INTERNSHIP REPORT

ON

SUBSTATIONS EQUIPMENTS MANUFACTURING AT ENERGYPAC

By

MASUD RANA

TAWHID REAZWAN

Submitted to the

Department of Electrical and Electronic Engineering
Faculty of Sciences and Engineering
East West University

in partial fulfillment of the requirements for the degree of
Bachelor of Science in Electrical and Electronic Engineering
(B.Sc. in EEE)

Fall, 2010

Approved By

15.01.2011

Academic Advisor

S. M. Shahriar Rashid

Department Chairperson

Dr. Anisul Haque

Approval Letter

To whom it may concern

ENERGYPAC
এনার্জিপ্যাক

CORP. OFFICE :
JIBAN BIMA TOWER, 9TH & 11TH FL.
10 DILKUSHA COMM. AREA
DHAKA-1000, BANGLADESH
PHONE 9561883
FAX : 880-2-9563728
E-mail : info@energypac-bd.com
rabiul@energypac-bd.com

EEL/F/Admin/EWU/TR/2010-05(02)
Date: 23rd May'2010

TRAINING CERTIFICATE

This is to certify that **Masud Rana**, Bearing Roll No. **2007-1-80-019**, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. He was attended an Industrial Practice, which was programmed from 2nd May'2010 to 20th May'2010 at Energypac Engineering Ltd, Baruipara, Savar, Dhaka, Bangladesh. During his Industrial attachment he has taken some practical experience about Power Transformer, Distribution Transformer, Instrument Transformer (Both CT & PT) and Switchgear Items (LT, HT & PFI) etc.

Nothing has been recorded against his character and conduct during his attachment.

I wish him every success in life.

Fida Hasan
23/05/10

Fida Mahmood Hasan
Manager (Admin & Utility).

Acknowledgment

We had a remarkable time during our internship at Energypac. We very much acknowledge the encouragement and assistance given to us by the people at Energypac. We are very grateful to Energypac Engineering Limited for giving us the opportunity to complete our internship in their organization. We want to specifically mention Mr. Munirul Huda, who is the Sr.Engineer, EMR & QC of Energypac Engineering Ltd. for his support and guidance during the internship program at Energypac.

We are grateful to our honorable supervisor Dr Md. Ishfaqur Raza, Associate Professor, Department of Electrical & Electronic Engineering, East West University (EWU) and S. M. Shahriar Rashid, Research lecturer Department of Electrical & Electronic Engineering, East West University (EWU) for providing me much needed assistance and diluting time constraints and also to encouraging me to prepare the internship report on "Substation Equipments Manufacturing at Energypac".

We would also like to mention the name of Dr. Anisul Haque, Chairperson& Professor of the Department of Electrical & Electronic Engineering, and East West University (EWU) for being so kind during the period of my internship. Finally, We would like to thank some persons who had given us appointment from their precious time to collect related data of my report and also helped us to understand many related matters and gave their precious time to us more than once, they are Engr. Asaduzzaman, Ad.GM, Production, EELF, Engr. Asim Kumar Bhakta, Manager, Testing & Finishing, EELF, Engr. Syed Muztaba Ali, DGM, Production, EELF, Engr. Mozaharul Islam, DGM, Production, EELF, Engr. Moniruzzaman, Manager, Production, EELF, Engr. Belal Hossain, Manager, Production, EELF,

But the most of all, we would like thank the omnipotent Allah for giving the chance to complete my internship and preparing the internship report.

Executive Summary

To fulfill the requirements to be a B.Sc Engineer from East West University, we have chosen the Industrial attachment or internee. We did our internship at Energypac Engineer Ltd. Our internship title is "Substation Equipments Manufacturing". Our major area is Power. So as a Power Engineer Substations Equipments are related to our field.

At Energypac we have gathered practical knowledge about Power transformer, Distribution transformer, Instrument transformer (both CT and PT), Isolator, Breaker and Switchgear Items (LT, HT and PFI). We saw the whole process of Manufacturing of the above terms. Also testing procedure of the Equipments. Before doing this internship we have limited bookish knowledge about transformer and Switchgear. But now we have little bit strong knowledge about this Equipments comparing to before. In transformer section we saw the whole process step by step. We learnt how to test a transformer. We learnt a Special test which is Lighting Impulse. We learn what the difference between transformer and instrument transformer is and uses CT and PT. why CT and PT are used at high voltage range. Also saw the manufacturing steps of instrument transformer and Switchgear items. At switchgear part LT panel and HT panel, what types of breaker are used for LT and HT panel. Also why power factor is important and how we can improve power factor by using PFI panel. Why we used Circuit Breaker, how many types of Breaker, especially Vacuum Circuit Breaker (VCB). The uses of Isolator and manufacturing steps of it. Also we saw the paint and fabrication process of these items.

- our Acceptance Letter of industrial attachment from Ahmed Toufique Ahsan, Deputy Manager HR & Admin), Energypac Engineering Ltd. On that latter he told us to contract with Mr. Munirul ..da, Sr.Engineer, Breaker and Quality control. At 2nd may, 2010 our first day of training Mr. ..nirul Huda gave us our training Schedule.

Training schedule

Date	Section	Duration	Contract person
02.05.10 - 06.05.10	Transformer & Testing	5 days	Engr. Asaduzzaman, Ad.GM Engr. Asim Kumar Bhakta, Manager
09.05.10 – 12.05.10	Switchgear	4 days	Engr. Syed Muztaba Ali, DGM
13.05.10 – 17.05.10	CT / PT	3 days	Engr. Mozaharul Islam, DGM
18.05.10 – 19.05.10	Isolator and Breaker	2 days	Engr. Moniruzzaman, Manager Engr. Belal Hossain, Manager
20.05.10	Fabrication, CNC,M/C Shop, Power Coating & Paint	1 day	Engr. M.A. Wazed, AGM Mr. N.M. Habibullah, Dy. Manager Mr. Moniruzzaman , Asstt Engr.

Working Time: Sunday to Thursday
10:00 AM to 05:00 PM (1 PM to 2 PM Lunch & Prayer)

LIST OF FIGURES

1. Company Information and Background

1.1. Company Profile:

ENERGYPAC ENGINEERING LTD.

Vission:

We will be the most preferred business partner of our customers.

Mission:

We will provide total power solutions to enhance the business of our customers, concurrently creating better technologies that benefit both the customers and the environment.

Strategy:

Our strategic aim is to strengthen the leading position we enjoy in our markets, and to ensure continued growth. We rely on our capability to integrate and deliver solutions from our broad equipment and service portfolio which meet the specific needs of our customer segments globally. Our priority is to offer the best efficiency, reliability and value available.

Board and management:

Enamul Haque Chowdhury
Managing Director
Energypac Engineering Ltd.

Engr. Rabiul Alam
Director & CEO
Energypac Engineering Ltd.

Humayun Rashid
Executive Director
Energypac Engineering Ltd.

Test and Certifications:

test of electrical products are necessary to ensure to validate claims including recycled nt, recyclability, degradability, compostability, rapidly renewable materials, regional ials, volatile organic compounds (VOCs) content, energy efficiency, energy audits, water ency, hazardous or toxic substances, reclamation, mold resistance. For compliance of n, quality and performance, competence to sell products in local and foreign market, gypac is in continual process of testing its products in its own lab, as well as reputed utions like:

H - Central Power Research Institute, India.

T - Bangladesh University of Engineering and Technology, Bangladesh.

gypac is one of the leading power engineering companies in Bangladesh. Continual research levelopment, state of the art production facility, quality products, competent services, and rywide operations have made it warmly acceptable to the customers. Energypac was porated in 1982 as a private limited business enterprise. It is powered by 1200 skilled ower of which 150 are graduated engineers. The relentless efforts and dedication of these e are providing continual help to improve technology to innovate and develop new ucts, just in time delivery, pre and post sales services to maintain a long term business onship with the customers. To meet countrywide demand of its products and services, gypac has extensive distribution network throughout Bangladesh with full-fledged offices in ajor cities like Chittagong, Khulna, Rajshahi, Sylhet, and Bogura. In an effort to introduce oducts globally, Energypac has established its offices in India, and China. Energypac has ly experienced its products and service supply to India, Yemen, Ghana, Sudan, Uganda, ia, SaudiArabia, and UnitedKingdom.

ypac is an ISO 9001:2008 and 14000:2004 certified company. Energypac enhances the ess of its customers by providing them with complete solutions. While creating better and onmentally compatible technologies, Energypac focuses on the customer's demand with priate products and solutions as well as services.

ganization Chart of Factory:

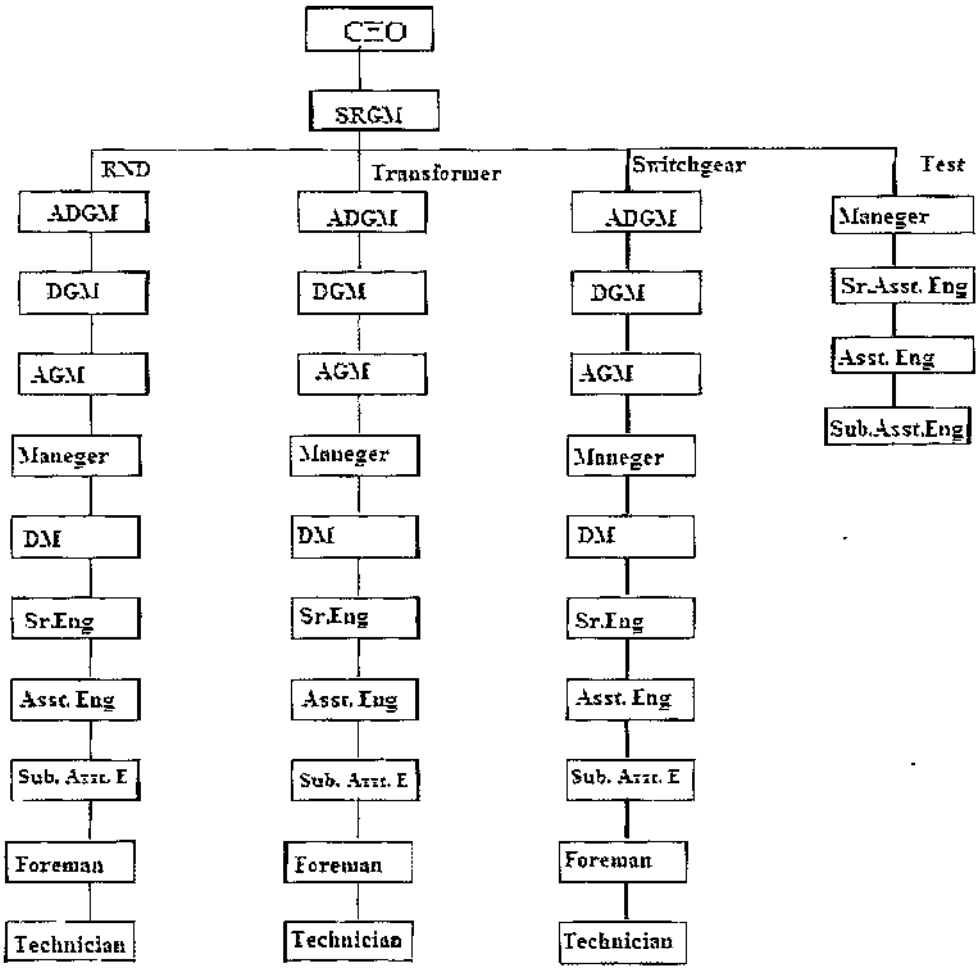


Figure 1: Company Organization Chart

1.2. Origin of this Report:

s report is based on internship program. Energypac Engineering Ltd arranges internship gram to gather practical knowledge about manufacturing of substation equipments. Which is owed by their Engineers for universities students. In this particular report, we were internee he previously mentioned program and the corresponding organization was Energypac ineering Ltd which is a prominent private and leading manufacturing company of gladesh.

1.3. Report Background:

The purpose of this report is to fulfill the internship requirement for the degree of B.Sc in Electrical and Electronics Engineering from East West University. We had started our industrial training in the factory of manufacturing substation equipments and successfully completed with lots of experiences. And based on that we prepared this report where we tried to mention every point that we gather from there.

1.4. Objective of this Report

first objective of writing the report is fulfilling the partial requirement of EEE program. In report, we have attempted to give an overview of Energypac Engineering Ltd in ufacturing substation and protection equipments. The study aims at some objectives, which as follows

- Understanding company management
- Understanding manufacturing process
- Understanding design techniques
- Understanding how Energypac Engineering Ltd runs its business
- Finding out the every risk related to Energypac Engineering Ltd
- Identifying the problems of Energypac Engineering Ltd
- Recommending how it can be solved

1.5. Methodology:

gypac is one of the leading power engineering companies in Bangladesh. The report is based econdary research

The secondary data has been collected from

1. Different papers of Company
2. Updated website of Energypac Engineering Ltd.
3. Report submitted by several internship students.

1.6. Scope of study:

The scope of organization part covers the organizational structure, background, and objectives, unctional departmentalization, manufacturing process, design strategy of Energypac ngineering Ltd as a whole and especially this report focuses on manufacturing process, design rategy of Energypac Engineering Ltd.

2. Transformer

2.1. Introduction:

In this section we were worked five days (02-05-2010 to 06-05-2010).

ansformer section our supervisor was Engr. Asaduzzaman, Ad.GM, production, EELF, Mr. luzzaman assigned an Engineer named Asif for Us.

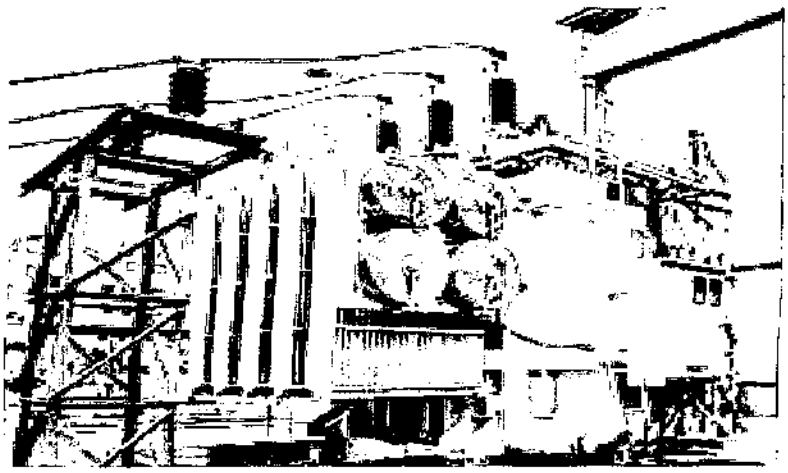


Figure 2: Power Transformer (11KV/415V)

rgypac is one of the largest company not only Bangladesh but also in south-Asia for making Sub ion Equipment. In a Sub Station Transformer is used for Step down purpose.

Energypac makes two types of transformer

1. Power Transformer up to 50 MVA
2. Distribution Transformer up to 4.5 MVA (11/0.415 kV)

They can make 50 MVA transformer but they can repair up to 75 MVA Power transformer. There next target is to make 75 MVA Power Transformer.

2.2. Transformer manufacturing process

2.2.1. Design:

To manufacture Transformer first things that you need is design. Design is based on Customer demand. Suppose DPDC and DISCO is two big customer of Energypac. Their requirements are different from one another. According to the Customer requirement the designers of Energypac design the Transformer. In designing part the designer have to design the Structure, Core diameter, insulation label, cooling system, tapping system, Coil thickness, tank and conservator.... etc many other things . Due to company privacy we don't saw the design.

2.2.2. Coil Winding:

High Voltage Coils:

H.V. Coils are the components of finished transformers. They are made on automatic layer setting winding machines. A solid cylindrical former of predetermined diameter and length is being used as hase over which is made. Generally round insulated wire of either copper (Cu) or Aluminum (Al) is used as basic raw material. The coils are made in number of layers. The starting and finishing leads of each coil are terminated on either side of the coil. These leads are properly sleeved and locked at number of points.

Low Voltage Coils:

L.V. Coils are also one of the components of transformer. The procedure of making low voltage coil is generally same as described earlier. The shape of the basic raw-material (Al or Cu) is rectangular.

2.2.3. Core Assembly:

Transformer cores are made of high permeable cold rolled grain oriented (CRGO) electrical steel insulated on both sides mostly imported from Japan, Europe, and USA. Primary consideration is to reduce no load losses, no load current and noise level- high quality core clamping bolts, channels and supports being used. In order to achieve better reduced losses and low noise levels with smaller core dimensions, core sheets produced with highly developed technologies are used. Generally, the thickness of core laminations is 0.30 or 0.23mm and it is possible or obtain better results with 0.23mm thick laser treated core sheet. CNC machinery is used for lengthwise and broadways cutting to achieve better results with these low loss core sheets.

They have used silicon steal sheet as core material. They used it because it has good conductivity so it can create strong magnetic field.

2.2.4. Core and Coil Assembly:

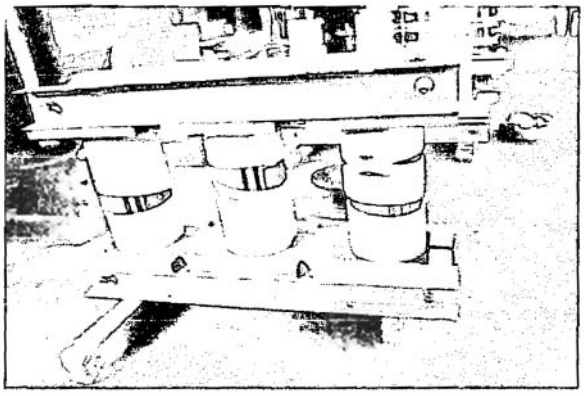


Figure 3:Core setup of Transformer

After cutting the steel sheet, with the help of iron frame the sheets are organize in such way that its ooks like a frame. From the above figure we can saw it easily. After doing this insulation tape is rolled it. The insulation tape is round it because when the transformer is in working condition then the insulation tape will compact the core for get together. The cores are made by slicing the steel sheet if any one got release from the system then it will occur an accident. Insulation:

Insulation is must for a transformer otherwise turns to turns or LT and HT Coil or Coils and transformer's body will short. To avoid this types of short or faults they have used different types of insulations. The transformer oil used in Transformer for insulation is good insulator. During our internship at Energypac a Diploma Engineer said that 2.5mm Transformer oil can block up to 60KV. Energypac imported Transformer oil foreign country like Germany, USA and Japan etc.Energypac used DPC paper for LT coil insulation which is well known as Low tension insulation paper. Energypac used caret paper for HT coil insulation which is well known as High tension insulation aper. They have also used brize board as insulation between LT and HT coil. When Tap changing oils are rolled then between two Tap there is a gap. This gap is for insulation as there is no short is ccurring and the gap can hold oil. They also used Bush as external insulation.

2.2.5. Tapings and Tap Switch:

enerally Taps are provided on HV Windings for HV Variation or LV Variation as specified by stomer. These are brought up to a gang operated switch, suitable for external manual operation d can be locked in any desired position to avoid unauthorized operation. All the moving contacts e spring loaded to ensure proper pressure and good contacts. Higher capacity transformers,

ially above 3000 KVA ratings, can be supplied with On Load Tap Changer along with necessary ols to make it suitable for manual, local electrical or remote Electrical operation. ding windings are carefully designed to keep unbalance to minimum. For large tapping range, rate regulating windings are used to maintain Ampere-Turn balance at all tap position.

Energypac used two types of Tap Changing

1. On load Tap Changing
2. Off load Tap Changing

re is another term which style Tap changing Reverse winding or Force find winding. For mple DESCO's demand is reverse winding that is there are twelve option of Tap change in per se. DPDC's demand is Force find winding that is Tap changing option will start from mid point.

2.2.6. LT and HT Connection:

nerally the Transformers that are made by Energypac either Delta to Y or Y to delta connected. If gh voltage side Delta connected then Low Voltage side Y connected and vise versa.
cording to Energypac policy some one can easily say which side contents what connection by ne plate, suppose in name plate there is a term Dyn11 that means for that Transformer High ltage side is Delta connected and Low Voltage side is Y connected.
ergypac follow another policy that is from which side HT connection come out, LT connection ne out from opposite site. This is for safety because in transformer tank there is oil, if HT and LT nection come out from one side then there is change of dielectric breakdown of oil.

2.2.7. Drying out Procedure:

transformers with voltages of 11 KV and above, drying out treatment takes place in a vacuum ing oven. The core and windings assembly is placed in oven and initially heated at 80°C for a iod during this period, heated air is circulated rapidly and the moisture laden air is bled off at quent intervals. Vacuum is then applied, and heating of the core and windings assembly is tinued simultaneously. The mixture of air and moisture that is extracted is passed through a denser and collected in the form of water which is measured and recorded. The end point of ing process is decided by the measurement of dispersion factor, insulation resistance, tan-delta,

ıd the collection of water.

or bigger transformers, 25 MVA and above, Core coil assembly along with tank are in the oven and ter completion of heating cycle, hot, degassed oil is then allowed into the transformer tank under acuum. This oil is then circulated through the transformer and the oil deggassing plant until all gas apped in the core, windings, and the insulation is removed. This ensures a high degree of stability ı the insulation structure and early attainment of its mature condition, which would not otherwise be chieved until the transformer had been in service for some time.

2.2.8. Transformer Tank Construction:

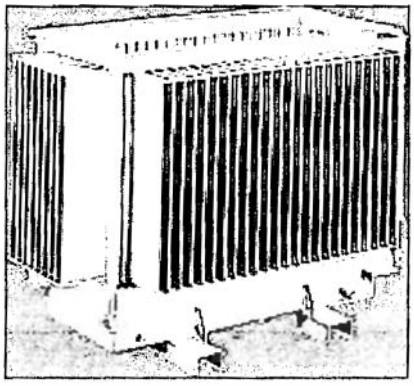


Figure 4: Transformer tank

All tanks are made of high quality steel and can withstand vacuum as specified by the international standards and the customer. All welds are tested, ensuring 100% leak proof of seems and mechanical strength. Transformer with Corrugated Fin-Type radiators can also be supplied. The fins are manufactured of Gold-rolled steel. The fin height and length are according to customer's specifications and fins can be plain or embossed. All transformer tanks are given a smooth finishing by using the "SHOT BLASTING" process. Here "SHOT BLASTING" process is done by an automatic machine.

2.2.9. Terminations:

Terminals to suit Customer's requirements can be provided. Outdoor bushings are normally provided for the HV & LV terminals. HV outdoor bushings are supplied with arcing horns as standard. Air insulated and compound filled cable boxes, with or without disconnecting chambers, can be provided to suit customer's specification. The terminals of our transformers can be made suitable for heat shrinkable cable termination system.

2.2.10. Painting :

The entire procedure of painting of Energypac is done under two stages:

1. Cleaning of tanks
    - The cleaning of tank is done normally by chipping/grinding.
    - The outside surface of the tank is short blasted to achieve a very fine and smooth finish
2. Painting of tanks
    - 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.

2.2.11. Tanking up:

Figure 5:Transformer Tanking up

The core-coil assembly and tank supplied by the fabrication department are taken into tank-up stage. The procedure is:

- The core-coil assembly is taken out of the oven or vacuum dry plant.
- The tanks, supplied by fabrication department are brought to tank-up department duly painted.
- Fittings like drain valves, HV& LV Bushings, conservator, oil level indicator and explosion vent are fitted in the tanks.
- The Core-coil assembly is then placed into the tank and properly locked up.
- Pure filtered transformer oil is filled in the tank to immerse the assembly only.

- Connections of primary and secondary to the terminal bushings are made. Operating handle for ratio switch is fitted, wherever required.

2.3. Some important steps that Energypac follow during Manufacturing:

2.3.1. Mechanical Design:

Energypac follow a mechanical design when they design a transformer. The Center of mass of three phases and the Center of mass of whole transformer must be at same point otherwise the transformer will explore.

We know, W=F*S W=Work, F=Force, S=Separation (or Distance).

If the centre mass are at same point then S=0 that means W=0. Otherwise it stretch pressure on transformer body then the transformer must explore.

2.3.2. Different size of LT and HT winding:

To keep same Center of mass of the Transformer they used different sizes of HT and LT Coil. In general they kept HT coil is bigger then LT coil.

2.4. Protection:

Protection is for safety. There are some protection systems that Energypac used in transformer.

2.4.1. Cooling:

Figure 6:Cooling System of Transformer

ONAN: Oil Natural Air Natural

ONAF: Oil Natural Air Force

In transformers, the cooling has a special importance to ensure safe operation and to increase the lifetime of the transformer. The heat occurred in the transformers is dissipated at the cooling unit by the help of oil. The simplest and mostly used cooling system is ONAN (Natural Air Cooling with

rs). ONAF (Radiators Additionally Cooled by Fans) cooling system, in which cooling air is
o the radiators by fans, is also used.

2.4.2. Thermal Protection:

ıal protection they used a thermometer to detect the temperature of oil and winding. There
types of thermal protection

- Oil Temperature Indicator (OTI)
- Winding Temperature Indicator (WTI)

ometer shows the actual oil temperature, alarm and trip signals are provided as protection
over loading and as per requirement of transformer.

2.4.3. Gas insulation relay:

ac used Buchholz Relay as gas insulation relay.

lz Relay detects the internal faults and the insulating liquid loss, the alarm contact in the
loat design signals oil leakage and/or gases, while a trip contact is activated in the event of
alfunctions. Energypac provide Buchholz relay as to customer's requirement.

2.4.4. Bushing:

ac provide outdoor bushing as per customer requirement. Outdoor bushing is for insulation
nd LT. The Bushing length depends on the length of HT and LT terminal.

2.4.5. Oil Level Indicator:

ed for insulation so the oil is not proper level then the does not work properly. According to
ac there is an indicator that's indicating the oil level inside the transformer. Also they
the oil quality. If the quality of oil decreases in a certain level then they refine the oil.

2.4.6. Silica Gel:

ansformer design in Energypac, they use silica gel for purifying or drying the air that goes in
ervator tank of the transformer. A transformer literally, breaths through the conservator tank
of the thermal expansion of the insulating oil inside. The oil that goes inside the conservator
olated by a deprogram inside the conservator to avoid contact and contaminating the oil. As
Breather (silica gel) are used to absorb the moisture content from the sucked air, while the
ıer oil gets expanded due to heating. Breathers make use of silica gel colored with brown
ensively in power transformers. When its absorb moisture its colour change and become

2.5. Test:

2.5.1. Introduction:

Energypac is the only private company probably in Bangladesh, who got certificate from foreign country for their testing. Here is the list of Energypac's certificate

1. **CPRI** - Central Power Research Institute, India
2. **BUET**- Bangladesh University of Engineering and Technology, Bangladesh Energypac are in

There are several steps of testing that Energypac follow:

1. In Process test:
    a) Magnetic Balance Test
    b) Excitation Current Test
    c) Vacuum Test
2. Routine test:
    a) Resistance Test
    b) Turns Ratio Test
    c) No-load loss Test
    d) Full load loss test
    e) High Voltage Test
    f) Double Voltage double frequency Test
    g) Vector group Test
    h) Di-electric strength of oil Test
    i) Induced overload Test
    j) Tap changer
3. Type Test:
    a) Lighting Impulse Test
    b) Temperature rise Test
4. Special Test:
    a) Tan Delta Test
    b) FRAX Test

n general Energypac doing the above listed test but during our internship we can not saw all of hem. Here we write only the tests that we saw during five days at transformer sections.

2.5.2. Magnetic Balance Test:

The Magnetic Balance test is conducted on Transformers to identify inters turn faults and magnetic mbalance. The magnetic balance test is usually done on the star side of a transformer. A two phase supply 440V is applied across two phases, say, 1U and 1V. The phase W is kept open. The voltage s then measured between U-V and U-W. The sum of these two voltages should give the applied voltage. That is, 1U1W + 1V1W will be equal to 1U1V.

For instance, if the voltage applied is 440V between 1U1V, then the voltages obtained can be

$$1U1V = 1U1W + 1V1W$$

$$440V = 260V + 180V$$

The voltages obtained in the secondary will also be proportional to the voltages above. his indicates that the transformer is magnetically balanced. If there is any inter-turn short circuit that may result in the sum of the two voltages not being equal to the applied voltage.

2.5.3. Measurement of winding resistance:

This test measures the resistance of the HV & LV winding. The values of resistance should be balance for all three phases and should match the designed values.

Equipment used: Digital resistance meter.

2.5.4. Measurement of insulation resistance:

Measures the insulation resistance of HV & LV windings with respect to earth (body) and also between LV & HV winding.

Equipment used: insulation tester OR Mugger is used.

2.5.5. High Voltage tests on HV & LV:

This test checks the insulation property between Primary to earth, Secondary to earth and between Primary & Secondary.

HV high voltage test: LV winding connected together and earthed. HV winding connected together and given 28 KV (for 11KV transformer) for 1 minute.

LV high Voltage test: HV winding connected together and earthed. LV winding connected together and given 3 KV for 1 minute.

Equipment used: High Voltage tester (100KV & 3KV)

Here the term High Voltage means the Voltage which is 2.5 times of rated Voltage.

High Voltage = 2.5 * Rated Voltage

2.5.6. Double Voltage double frequency:

This test checks the inter turn insulation.

For an 11KV/433V transformer, 866 Volts are applied at the 433V winding with the help of a Generator for 1 minute. This induces 22KV on 11KV side. The frequency of the 866V supply is also increased to 100HZ.

Equipment used: MOTOR GENERATOR SET

2.5.7. Turns Ratio:

This test is also called Voltage ratio test.

This test measures the voltage ratio as per the customer's requirement.

$$\frac{V1}{V2} = \frac{N1}{N2}$$

The voltage ratio is equal to the turn's ratio in a transformer. Using this principle, the turn's ratio is measured with the help of a turn's ratio meter. If it is correct, then the voltage ratio is assumed to be correct.

Equipment used: Turns Ratio meter.

2.5.8. Measurement of No load loss & current:

The iron losses and no load current are measured in this test. The 433V winding is charged at 433V supply & the 11KV winding is left open .The power consumed by the transformer at no load is the no load loss in the transformer. Effect of actual frequency must be taken into account

Equipment used: Wattmeter's or power analyzer.

2.5.9. Lightening Impulse Test:

Actually during our internship we don't saw this test but we learnt some theoretical knowledge about this type test of transformer.

This is a type test so within 1000 transformers only 5 (Five) or 6(Six) transformers is done this test. All the dielectric tests check the insulation level of the job.

- Impulse generator is used to produce the specified voltage impulse wave of 1.2/50 micro seconds wave.
- One impulse of a reduced voltage between 50 to 75% of the full test voltage and subsequent three impulses at full voltage.

- For a three phase transformer, impulse is carried out on all three phases in succession. The voltage is applied on each of the line terminal in succession, keeping the other terminals earthed.
- The current and voltage wave shapes are recorded on the oscilloscope and any distortion in the wave shape is the criteria for failure.

2.6. Name Plate:

ording to Energypac the full information about a transformer should noticed on Name Plate of transformer. Here we list information's according to Energypac for a three phase transformer. al NO., Rated Power, Standard, Class, Rated Frequency, Type of Cooling, Ambient temp, ıding temp, Insulation level, Voltage(HT, LT), Rated Current, Vector group, Impedance Voltage, al weight, Lift able weight, Oil weight and Year of Manufacturing.

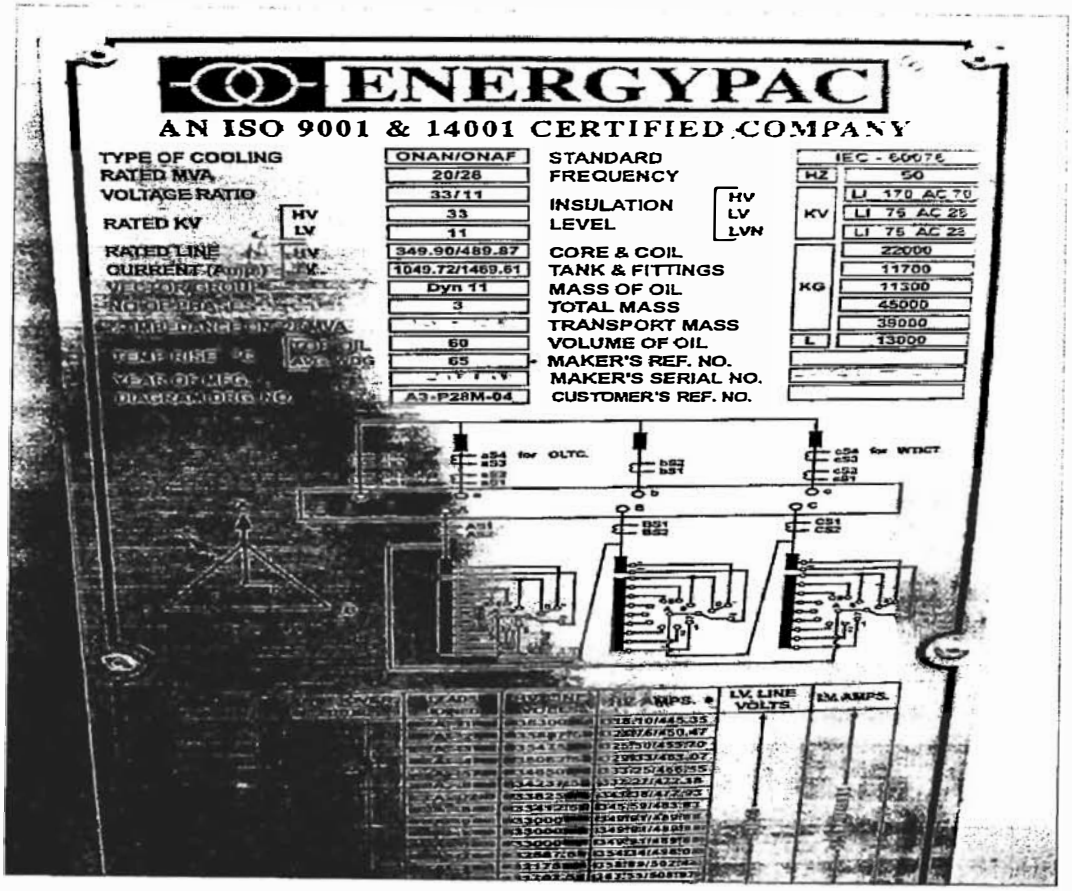


Figure 7: Name Plate of Transformer

3. Switchgear

3.1. Introduction:

Switchgear is used in association with the electric power system, or grid, refers to the combination of electrical disconnects, fuses and/or circuit breakers used to isolate electrical equipment. Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream. This type of equipment is important because it is directly linked to the reliability of the electricity supply. One of the basic functions of switchgear is protection, which is interruption of short-circuit and overload fault currents while maintaining service to unaffected circuits. Switchgear also provides isolation of circuits from power supplies. Switchgear is also used to enhance system availability by allowing more than one source to feed a load.

Two types of Switchgear which are manufacture by Energy Pac

1. LT(Low Tension) Switchgear
2. HT(High Tension)Switchgear

3.2. Low Tension (LT) Panel:

3.2.1. Introduction:

Energy Pac Engineering Limited manufactures low voltage switchgear (hereafter called LT Panel) which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 415V (Phase to Phase)and 220 V(Phase to Neutral).

LV Switchgear being one of the major power products of Energypac is produced for indoor and outdoor installation complying with the latest international standards, i.e. IEC. Energypac switchboards are steel sheet fabricated, totally enclosed, floor mounting and vermin & dust proof, these are supplied with factory fitted relevant components and copper bus bars, internal wiring, terminal block etc.

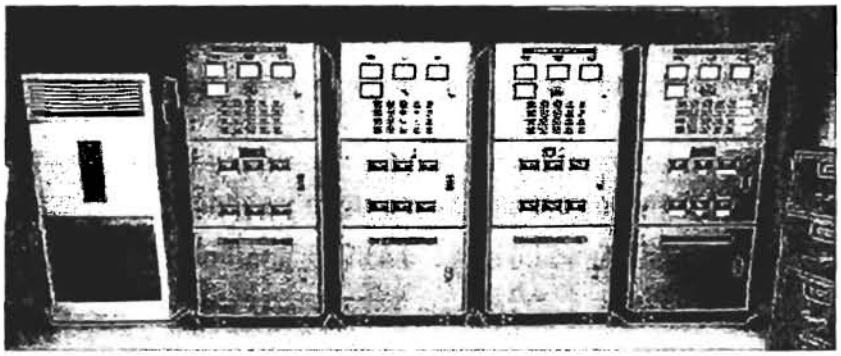


Figure 8: LT Panel

3.2.2. Different types of interrupting device:

Energypac uses different types of interrupting device

- Fuses
- ~~MCB(Miniature circuit Breaker)~~
- ACB(Air circuit Breaker)
- ~~MCCB(Molded cage circuit Breaker)~~

3.2.3. Operating Mechanism:

n Energy Pac two types of operating method are used in LT

- Manually-operated
- Motor-operated

3.2.4. Application:

's mainly used in power station, industrial enterprise, Commercial/Residential Buildings for power stribution and can be used to control, protect and inspect the circuit.

3.2.5. Technical Data:

- Metal clad, sheet steel
- Rated voltage: up to 415 V
- Rated Breaking current: up to 100KA
- Rated making current: 130 KA.
- Short circuit duration: 1 or 3 seconds.

3.3. HT (High Tension) Panel:

3.3.1. Introduction

Energy Pac's H.T Switch gear equipped with Load Break switch (LBS), Vacuum Circuit Breaker (VCB), Disconnect or etc. to meet individual requirement which comply with IEC and other relevant international standard, it has features of long service life reliability and high degree of quality safety. High Tension Switches are suitable for inexpensive electrical sub-station with transformer feeder, measuring, sectionalizing Auto change over and motor protection.

3.3.2. HT Voltage Range:

HT switchgears are used for two types of voltage class

- Medium voltage (1,000–35,000 volts AC)
- High voltage (more than 35,000 volts AC)

3.3.3. Technical Data:

- Metal clad, sheet steel
- Rated voltage: 3.3, 6.6 11 & 33 KV
- Rated frequency: 50Hz.
- Rated Breaking current: 13.1, 16, 18.4, 20, 25 &31.5 KA.
- Rated making current: 34, 40, 50, 63 & 80 KA.
- Short circuit duration: 1 or 3 seconds.

3.3.4. Different type of Interrupting Device and Operating Mechanism:

HT of Energy Pac uses interrupting device which are

- Fuses
- Vacuum Circuit Breaker
- Load break switch

In Energy Pac two types of operating method are used in HT

- Manually-operated
- Motor-operated

3.3.5. Application:

It's mainly used in power station, industrial enterprise; Commercial industry and Transmission can be used to control, protect and inspect the circuit.

3.4. Power Factor Improvement (PFI) Plant:

3.4.1. Introduction:

Energypac Power PFI plant has been designed to meet the needs of all forms of power factor correction by capacitor banks from small unit to a large plant. Energypac Power manufactures floor & wall mounting auto/manual power factor improvement (PFI) plant comprises of capacitor Banks, power factor improvement Relay, Contactors, HRC fuses, Manual/Automatic change over switch reactors for large plant comply with IEC and other relevant international standard the automatic PFI plant are available in steps of 2.5 KVAR to 50 KVAR capacitor Banks.

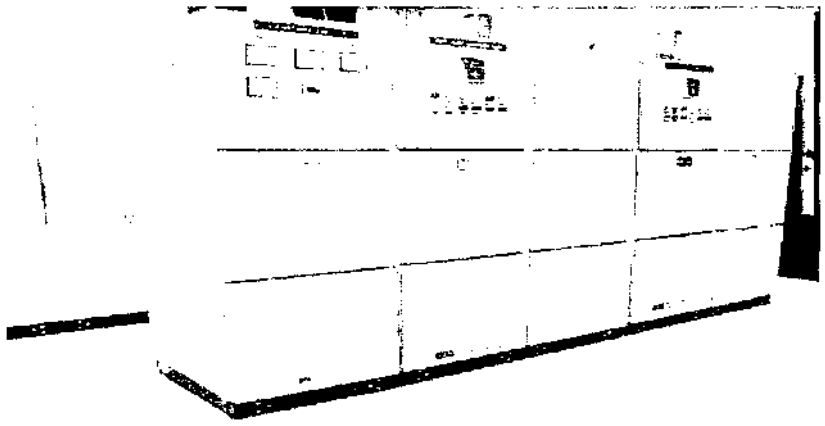


Figure 9: PFI Plant

3.4.2. Purpose of PFI:

The purpose of using PFI plant to save thousands of taka on electricity bills. It increases power consumption efficiency anyone can add more machinery without increasing electricity costs. It provides good voltage regulation. It minimizes power loss and wastage. It is compact, and requires almost no maintenance. Motor, Transformers and other inductive loads require reactive power. PFI Plant is used to improve the power factor of the inductive loads of the system's network by Capacitor Banks. The use of appropriate rating of PFI Plant reduces undesirable wastage of power, all control & indicating devices are located on the front door of the panel for easy viewing from the operator's desk.

Adding capacitors is generally the most economical way to improve a facility's power factor. While the current through an inductive load lags the voltage, current to a capacitor

leads the voltage. Thus capacitors serve as a leading reactive current generator to counter the lagging reactive current in a system. This action is explained in terms of the energy stored in capacitors and induction devices. As the voltage in ac circuits varies sinusoidal it alternately passes through zero□voltage points and maximum voltage points. As the voltage passes through zero voltage and starts toward maximum voltage the capacitor stores energy in its electrostatic field, and the induction device gives up energy from its electromagnetic field. As the voltage passes through a maximum point and starts to decrease, the capacitor gives up energy and the induction device stores energy. Thus when a capacitor and an inductor are installed in the same circuit, there is an exchange of magnetizing current between them with the capacitor actually supplying the magnetizing requirements of the induction device. The capacitor thus releases the energy source (the utility) from the need to supply the magnetizing current. Simply stated, capacitors supply the magnetizing current required by motors at or near the motor site, instead of from the utility (figure). This frees up utility capacity to provide more real power.

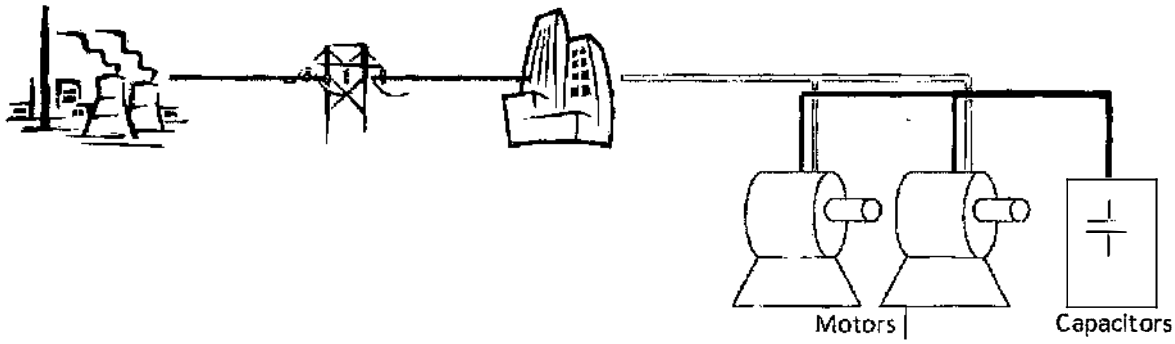


Figure 10:Power Factor Improvement

3.5. Metering Panel:

Metering Panel manufactured by Energypac is ordered by DPDC. The purpose of this online metering is to eradicate corruption. It is the panel consists of three CT, three PT, ammeter, voltmeter, and modem. CT and PT are used for measure the current and voltage. Modem read the measured data and send it to remote server. This online meter is set in distribution end and generation end.

Technical Data:

- **Rated voltage: 11 KV**
- **Rated current: 5 A**

4. CT and PT

During our internship we worked CT and PT Section from 13th may to 17th may, 2010.
In this Section our Supervisor was Engr. Mozaharul Islam, DGM, Production, EELF. After introduction he briefing us on Breaker then he assigned a Diploma Engineer for us named Masum.

4.1. Introduction:

Energypac introduced its indigenously developed Instrument Transformers in 1995. Since then Energypac is the only manufacturer of instrument transformers in Bangladesh. Energypac manufactures outdoor/indoor, oil cooled/cast resin Current Transformers (CT) ranging from 11 kV to 230 kV. Energypac's modern manufacturing plant is equipped with full range of testing equipment, plant and machinery to manufacture these transformers. Energypac have supplied hundreds of these transformers to different customers in home and abroad which are working satisfactorily under different service conditions at sites. Energypac Instrument Transformers are manufactured in accordance with latest IEC/ANSI Standards.

There are two types of instrument transformer. These are:

1. Current transformer (CT).
2. Potential Transformer (PT).

4.2. Current transformer (CT):

It is not possible to measure the current in high voltage of a system is directly because of insulation problem of measuring instruments. It is also not possible to use current flowing through the system directly for protection purpose due to its high value and high insulation problem. So we must need a transformer which takes high input but the output is low. This type of transformer is called CT. It can be designed for Single or Multi ratio. The ratio selection can be achieved by providing two or four sections or primary for series/parallel connection, the current ratio shall be in proportion of 1:2:4. The advantage of this type of ratio is that output from each secondary remains constant for any selected ratio.

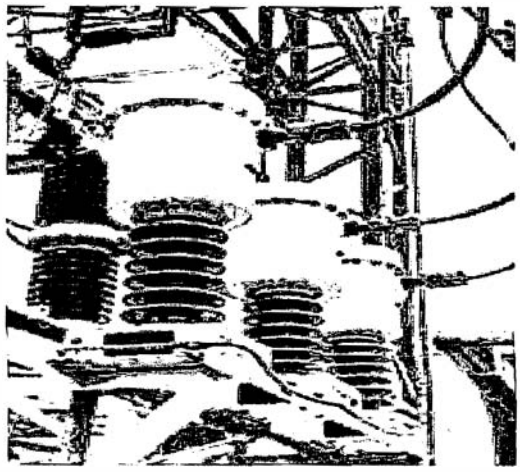


Figure 11: Indoor type CT

Figure 12:Outdoor type CT

4.3. Potential Transformer (PT):

Direct measurement of voltage in high voltage system is not possible because of insulation problem of measuring instruments. It is also not possible to use direct voltage for the system protection purpose due to its high value and high insulation problem of protective relays. So we must need a transformer which takes high input voltage but the output voltage is low. This type of transformer is called PT. This transformer is used for step-down the high system voltage to low standard value accurately in proportion to their ratio.

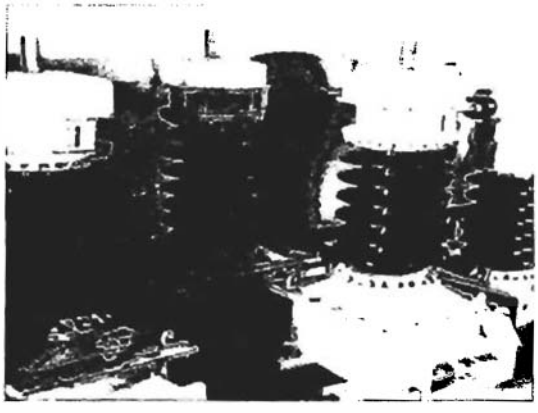


Figure 13:Indoor type PT

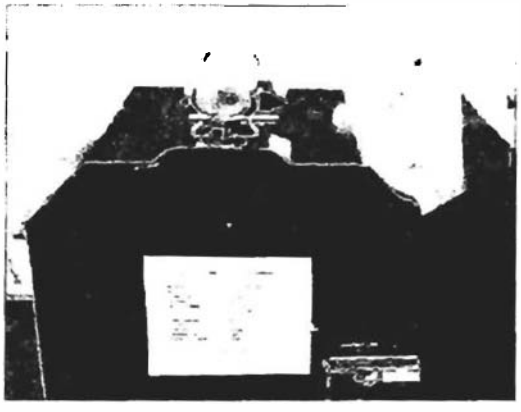


Figure 14:Outdoor type PT

4.4. Basic functions:

Current transformers:

1. To reduce the line current to a value which is suitable for standard measuring instruments, relays, etc.
2. To isolate the measuring instruments namely meters, relays, etc. from high voltage side of an installation.
3. To protect measuring instruments against short circuit currents.
4. To sense abnormalities in current and to give current signals to protective relays to isolate the defective system.

Potential transformers:

1. To reduce the line voltage to a value which is suitable for standard measuring instruments, relays, etc.
2. To isolate the measuring instruments, meters, relays, etc. from high voltage side of an installation.
3. To sense abnormalities in voltage and give voltage signals to protective relays to isolate the defective system.

4.5. Types of instrument transformer:

Energypac manufactures two types of CT and PT based on construction:

1. Indoor type
2. Outdoor type

Indoor Type:

In indoor type transformer only one types of transformer is used. This is Epoxy resin cast type. In this transformer there have no oil expansion chamber.

Outdoor type:

In outdoor type transformer two types of transformer is used.

1. Oil merged type.
2. Epoxy resin cast type.

Types of CT and PT based on design:

Current transformers:

Energypac produces two types of CT:

1. Live tank.
2. Dead tank.

Potential transformers:

Single phase electromagnetic PT is manufactured in two types:

1. Single Pole (between lines & earth).
2. Double Pole (between line-to-line).

4.6. Manufacturing process:

Instrument transformer consists of

- Electromagnetic Core.
- Primary and Secondary Windings.
- Bottom Tank and Oil Expansion Chamber.
- Porcelain Bushing.

4.6.1. Electromagnetic core:

1. High permeability CRGO silicon steel is used as core material.
2. Shell type construction is used to minimize leakage reactance.
3. The core material of Epoxy resin cast type is high quality cold rolled grain oriented steel which is annealed.

4.6.2. Primary and Secondary Windings:

Epoxy resin cast type:

LT winding is designed as multi-layer winding. LT winding is wound on the core with additional insulation between adjacent layers. HT winding is designed in such a way that the mechanical stresses due to thermal dilation, in case of short circuit currents are not transmitted to the main insulation of the transformer. The conductors used for windings are made of electrical grade electrolytic copper. Conductors used for secondary windings are insulated with high quality, synthetic resin based insulation varnish

Oil merged type:

Copper enameled wire is used for winding. Secondary winding is done automatically and distributed equally on the periphery of the core to minimize leakage reactance. Primary winding is of braided electrolytic copper conductors with double cotton covering. Varnished fiber glass sleeve is provided as an additional insulation on this conductor.

4.6.3. Bottom Tank and Oil Expansion Chamber:

Bottom tank and oil expansion chamber are made of MS sheet.

4.6.4. Porcelain Bushing:

Hollow cylindrical type of bushing is used.

4.7. Insulation:

Energypac used three types of insulation processes.

1. Insulating paper.
2. Oil.
3. Varnish.

4.7.1. Insulation paper:

There are two types of insulation paper.

1. Crepe paper.
2. Kraft paper.

High quality crepe insulating paper is used to build up main insulation of the CT and PT. And the craft paper is used to avoid Short circuit between core and coil.

4.7.2. Oil:

Energypac used few types of oil for insulation.

1. Insulating Oil.
2. Transformer oil.
3. Mineral oil.
4. Pironol oil.

4.7.3. Varnish:

Conductors used for windings are insulated with high quality, synthetic resin based insulation varnish.

4.8. Testing:

Energypac follow some standards for their testing, and they must ensure quality test facility as those standards. These standards are:

IEC-76, VDE 0537, ANSI C 57.12 and BS 171.

Energypac must ensure four types of tests. These tests are:

1. Routine test
2. Partial Discharge test
3. High voltage test
4. Quality test

4.8.1. Routine test:

Routine test is must performed for every transformer. Actually by performing this test we get knowledge about a transformer. These tests are:

1. Resistance test.
2. Ratio test.
3. No load test.
4. Full load test

4.8.2. Partial discharge:

Partial discharge test is used for checking and decreasing the charge carrier between the winding. If there have any bubble between HT and LT Winding, it create Charge carrier. This situation is very harmful for a transformer. To avoid this first time a high voltage (approximately 200 KV) is applied to the primary side and the secondary side is shorted. Now if we increase the voltage, the capacitance or the charge carrier is discharging between primary and secondary side. By following this procedure this test is continued.

4.8.3. High voltage test:

High voltage test is used for checking the insulation property between Primary to earth, Secondary to earth and between Primary & Secondary winding. High voltage test means applying high voltage (approximately 28 KV) on Primary side for 1 minute and the other side that means the low voltage side must be neutral and grounded.

Observation:

We measure the leakage current and by observing the value of this current we can conclude about the insulation property between Primary to earth, Secondary to earth and between Primary

& Secondary winding. If the value of leakage current is low, the insulation is better. But if the value of leakage current is higher, the insulation is bad.

4.9. Nameplate:

According to Energypac the full information about a transformer should noticed on Name Plate of the transformer. Here we list information's according to Energypac for a Current transformer.

Serial NO., Rated voltage, Insulation level, Construction, Rated thermal current, Ratio, rated burden, Highest system voltage, rated frequency, Type ,No of phase, Total weight and Year of Manufacturing.

5. Breaker and Isolator

During our internship we worked Breaker Section on 18th may, 2010 and Isolator section at 19th may, 2010.

In breaker Section our Supervisor was Engr. Moniruzzaman, Manager. After introduction he briefing us on Breaker then he assigned an Engineer for us named Tauhid.

In Isolator section our Supervisor was Engr. Belal Hossain, Manager, Production, EELF.

In the report we write the information according to the workers and Engineers of Energypac Engineering Ltd.

Breaker

5.1. Circuit Breaker:

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

5.2. Energypac's Concept:

Energypac designed equipment offers following concepts:

a) Customer friendly

b) High degree of safety

c) High operational reliability

d) Rugged design

e) Simple in construction

f) Modular and compact

g) Easy maneuverability of truck

h) Extensible with high degree of customization

5.3. Types of Breaker:

In general Energypac used three types of breaker they are

1. Low Voltage Breaker
2. Medium Voltage Breaker
3. High Voltage Breaker

5.3.1. Low Voltage Breaker:

Low Voltage Range: from 1 V to 1KV

Energypac used Miniature Circuit Breaker (MCB) as low Voltage Breaker. They don't manufacture this MCB. They imported MCB from Germany. They used it in Switchgear.

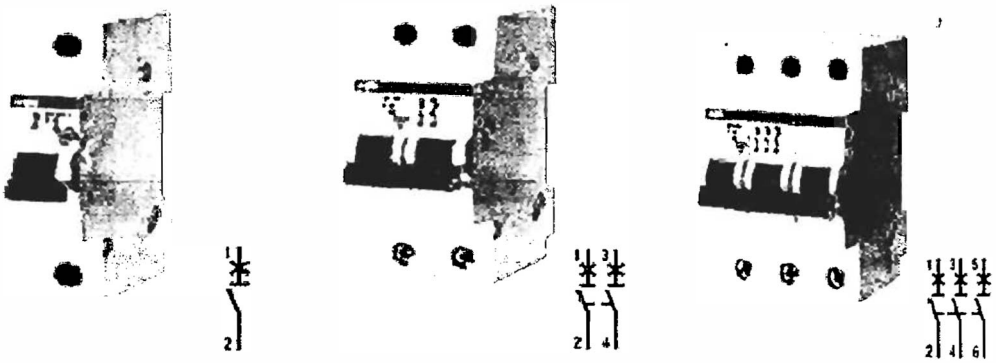


Figure 15: MCB (SP, DP and TP)

Function: Protection and control of the circuits against overloads and short-circuits, protection people and big-length cables in TN and IT systems.

Operating Voltage: 230/440 V

Three types of MCB Energypac used with Breaking Capacity up to 6kA, they are

1. Single Pole (SP)
2. Double Pole (DP)
3. Triple Pole (TP)

5.3.2. Medium Voltage Breaker:

Low Voltage Range: from 1KV V to 11KV

Energypac used Molded Case Circuit Breaker (MCCB) as medium Voltage Breaker. They don't manufacture this MCCB. They imported MCCB from Italy. They used in switchgear items.

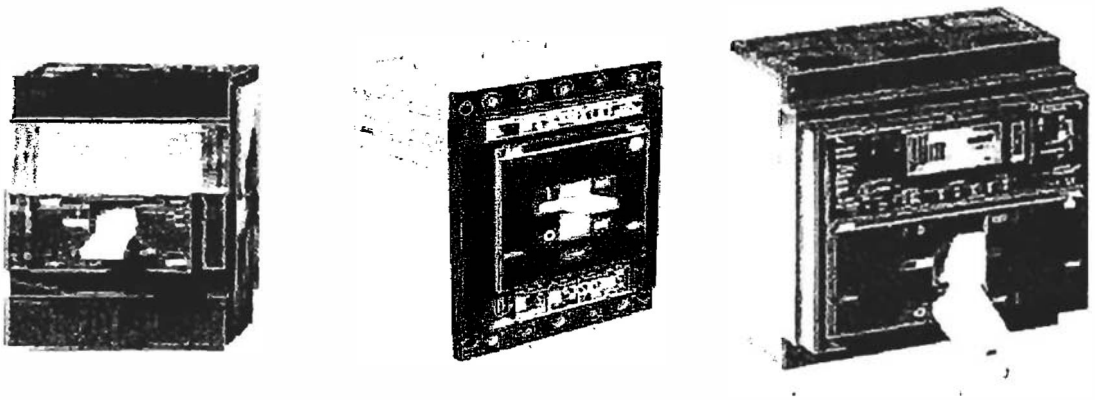


Figure 16: MCCB

Function: Protection and control of electrical machineries against overloads, short-circuits and ground fault protection (Optional).

Application: The molded-case circuit-breakers are used in industrial and civil low voltage plants with currents from 16 to 1600A. They are used in D.C. & A.C. switchgear, for motor protection, generators, capacitors etc.

5.3.3. High Voltage Breaker:

Low Voltage Range: from 11KV to 33KV

Energypac is the first and only company in Bangladesh to introduce horizontal isolated, horizontal draw out type vacuum circuit breaker in the country way back in 1998. Large numbers of these circuit breakers are today in operation in Bangladesh and other parts of the world.

Energypac used Vacuum Circuit Breaker as high Voltage breaker. They manufacture the Vacuum circuit Breaker. In manufacturing process they follow two standard, they are

IEC - International Electrotechnical Commission
ANSI -American National Standards Institute

Energypac manufacture two types of Vacuum Circuit Breaker

1. Indoor Vacuum Circuit Breaker, Up to 33 kV
2. Outdoor Vacuum Circuit Breaker, Up to 33 kV

5.4. Vacuum Circuit Breaker:

Vacuum circuit breakers are circuit breakers which are used to protect medium and high voltage circuits from dangerous electrical situations. Like other types of circuit breakers, vacuum circuit breakers literally break the circuit so that energy cannot continue flowing through it, thereby preventing fires, power surges, and other problems which may emerge.

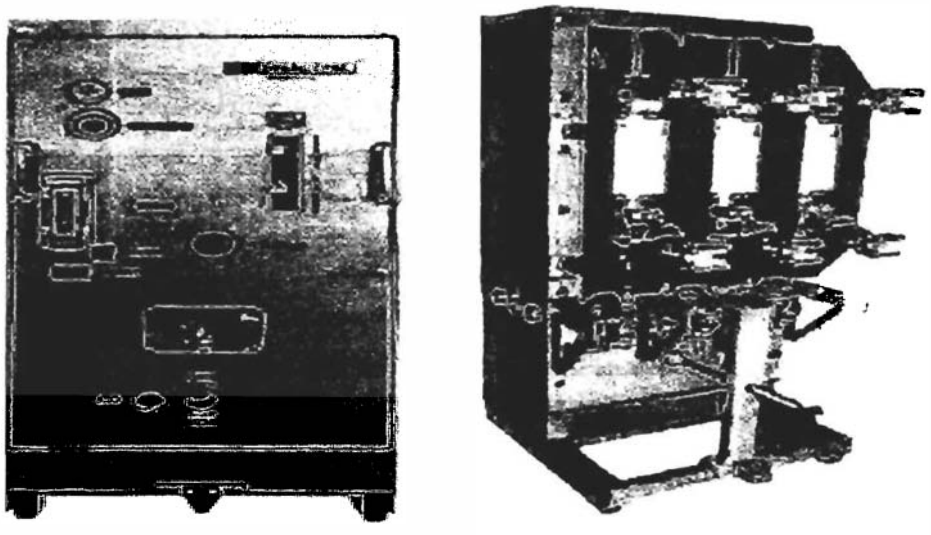


Figure 17:Vacuum Circuit Breaker

We know that in general the names of circuit breaker are according to their medium where the break occurring. Energypac used Vacuum Interrupter in their circuit breaker.

5.4.1. Closing Mechanism:

The closing mechanism includes the following indications:

- Breaker on/off
- Spring charged or discharged

5.4.2. Brand Feature:

The following features are also provided on the switchgear.

- Operation counter
- Local on/off switch
- Local/remote switch
- All necessary fuses and wiring

5.4.3. Vacuum Interrupter:

The construction is of metal clad type and uses high grade CRCA steel of adequate thickness ensuring safety and security. HHV 12 employs rated vacuum interrupters for arc extinction. The interrupters are procured from most renowned and the best quality manufacturer of the world, CUTLER-HAMMER (EATON), USA.

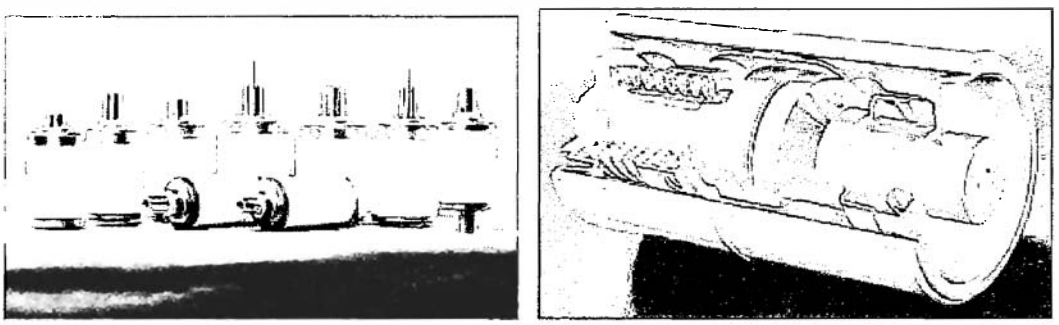


Figure 18:Vacuum Interrupter

In a vacuum interrupter there is a fixed conductor and a moveable conductor. These two conductors are connected through two terminals. There is a bellows at moveable ends. Also there is an Arc shield between the contracts.

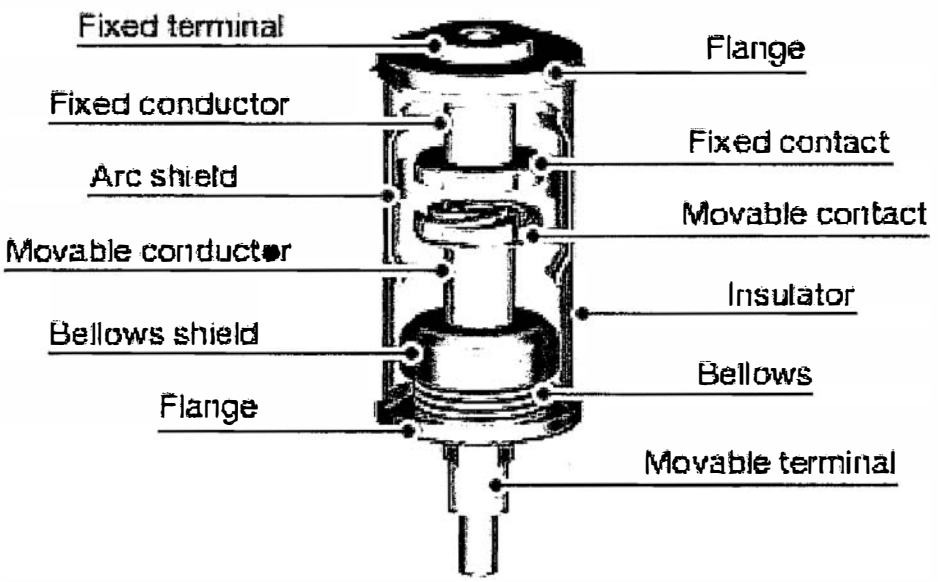


Figure 19:Specification of Vacuum Interrupter

5.4.4. Special Charter tics of Vacuum Interrupter:

Special characteristics of vacuum interrupters are:

a) Very low arcing time

b) Quick recovery of dielectric strength

c) Small contact gap

d) Trouble free service

e) Low energy mechanism

5.5. Working Principle of VCB

The mechanism M-37 is of conventional design and is very simple in operation and construction. Mechanism is designed for operation of very short stroke required in vacuum interrupter and is normally charged by motor. When charged, the closing spring is held by a latch which can be released either by manual means or by a solenoid to close the circuit breaker. The energy required for opening is provided by the springs, incorporated in the drive assembly which is compressed during the closing stroke.

In a vacuum circuit breaker, two electrical contacts are enclosed in a vacuum. One of the contacts is fixed, and one of the contacts is movable. When the circuit breaker detects a dangerous situation, the movable contact pulls away from the fixed contact, interrupting the current. Because the contacts are in a vacuum, arcing between the contacts is suppressed, ensuring that the circuit remains open. As long as the circuit is open, it will not be energized.

Vacuum reclosers will automatically reset when conditions are safe again, closing the circuit and allowing electricity to flow through it. Reclosers can usually go through several cycles before they will need to be manually reset. Other types of vacuum circuit breakers require resetting every time the breaker trips.

5.6. Key Features:

- Long maintenance free operation
- Fully metal clad design
- Horizontal isolation
- Bus bar system fully insulated

- Manual or motor charged main closing mechanism
- Fully rated with switches
- Complete set of interlocks and padlocking facilities
- Isolatable voltage transformer
- Ample current transformer accommodation
- Extensive use in tropical environments
- Safety interlocks

5.7. Applications:

- Power stations
- Transformers
- Chemical industry
- Steel Industry
- Automotive industry
- Airport power supply
- Cold storage power supply
- Building power supply

5.8. Technical Particulars:

Applicable Standard: IEC60056

Type Designation: OFVp-36

Normal Voltage: 33kV

Rated Voltage: 36 kV

Frequency: 50 Hz

Normal rated current: up to 1600 Amps

Short circuit breaking capacity: up to 25 kA

Rated 1 minute Power frequency withstand voltage: 75 kV rms

Rated impulse withstand voltage: 170 kV peak

Nominal creepage of bushings

Support – 910 mm

Interrupter housing – 910 mm

Duty cycle 0 full breaking capacity:

Normal – 0-3 MIN – CO- 3 MIN-CO

Auto reclose - --0.3 sec-CO-3 MIN-CO

5.9. Test:

For testing Energypac follow the standard of IEC, ANSI, CPRI and also BUET. They have got certificate from the mentioned organizations.

1. Physical test
2. Resistance test.
3. Insulation test.
4. High voltage test.
5. Timing test.

Isolator and Load Break Switch

5.10. Isolator:

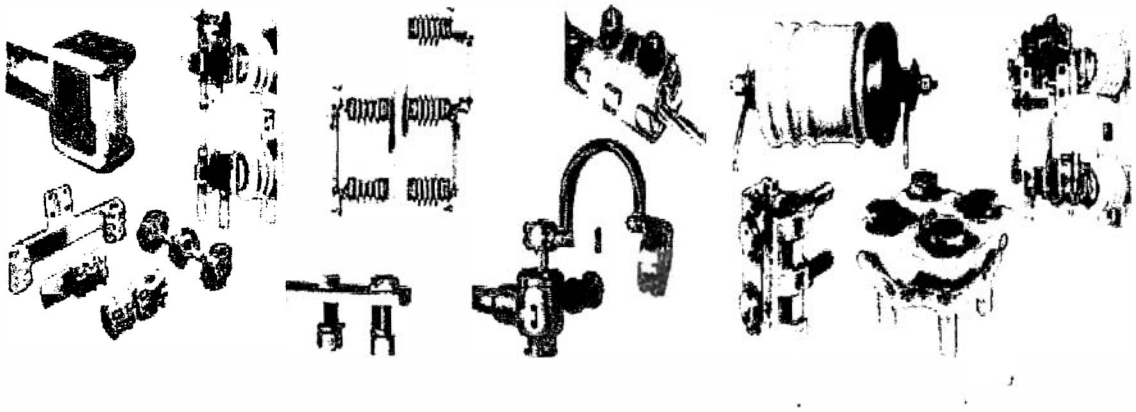


Figure 20: Different types of Isolators

Isolator is an off load device which is used for isolating the downstream circuits from upstream circuits for the reason of any maintenance on downstream circuits. It is manually operated and does not contain any solenoid unlike circuit breaker. it should not be operated while it is having load. First the load on it must be made zero and then it can safely operated. Its specification only rated current is given.

Isolator (disconnecting switch) operates under no load condition. It is manually operated. It does not have any specified current breaking capacity or current making capacity. Its main purpose is to isolate one portion of the circuit from the other and is not intended to be opened while current is flowing in the line. Such switches are generally used on both sides of circuit breakers in order that repairs and replacement of circuit breakers can be made without any danger. They should never be opened until the circuit breaker in the same circuit has been opened and should always be closed before the circuit breaker is closed.

5.11. Brand Features of Isolator:

The brand features of Isolators manufactured by Energypac Engineering Limited:

- Simple construction
- Self cleaning contacts
- Low operating forces required
- All steel parts hot-dip galvanized.

5.12. Main Assemblies:

The Isolator comprise of the following main assemblies:

- The main current carrying parts called as the hamper assembly.
- Support insulators mounted between the current carrying parts and base.
- The bottom base assembly.
- The operating mechanism box.
- Inter-stack, inter phase and down operating pipes.
- Earthing switch and its operating mechanism box wherever called for.
- Supporting structure mounted between the base and the ground.

5.13. Types of Isolator:

Isolator or Disconnectors Types:

Energypac manufactures outdoor offload disconnectors of the following types:

- Pantograph – type EPG
- Centre Break-type ECB
- Double Break – type EDB

5.13.1. Pantograph Type:

- Rated voltage from 12 kV to 245 kV
- Rated current up to 3150 Amps
- Short time current rating up to 50 kA.

Type: EPG

- Very low civil engineering profile.
- Trapeze contact fixing to suit upper bus arrangement.
- 4 point contact
- Available for flexible / rigid bus bar layouts.

- Current transformer through multifinger hinge contacts.
- Individual pole operation.
- Structure to suit requirements.

5.13.2. Centre Break Type:

- Rated voltage from 12 kV to 245 kV.
- Rated current up to 3150 Amps
- Short time current rating up to 50kA.

Type: ECB

- Very low operating torque
- Self wiping contacts
- Simultaneous operation of 3 poles by single operating mechanism up to 245 kV.
- Structure to suit requirements.

5.13.3. Double Break Type:

- Rated voltage from 12 kV to 245 kV.
- Rated current up to 3150 Amps
- Short time current rating up to 50kA.

Type: EDB

- Turn and twist contacts
- Vertical/Horizontal terminal take off
- Totally enclosed actuator assembly
- Simultaneous operation of 3 poles by single operating mechanism up to 245 kV.
- Structure to suit requirements.

The disconnectors consist of separate poles which can be arranged for single pole operation or linked together by operating rods to form 2 or 3 pole units.

5.14. Operating Mechanism:

Currently the following operating mechanisms are

- Manually operated mechanism
- Manually operated geared mechanism
- Motor operated mechanism.

5.15. Maintenance:

All the bearings provided are sealed for life and need no greasing. All contacts are to be checked and appropriately maintained and cleaned during annual maintenance.

5.16. Tests for Isolators:

- Meager test.
- Contact resistance test.
- High voltage test.
- Ampere test.

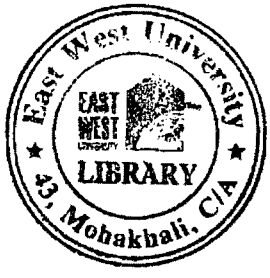
5.17. Load Break Switch (LBS):

Load break switch generally is the combination of isolator and a switch. In distribution system, voltage up to 33KV there load break switch is used. The faults levels may not be high enough to justify the use of circuit breakers economically. Load break switches are capable of making breaking currents under normal conditions. It can carry the specified current of specified values for specified time. It is capable of making but not breaking, short circuit currents.

Load break switches serve the following requirements:

- Breaking rated currents
- Making rated currents
- Making specified short circuit currents
- Carrying specified short circuit currents
- Interrupt small inductive, capacitive currents

This protective equipment is used at 11 kV sub-station. The main Load Break Switch (LBS) mechanism is available for 630A & the over current protection scheme is done through HRC fuse. The panel includes 3 numbers of CT (Current Transformer) & 2/3 numbers of PT (Potential Transformer) for measuring system current & voltage respectively & 3 numbers of HRC Fuses for protection of overload. The scheme is so designed that if fault occurs in any phase it will isolate the whole three phases from the system instantly. The panel also includes 3 numbers of Ampere meters & one number of Voltmeter with selector switch for monitoring system current & voltage. The standard panel size is 900x900x1800 mm & weight is around 450 kg.



6. Manufacturing And Testing

6.1. Introduction:

In this report we write information's that collected during our internship. The information's are according to the workers and Engineers of Energypac Engineering Ltd and also we practically saw and observed all those things.

6.2. Transformer:

In our training schedule we clearly mentioned about the working days and respective supervisor of that sections. Here is the only those information's that we noted during our internship.

Energypac makes two types of transformer

1. Power Transformer up to 50 MVA
2. Distribution Transformer up to 4.5 MVA (11/0.415 kV)

They can make 50 MVA transformer but they can repair up to 75 MVA Power transformer. There next target is to make 75 MVA Power Transformer.

6.2.1. Coil and Coil Winding:

Figure 21: HT and LT Coil of Transformer

For transformer there are three types of coil. They are

1. Low Voltage Coil or LT Coil
2. High Voltage Coil or HT Coil
3. Tap Changing Coil

To manufacturing a transformer the Coils (LT, HT and Tap changing) all are depends on design. Based on design the diameter of the coils are select. Its also depends on the KVA or MVA rating and the property of the material. Transformer LT and HT Coil defined by different diameter. In general LT coil is bigger diameter then HT coil because at LT side Voltage is low but current high on the

other hand at HT side Voltage is high but current is low. Tap changing coil's diameter is also depends on design issue. After completing a frame structure of core, first insulated LT coils are rolled on core. Second insulation space or board for differentiate between HT and LT. Third insulated HT coils are rolled then at last some case Tap changing coils are rolled.

6.2.2. Core Cutting:

Energypac used silicon steal sheet as core material for their large KVA or MVA rating transformer. They used automatic core cutting machine. Which is fully automatic operate by computer. In this machine core are cutting in three class, they are class A, class B and class C.

Figure 22: Transformer core size (Class A, Class B and Class C)

Energypac Engineering Limited used Automatic Core cutting machine for cutting their core.
insert to machine from one side and the output stored in another side hole process is fully automatic.
But the operator has to flow five steps.

Steps of Automatic Core Cutting Machine

1. Based on design fixed grade and thickness silicon steel sheet to be provided.
2. According to Core class A, B, C and D's dimension the big pieces cut down by Power press machine.
3. From the big pieces based on A, B, C and D design the small pieces should cut.
4. Based on design the pieces should cut in 45 degree angle or normal cutting.
5. Based on design the Core should be punch

Caution for Automatic Core Cutting machine

1. Must be careful for the insulation label of silicon steel sheet.
2. Must be sure that the design dimension is right.

Difference between normal cutting and auto Core cutting

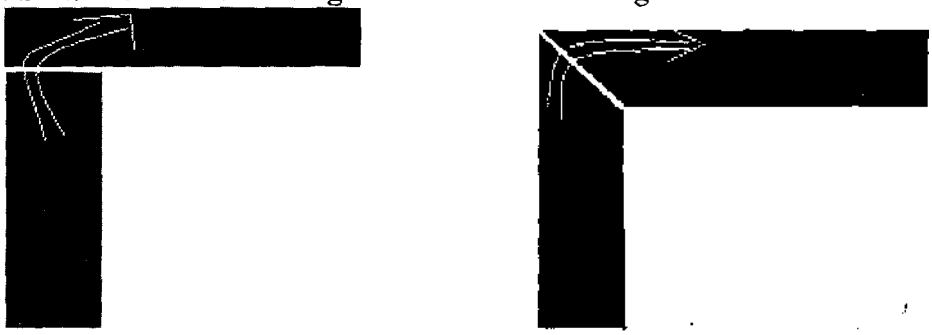


Figure 23: Normal Core Cutting and auto Core Cutting

Energypac used normal core cutting for low KVA rating transformer like Current transformer (CT) and Potential transformer (PT), Auto core cutting for Power and Distribution transformer. In Normal core cutting they have cut the steel sheet in 90^0 angles. In Auto core cutting they cut the steel sheet in 45^0 angles. Due to the cutting angle the flux passing cross area in auto cutting is bigger then normal cutting. So in normal cutting there is some loss of flux but in auto cutting there is no loss of flux.

6.2.3. Insulation:

- DPC Paper for LT Coil
- Caret Paper for HT Coil
- Brize Board between LT and HT Coil
- Transformer Oil
- External Bushing

Insulation is must for a transformer otherwise turns to turns or LT and HT Coil or Coils and transformer's body will short. To avoid this types of short or faults they have used different types of insulations. The transformer oil used in Transformer for insulation is good insulator. During our internship at Energypac a Diploma Engineer said that 2.5mm Transformer oil can block up to

60KV. Energypac imported Transformer oil foreign country like Germany, USA and Japan etc. Energypac used DPC paper for LT coil insulation which is well known as Low tension insulation paper. Energypac used caret paper for HT coil insulation which is well known as High tension insulation paper. They have also used brize board as insulation between LT and HT coil. When Tap changing coils are rolled then between two Tap there is a gap. This gap is for insulation as there is no short is occurring and the gap can hold oil. They also used Bush as external insulation.

6.2.4. Tapings and Tap Switch:

Energypac used two types of Tap Changing

- On load Tap Changing
- Off load Tap Changing

There is another term which style Tap changing Reverse winding or Force find winding. For example DESCO's demand is reverse winding that is there are twelve option of Tap change in per phase. DPDC's demand is Force find winding that is Tap changing option will start from mid point.

6.2.5. LT and HT Connection:

Generally the Transformers that are made by Energypac either Delta to Y or Y to delta connected. If High voltage side Delta connected then Low Voltage side Y connected and vise versa.

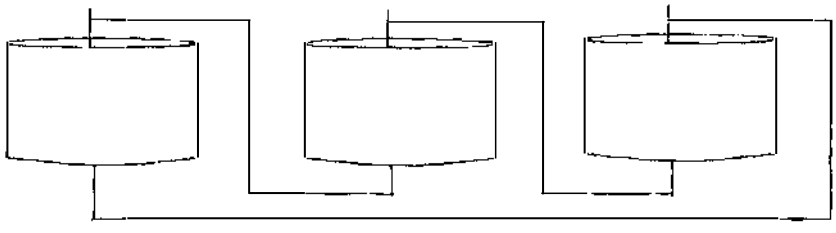


Figure 24: Delta connection

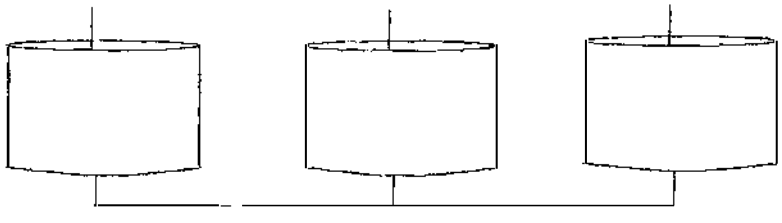


Figure 25: Y- Connection

According to Energypac policy some one can easily say which side contents what connection by name plate, suppose in name plate there is a term Dyn11 that means for that Transformer High Voltage side is Delta connected and Low Voltage side is Y connected.

Energypac follow another policy that is from which side HT connection come out, LT connection come out from opposite site. This is for safety because in transformer tank there is oil, if HT and LT connection come out from one side then there is change of dielectric breakdown of oil.

6.2.6. Fittings and Accessories:

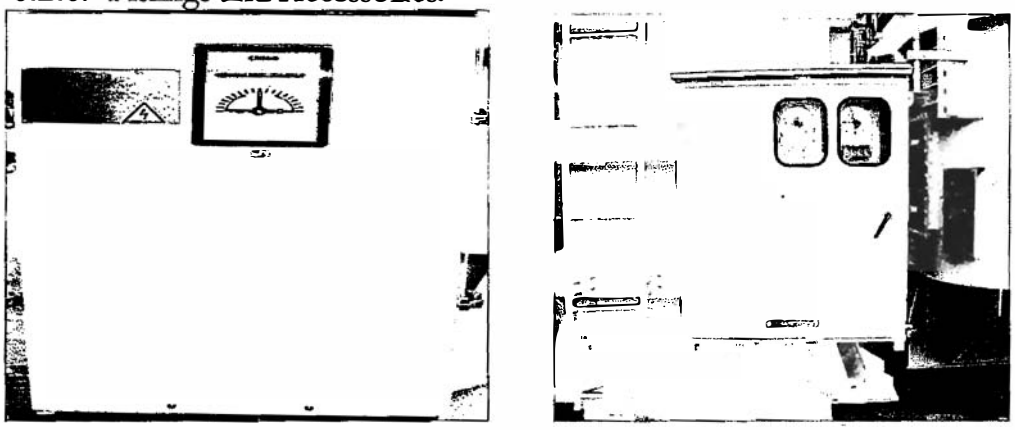


Figure 26: Driving box, Mashing box

All the standard fittings; confirming to respective standards are provided on each transformer.

- Driving box : Tap changing (On load or OFF load tap changer)
- Mashing box: Oil Temperature Indicator(OTI), Winding Temperature Indicator(WTI)
- Gas insulation relay: Buchholz relay
- Pressure relief valve
- Oil level

Any other additional special fittings can be provided to suit individual requirement of customer.

6.2.7. Testing:

Testing that Energypac follows we already talked in Chapter 1. Here just we describe some test that we saw during ours internship at Transformer section

Magnetic Balance Test:

The Magnetic Balance test is conducted on Transformers to identify inters turn faults and magnetic imbalance. The magnetic balance test is usually done on the star side of a transformer. A two phase

upply 440V is applied across two phases, say, 1U and 1V. The phase W is kept open. The voltage s then measured between U-V and U-W. The sum of these two voltages should give the applied oltage. That is, 1U1W + 1V1W will be equal to 1U1V.

or instance, if the voltage applied is 440V between 1U1V, then the voltages obtained can be

$$1U1V = 1U1W + 1V1W$$

$$440V = 260V + 180V$$

he voltages obtained in the secondary will also be proportional to the voltages above. his indicates hat the transformer is magnetically balanced. If there is any inter-turn short circuit that may result n the sum of the two voltages not being equal to the applied voltage.

Turns Ratio:

his test is also called Voltage ratio test.

his test measures the voltage ratio as per the customer's requirement.

$$\frac{V1}{V2} = \frac{N1}{N2}$$

he voltage ratio is equal to the turn's ratio in a transformer. Using this principle, the turn's ratio is neasured with the help of a turn's ratio meter. If it is correct, then the voltage ratio is assumed to be correct.

Equipment used: Turns Ratio meter.

Double Voltage double frequency:

his test checks the inter turn insulation.

or an 11KV/433V transformer, 866 Volts are applied at the 433V winding with the help of a Generator for 1 minute. This induces 22KV on 11KV side. The frequency of the 866V supply is also ncreased to 100HZ.

Equipment used: MOTOR GENERATOR SET

High Voltage tests on HV & LV:

his test checks the insulation property between Primary to earth, Secondary to earth and between rimary & Secondary.

HV high voltage test: LV winding connected together and earthed. HV winding connected together and given 28 KV (for 11KV transformer) for 1 minute.

LV high Voltage test: HV winding connected together and earthed. LV winding connected together and given 3 KV for 1 minute.

Equipment used: High Voltage tester (100KV & 3KV)

re the term High Voltage means the Voltage which is 2.5 times of rated Voltage.

High Voltage = 2.5 * Rated Voltage

6.3. Switchgear:

The shed of switchgear mainly consist of

- Low Tension (LT) Panel
- High Tension (HT) Panel
- Power Factor Improvement (PFI) Panel
- Metering Panel

6.3.1. Content and Working Principle:

The Panel of LT switchgear consists of

- Bus Bar.
- Relay.
- ammeter.
- voltmeter.
- CT and PT.
- Breaker.
- Fuse.
- Indicator flags.

ımeter measures current by the help of CT. Ring CT is used in LT switchgear Panel. Ammeter not measure more than 5A current. So CT is mandatory for measuring current. But voltmeter onnected directly with the line in case of LT panel. Because internal resistance of voltmeter is y high. Relay is parallel with ammeter. The function of relay is to sense over current and give signal to breaker. A master coil is used to trip whole system. Magnetic coils are used to trip arate load connection. Here generally Miniature circuit breaker is used which is spring charge :or controlled breaker. As a protection of MCB, a control switch is used. When current exceed 0A of current, the control switch (fuse) become disconnected and circuit breaker will trip. :re are three relay which energized the magnetic coils to trip the breaker. CT, fuses, circuit ıker are connected with bus bar. For three phase current display, there are three ammeters.

r voltage and current monitoring, voltmeter, Ammeter, Indicating lamps, selector switch etc. e mounted on the upper portion of the front cover of the LT. panel Box. Copper bus bars of equate size with Red, Yellow & Blue marking are mounted on the upper portion of the Box. ıe bus bars are firmly supported by insulators having adequate mechanical and electrical ·engtb.

6.3.2. Technical Data of LT and HT Panel:

Types	LT panel	HT panel
Rated voltag	up to 415 V	3.3, 6.6 11 & 33 KV
Rated frequency	50Hz.	50Hz.
Rated Breaking current	up to 100KA	13.1, 16, 18.4, 20, 25 &31.5 KA
Rated makir current	130 KA	34, 40, 50, 63 & 80 KA.
Short circuit duration	1 or 3 seconds	1 or 3 seconds
Interrupting Device	Fuses, MCB, MCCB	VCB
Application	Power control and distribution systems of AC 50Hz & 415 V	power station, industrial enterprise, Commercial indust and Transmission

6.3.3. Power Factor Improvement (PFI) Plant:

ıergypac Power Factor Improvement (PFI) plant has been designed to meet the needs of all forms of ower factor correction by capacitor banks from small unit to a large plant. Energypac Power anufactures floor & wall mounting auto/manual power factor improvement (PFI) plant comprises of apacitor Banks, power factor improvement Relay, Contactors, HRC fuses, Manual/Automatic change ver switch reactors for large plant comply with IEC and other relevant international standard the utomatic PFI plant are available in steps of 2.5 KVAR to 50 KVAR capacitor Banks.

6.3.4. Metering Panel:

Metering Panel manufactured by Energypac is ordered by DPDC. The purpose of this online metering is to eradicate corruption. It is the panel consists of three CT, three PT, ammeter, voltmeter, and modem. CT and PT are used for measure the current and voltage. Modem read the measured data and send it to remote server. This online meter is set in distribution end and generation end.

Technical Data: Rated voltage: 11 KV, Rated current: 5 A

6.4. Instrument Transformer (CT, PT):

- **CT- Current Transformer**
- **PT- Potential Transformer**

At High Voltage we can't measure Current or Voltage directly because of Insulation Problem of Measuring Instrument.

6.4.1. Basic functions:

Current transformers:

5. To reduce the line current to a value which is suitable for standard measuring instruments, relays, etc.
6. To isolate the measuring instruments namely meters, relays, etc. from high voltage side of an installation.
7. To protect measuring instruments against short circuit currents.
8. To sense abnormalities in current and to give current signals to protective relays to isolate the defective system.

Potential transformers:

4. To reduce the line voltage to a value which is suitable for standard measuring instruments, relays, etc.
5. To isolate the measuring instruments, meters, relays, etc. from high voltage side of an installation.
6. To sense abnormalities in voltage and give voltage signals to protective relays to isolate the defective system.

6.4.2. Testing:

Quality test:

Quality test is performed for checking the quality and find out the Accuracy class of the transformer. For this they measure some important data. These are:

1. Flow of Current through the transformer in percent.
2. Ratio error in percent that means the desire current and the output current ratio in percent.
3. Phase error
4. Burden at 1A current.
5. Burden of Power factor.
6. Burden of Impedance.
7. Frequency
8. Accuracy class.

After observing all of this data we can conclude that which class of transformer is that.

High voltage test:

High voltage test is used for checking the insulation property between Primary to earth, Secondary to earth and between Primary & Secondary winding. High voltage test means applying high voltage (approximately 28 KV) on Primary side for 1 minute and the other side that means the low voltage side must be neutral and grounded.

Observation:

We measure the leakage current and by observing the value of this current we can conclude about the insulation property between Primary to earth, Secondary to earth and between Primary & Secondary winding. If the value of leakage current is low, the insulation is better. But if the value of leakage current is higher, the insulation is bad.

6.5. Breaker:

In general Energypac used three types of breaker

- Low Voltage Breaker(from 1 V to 1KV) : MCB
- Medium Voltage Breaker(from 1KV V to 11KV) : MCCB
- High Voltage Breaker(from 11KV to 33KV) : VCB

Energypac manufactures two types of Breaker:

- Indoor Vacuum Circuit Breaker, Up to 33 kV
- Outdoor Vacuum Circuit Breaker, Up to 33 kV

We know that in general the names of circuit breaker are according to their medium where the break occurring. Energypac used Vacuum Interrupter in their circuit breaker.

Vacuum Interrupter Imported from CUTLER-HAMMER (EATON), USA.

Special Charter tics of Vacuum Interrupter:

Special characteristics of vacuum interrupters are:

a) Very low arcing time

b) Quick recovery of dielectric strength

c) Small contact gap

d) Trouble free service

e) Low energy mechanism

6.6. Isolator:

Isolator or Disconnectors Types

- Pantograph
- Centre Break
- Double Break

7. Problems And Recommendations

- We faced some problems during internship as we had not completed some prerequisite courses which were related to the internship program.
- The authority of Energy Pac could not give us sufficient time as that was the time of closing of the year's activity book. This is critical and very busy time for them.
- Because of the company confidentiality, we could not achieve some important information through we were much interested to know these things.
- Students must complete the courses related to their internship before beginning the program. Taking the courses before the internship helps the students understand the topics much better.

8. Conclusion

We passed some remarkable days at Energypac during our internship program. By our internship program we have reached our expected practical life. The completion of fifteen days industrial attachment at Energypac Engineering Ltd we have got the impression that the factory is one of the most modern factory in Bangladesh though it was established only few years ago. The authorities in Energypac were very concerned about all kinds of safety. The friendly environment in Energypac encouraged us to cooperate with each other. Finally we learned a lot and obtained practical knowledge from our internship at Energypac, which will help us in our future life.

References

1] http://www.energypac-bd.com/index.php
2] http://www.energypac-bd.com/company.php?id=47
3] http://www.energypac-bd.com/company.php?id=53
4] http://www.energypac-bd.com/company.php?id=84