeter	Rise sun	
9.	Voltmeter	Rise sun	

Table 8: Equipment Standard

Powermann always give client's priority about their brand choice.

3.3.5.5 Power Factor Improvement (PFI) Plant

In this section we have only observed the connection given by engineers and we have no practical experience with this section. Through the supervisor, we have familiar with these functions (Figure: 33):

1. Modular Design
2. Compact Arrangement
3. Low Losses Capacitors
4. High reliability
5. Factory Wired
6. Extendible

Figure 33: PFI (power factor improver)

Reactive Power

We know that reactive loads such as inductors and capacitors dissipate zero power, yet the fact that they drop voltage and draw current gives the deceptive impression that they actually do dissipate power. This "phantom power" is called reactive power, and it is measured in a unit called Volt-Amps-Reactive (VAR), rather than watts.

Essential of reactive power

Motors, transformers and other inductive loads require reactive power. Transmitting/distributing the reactive power from the power station to the loads is uneconomical. It impose undue burden on generators and transmission/ distribution system, causes additional losses, increases, voltage drop and the overall power requirement of the plant.

Economic and technical reasons thus make it expedient to relieve the generators, transmission/distribution system and able of reactive power. The automatically controlled capacitors i.e. Powermann power factor improvement (PFI) plant is well suited for this purpose.

SL no.	Equipment	Brand	Country of Origin
1.	Capacitor	Fraco	Germany
2.	Capacitor	Siemens	Germany
3.	Magnetic Contactor	Togami	Japan
4.	Reactive Power Controller (Relay)	Inter	Turkey
5	Reactive Power Controller (Relay)	Beluk	Germany

Table 9: Equipment Standard of PFI

Type of PFI Plant

1. Automatic
2. Manual
3. Auto-manual

Basic function

- Power Factor Improve

3.3.5.6 Overall panel Dimension

Equipment	SL no.	Height(mm)	Width(mm)	Depth(mm)
HT	1	2100	1050	900
	2	2100	900	900
	3	2100	850	900
LT	1	2200	900	900
	2	2000	800	900
	3	1800	700	700
	4	1600	600	600
	5	1600	700	600
PFI	1	2200	900	900
	2	1800	700	700
	3	1600	600	600
	4	1600	700	600
Metering panel(HT)	1	1350	1000	900
	2	1800	800	600
Metering panel(LT)	1	34"	24"	15"

Table 10: Panel dimension

3.3.5.7 Safety

Proper Earth (Grounding). Bus bar is in standard secured position internal power protection against electrical, mechanical and thermal stress.

4 PROBLEMS AND RECOMMENDATIONS

Coil section:

Insulation:

1. Super enamel: Super enamel is insulated by the manufacturing company, so there is a possibility to break down the insulation system due to transportation, long storage or friction.

2. Manual: Copper strip and bear copper are insulated by DPC paper by DPC machine. The possibility of break down the insulation system of DPC is less than the super enamel. Although insulation system can be broken down due to technical problem or making coil.

Core section:

Due to lack of sharpness 'babry' is occurred, if the core is assembled with babry then air gap increases, for that reason transformer creates noisy sound.

Tank section:

Tank must be heavily constructed otherwise it cannot bear the load. Due to inaccuracy of welding, leakage can be occurred, so we need to maintain full accuracy.

Paint section:

If the ratio between chemical and water is incorrect, then transformer body is affected by red-oxide. So the ratio must be maintained.

Nickel section:

The material of anode (Zn) must be pure; otherwise the metal which is used in cathode is affected by red-oxide. The ratio between water and H_2SO_4 is carefully maintained.

Lathe:

Measurement of every bolt, tie rod, panja, and suspension rod must be accurate otherwise fitting problem will be created.

Heat problem:

The major problem of transformer is heat, if we can able to minimize the heat then efficiency become high. When current flows through the transformer then the heat arises and resistance increases. To solve that we used oil in the transformer and we have to be careful so that transformer oil can circulate properly. Oil is used to cool down the transformer. Radiator is used to cool down transformer by the help of air.

5 CONCLUSION

In this report we have mainly focused on manufacturing process of substation equipments. There are two parts of substation one is transformer which is totally manufactured and another one is switchgear which is only assembled in the factory. Here we have tried to gather practical knowledge about transformer and switchgear that we have learned from theory. We have learned approximately all about transformer and switchgear. We have tried to write all about in this report .thanks all of our honorable teacher and Powermann management team, employee and worker who helped us to complete our internship successfully.

6 REFERENCES

[1]. Powermann office manual

[2]. http://www.powermannbd.net/aboutus.html