INTERNSHIP REPORT

ON

MANUFACTURING PROCESS OF SUBSTATIONAL EQUIPMENT

By

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ID : 2007-1-80-006
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Submitted to the

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

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For the degree of
Bachelor of Science in Electrical and Electronic Engineering

(B.Sc. in EEE)
Fall, 2010

Approved By

Academic Advisor
S. M. Shahriar Rashid

Department Chairperson
Dr. Anisul Haque

Apporoval Letter

ENERGYPAC®
এনার্জিপ্যাক®

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EELF/Admin/EWU/TR/2010-10(002)
Date: 2nd Oct'2010

TRAINING CERTIFICATE

This is to certify that **Tandra Haque**, Bearing Roll No. **2007-1-80-006**, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. She was attended an Industrial Practice, which was programmed from 21st Aug'2010 to 4th Sep'2010 at Energypac Engineering Ltd, Baruipara, Savar, Dhaka, Bangladesh. During her Industrial attachment she has taken some practical experience about Power Transformer, Impulse, Distribution Transformer, Instrument Transformer (Both CT & PT), Fabrication, CNC, Machine Shop, Paint, Powder Coating, Isolator and Switchgear Items (LT, HT & PFI) etc.

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

I wish him every success in life.

Fida Hasan
02/10/10

Fida Mahmood Hasan
Manager (Admin & Utility).

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Acknowledgment

he very outset, we like to express our heartfelt gratitude to the Management of Energypac for ng us a unique opportunity to do our industrial training at the factory of Energypac located at ar.

spent two weeks there in the factory from 21 August to 04 September 2010. We started our work 30am in the morning and ended at 3.30pm. It was an exciting as well educative memory for us. at we read in the book that we saw practically in the factory. It was a wonderful experience. The k environment was excellent and we received outstanding cooperation from all concerned cials of EP. Specifically we want to mention the name of Engr. Moniruzzaman, Manager for his port and guidance during the time of industrial training.

take this opportunity to extend our sincere thanks and gratitude to our honorable supervisor Dr Ishfaqur Raza,Associate Professor, Department of Electrical & Electronic Engineering, East t University (EWU) and S. M. Shahriar Rashid, Research Lecturer, Department of Electrical & tronic Engineering, East West University (EWU) for sparing their valuable time for us. They ed us with their guideline and advice to prepare the report. Their positive attitude was always a ce of inspiration for us.

ould be injustice if we do not to mention the name of Dr. Anisul Haque, Chairperson and essor of the Department of Electrical & Electronic Engineering, East West University (EWU). was instrumental for our industrial training because EEE Department under his dynamic ership has been able to maintain good relation with a Company like EnergyPac. It was easy for ecause of him to get opportunity at the EP for industrial training.

but not the least, We would like to thank some persons who had given us appointment from precious time to collect related data of our report and also helped us with utmost patience to e us understood many related matters. They are Engr. Asaduzzaman, Ad. GM, Engr. Syed taba Ali, DGM, Engr. Mozaharul Islam, DGM, Engr. Belal Hossain, Manager, Engr. MD. iiduzzaman Bulbul, Asstt. Engineer.

Executive Summary

e internship report is the outcome of the 2-week attachment learning with Energypac from 21 gust to 04 September 2010. The intensive attachment gave us a practical exposure to look at the erational procedures of the different departments of Energypac. What our respected teachers ght us in the class that we observed and examined practically at Energypack during the tenure of attachment. No doubt the duration was short but it was compact with tasks. We had to look many ngs in short period. The internship report is the manifestation of our practical learning at ergypac.

e internship report consists of six chapters including introduction and conclusion.

e chapter 1 on introduction displays company profile including its history, strategic business units, siness partners and products and services. Besides, it delineates the objective, scope and thodology of the internship report.

e Chapter 2 spells about transformer – the core product of Energypac. The Energypac has five partments to process the transformer. These are coil winding, core assembly, core-coil assembly, k-up and transformer tank. The chapter gives a detailed description of each department so that the ders get a transparent idea about transformer made by Energypac.

e Chapter 3 delineates about switchgear, its types and characteristics, structure and mechanism.

e Chapter 4 provides details of breaker and isolator produced by Energypac. The scenario of ergypac with regard to breaker and isolator has been recorded. Energypac mainly manufactures cuum circuit breaker, load break switch and isolator. Their principles as well as operational chanisms have also been incorporated.

e Chapter 5 tells about instrument transformer and its principles. It provides a comparison of ory and practice.

e chapter 6 provides the fabrication process and how transformer or switchgear panels have to or.

e chapter 7 provides the actual scenario of our observation at Energypac.

e chapter 8 provides the recommendations and problems of our internship.

e chapter 9 on conclusion gives the merit of our attachment with Energypac. It has enriched our owledge with regard to the different branches of electrical and electronic engineering.

Details of Training Schedule

Date	Section	Duration	Contact Person
08.10 – 24.08.10	Transformer & Impulse	4 days	Engr. Asaduzzaman, Ad. GM Engr. Asim Kumar Bhakta
08.10 – 28.08.10	Switchgear	3 days	Engr. Syed Muztaba Ali, DGM
08.10 – 30.08.10	CT/PT	2 days	Engr. Mozaharul Islam, DGM
08.10 – 01.09.10	Isolator & Breaker	2 days	Engr. Moniruzzaman , Manager Engr. Belal Hossain, Manager
08.10	Fabrication, CNC, M/C Shop, Powder Coating & Paint.	1 day	Engr. M.A. Wazed AGM Mr. N.M Habibullah, Dy. Manage Mr. Moniruzzaman, Asstt. Engr.

re, we worked for 12 days from 9.30am - 3.30 pm. Lunch break for 1-1.30pm.

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1. Company Overview

1.1. Company profile

Energypac is one of the leading power engineering companies in Bangladesh. Continual research and, state of the art production facility, quality products, competent services, and countrywide operations have made it warmly acceptable to the customers.

Vision

To Become Country Leader as well as Establish Credibility in the International Market

Mission

To Minimize Deficit of the Power Generation System & to improve the quality of lives of the employees & the community

Strategy

To achieve this mission through best quality products & excellence in its service

Board of Directors

- Enamul Haque Chowdhury, Managing Director
  Energypac Engineering Ltd.
- Engr. Rabiul Alam, Director & CEO
  Energypac Engineering Ltd.
- Humayun Rashid, Executive Director
  Energypac Engineering Ltd.

Achievement

- Successful sales of Largest B-Engine in Bangladesh which is First in ASIA
- Largest market share of Power Business in the Private Sector
- Total Turnkey Project Implementation of 9.99 MW Plant
- Total O & M Contract of 9.99 MW Plant
- Guascor Genest Sales Crossed 150 Units
- FG Wilson DEG Sales Crossed Record 2300 Units

1.2. Objective of the Internship

The first objective is complete EEE499 course. Here, is an overview of the substation equipment manufacture by EnergyPac Engineering Ltd. We gathered some practical knowledge. So, the objective of practical knowledge:

- Idea about how EnergyPac Engineering Ltd develops its business
- Idea about company management
- Idea about safety
- Idea about risk in factory
- Idea about substation equipment

1.3. Scope and Methodology:

Scope

The scope incorporates structure of a factory, manufacturing process, different department running system of EnergyPac Engineering Ltd. This will give an overview of manufacturing process of EnergyPac Engineering Ltd.

Methodology

This report has been prepared on the basis of:

- Information collected from primary sources (primary information has been procured through personal interview as well as discussion with relevant officials of Energypac).
- Information from secondary sources (secondary data has been gathered by using company website).

2. Transformer

2.1. Introduction

Transformer is a static device which transforms A.C electrical power from one voltage to another voltage keeping the frequency same by electromagnetic induction.

2.2. Brand Feature of Transformer

It was found Energypac Engineering Limited manufactures largest sized power transformers and distribution transformer in the South-East Asian region. Energypac has modern design and production techniques supported by Computer Aided Design and required software. Each production step is operator controlled to ensure the highest quality. Power transformer is necessary only in power generating station and distribution transformer is necessary for electricity distribution purpose. Any change in configuration solely depends on customer's choice.

Figure 1: 33/11KV Transformer

2.3. Manufacturing

Energypac Engineering Limited manufactures two types of transformer

- Power Transformer up to 50MVA
- Distribution Transformer 4.5 MVA (11/0.415 kV)

It was found that Energypac manufacture up to 50 MVA transformers. There future target is 75MVA, 230KV Power Transformer.

2.4. Transformer Construction Process:

2.4.1. Construction

The construction system is described below:

2.4.2. Coil

Coil is the basic raw material of transformer. It was found that Energypac use electrolyte copper coil for winding. Here, three types of coil are necessary high voltage (H.V) coil, low voltage (L.V) coil and tap changing coil. H.V coil is thin, because in H.T (high tension) side voltage is high and current is low so, the coil have to carry low rate of current. L.V coil is thick, because in L.T (low tension) side voltage is low and current is high so, the coil have to carry high rate of current. This coil is also used for tap changing. The coil size is of H.V coil, L.V coil and tap changer depends on voltage rating, KVA or MVA rating and design issues. H.V coil is cylindrical shaped and L.V coil is rectangular in shaped.

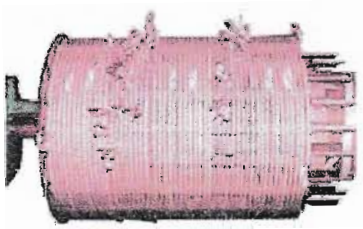

Figure 2: Transformer LT Coil

2.4.3. Core

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. This core is nothing but silicon sheet. This is used because it has good conductivity. Primary consideration is to reduce no load losses, no load current and noise level- high quality core clamping bolts, channels and supports being used. To reduce losses and noise level, better technologies are used in core sheet. 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.

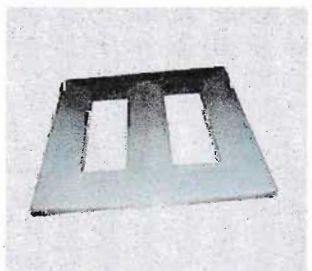

Figure 3: Transformer Core

2.4.4. Insulation

Insulation is necessary for transformer otherwise the active part and body will be shorted. To protect from this, different types of insulation is used. For H.V coil insulation crape paper is used; in the market this named High tension insulation paper and for L.V coil insulation DPC paper is used; in the market it named Low Tension insulation paper. Transformer oil is also used for insulation. 2.5mm Transformer oil can block up to 60KV. Transformer oil is from Germany. Brize board is used for insulation between LT and HT coil. Tap changing coil are also rolled with insulation paper.

2.4.5. Coil Winding

The windings are designed in accordance with the temperature rises, insulation and impulse voltage levels, overload conditions, short circuit stresses which are issued in international manufacturing standards. Coil winding is done by automatic layer setting winding machines. Normally layer winding is used up to 36 kV voltage level and continuous disc winding is used for higher voltage levels. The starting and finishing leads of each coil are terminated on either side of the coil.

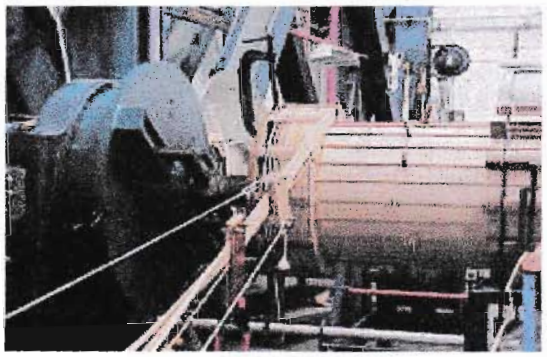

Figure 4: Coil winding machine

2.4.6. Core Assembly

Core Cutting

It was found that Energypac uses automatic core cutting machine which is automatic operated by computer. The name of the core cutting machine is Micro Tool and Machine (MTM). In this machine core are cutting in three class, they are class A, class B and class C. The core is cut thin sheets because it reduces eddy current loss. Here, A shape is called corner shape and B shape is called Benoze shape.

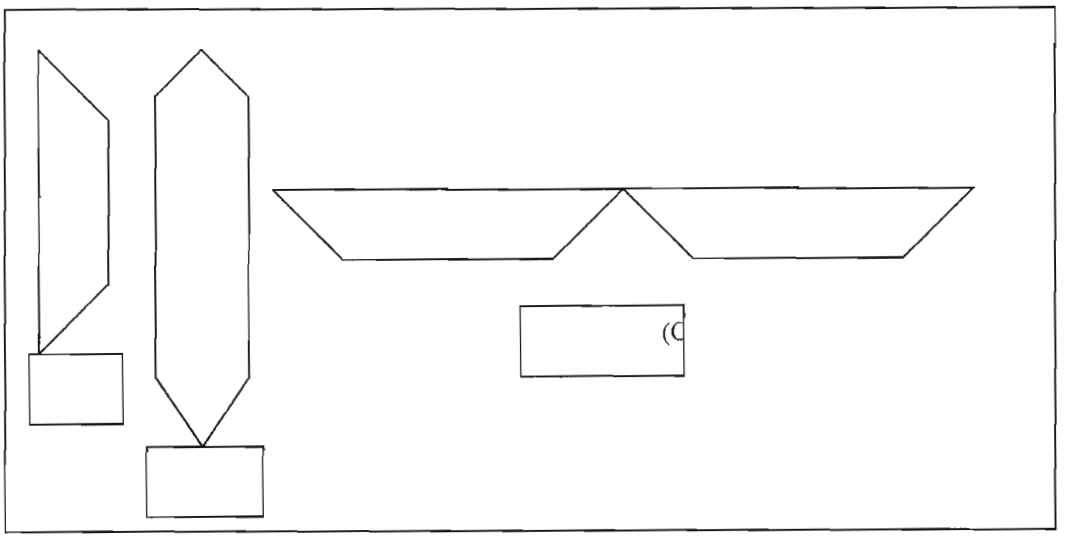

Figure 5 Transformer Core Shape

After cutting the core, the cores keep all together. It looks like the figure below.

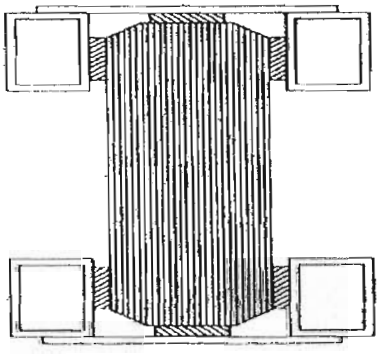

Figure 6: Side view of core

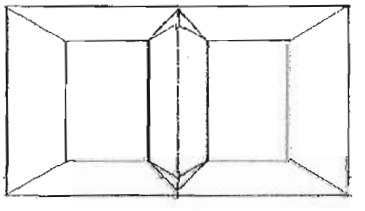

Figure 7: Actual shape of Transformer core

Steps of Automatic Core Cutting Machine (Micro tool and Machine)

- Based on design fixed grade and thickness silicon steel sheet to be provided
- According to Core class A, B, C and D's dimension the big pieces cut down by Power press machine.
- From the big pieces based on A, B, C and D design the small pieces should cut
- Based on design the pieces should cut in 45° degree angle or normal cutting
- Based on design the core should be punch or not be punched

Caution for Automatic Core Cutting machine

- Must be careful for the insulation label and dimension of silicon steel sheet

The core is cut in two ways normal cutting and Auto core cutting

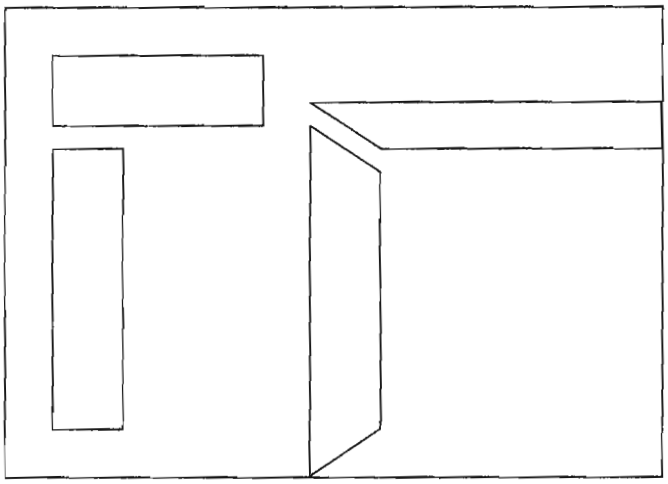

Figure 8: Normal Core cutting & Auto Core cutting

Normal core cutting is used for CT and PT because their power rating is not very high. Auto core cutting or 45^0 angle cutting is used for power and distribution transformer. In auto core cutting flux cut higher than normal core cutting

2.4.7. Core and coil assembly

When the silicon sheet is cut, then with the support of iron frame sheets are keep in the way that it look like a frame. An insulation tape is rolled to keep the sheets all together. Then the coils are set in the core.

Figure 9: Core and coil assembly

2.4.8. Tap Changer and Tap Switch

Taping is provided in HT side or LT side to vary voltage level; this is done as per customer's choice. Tap changing can be manual or automatic. Energypac provide two types of tap changer:

- On-load Tap Changer
- Off-load Tap Changer

Any undesired condition it can be turned off. Transformer above 3000KVA taping is on load. The tap changers are sourced from the best and proven sources of Europe or best manufacturer. Tap changers are compact and mounted on the tap of the tank. Motor drive mechanism is used for the control of on-load tap changer. This control can either be made locally on the transformer or remotely from the control room. The operation of off-load tap changers can either be made on the cover or on the sidewall of the transformer by manual drive mechanism.

2.4.9. Vacuum Drying process

Power and distribution transformers have to pass through the process of vacuum drying process. This system is used to clear moister from core, insulation and coil. A heat air is circulated inside plant absorb all the moisture. Transformers have to keep 15-16hour in this plant. This ensures a high degree of stability in the insulation structure and early attainment of its mature condition, which would not otherwise be achieved until the transformer had been in service for some time. Immediately after drying, the transformers are tanked and insulating oil are filled with a vacuum oil filtering machine.

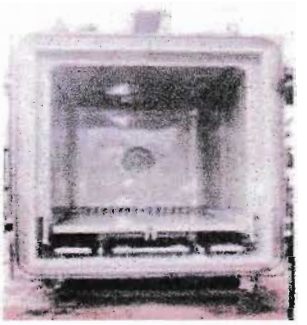

Figure 10: Vacuum Drying Plant

2.4.10. Fittings

The fittings in transformer provided by Energypac:

- Driving gear 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
- If need any other fittings it will be added as per customer choice.

2.4.11. Tank Construction

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 seams and mechanical strength. Transformer with Corrugated Fin-Type radiators can also is 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. On the tanks, there are oil treatment connection valves, oil sampling cocks, lifting lugs, butterfly valves to which radiators are connected and the oil connection valves to other types of coolers in case.

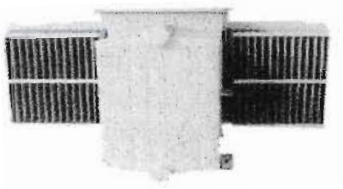

Figure 11: Transformer Tank

2.4.12. Tank 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.
- 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 wherever required.

2.5. Other Parts of Transformer

2.5.1. Cooling

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

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

Figure 12: Cooling system of Transformer

2.5.2. Gas Insulation Relay

It was found that Energypac use Buchholz Relay as gas insulation relay. Buchholz relay also detects the internal faults and the insulating liquid loss, the alarm contact in the double float design signals oil leakage and/or gases, while a trip contact is activated in the event of severe malfunctions. It is provided as per customer choice.

2.5.3. Thermal Protection

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

2.5.4. Conservator

Conservators are used to compensate the increase of oil volume due to heat. The oil rows from tank to conservator or from conservator to tank through the pipe between cover and conservator depending on expansion and extraction of the oil, air enters or exists the conservator through a dehydrating breather equipped with silica gel particles. To avoid faster aging of the oil, special oil preservation system (Air cell) is used.

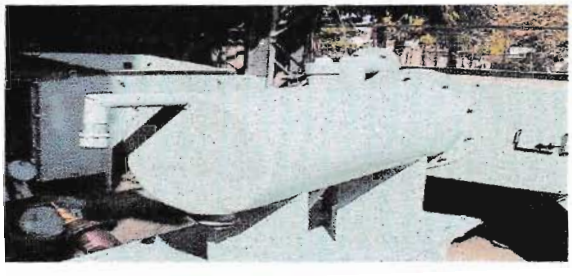

Figure 13: Transformer's Conservator

2.5.5. Bushing

Outdoor bushing is for insulation of HT and LT. The Bushing length depends on the length of HT and LT terminal.

Figure 14: Bushing

2.5.6. LT and HT Connection:

HT side is always Delta connected and LT side is always Y connected.

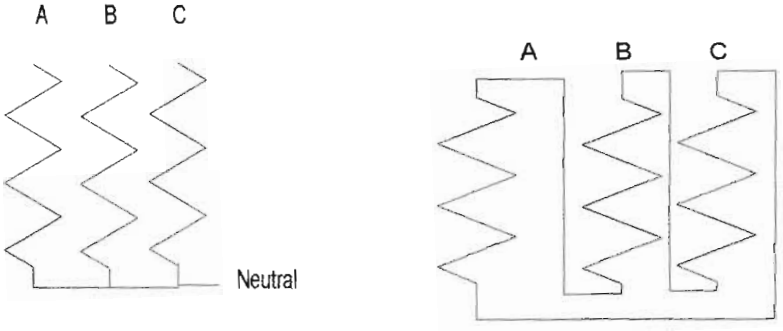

Figure 15: Y & Delta connection

2.5.7. Painting

Painting is necessary for transformer. There two systems to paint the transformer:

Cleaning

- To clean the tank at first sand is blasted in the tank accordance with international standards
- The outside surface of the tank is short blasted to achieve a very fine and smooth finish

Painting

- A covering of paint of hot oil resistance paint is applied on the internal surface of the tank, when the tank has been cleaned
- Red Oxide primer is used to paint the outside of the tank.

2.6. TESTING SECTION

List of the tests and description are given as follows:

1. In Process Test
    - Magnetic Balance Test
    - Excitation Current Test
    - Vector Group Test
2. Routine Test
    - Insulation Resistance Test
    - Winding Resistance Test
    - Winding Ratio Test
    - No Load Loss Test
    - Full Load Loss Test
    - High Voltage Test
    - Double Voltage Double Frequency Test
3. Type Test and Special Test
    - Lighting Impulse Test
    - Switching Impulse Test
    - Measurement of Acoustic Sound Level Test

2.6.1. Magnetic balance test

The Magnetic Balance test is conducted on Transformers to identify inter turn faults and magnetic imbalance. 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 is 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. This 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. The Magnetic balance test is

only an indicative test for the transformer. Its results are not absolute. It needs to be used in conjunction with other tests.

2.6.2. Excitation Current Test

In this test, the magnetic balance and eddy current loss is checked.

2.6.3. Vector Group Test

This test verifies the Dyn-11 vector group of a distribution transformer. Dyn means Delta-connection in HT side and Y-connection in LT side. This test is done by voltmeter. Let, 1U1V1W-which is primary -Delta Connection and 2U2V2W2N- Which is secondary-Star connection. Then connecting terminals 1U& 2U and give three phase Supply is given to 1U-1V-1W.

Then measure

- 1U-1V
- 1V-1w
- 1W-1U
- 1W-2W
- 1V-2W
- 1V-2V
- 1W-2V
- 1U-2N
- 1V-2N

Then calculate it

- 1.1V-2W=1V-2V
- 2.1W-2V>1W-2W
- 3.1U-1V=1V-2N+1U-2N

If this is matches the vector group test will be done.

2.6.4. Insulation Resistance Test

The winding insulation resistance test (also known as the Meggar test) is a measure of quality of insulation within the transformer. It can vary due to moisture content, cleanliness and the temperature of the insulation parts. All measurements are corrected to 20°C for comparison purposes. It is recommended that tank and core are always grounded when this test is performed. Each winding should be short-circuited at the bushing terminals. Resistances are then measured between each winding and all other windings and ground. The Megger meter is hold between HT-LTG (LT is grounded), LT-HTG (HT is grounded) and HTLT-G. This test is done by Meg ohmmeter.

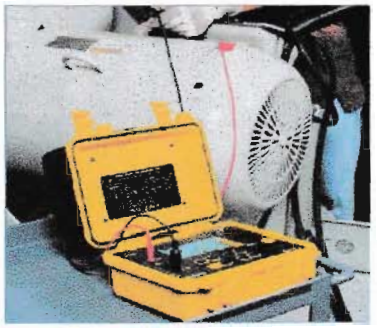

Figure 16: Meg ohmmeter

2.6.5. Winding Resistance Test

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. The Digital Resistance Meter is used in this test.

2.6.6. No Load Loss Test

The no load test is performed, when power supply is given in HT side while the other winding is supplied with rated voltage at rated frequency. Then the no-load losses (P0) and the no-load current (I0) are measured.

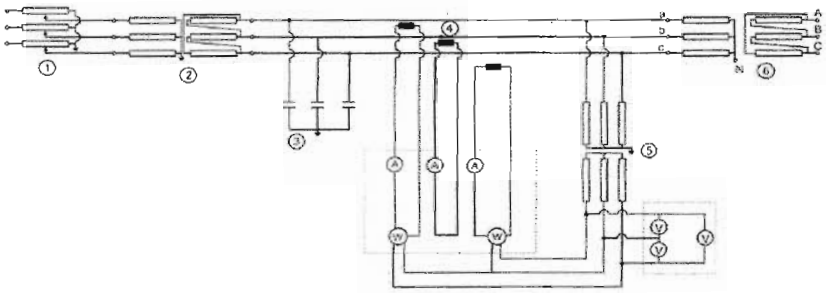

Figure 17: Measurement Circuit

2.6.7. Full Load Loss Test

This test measures the power consumed by the transformer when the LT winding is short circuited and the rated current is passed through the HT winding. This test is done by wattmeter or power analyzer.

2.6.8. Winding Resistance Test

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. This test is done by digital winding meter.

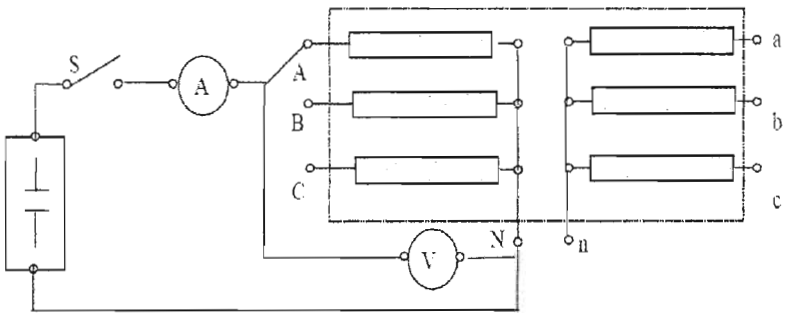

Figure 18: Measurement Circuit

2.6.9. Double Voltage Double Frequency Test

In an11/33KV and 50Hz transformer 66KV and 100Hz is applied for one minute. This test checks the turn's insulation.

2.6.10. Lighting Impulse Test

The purpose of impulse Voltage test is to confirm that the transformer insulation's withstand the lightning over voltages which may occur in service. The Power Transformers used in high voltage systems at any time may be affected by the atmospheric discharges. The magnitudes of the lightning over voltages always depend on the impulse current and impulse impedance where the lightning impulse occurs. This value is several times of operating voltage. In the transformer, maximum seven times greater voltage is applied to check its insulation. High voltage is applied in the HT side. Applied voltages are:

- 415V ----- No voltage
- 11KV----- 75KV
- 33KV----- 170KV
- 132KV----650KV

3. Switchgear

3.1. Introduction

A great demand for electrical energy is a notable feature of modern civilization. Electrical Energy Measurement system ensures supply of energy to every consumer at all times at rated voltage, rated frequency and specified wave form, at lowest cost and with maximum environmental degradation. For this purpose, means must be provided to switch on or off generators, transmission lines, distributors and other equipment under both normal and abnormal conditions. This is achieved by an apparatus called switchgear. It is essentially consists of switching and protecting devices such as switches, fuses, circuit breakers, relays etc.

3.1.1. Switchgear

The term switchgear, 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 a general term covering a wide range of equipment concerned with switching and protection. The main functions of switchgear are:

- Electrical protection
- Electrical isolation of sections of an installation
- Local or remote switching

3.1.2. Switchgear Panel

Typically switchgear in substations is located on both the high voltage and the low voltage side of large power transformers. Low voltage switchgear is enclosed within a building. With the advancement of power system, lines and other equipments operate at high voltages and carry large currents. To operate, control and maintain the switchgear; the switchgear control panel is necessary. Control panels are installed in control room. Mainly there are two types of switchgear panel:

- High Tension Panel (HT Panel)
- Low Tension Panel (LT Panel)

From control panel, the operator can know, what is happening in the plant. The operator can control, start, regulate or switch off the main circuits from control panels. The control panels are designed and assembled to customer's specifications. Control panels can be utilized in the following applications:

- Power station
- Industrial enterprise
- Commercial/Residential Buildings for power distribution
- Control, protect and inspect the circuit

In generating stations and sub-stations, the control and relay equipment is installed in control-rooms. The arrangement of control and relay equipment needs careful attention to suit the layout and operational requirements of the installation.

3.2. Manufacturing

Energypac Engineering Limited manufactures two types of switchgear panel

- HT switchgear(High voltage)
- LT switchgear(Low voltage)

3.2.1: Voltage range of HT switchgear

- 11KV
- 33KV
- 132KV
- 230KV

LT switchgear working voltage is up to 440V phase to phase.

3.2.2: Products under HT switchgear are:

- HT metering panel up to 230KV
- Load Break Switch (for 11KV substation)
- Vacuum Circuit breaker (Indoor-Outdoor, up to 33KV
- Control, Metering and relay panel up to 230KV**g**

3.2.1. Products under LT switchgear are:

- LT metering panel up to 415V (phase to phase)
- Distribution box
- Motor control panel
- Power factor improvement plant (PFI plant)

The product details are discussed below which we are observed

3.3. Low Tension Panel (LT) Switchgear

3.3.1. Brand Feature of LT Panel

It was found that Energypac Engineering Limited manufactures low voltage switchgear which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 440V. The design meets with the standard of IEC439;GB7251.

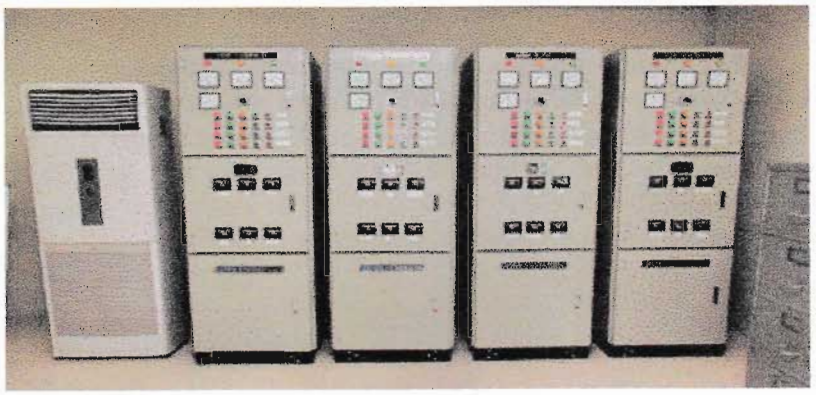

Figure 19: LT switchgear panel

The essential components in LT switchgear panel used in Energypac Engineering Limited:

- Molded Case Circuit Breaker (MCCB) from ABB; Tmax series and triple pole
- Miniature Circuit Breaker(MCB) from ABB; SH series and three types of MCCB are Used:
- TP(Triple pole)
- DP(Double Pole)
- SP(Single Pole)
- Bus-bar
- Ring CT from Energypac
- Ammeter, Voltmeter, Indicator lamps

The details of each component are described below

3.3.2. Molded Case Circuit Breaker

Protection and control of electrical machineries from

- Overloads
- Short-circuits
- Ground fault protection

3.3.2(A): Current ratings: 16Amp to 1600Amps

3.3.2(B): Structure

It was found that the Molded Case Circuit Breaker used by Energypac Engineering Limited which manufactured by ABB. The sheet steel structure of circuit breaker is extremely compact, considerably reducing overall dimension. Safety is improved by adopting double insulation for the live parts and total segregation between phases. The sizes have the same height and depth for all of the circuit breakers in each version. The compact dimensions also allow them to replace power circuit breakers.

3.3.2(C): Operating Mechanism

A stored energy type operating mechanism is used. The springs are charged manually by operating the front lever or using a geared motor, supplied on request. The opening springs are charged automatically during the closing operation. When closing coil, shunt trip and motor operator are installed, the circuit breaker can be operated by remote control and, if required, managed by a supervision and control system.

Figure 20: Molded Case CB

The following operating cycles are possible without recharging the springs:

- Starting with the circuit breaker open (0) and the springs charged. Closing-opening
- Starting with the circuit breaker closed (|) and the springs charged. Opening- closing-opening.

3.3.2(D): Application

They are used in D.C A.C. switchgear, for motor protection, generators, capacitors etc.

3.4. Bus-bar

The bus-bar is designed to carry normal current continuously. The size of bus-bar depends on the rated normal current and temperature rise due to passing of normal current. The bus-bar is made with electrolytic copper with high conductance. Copper bus bars are colored red, yellow and blue. The standard of bus-bar is IEC431.

Figure 21: Bus-bar

3.5. Miniature Circuit Breaker

The operating voltage is 230V-440V. During overloads or faults it automatically trip off. The tripping mechanism is actuated by magnetic and thermal sensing. It is small in size and easy mechanism.

(i) (ii) (iii)

Figure 22: (i) SP (ii) DP (iii) TP

3.6. Operating Mechanism of LT Switchgear Panel

The panel includes three numbers of ring CT for current measuring purpose. Also, there are three ammeter and one voltmeter to monitor current and voltage value. The ammeter's are connected in the bus-bar through CT because the ammeter can measure current from 1A-5A. But the voltmeter is directly connected to bus-bar because the internal resistance of voltmeter is very high. When fault occur like over-current, short-circuit, earth-fault etc initially MCB trips and then the MCCB operates and if fault occur in the bus-bar then only MCCB trips; then the whole system will be disconnected. If any fault occurs in any phase, the whole phase will disconnect instantly. In LT panel, there are some indicator lamps which indicate the panel on/off, trip signal, spring charge lamp.

3.7. High Tension Panel (HT) Switchgear

3.7.1. Brand Feature of HT Panel

It was found that Energypac Engineering Limited manufactures higk voltage switchgear which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 4230KV. The design meets with the standard of IEC.

The essential components in HT switchgear panel used in Energypac Engineering Limited:

- Vacuum Circuit Breaker (VCB) (Discussed in Chapter-4, section-4.1)
- Relay from Areva Company
- Bus-bar (Discussed in Chapter-3; section-3.4)
- Ring CT (current transformer) from Energypac
- Potential Transformer from Energypac
- Ammeter, Voltmeter

The details of relay described below:

3.8. Relay

It was found that Energypac Engineering Limited uses relay which is manufactured by Areva Company. Relay senses the fault and send trip signal to circuit breaker. The relay senses directional/non-directional earth fault, three phase over current, Watt metric protection, Undercurrent, negative phase sequence over current, thermal overload, under voltage, over voltage etc fault. To operate relay first the relay should be set for pacific values. This relay includes IDMT (Inverse/Definite Minimum Time) characteristics. IDMT relays have such tripping characteristics that, for a particular range of low values of current the tripping time varies inversely with the value of current. But beyond a certain current limit the tripping time becomes constant (definite) and causes tripping in minimum time.

3.9. Operating Mechanism of HT switchgear

The panel includes three numbers of ring CT and PT for current and voltage measuring purpose respectively. Also, there are three ammeter and one voltmeter to monitor current and voltage value. The ammeters are connected in the bus-bar through CT because the ammeter can measure current from 1A-5A and the voltmeter is also connected to bus-bar through PT because voltmeter can not measure voltage in Kilo Volt range. When any kind of fault occurs, initially the relay senses the fault and then send trip signal to VCB; then the VCB trips and the whole system will be disconnected. If any fault occurs in any phase, the whole phase will disconnect instantly. In HT panel, there are some indicator lamps which indicate the panel on/off, trip signal, spring charge lamp.

3.10. Power Factor Improvement Plant

3.10.1. Principle

The electrical energy is almost exclusively generated, transmitted and distributed in the form of alternating current. Therefore, the question of power factor immediately comes into picture. Most of the loads are inductive in a nature and hence have low lagging power factor.

The cosine of angle between voltage and current in an A.C circuit is known as power factor. The power factor plays an important role in A.C circuits since power consumed depends upon this factor,

$P = V_L I_L \cos\varphi$

$I_L = P/\sqrt{3}V_L\cos\varphi$; it is clear that from above that for fixed power and voltage, the load current is inversely proportional to the power factor. Lower the power factor, higher is the load current.

3.10.2. Brand Feature of Power Factor Improvement (PFI) Panel

It was found that Energypac manufacture PFI Plant for improving the degraded Power Factor of the system. PFI plant consists of:

- Power factor correction (PFC) relay
- H.R.C fuse from ABB, German
- Miniature Circuit Breaker(MCB) from ABB, German (Described in Chapter-3, Section-3.3.4)
- Magnetic Contactor from ABB, German
- Capacitor bank from Cali-lab company, India
- Ammeter, Voltmeter and Wattmeter

These are described below:

Figure 23: PFI Plant

3.11. PFC Relay

It was found that Energypac uses PFC relay which manufactured from ABB, German. It is use for sense lower power factor. Let, power factor should not be less than 0.95. Then, manually it should be set in the relay. When pf will be less than 0.95 the relay starts operation.

3.12. H.R.C Fuse

It was found that Energypac Engineering Limited uses HRC fuse which is manufactured by ABB. In electrical system fuse acts as protection device and depending on application different type of fuse is to select. Out of these different types of fuses HRC is also one of the types and it stands for "High Rupturing Capacity". This type of fuses normally used where some delay is acceptable for protecting the system. HRC fuse link is a very common, simple and effective electrical protection device against over load and short circuit current. The main advantage of using an HRC fuse is that, when a fault current condition occurs, a tremendous amount of heat is created within the fuse. That heat melts the silica sand filling of the fuse into glass. Glass, being an insulator, suppresses any arc-over and breaks the circuit instantaneously.

Figure 24: H.R.C fuse

3.13. Magnetic Contactor

It was found that Energypac Engineering Limited uses magnetic contactor which is manufactu
ABB. When electricity flows through the magnetic contactor, it causes the electromagnet to ge
a strong magnetic field. This field pulls the iron core into the coil, and creates an electrica
Electricity passes in through one contact and as a result, the moving contact and fixed co
become together.

Figure 25: Magnetic contactor

3.14. Capacitor Bank

A capacitor bank is a grouping of several identical capacitors interconnected in parallel or in
with one another. The characteristics of capacitor bank:

- Capacitor's terminal predigest the Parallel application form
- Prevent tip-and-run protection
- Building-in discharge resistance and safety installation, the use of safe and reliable

Figure 26: Capacitor Bank

3.15. Operating Mechanism of PFI Plant

When pf start decreasing, the PFC relay senses it. Then the magnetic contactor connects and c
one capacitor bank operates. These are three phase capacitor bank. This system is automatic.
MCB protects relay, indicator bulbs, meters and H.R.C fuse protects the magnetic contactor.

3.16. TESTING

3.16.1. Testing for LT Switchgear

- MCCB/ ACB performance Test
- CT Test
- Ammeter and Voltmeter performance Test
- Insulation Resistance Test

- Performance Test
- Wiring Test

3.16.2. Testing for HT Switchgear

- Vacuum circuit Breaker Test
- Load Break Performance Test
- IDMT Relay Test
- CT & PT Test
- Insulation Resistance Test
- Ammeter and Voltmeter performance Test
- Wiring Test

3.16.3. Testing for HT Switchgear

- Magnetic Contactor Performance Test
- Relay Operating Test
- Fuse Test
- Insulation Resistance Test
- Ammeter and Voltmeter performance Test

These are described below:

3.16.4. Contact Resistance Test

This test involves observing the resistance loss. When contactor of circuit breaker moves fr incoming bus bar to outgoing bus bar then if resistance loss is high then contactor did not w properly. If contactor not maintains properly carbon build up due to repeated operation wh reduces the contacts ability. So for proper contact mechanism it is required to keep low of cont resistance to reduce power losses.

3.16.5. Common Test

In this test, 25 kV is applied in an 11 kV line to check the interrupt condition of circuit breaker. circuit breaker is appropriate then it must be interrupted.

3.16.6. Timing Test

If fault occurs then it is required for relay to trip within 30 ms. Thus For observing the re performance this test is occurred.

3.16.7. Insulation Test

This test is required for observing the insulation condition which is strongly recommended prevent electrical shocks. The equipment required for this testing is Megohmmeter with a timed t function and temperature indicator.

4. Breaker and Isolator

4.1. Introduction

During operation of power system, it is necessary to switch on/off the various circuits under norm and abnormal condition. For doing this circuit breaker, isolator, load break switch, fuse and oth equipment are necessary.

4.2. Manufacturing

EnergyPac Engineering Ltd three types of breaker and isolator:

- Vacuum Circuit Breaker(VCB)
- Load Break switch(LBS)
- Isolator

These are described below:

4.3. Vacuum Circuit Breaker

4.3.1. Principle

A circuit breaker is an automatically-operated electrical switch designed to protect an electric circuit from damage caused by overload or short circuit.

In such breakers, vacuum is used as the arc quenching medium. Since vacuum offers the highe insulating strength, it has far superior arc quenching properties than any other medium. When t contacts of a breaker are opened in vacuum, the interruption occurs at first current zero wi dielectric strength between the contacts building up at a rate thousands of times higher than th obtained with other circuit breakers. Thus the arc extinction process in vacuum circuit breaker related to a great extent to the material and shape of the contacts and the technique adopted condensing the metal vapour. The contact geometry is so designed that the root of the arc keeps moving so that the temperature at one point on the contact does not reach a very high value. T rapid building up of dielectric strength after final arc extinction is a unique advantage of vacuu circuit breaker. They are ideally suitable for capacitor switching as they can give restrike fr performance.

The vacuum circuit breakers interrupter the small currents before natural current zero causi current chopping. However the chopping level depends on material of contact. The vacuum circu breaker comprises one or more sealed vacuum interrupter units per pole. The moving contact in t interrupter is connected to insulating operating rod linked with the operating mechanism. T contact travel is of the order of a few millimeters only. The movement of the contacts within t sealed interrupter unit is permitted by metal bellows.

4.3.2. Brand Feature 0f VCB

It was found that Energypac Engineering Limited is the first and only company in Bangladesh introduce horizontal isolated, horizontal draw out type vacuum circuit breaker in the country w back in 1998. Large numbers of these circuit breakers are today in operation in Bangladesh and oth parts of the world. The vacuum circuit breaker is designed to meet the requirement laid down by IE 60056. The special features of this equipment are following:

- Customer friendly
- High degree of safety
- High operational reliability
- Rugged design
- Simple in construction
- Modular and compact
- Easy maneuverability of truck

Figure 27: Outdoor and indoor type VCB

Energypac Engineering Limited manufactures following types of Vacuum Circuit Breaker:

- Indoor Vacuum Circuit Breaker, up to 33KV
- Outdoor Vacuum Circuit Breaker, up to 33KV

There is no significant difference between Indoor and outdoor vacuum circuit breaker. The CB has three main parts.

- Fixed contact
- Moving contact
- Vacuum interrupter from Cutler-Hammer (Eaton), USA

4.3.3. Characteristics of vacuum interrupters are:

- Very low arcing time
- Quick recovery of dielectric strength
- Small contact gap
- Trouble free service
- Low energy mechanism

Figure 28: Vacuum Interrupter

4.3.4. Operation of Vacuum Interrupter

It was found that the vacuum Interrupter used by Energypac Engineering Limited which manufactured by Cutler-Hammer (Eaton), USA. The vacuum interrupter design is complex, involving carefully selected contact materials and contact geometry. The concept of vacuum interruption is basic. Two separate contacts and other components are within an evacuated and hermetically sealed ceramic envelope, also known as the "vacuum interrupter." Vacuum interrupter 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. Arcing is established within the vacuum interrupter by withdrawing the movable contact away from the fixed contact.

The closing mechanism includes the following indications:

- Breaker on/off
- Spring charged or discharged
- Operation counter

4.3.5. Application

- Power stations
- Transformers

Also, this circuit breaker is used in different industry.

4.4. Load Break Switch

4.4.1. Principle

Load break switch an electric switch in a circuit with several hundred thousand volts, designed to carry a large amount of current without overheating the open position, having enough insulation to isolate the circuit in closed position, and equipped with arc interrupters to interrupt the load current. 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. In such cases, the load break switches are used in conjunction with HRC fuses and circuit breakers. 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

4.4.2. Brand Feature of LBS

It was found that Energypac Engineering Limited manufactures 11KV indoor type load break switch. Load-break switches are required to maintain the capability of interrupting the load current.

Figure 29: Load Break Switch

4.4.3. Construction

Energypac Engineering Limited uses the following components in the construction of load break switch:

- Interrupter Switch
- Bus-bar (Described in Chapter-3, Section-3.4)
- HRC fuse from ABB (Described in Chapter-3, Section-3.12)

- Current Transformer(CT)
- Potential Transformer(PT)
- Ammeter
- Voltmeter

These are major parts of load break switch. The construction is described below:

Interrupter Switch

The switch blades are operated through a stored energy spring operating mechanism, which provides uniform contact movement and mechanical power for positive action and fault closing, independent of switchgear operator reaction time. Manual opening and closing are provided through a dependable, operating handle system that connects the operating mechanism to the front of the switch enclosure for convenient and safe actuation by the operator.

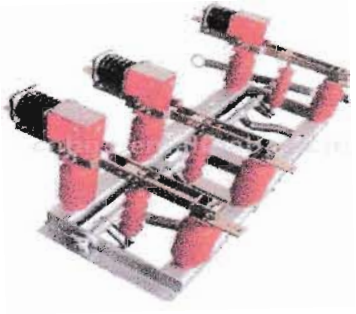

Figure 30: Interrupter Switch

4.4.4. Operating Mechanism of LBS

Load break switch operates when the current exceeds 630A. The overload protection mechanism is provided by HRC fuse. The panel includes three numbers of CT and PT for current and voltage measuring purpose respectively. If any fault occurs in any phase, the whole phase will disconnect instantly. Also, the panel includes three number of ammeter and one voltmeter to monitor the current and voltage value.

4.5. Isolator

4.5.1. Principle

Isolator (disconnecting switch) operates under no load condition. 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. Isolators used in power systems are generally 3-pole isolators. The 3-pole isolators have three identical poles. Each pole consists of two of two or three insulator posts mounted on a fabricated support.

4.5.2. Brand Feature of Isolator

It was found that Energypac Engineering Limited manufactures outdoor offload isolators which has the rated voltage is 12-245KV, rated normal current is up to 3150Amps and short time current rating up to 50 kA. The isolators are designed to meet the requirement laid down by IEC 129 and ANSI 37.30. The isolators 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. For all sizes up to 245 KV, the base frame is of welded design and has minimum four fixing holes. The major features are: [1]

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

Figure 31: Isolators from Energypac

4.5.3. 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.

4.5.4. Manufacturing

Energypac Engineering Limited manufactures outdoor offload Isolators of the following types:

- Pantograph
- Centre Break
- Double Break

The characteristics of this type of isolators are described below:

Pantograph Isolators

- Very low civil engineering profile.
- Trapeze contact fixing to suit upper bus arrangement.
- 4 point contact
- Available for flexible / rigid busbar layouts.
- Individual pole operation.
- Structure to suit requirements.

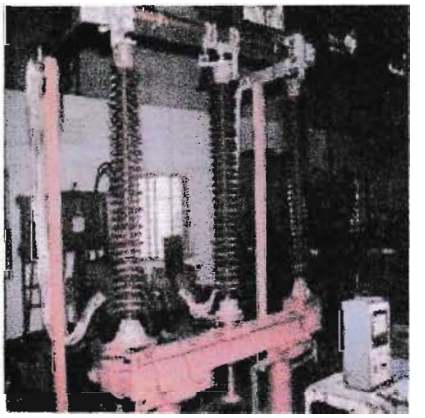

Figure 32: Pantograph Isolator

Centre Break Isolators

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

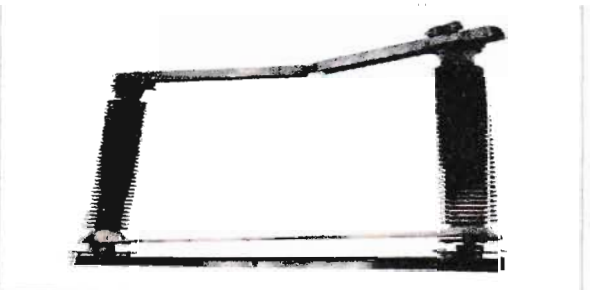

Figure 33: Centre Break Isolator

Double Break Isolators

- 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.

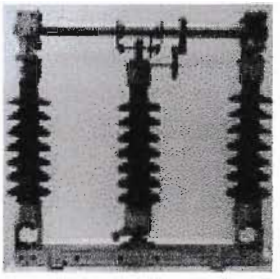

Figure 34: Double Break Isolator

4.5.5. 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. [1]

4.6. Tests for Isolators

4.6.1. Routine Tests

1. Resistance Test

- Operating mechanism
- Operating universal joints and links
- Auxiliary contact
- Inter lock

2. Voltage Test On

- Auxiliary contact
- Operating Mechanism

3. Functional Test On

- Main circuit and attachment
- Beam and bearing
- Earthing switch

4.6.2. Type Test

Isolators offered have been successfully type tested as per IEC 129 and ANSI 37.30 standards at CPRI, India.

5. Instrument Transformer

5.1. Introduction

The transformers which are used in conjunction with measuring instruments, protective relays and control circuits; these are called instrument transformer. Instrument transformers include measuring and protective current transformers and voltage transformer. The design and use of these transformers is quite different from that of well known power transformers.

5.2. Brand Feature of CT and PT

It was found that Energypac Engineering Limited manufactures outdoor or indoor type; oil cooled or cast resin Current Transformers (CT) and Potential Transformer ranging from 11kV to 230 kV. This Instrument Transformers are manufactured in accordance with latest IEC/ANSI Standards. Energypac produced Instrument Transformers since 1995. Since then Energypac is the only manufacturer of instrument transformers in Bangladesh. Energypac ensure quality test facility as to IEC-76, VDE 0537, ANSI C 57.12 and BS 171 and every transformer are dispatched from the factory after being tested properly and passing quality requirements.

5.3. Current Transformer

5.3.1. Principle

Instrument transformers which used in conjunction with ammeters, over current relays etc is called current transformer (CT). CT steps down current from high value too a low value. Their current ratio is substantially constant for given range of primary current and phase angle error is within specified limits. The VA rating of current transformers is small as compared with that of a power transformer. Basic functions of current transformer's are:

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

Current transformers must be further classified into two groups:

- Protective CT used in association with relays, trip coils, pilot wires etc.
- Measuring CT used in conjunction with ammeter, wattmeter etc.

5.4. Potential Transformer

5.4.1. Principle

Potential transformers (PT) are used for measurement and protection. It is either measuring type or protective type. Basic functions of potential transformers are:

- To reduce the line voltage to a value which is suitable for standard measuring

instruments, relays, etc.

- To isolate the measuring instruments, meters, relays, etc. from high voltage side of an installation.
- To sense abnormalities in voltage and give voltage signals to protective relays to isolate the defective system.

PT may be single phase or three phase units. PT is necessary for voltage, directional, distance protection. The primary side of PT is connected to power circuit between phase and ground. The VA rating of PT is smaller as compared with that of power transformer

5.5. Manufacturing

Energypac manufactures two types of CT and PT based on construction

- Indoor type (Epoxy resin cast type)
- Outdoor type(Epoxy resin cast type and oil merged type)

Current transformers

Energypac manufactures two types of CT

- Live tank.
- Dead tank

Potential transformers:

Single phase electromagnetic PT is manufactured in two types:

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

5.6. Construction of CT

5.6.1. Core

- High permeability CRGO silicon steel is used as core material
- Primary winding is of braided electrolytic copper conductors with double cotton covering
- Secondary winding is done automatically and distributed equally on the periphery of the core to minimize leakage reactance.
- Toroidal cores from continuous strips are made there and annealed in controlled atmosphere to achieve best quality secondary cores.

5.6.2. Insulation

- High quality crepe insulating paper is used to build up main insulation of the CT.
- Varnished fiber glass sleeve is provided as an additional insulation on this conductor.
- Craft paper is also used for insulation.

5.6.3. Bushing

- Brown/white glazed porcelain bushing with different shade profiles to suit different pollution conditions are used.
- These bushings are hollow cylindrical type conforming to bushings.

5.6.4. Oil

- Insulating oil
- Transformer oil
- Mineral oil
- Pironol oil

This oil is used for both CT and PT.

5.7. Construction of PT

5.7.1. Core

- CRGO silicon steel is used for building up electromagnetic core.
- Shell type construction is used to minimize leakage reactance.
- Primary is wound with multilayer and graded insulation.
- Secondary is separately wound and inserted in the primary winding as per the requirement.

5.7.2. Insulation

High quality electrical grade Kraft paper and crepe paper is used for insulating primary and secondary of PT.

6. Fabrication Process

6.1. Introduction

First of all they are doing powder coding on the steel path. After finishing the powder coding the steel path was fell down in the acid tank. Similarly the steel path needs to drop in rinse tank which was filled with normal water. So they put in normal water tank. Then the path fell into the drastic tank. Again the path fell into normal water then it dropped into phosphate tank. At last it was sending in dry-off oven. Powder spray is done in dry- off oven. The spray process is done by electrically. Generally they spray the barzer powder. The temperature of the dry-off oven must be at 180 degree Celsius. The process takes 13 to 15 minutes.

6.1.1. Sand Blasting Process

- Without switchgear all are liquid plant
- There is an radiator tank where sandblasting is done
- For completing sandblasting they mixed sand with air and this put at air blasting tank about 730kg. There is a nozzle in the tank. For completing the sandblasting they spray the sand by nozzle.

6.1.2. Coloring Assembly

- Two types of color are used like AD zinc phosphate primer (light gray) and other is fenile (dark gray)
- Fenile is used after 12 hours later of zinc phosphate.
- T6 fenile is used for mixing
- Mixing ratio is 4:1 where 4 liters color is used for 1 gallon fenile.
- They also used epoxy primer where color is light gray and it is a curing agent of epoxy primer. For this purpose they use T7 fenile where color ratio is 2:1:2 that mean 2% color, 1% curing and 1% fenile. They use epoxy enamel after 24 hours later. Color is verge gray and curing agent for epoxy enamel. Mixing ratio is 2:1:1 where 2% color, 1% curing and 1% fenile. Also use T7 fenile.

6.1.3. Machine Shop

Following machines are used in Energypac machine shop. These machines name and working operation are given below.

1. Lathe machine

The lathe machine is using for following purposes.

- Turning
- Facing
- Threat cutting
- Hole enlarging
- Tapping

2. Milling machine
   To make gear on the shaft
   To make key way on the outside of the shaft
3. Shaper machine
   - To make key way on the inside of the shaft
4. Chaser machine
   - Cutting a threat only outside
   - Use for ring type elements
5. Drill machine
   - Only used for making a drill on the path
6. Surface grinding machine
   - Only used for smoothing job surface
7. Power Saw machine
   - Only for cutting metal plate, shaft, rod etc.

6.1.4. CNC Machine

The full meaning of CNC is computer numerical control. The operating system is electrically. CNC machine has the given assembly.

- Third generation scream manufacturing and fabrication
- It has hydraulic punch and capacity is 30 ton
- All are control by CNC
- Sheet thickness can be punch 1.6 mm to 6mm
- Usable software is AP100 includes cat, cam, and programming caesural dataset.

7. Observation

7.1. Introduction

This chapter has been prepared on the basis of our observation of different operations at Energypac. Here, what we have observe in the internship program days that are described.

7.2. Transformer

At first day, in transformer section our supervisor was Engr. Asaduzzaman, Ad.GM, production, EELF. Mr. Asaduzzaman assigned an Engineer named Asif for Us.

We observe that coil winding process is operating. The engineer told us, that this coil is made with copper. . Here, three types of coil are necessary high voltage (H.V) coil, low voltage (L.V) coil and tap changing coil. H.V coil is thin, because in H.T (high tension) side voltage is high and current is low so, the coil have to carry low rate of current. L.V coil is thick, because in L.T (low tension) side voltage is low and current is high.

Then we watched the vacuum drying plant. There a transformer is inside of the plant. This system is used to clear moister from core, insulation and coil. A heat air is circulated inside plant absorb all the moisture. Transformers have to keep 15-16hour in this plant.

There we watched a transformer core which is made with silicon which is imported from Japan, Europe, and USA.

Then we observe the taping system. Taping is provided in HT side or LT side to vary voltage level. Tap changing can be manual or automatic. Energypac provide two types of tap changer:

- On-load Tap Changer
- Off-load Tap Changer

For H.V coil insulation crape paper is used; in the market this named High tension insulation paper and for L.V coil insulation DPC paper is used; in the market it named Low Tension insulation paper. Transformer oil is also used for insulation.

It was found that Energypac uses automatic core cutting machine which is automatic operated by computer. The name of the core cutting machine is Micro Tool and Machine (MTM).

When the silicon sheet is cut, then with the support of iron frame sheets are keep in the way that it look like a frame. An insulation tape is rolled to keep the sheets all together. Then the coils are set in the core.

Outdoor bushing is for insulation of HT and LT. The Bushing length depends on the length of HT and LT terminal.

There we observe, HT side is always Delta connected and LT side is always Y connected.

7.3. Switchgear

In switchgear section our supervisor is Engineer. Mahabub.

In the switchgear section, we observe LT switchgear initially. There we watched that LT panel consists of:

- Molded Case Circuit Breaker (MCCB) from ABB; Tmax series and triple pole
- Miniature Circuit Breaker(MCB) from ABB; SH series and three types of MCCB are Used:
- Bus-bar
- Ring CT from Energypac
- Ammeter, Voltmeter, Indicator lamps

Then the supervisor told us its operation. LT switchgear operating system is described previous.

Then we observe HT panel. There we watched that HT panel consists of:

- Vacuum Circuit Breaker (VCB)
- Relay from Areva Company
- Bus-bar
- Ring CT (current transformer) from Energypac
- Potential Transformer from Energypac
- Ammeter, Voltmeter

Then the supervisor told us its operation. LT switchgear operating system is described previous.

Then we observe PFI plant. There we watched that PFI plant consists of:

- Power factor correction (PFC) relay
- H.R.C fuse from ABB, German
- Miniature Circuit Breaker (MCB) from ABB, German
- Magnetic Contactor from ABB, German
- Capacitor bank from Cali-lab company, India
- Ammeter, Voltmeter and Wattmeter

7.4. Breaker and Isolator

In the breaker and isolator section our supervisor is Engineer Tauhid. EnergyPac Engineering Ltd three types of breaker and isolator:

- Vacuum Circuit Breaker(VCB)
- Load Break switch(LBS)
- Isolator

Our supervisor told us that Energypac manufactures following types of Vacuum Circuit Breaker:

- Indoor Vacuum Circuit Breaker, up to 33KV
- Outdoor Vacuum Circuit Breaker, up to 33KV

There we observe that CB has three main parts.

- Fixed contact
- Moving contact
- Vacuum interrupter from Cutler-Hammer (Eaton), USA

Then the supervisor told us its operation. VCB operating system is described previous.

Then we observe Load Break Switch. Our supervisor told us that Energypac manufactures 11KV indoor type load break switch. There we watched that LBS that consists of:

- Interrupter Switch
- Bus-bar
- HRC fuse from ABB
- Current Transformer(CT)
- Potential Transformer(PT)
- Ammeter
- Voltmeter

Then the supervisor told us its operation. LBS operating system is described previous.

Our supervisor told us that Energypac manufactures isolators which rated voltage is 12-45KV. There we watched three types of isolators:

- Pantograph
- Centre Break
- Double Break

7.5. Instrument Transformer

In the instrument transformer section our supervisor is Engineer Masum. EnergyPac manufactures instrument transformer which voltage range is from 11KV-230KV.

There we observe the following type of instrument transformer:

- Indoor type (Epoxy resin cast type)
- Outdoor type(Epoxy resin cast type and oil merged type)

We observed that for insulation Energypac use:

- High quality crepe insulating paper
- Varnished fiber glass sleeve
- Craft paper

We observed that in bushing Energypac use:

- Brown/white glazed porcelain bushing

7.6. Fabrication Process

Chapter 6 Fabrication process is based on our own observation.

8. PROBLEMS AND RECOMMENDATIONS

Problems

- The tenure of internship program is too short.
- The internship program should be scheduled in such a way so that it does not clash with the university classes.
- Practical participation in different works of Energypac would give us more experience, but unfortunately it was not within the policy of Energypac. We were just observer.

Recommendations

- The tenure of our internship program with Energypac was only for two weeks. Even the short duration gave was exposure to the practical aspects of theoretical issues. Considering the benefits of practical exposure, the following recommendations have been put forward for the consideration of the Management of Electric and Electronics department of East West University.
- The EEE Department should sign MoU (Memorandum of Understanding) with prospective companies like Energypac for ensuring internship program for the students.
- More theoretical knowledge about Power station equipment & Switchgear

9. CONCLUSION

Energypac could be regarded as the practical ground of the Electrical and Electronic Engineering Department of East West University. The theories that we have learned at the University could be experimented at the Energypac. High level R & D, state of the art production facility, quality products, competent services, and countrywide operations have made Energypac an internationally reputed company. We consider ourselves very much lucky to have our internship program with a reputed company like Energypac. It gave us an opportunity to apply our theoretical knowledge in practice. Our achievements from EnergyPac are:

- Industrial training provided by Energypac has enriched our practical knowledge.
- It has opened our eyes about practical operation of different equipments.
- It has widened our knowledge about engineering manufacturing companies of Bangladesh.
- It has increased our confidence to face interview in future.
- Energypac gave us the unique experience of observing the equipment

Energy Pac is the leading company in Bangladesh. Its strategic aim is to strengthen the leading position and to ensure continued growth which leads it to be the leading manufacturing company or leading power engineering company in Bangladesh and start to introduce themselves not only in Bangladesh, all over the world.

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