INTERNSHIP REPORT

MANUFACTURING AND TESTING PROCESS OF CT-PT, POWER AND DISTRIBUTION TRANSFORMER, SWITCHGEAR, BREAKER AND ISOLATOR

PREPARED BY

Nazmus Sakir Akib
MD. Nur Rashed Khan
Nawshad Ahmed Chowdhury

Submitted to
Department of Electrical and Electronic Engineering
Faculty of Science and Engineering
East West University

Summer, 2011

Approved By

Academic Advisor

Sohana Tanzeem
15.09.11

Ms. Sohana Tanzeem

Department Chairperson

Dr. Anisul Haque

Approval Letter

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
rablul@energypac-bd.com

July 14, 2011

TO WHOM IT MAY CONCERN

This is to certify that **Mr. Nazmus Sakir Akib**, ID No : 2007-2-80-024. from Department of Electrical & Electronic Engineering, East West University, has done his internship successfully at Energypac Engineering Limited under the guidance of Md. Mushfik Monjur, (Sr. Asstt. Manager) from May 29, 2011 to June23, 2011.

He has witnessed our factory manufacturing process and worked on a project titled **"Manufacturing & Testing process of CT-PT, Power & Distribution Transformer, Switchgear, Breaker & Isolator"**. This project was aimed to gain overall industrial experiences practically and to make a report on engineering products. As part of the project he has successfully completed 100 credit hours in Energypac Engineering Limited Factory.

During the internship he demonstrated good report with a self motivated attitude to learn new things. His performance exceeded expectations and was able to complete the project successfully on time.

We wish him all the best for his future endeavors.

For Energypac Engineering Limited,

13/7/11

Engr. Azizur Rahman Molla
Head of HRD
Energypac Engineering Limited

East West University
LIBRARY
A/1, Mohakhali, C/A

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

July 14, 2011

TO WHOM IT MAY CONCERN

This is to certify that **Mr. Md. Nur Rashed Khan**, ID No : 2007-2-80-026. from Department of Electrical & Electronic Engineering, East West University, has done his internship successfully at Energypac Engineering Limited under the guidance of Md. Mushfik Monjur, (Sr. Asstt. Manager) from May 29, 2011 to June23, 2011.

He has witnessed our factory manufacturing process and worked on a project titled **"Manufacturing & Testing process of CT-PT, Power & Distribution Transformer, Switchgear, Breaker & Isolator"**. This project was aimed to gain overall industrial experiences practically and to make a report on engineering products. As part of the project he has successfully completed 100 credit hours in Energypac Engineering Limited Factory.

During the internship he demonstrated good report with a self motivated attitude to learn new things. His performance exceeded expectations and was able to complete the project successfully on time.

We wish him all the best for his future endeavors.

For Energypac Engineering Limited,

13/7/11

Engr. Azizur Rahman Molla
Head of HRD
Energypac Engineering Limited

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

July 14, 2011

TO WHOM IT MAY CONCERN

This is to certify that **Mr. Nawshad Ahmed Chowdhury**, ID No : 2007-2-80-033, from Department of Electrical & Electronic Engineering, East West University, has done his internship successfully at Energypac Engineering Limited under the guidance of Md. Mushfik Monjur, (Sr. Asstt. Manager) from May 29, 2011 to June23, 2011.

He has witnessed our factory manufacturing process and worked on a project titled **"Manufacturing & Testing process of CT-PT, Power & Distribution Transformer, Switchgear, Breaker & Isolator"**. This project was aimed to gain overall industrial experiences practically and to make a report on engineering products. As part of the project he has successfully completed 100 credit hours in Energypac Engineering Limited Factory.

During the internship he demonstrated good report with a self motivated attitude to learn new things. His performance exceeded expectations and was able to complete the project successfully on time.

We wish him all the best for his future endeavors.

For Energypac Engineering Limited,

13/7/11

Engr. Azizur Rahman Molla
Head of HRD
Energypac Engineering Limited

ACKNOWLEDGEMENT

At the very outset, we wish to convey our heartfelt gratitude to Almighty Allah for His blessings to complete the Internship successfully. We are also thankful to the management of ENERGYPAC ENGINEERING LTD. for providing us such opportunity to accomplish our industrial training at the factory of ENERGYPAC ENGINEERING LTD at SAVAR.

We want to thank those who helped us and provided us with support to make this report successful. Without their assistance we could not have completed our Internship program. In this process our special thanks goes to Engr. Monirul Huda, Senior Engineer, ENERGYPPAC ENGINEERING LTD. He supervised our internship program and helped us to get acquainted with other engineers. A special thanks goes to Md. Mushfiq Monjur, Senior Assistant manager of ENERGYPPAC ENGINEERING LTD. who was the main coordinator of the program.

We did our internship from 29th May to 23rd June. We started our work at 9.00am in the morning and ended at 4.30pm. That was an enthusiastic as well as educative journey for us. We got the chance to see practically what we had learnt from the book. It was a wonderful experience. The work environment was excellent and we received outstanding cooperation from all concerned officials of ENERGYPAC ENGINEERING LTD.

We also want to thank each and every employee of ENERGYPPAC ENGINEERING LTD. for their continual support. Without their support it could be quite impossible for us to complete our internship program.

We are also very grateful to all of our faculty members for their encouragement and support through our internship program.

We take this opportunity to extend our sincere thanks and gratitude to our honorable supervisor Mrs. Sohana Tanzeem , Lecturer , Department of Electrical & Electronic Engineering, East West University (EWU) and Mr. Shamim Ahmed, Research Lecturer, Department of Electrical& Electronic Engineering, East West University (EWU) for sparing their valuable time for us. With their positive attitude they guide us to complete the report successfully. Their advice works as inspiration for us.

We are proud to say that Dr. Anisul Haque, Chairperson and Professor of the Department of Electrical & Electronic Engineering, East West University is an influence for our industrial training because without his good relationship with a Company like ENERGYPPAC it would not be possible for us to do the internship at ENERGYPAC ENGINEERING LTD.

EXECUTIVE SUMMERY

We did our internship at ENERGYPAC ENGINEERING LTD, SAVAR, BARUIPARA from 31st May to 29th June and this internship report is the result of that two weeks attachment with that company. We have observed and learned those things practically which our teachers taught us in the class. Energypac Engineering LTD. primarily manufactures substation equipment such as transformers and switchgears etc. In this report we have focused on various types of machines which are being used to manufacture the transformer and switchgear.

Various no of tasks were implicated to make a transformer. Among those most of the tasks were introduced to us. Most of the raw materials come from abroad to manufacture a transformer. We were shown the making of transformer coil, which depends on the transformer power rating. We were also shown the assembling and internal connection setup of the transformer, including cooling system, tank making and painting. After the manufacturing how those equipment is being tested this is also showed to us.

ENERGYPAC ENGINEERING LTD assemble different types of switchgear panels like LT panel, HT panel, PFI plant, ATS, EURO box etc. These different types of panels are assembled in the factory. To ensure the quality of the components used in assembling switchgear panel is vital. Though most of the switchgear elements, such as breaker, relay are imported from abroad, ENERGYPAC ENGINEERING LTD makes outdoor and indoor switchgear panel.

On the time of our internship at ENERGYPAC ENGINEERING LTD we got the opportunity to manufacture a transformer and switchgear and we completed all of the tasks related to our internship successfully. We saw the current transformer and potential transformer making process, while the complete working principle was shown to us. We also saw the isolator and circuit breaker making process. ENERGYPAC ENGINEERING LTD generally uses MINIATURE CIRCUIT BREAKER, VACCUM CIRCUIT BREAKER, MOLDED CASE CIRCUIT BREAKER, AIR CIRCUIT BREAKER. ENERGYPAC ENGINEERING LTD makes the vacuum circuit breaker only; the other types of circuit breaker are imported. Isolators are fully manufactured at ENERGYPAC ENGINEERING LTD. They manufacture three types of isolators like pantograph, center break, and double break.

Another important feature is the testing facility of ENERGYPAC ENGINEERING LTD. To ensure the best quality they test all their manufactured equipment. There are various types of test like magnetizing current test, high voltage test and special type test. These tests are done only at ENERGYPAC ENGINEERING LTD.

Details of Internship Schedule

Date	Section	Duration	Contact Person
29th May to 31st May	CT and PT	3 days	Engr. Waliur Rahman Faisal
1st June to 7th June	Switchgear	4 days	Engr. MD. Abdus Sattar mahbub
8th June to 20th June	Transformer	5 days	Engr. S. M. AL Masum
21st June to 23rd June	Circuit Breaker and Isolator	3 days	Engr. MD. Tawhidul Islam

Contents

List of Figures:

1. INTRODUCTION

1.1 Objective of the Internship:

The objective of the Internship program is to gather the industrial experience to become a successful engineer by profession. East West University offers a 4 credits hour course for all the students of Electrical and Electronics Engineering, i.e. EEE499 as a requirement for graduation. According to this aspect ENERGYPAC ENGINEERING LTD ENGYNEERING LTD has given the opportunity to complete this requirement.

1.2 Company profile

In Bangladesh, ENERGYPAC ENGINEERING LTD ENGYNEERING LTD is known as one of the leading power engineering companies. The reasons it is warmly accepted to the customers are its continual research, state of the art production facility, quality products, competent services, and countrywide operations. ENERGYPAC ENGINEERING LTD ENGYNEERING LTD was incorporated in 1982 as a private limited business enterprise. It is powered by 1200 skilled manpower of which 150 are graduate engineers. It maintains on time delivery, pre and post sales services, establishing a long term business relationship with the customers.

energy WORKS wonder

www. ENERGYPAC .com

The company's vision is to become country leader as well as to establish credibility in the International Market.

The company's mission is to improve the quality of lives of the employees & the community and also to Minimize Deficit of the Power Generation System.

The company's Strategy is to achieve this mission through excellence in its service and by using best quality products.

1.3 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.

1.4 Achievement

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

1.5 Philosophy

ENERGYPAC ENGINEERING LTD ENGYNEERING LTD has a management philosophy, which is "to produce high-quality Engineering that satisfies customer and creates a positive impression by applying the local technologies that we have developed throughout our history with the aim of contribution to a better way of life"

1.6 Scope and Methodology:

In this report, the main focus is on the structure of the factory, manufacturing process of transformer, current transformer, switchgear and potential transformer. This report also focused on the electrical equipment, which are needed to manufacture a transformer and switchgear assembling. Testing facilities of ENERGYPAC ENGINEERING LTD is also discussed briefly in this report. Relevant information about a substation as was observed during the internship program is also included in this report. This report has been prepared on the basis of information collected from two different sources. One is the primary source and the other is the secondary source. Primary sources (primary information has been procured through personal interview as well as discussion with relevant officials of ENERGYPAC ENGINEERING LTD). Information from secondary sources (secondary data has been gathered by using company website).

2. TRANSFORMER

2.1 INTRODUCTION:

Transformer is the basic and most important part of Power transmission system. In ENERGYPAC ENGINEERING LTD. different types of transformer is being manufactured and tested. This device is a static device which transforms A.C electrical power from one voltage levels to another voltage level by keeping the frequency same by electromagnetic induction. There are many types of transformer, beside them power transformer and distribution transformer is most significant.

2.2 Types of Transformer:

In power system many types of transformer is available. Among them ENERGYPAC ENGINEERING LTD. produces most of the transformers that is used in power system. ENERGYPAC ENGINEERING LTD. produces Distribution transformers, Power transformers, and Instrument transformers.

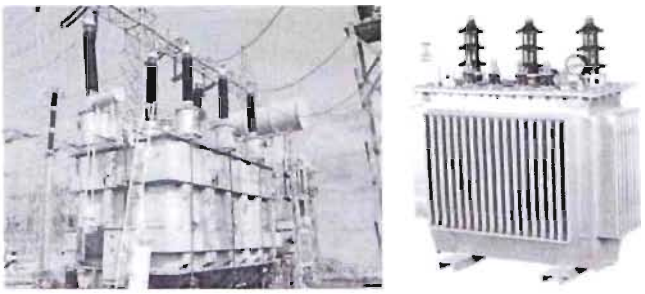

Figure 1: Power Transformer (left), Distribution Transformer(right)

2.3 Construction of Transformer:

To construct a transformer, several processes have to be followed. At the factory of ENERGYPAC ENGINEERING LTD, the processes of construction of transformer are maintained very nicely. It can be a model of construction of transformer. These processes are briefly illustrated below.

2.3.1 Coil section:

Coil is the basic raw material of transformer. ENERGYPAC ENGINEERING LTD. uses electrolyte copper coil for winding. There are three types of coil are necessary for the construction of transformer. These are High Voltage (H.V) coil, Low Voltage (L.V) coil and Tap changing coil.

H.V coil is used in high tension side, which has thin diameter. It's because in H.T (high tension) side, voltage is high and current is low, so, the coil have to carry low rate of current. Whereas, L.V coil, is used in low tension side, 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, apparent power rating and design issues. H.V coil is cylindrical shaped and L.V coil is rectangular in shaped.

2.3.2 Core section:

The main purpose of core is to hold the windings of transformer. Transformer cores are made of high permeable cold rolled grain oriented (CRGO) electrical steel insulated on both sides. These are mostly imported from Japan, Europe, and USA. This core is nothing but silicon sheets. This is used because it has good conductivity. Primary considerations of core making are to reduce no load losses, no load current and noise level. And to fulfill these requirements, 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 2: Transformer Core

2.3.3 Insulation section:

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 as 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 brought from Germany. Braze board is used for insulation between LT and HT coil. Tap changing coil are also rolled with insulation paper.

2.3.4 Coil windings:

Coil winding depends on several factors. While the windings are designed, it is 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.

2.3.5 Core and coil assembly:

There are two ways of core cutting. One is Normal cutting and 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° angle cutting is used for power and distribution transformer. In auto core cutting flux cut higher than Normal core cutting. ENERGYPAC ENGINEERING LTD uses automatic core cutting machine, which operated by computer. The name of the core cutting machine is Micro Tool and Machine (MTM). By this machine core are cut in three classes, they are class A, class B and class C. The core is cut in thin sheets. It's because, it reduces eddy current loss. Here, A shape is called corner shape and B shape is called Benoze shape. When the silicon sheet is cut, then with the support of iron frame sheets are kept in the way that it looks like a frame. An insulation tape is rolled to keep the sheets all together. Then the coils are set in the core. Steps of Automatic Core Cutting Machine (Micro tool and Machine) are given below-

- Based on design fixed grade and thickness silicon steel sheet is 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.

2.3.6 Tap changer and tap switch:

Taping is provided in HT side or LT side to vary voltage level. According to the demand of customer, this facility is provided. Tap changing can be manual or automatic. ENERGYPAC ENGINEERING LTD provides 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.

2.3.7 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.

2.3.8 Fitting:

After assembling all the parts ENERGYPAC ENGINEERING LTD itself combines these parts together. While fitting of a transformer ENERGYPAC ENGINEERING LTD follows below things:

- 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.

2.3.9 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.

2.3.10 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.

2.3.11 Adding other features of transformer:

2.3.11.1 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, air flow etc. 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.

2.3.11.2 Gas insulation relay:

ENERGYPAC ENGINEERING LTD uses 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.

2.3.11.3 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.

2.3.11.4 Bushing:

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

Figure 3: Bushing

2.3.11.5 Connection type:

According to the design and demand three phase transformers are provided with two different connections; Wye and Delta connections. These connections are made internally in a transformer

2.3.11.6 Cleaning and 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.

2.4 Testing:

The main feature that ENERGYPAC ENGINEERING LTD attracts the customer to their product is testing. The testing section of ENERGYPAC ENGINEERING LTD is very prominent and well known to the world wide buyers. It is considered that ENERGYPAC ENGINEERING LTD has the best testing equipment and process in this whole sub-continent. Testing of power plant equipment that is made by ENERGYPAC ENGINEERING LTD is divided into two steps. One is in-process test and another is routing test. The brief of those tests has given below.

2.4.1 In Process Test:

Under this process there are three types of tests that have usually done. These tests are obvious tests that ENERGYPAC ENGINEERING LTD does for their all products. The names of these tests are given below;

- Magnetic Balance Test
- Excitation Current Test
- Vector Group Test

2.4.1.1 Magnetic Balance Test:

The Magnetic Balance test is conducted on Transformers to identify inner 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.

2.4.1.2 Excitation Current Test:

In this test, the magnetic balance and eddy current loss is checked. This test is to monitor the exciting current available in any winding with an ammeter, which is connected with a single phase supply. Three such single-phase tests are necessary for a three-phase transformer. The relationship between the single phase readings is important; it should be as follows:

- The readings taken on phase A and C should be within 5% of each other.
- Reading on phase B should be between 65% and 90% of the readings on phase A and C

2.4.1.3 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 measures

- 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.

2.4.2 Routing Test:

Under this process the following tests are done.

2.4.2.1 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.

2.4.2.2 Windings 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.

2.4.2.3 No-load 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.

2.4.2.4 No-load losses 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.

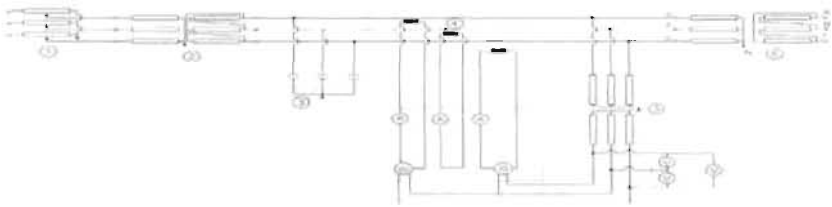

Figure 4: Measurement Test

2.4.2.5 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.

2.4.2.6 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.

2.4.3 Type Test and Special Test:

According to the interest of customer these tests are done. Lighting Impulse Test, Switching Impulse Test and Measurement of Acoustic Sound Level Test can be listed under this section. The brief of Lighting Impulse Test is given below.

2.4.3.1 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:

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. It is related to safety of the transformer. Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream.

3.2 Basic functions of switchgear:

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

3.3 Switchgear Panel

In both the high voltage and the low voltage side of large power transformers are located in switchgear substation. In order to operate, control and maintain the switchgear, switchgear panel is required. Within a building, low voltage switchgear is enclosed. With the advancement of power system, lines and other equipments operate at high voltages and carry large currents. Energypac Engineering LTD normally manufactures two types of switchgear panel.

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

3.4 LT (Low Tension) Switchgear

Energypac Engineering LTD is produced indoor and outdoor LT switchgear installation complying GB7251 with design LT panel [1]. LT Panel switchboards of Energypac Engineering LTD are well steel sheet fabricated, floor mounting, fully enclosed, vermin and dust proof. LT switchgear can operate by both manually and automatically that means motor controlled operate.

Figure 5: LT switchgear panel

with the latest international standards which is the major power products of Energypac Engineering LTD. Energypac Engineering LTD Engineering Limited manufactures low voltage switchgear 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) and maintain the standard of IEC439

3.5 Construction

The essential components in LT switchgear panel used in Energypac Engineering LTD.

- 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
- Single Pole(SP)
- Double Pole (DP)
- Triple pole(TP)
- Bus-bar
- Ring CT from Energypac Engineering LTD
- Ammeter, Voltmeter
- Relay
- Indicator flags

3.6 Products of LT switchgear are:

- Distribution box
- Motor control panel
- Power factor improvement plant (PFI plant)

3.7Operating Mechanism of LT Switchgear Panel

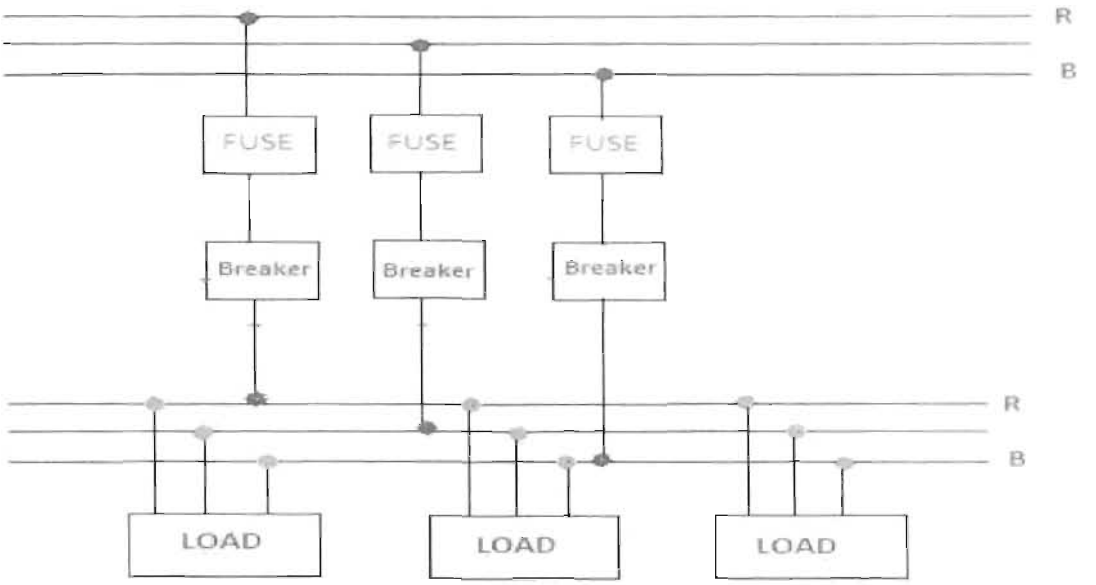

Figure 6: Block diagram of LT panel

By the help of CT from the main bus bar, ammeter measures current in a LT panel. In LT switchgear panel Ring CT is used. Ammeter cannot measure more than 5A current. So measuring the current, CT is mandatory but voltmeter is connected directly with the line in case of LT panel, because the internal resistance of voltmeter is very high. For this purpose Miniature circuit breaker (MCB) is used which is spring charge motor controlled breaker. A control switch is used to protect the MCB. The control switch (fuse) becomes disconnected when current exceed 1000A of current and then circuit breaker will trip. In a bus bar CT, fuses, circuit breaker are connected. For three phase current display, there are three ammeters. On the upper portion of the front cover of the LT panel Box voltmeter, Ammeter, Indicating lamps, selector switch etc. are mounted for monitoring the voltage and current. Copper bus bars of adequate size with Red, Yellow & Blue marking are mounted on the upper portion of the Box. The bus bars are firmly supported by insulators having adequate mechanical and electrical strength.

3.8 Application of LT panel

- Power station for high voltage purpose
- Industrial enterprise
- Commercial/Residential Buildings for power distribution and can be used to control, protect and inspect the circuit.

3.9 Technical Data of LT panel

Technical data means the nameplate value or the ratings which is very important. Every equipment has a rating that it can serve this maximum or minimum output. These are:

- Rated voltage: up to 415 V
- Rated frequency: 50Hz.
- Rated Breaking current: up to 100KA
- Rated making current: 130 KA.
- Metal clad, sheet steel
- Short circuit duration: 1 or 3 seconds.

3.10 Power Factor Improvement (PFI) Plant

Power Factor of the system is degraded due to inductive load of different industries and big apartments. Energypac Engineering LTD manufactures PFI (Power Factor Improvement) Plant for improving the degraded Power Factor of the system. Energypac Engineering LTD have microprocessor based PFC (Power Factor Correction) relay up to 16 stages. The Capacitors Energypac Engineering LTD uses are of different ratings (2.5, 5, 10, 20, 25, and 50 KVAR.... etc) and corresponding Magnetic Contactor for suitable stepping of the Capacitor bank. Sometimes Energypac Engineering LTD uses detuned Reactor with the Capacitors for harmonic filtration of the system. The standard panel size is 600x600x1700 mm (single unit) and the weight is around 200 kg [2].

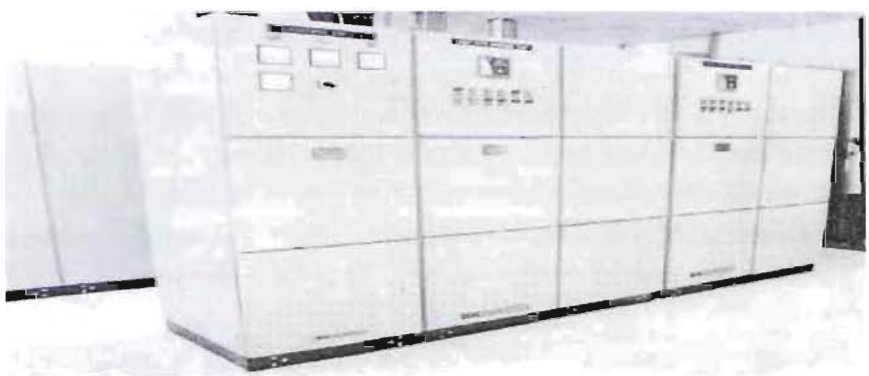

Figure 7: PFI plant

By using PFI plant money can save on electricity bills. It increases power consumption efficiency. It provides good voltage regulation and minimizes the power loss and wastage. Almost no maintenance is required for PFI plant. Motor, Transformers and other inductive loads require reactive power. 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

3.11 The PFI Panel of LT switchgear consists of

- Bus Bar
- Breaker
- Voltmeter
- CT
- PT
- Capacitor
- HRC fuse
- Relay
- Ammeter
- Magnetic coil
- Indicator flags

3.12 Operating mechanism of PFI plant of LT switchgear

To improve a facility of power factor, the most economical way is adding a capacitor. While the current through an inductive load lags the voltage, current to a capacitor leads the voltage. By adding a capacitor bank parallel with the load then the power factor will improves if all the loads are inductive. Ammeter measures current from the main bus bar, by the help of CT. In LT switchgear Panel, ring CT is used. Ammeter cannot measure more than 5A current. By using PT voltmeter measures the voltage. Relay is added with load bus bar. The function of relay is to sense power factor of the system and it can give trip signal by using magnetic coil if any fault occurs. Miniature circuit breaker is used in this process which is spring charge motor controlled breaker. A control switch is used for the protection of MCB. When current exceed 1000A of current, the control switch (fuse) become disconnected and circuit breaker will trip. CT, fuses, circuit breaker are connected with the bus bar.

Consideration that must be needed

Power factor correction capacitors should never connect with the motor terminals on elevator motors, plugging or jogging applications, multi-speed motors or open transition, wye-delta, auto transformer starting and some part-winding start motors.

3.13 HT Switchgear

Energypac Engineering LTD manufactured high voltage switchgear panel (HT panel) which is applied for power control and distribution systems of AC 50Hz and rated voltage up to 4230KV according to the standard of IEC. Energypac Engineering LTD's H.T Switch gear equipped with Load Break switch (LBS), Vacuum Circuit Breaker (VCB), Disconnect or etc. High Tension (HT) Switches are appropriate for economical electrical sub-station with transformer feeder, measuring and motor protection.

Energypac Engineering LTD's HT switchgears are used for two types according to voltage class

- Medium voltage applied for 1KV to 33 KV
- High voltage applied for more than 33 KV

3.14 Products under HT switchgear are

- Load Break Switch which is for 11KV substation
- Control, Metering, and Relay Panels up to 230 kV
- Vacuum Circuit breaker for both indoor-outdoor, up to 33KV

3.15 In Energypac Engineering LTD two types of operating method are used in HT

- Manually-operated
- Motor-operated

The HT Panel of HT switchgear consists of:

- CT.
- PT.
- Ammeter.
- Voltmeter.
- Master relay.
- General relay.
- Bus Bar.
- Magnetic coil.
- VCB.
- Indicator flags

3.16 Working principle of HT switchgear

To measuring the current and voltage from the main bus-bar, HT panel consist of three numbers of CT and PT respectively. Ring CT is used in ammeter because it cannot measure more than 5A current. A fixed dc voltage is used as input of a master relay by using a converter. The input voltage is 110 volt (DC). Microprocessor based master relay is in this panel. The Relay first sense the fault when any faults occur in the line. Then the relay send trip signal to the circuit breaker. There are three relay which energized the magnetic coils to trip the breaker. The relay can sense over current, over voltage, oil level of transformer, oil temperature, winding temperature of transformers etc. To trip the whole system a master coil is used and magnetic coils are used to trip take apart load connection. VCB (vacuum circuit breaker) is used which spring is charged motor controlled breaker. When the breaker trips, the whole system gets disconnected from the service. The whole phase will be disconnected immediately if any fault occurs in any phase. On the upper portion of the front cover of the HT panel Box there are some selector switches, trip signal, spring charge lamp and indicating lamps, which indicate the panel ON or OFF and are mounted in HT panel.

3.17 Function of HT switchgear

- Industrial enterprise.
- Commercial industry and Transmission can be used to control, protect and inspect the circuit
- Power station

3.18 Technical Data of HT switchgear

- 12KV & 33KV which is rated voltage
- 630A, 800A, 1250A are the rated current
- 50Hz rated frequency
- Short time current rating for 3sec is 20kA
- Basic impulse level is 75kV
- Making Current is 50kA

3.19 Relay

To fault protection of system operation the protection relays are prepared. Protection relays are designed and applied to provide maximum discrimination between faulty and healthy circuits. To give remote signal and audible alarm alerting the control room attendant of the operation of protection devices and mal-operation of power equipment the facilities are provided[3]. Relay can senses directional and non-directional earth fault, negative phase sequence over current, thermal overload, under voltage, over voltage, three phases over current, Watt metric protection,

undercurrent, , oil level of transformer, oil temperature, winding temperature of transformers etc. fault. By sending the trip signal to circuit breaker, relay can operate this.

Figure 8: Relay

3.20 H R C Fuse

In PFI panel, HRC fuse is used. There are special types of fuse in electrical system and it works as a protection device in electrical system. HRC fuse means "High Rupturing Capacity". Where some delay is adequate for protecting the system, this type of fuses normally used there. A huge amount of heat is created within the fuse when a fault current condition occurs and that heat melts the silica sand filling of the fuse into glass.

HRC fuse link is a very common, simple and helpful electrical protection device against over load and short circuit current.

Figure 9: HRC Fuse

4. Circuit Breaker

4.1 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. To detect a fault condition and by interrupting continuity, to immediately discontinue electrical flow is its basic function [4]. The circuit-breaker fulfills all of the basic switchgear functions, while, by means of accessories, numerous other possibilities exist. The circuit-breaker is the only item of switchgear capable of simultaneously satisfying all the basic functions necessary in an electrical installation. [5]. 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.

4.2 Types of Breaker

In general Energypac Engineering LTD used three types of breaker. These are:

- Low Voltage Breaker
- Medium Voltage Breaker
- High Voltage Breaker

4.2.1 Low Voltage Breaker

Low Voltage Range is from 1 V to 1KV. Energypac Engineering LTD used Miniature Circuit Breaker (MCB) as low Voltage Breaker. They do not manufacture this MCB. Energypac Engineering LTD imported MCB from Germany.

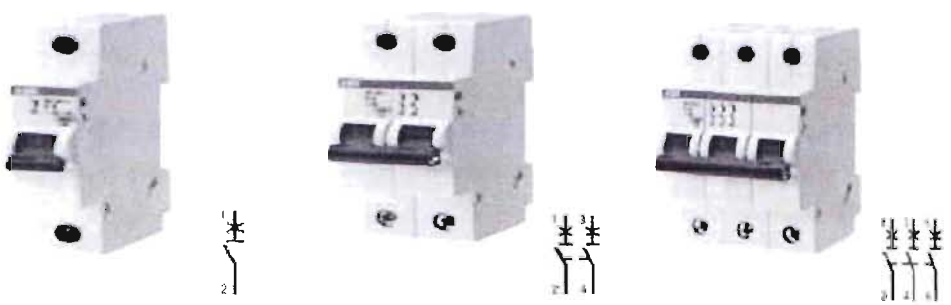

Figure 10: MCB (SP, DP and TP)

Operating Voltage: Operating Voltage of MCB is 230/440 V

Energypac Engineering LTD used three types of MCB with Breaking Capacity up to 6kA, these are

- Single Pole (SP)
- Double Pole (DP)
- Triple Pole (TP)

Function: Protection and control of the circuits against overloads and short-circuits, protection people and big-length cables in TN and IT systems [6].

4.2.2 Medium Voltage Breaker

Voltage Range is from 1KV to11KV. Energypac Engineering LTD 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.

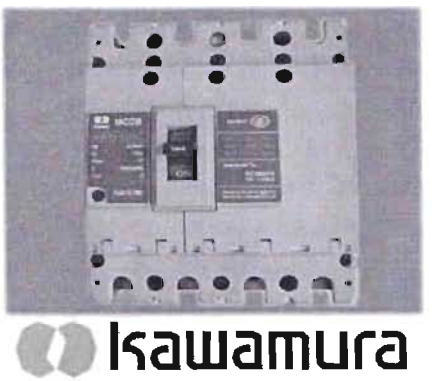

Figure 11: MCCB

Application:

The molded-case circuit-breakers are used in [7]

1. Industry

2. Civil low voltage plants with currents from 16 to 1600A.

3. D.C. & A.C. switchgear

4. Motor protection

5. Generators

6. Capacitors

Function: Protection and control of electrical machineries against overloads, short-circuits and ground fault protection (Optional)[7].

4.3 High Voltage Breaker

Low voltage range, from 11KV to 33KV. Energypac Engineering LTD used Vacuum Circuit Breaker as high Voltage breaker. They manufacture the Vacuum circuit Breaker. In manufacturing process they follows two standard, these are

IEC - International Electro technical Commission

ANSI -American National Standards Institute

Energypac Engineering LTD manufactures two types of Vacuum Circuit Breaker

- Indoor Vacuum Circuit Breaker which is up to 33 kV
- Outdoor Vacuum Circuit Breaker which is up to 33 kV

4.3.1 Vacuum Circuit Breaker

A circuit breaker in which a pair of contacts is hermetically sealed in a vacuum envelope, the contacts are separated by using a bellows to move one of them, an arc is produced by metallic vapor boiled from the electrodes, and is extinguished when the vapor particles condense on solid surfaces [10].To protect medium and high voltage circuits from dangerous electrical situations, Vacuum circuit breakers are used. This is operated by manual or motorized spring charged process of potential energy. The in built spring performs the usual electrical operation when the breaker is in non-operational mode [8]. In general the names of circuit breaker are according to their medium where the break occurring. Energypac Engineering LTD used Vacuum Interrupter in their circuit breaker.

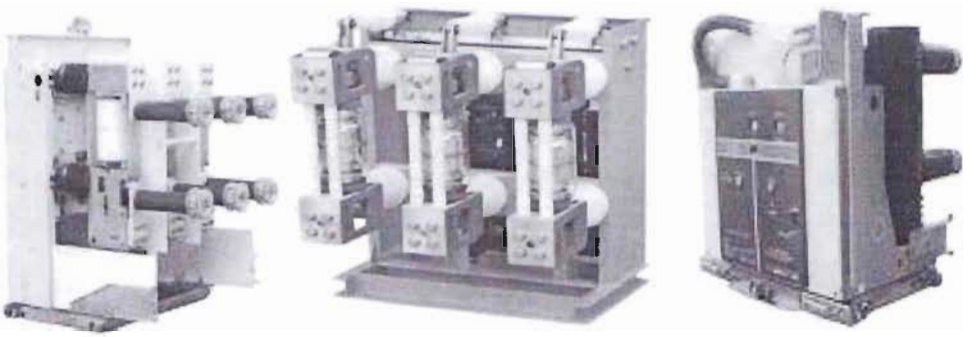

Figure 12: Vacuum Circuit Breaker

4.3.2 Closing Mechanism

The closing mechanism includes the following indications:

- Breaker on/off
- Spring charged or discharged

4.3.3 Brand Feature

The following features are also provided on the switchgear.

1. Operation counter

2. Local/remote switch

3. Local on/off switch

4. All necessary fuses and wiring

4.3.4 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 familiar and the best quality manufacturer of the world, CUTLER-HAMMER (EATON), USA. 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.

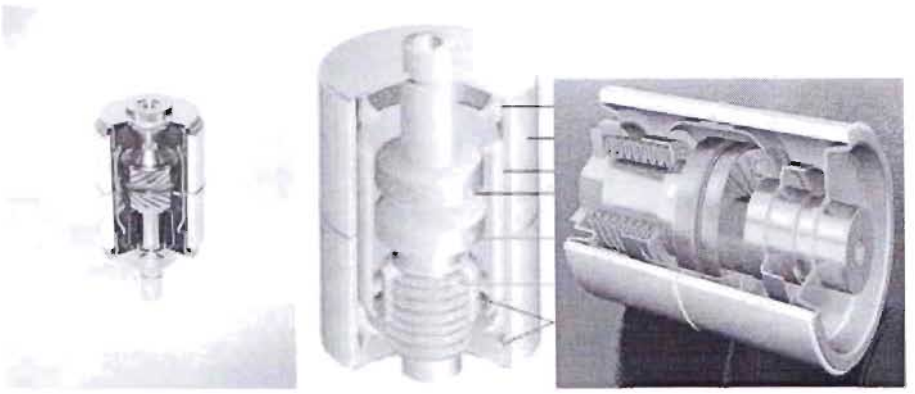

Figure 13: Vacuum Interrupter

4.3.5 Specification of Vacuum Interrupter

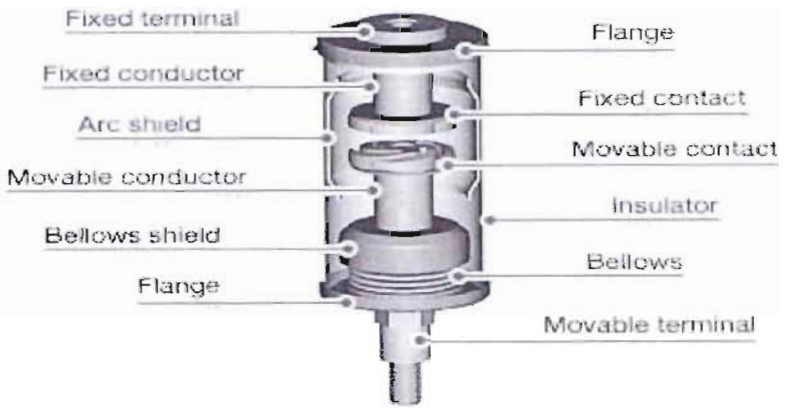

Figure 14: Specification of Vacuum Interrupter

4.3.6 Main features of Vacuum Interrupter [10]

- High quality vacuum interrupter design
- Long life
- Simplified arc quenching method
- Robust compact construction
- No evacuation tube
- Slim body design
- High reliability

4.3.7 Major applications of vacuum interrupter [10]

- Vacuum interrupters for circuit breakers
- Vacuum interrupters for switches
- Vacuum interrupters for contactors
- Vacuum interrupters rail circuit breakers
- Vacuum interrupter for recovers
- Vacuum interrupters for capacitor bank switching

4.3.8 Working Principle of VCB

In this breaker, vacuum is being used as the arc quenching medium. Vacuum offers highest insulating strength; it has far superior arc quenching properties than any other medium. When contacts of a breaker are opened in vacuum, the interruption occurs at first current zero with dielectric strength between the contacts building up at a rate thousands of times that obtained with other circuit breakers [12]. When the contacts of the breaker are opened in vacuum, an arc is produced between the contacts by the ionization of metal vapors of contacts. The arc is quickly extinguished because the metallic vapors, electrons, and ions produced during arc condense quickly on the surfaces of the circuit breaker contacts, resulting in quick recovery of dielectric strength. As soon as the arc is produced in vacuum, it is quickly extinguished due to the fast rate of recovery of dielectric strength in vacuum [12].

4.3.9 Applications of VCB

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

4.3.10 Technical Particulars

- 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

4.3.11 Testing

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

- Physical test
- High voltage test.
- Timing test.
- Resistance test
- Insulation test

Physical test:

This test is also called Mechanical Endurance test. It is observed that after hundred operations, whether the full setup of the device is damaged or not.

High voltage test:

In this test, high voltage is applied that means 2.5 times rated voltage is applied and observed whether the breaker can sustain it or not.

Timing test:

In this test, the circuit closing time and opening time is measured.

Resistance test:

In this test, a high current is applied to the device and the voltage of that device is measured. Digital low resistance ohm meter is used for this purpose. After that using that current and voltage the resistance is measured.

Insulation test:

In this test, high voltage is applied to the device and the voltage of the body is checked.

5. ISOLATOR

5.1. Introduction:

The main purpose of isolator is to disconnect the circuit at 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. Isolator plays its part whenever maintenance is required. While any act of maintenance is performed, isolator has to be kept open to make sure no current flows. Without switching off the isolator the maintenance operation cannot be performed. It acts as a switch.

5.2. Main Assemblies of Disconnector:

- 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.

5.3. Rating of Isolator:

Energypac Engineering LTD follows different type of rating for isolators. Such as, when the rated voltage is 12-245KV, the rated normal current is up to 3150Amps and short time current rating is 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.

5.4. Type of Isolator:

ENERGYPAC ENGINEERING LTD manufactures outdoor offload Isolators. They make three types of outdoor offload isolators,

- Pantograph isolator
- Double break isolator
- Center break isolator

5.4.1 Pantograph Isolator:

- 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.

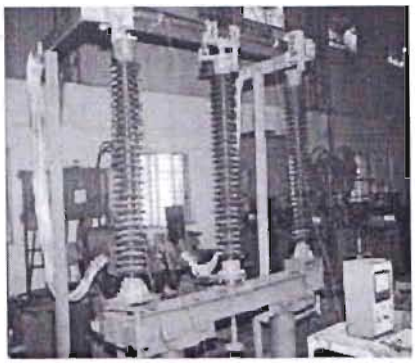

Figure 15: Pantograph Isolator

5.4.2 Centre Break Isolator:

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

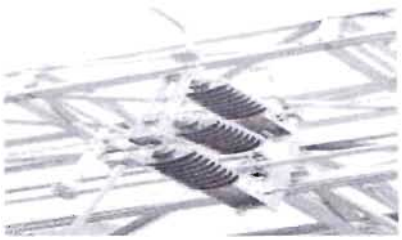

Figure 16: Centre Break Isolator

5.4.3 Double Break Isolator:

- 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

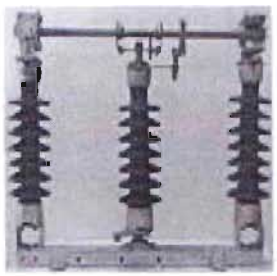

Figure 17: Double Break Isolator

5.5. Test for Isolator:

The following tests are done at ENERGYPAC ENGINEERING LTD for isolator.

- High voltage test
- Insulation test
- Analyzer test/timing test
- Meager test
- Routine test
- Common test
- Type test

6. INSTRUMENT TRANSFORMER

6.1. Introduction:

ENERGYPAC ENGINEERING LTD is the only manufacturer of instrument transformers in Bangladesh. The transformers which are used in conjunction with measuring instruments, protective relays and control circuits are called instrument transformer. Instrument Transformers are manufactured in accordance with latest IEC/ANSI standards. The transformers that are used for metering and protection purpose of electrical equipments are Instrumental Transformers. The design and use of these transformers is quite different from that of well known power transformers.

6.2. Brand feature of Instrument Transformer:

Instrument transformers are transformers which are used in conjunction with measuring instruments, protective relay and control circuits. 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. ENERGYPAC ENGINEERING LTD manufactures two types of CT and PT. It is found that Energypac Engineering LTD Engineering Limited manufactures outdoor or indoor type; oil cooled or cast resin Current Transformers (CT) and Potential Transformer ranging from 11kV to 230 kV.

6.3. Current Transformer:

Instrument transformers which are used in conjunction with ammeters, over current relays, etc is called current transformer or CT. CT actually steps down the current that is from a high value to a low value. The current ratio is substantially constant for given range of primary current as long as the phase angle error is within specified limits. The VA rating of current transformers is small as compared with that of a power transformer. Energypac Engineering LTD has the oil cooled/cast resin CT with ranging from 11 kV to 230 kV. Energypac Engineering LTD also manufactures outdoor/indoor type current transformer.

6.3.1. Basic functions of current transformer:

- 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

- 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.

6.3.2. Manufacture:

ENERGYPAC ENGINEERING LTD manufactures two types of CT

- Live tank.
- Dead tank

Figure 18: Current Transformer

6.3.3 CONSTRUCTION OF CURRENT TRANSFORMER

The current transformers can be designed as Single or Multi ratio. The ratio selection can be achieved by providing two or four sections in primary using series/parallel connections. Here the current ratio is 1:2:4. The core is made of High permeability silicon steel. There can be different shapes of core, such as rectangular, ring shape, oval, L - shape stamping and I – shape stamping, etc. In the figure 34 below are shown different types and shapes of core.

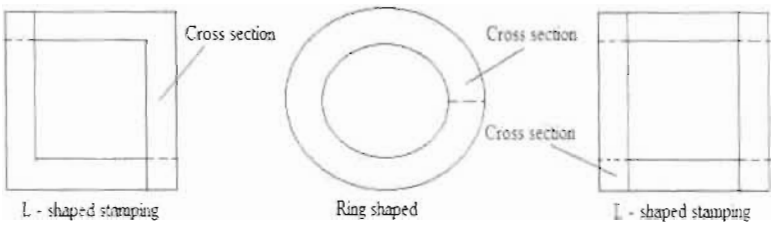

Figure 19: Core of the transformer

Energypac Engineering LTD uses tap (Ref. insulation is shown in figure 35) for giving insulation on the core. Secondary winding is done automatically and distributed equally on the periphery of the core to minimize leakage reactance. Primary winding was done by putting insulation on copper conductors with double cotton covering.

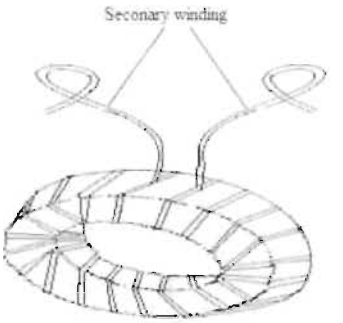

Figure 20: Secondary winding conductor wound on the tape

They give an additional insulation on copper conductor, known as varnished fiber glass sleeve. They also use high quality crepe paper to build main insulation of the CT. They use brown/white glazed porcelain bushing with different shade profiles to suit different conditions. The bushings are hollow and cylindrical.

6.4. Potential Transformer:

PT, the potential transformer is another kind of Instrumental transformer. Basically for measurement and protection potential transformers are used. In high voltage system, direct measurement of voltage is not possible because of insulation problem of measuring instruments. So, potential transformers are used to step-down the high system voltage to low standard value accurately in proportion to their ratio. It is either measuring type or protective type.PT may be single phase or three phase units. PT is necessary for voltage, directional and 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.

6.4.1. Basic Functions of Potential Transformers:

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

6.4.2. Manufacture:

Single phase electromagnetic PT is manufactured in two types:

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

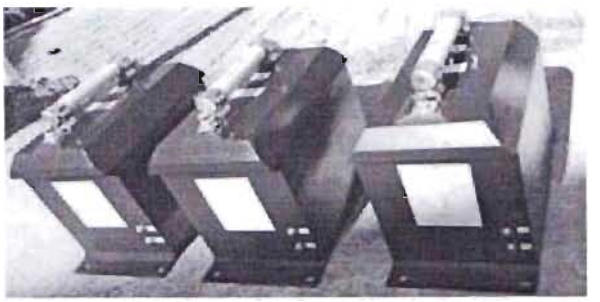

Figure 21: A potential transformer

6.4.3 CONSTRUCTION OF POTENTIAL TRANSFORMER

The mechanisms of potential transformers are similar to current transformer. There are two kinds of single phase electromagnetic PT, i.e. single pole (between lines and earth) and double pole (line-to-line). Type three phase PTs are star-star or star-delta connection. The Potential Transformer consists of primary and secondary windings, electromagnetic core, bottom tank, oil expansion chamber, and porcelain. For the construction of PT the basic functions that are kept under consideration are as follows.

CRGO silicon steel is used for building up electromagnetic core.

- Shell type construction is used to minimize leakage reactance.
- Primary is wounded with multilayer and graded insulation.
- Secondary is separately wounded and inserted in the primary winding as per the requirement.
- High quality electrical grade Kraft paper and crepe paper is used for insulating primary and secondary of PT.

6.5. Essential Element of Instrument Transformer:

There are some essential elements necessary for the making of instrument transformers These are core, coil, insulation, class of accuracy, bushing, oil etc.

6.5.1. Core:

- The core is made of high permeability CRGO (cold rolled grain oriented) silicon steel.
- 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.
- Cores from continuous strips are made there and annealed in controlled atmosphere to achieve best quality secondary cores.

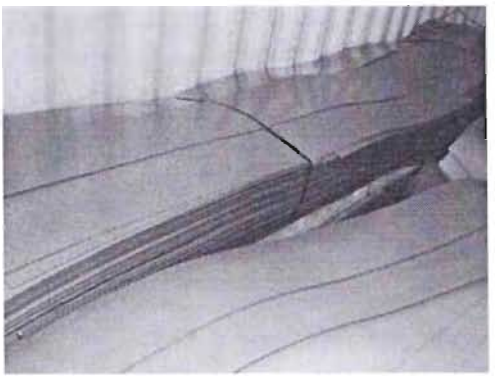

Figure 22: Sliced cores of CRGO (cold rolled grain oriented) silicon steel

6.5.2. Coil:

- The most usable coil is of the super enamel type.
- The coil making process is manual.

6.5.3. Insulation:

- The insulation saves transformers from short circuit, fire and transformer explosions.
- Main insulation is build up on the primary winding (paper condenser is formed on the pipe) with fine grading of 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.

6.5.4. Bushing:

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

6.5.5. Oil:

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

6.5.6. Class of accuracy:

Accuracy is very important for manufacturing. There are two reasons for increasing the accuracy of Instrument transformer.

- One is for metering
- The other is for protection.

For metering, the accuracy points are 0.1, 0.2, and 0.5.

6.6. Test for Instrument Transformer:

The following tests are done at ENERGYPAC ENGINEERING LTD for instrument transformers.

- High voltage test
- Insulation test
- Routine test
- Analyzer test/timing test
- Common test
- Meager test
- Type test

7. FABRICATION PROCESS

The first thing done in the fabrication process is powder coding the steel path. After powder coding, the steel part is dipped in the acid tank. Similarly the steel path needs to drop in rinse tank which is filled with normal water. Then the part is put into the drastic tank. Again the path is put into normal water, and then it is dropped into a phosphate tank. At last it is sent to a dry-off oven. Powder spray is done in dry-off oven. The spray process is done electrically. Generally they spray the Berger powder. The temperature of the dry-off oven must be 180 degree Celsius to continue the process. Completing the whole process needs 13 to 15 minutes only.

7.1 Sandblasting Process:

- All are liquid plant without switchgear
- Where sandblasting is done, there is a radiator tank
- For completing sandblasting they mix sand with air and this is put at air blasting tank about 730kg. There is a nozzle in the tank. By using the nozzle they spray the sand for completing the sandblasting.

7.2. Coloring Assembly:

This is an important section and is needed to reduce corrosion. For completing the coloring of transformer Energypac Engineering LTD follows the below process

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

7.3. Machine Shop:

At this machine shop there are various types of machine. Each machine has different name and different working principles. Generally they use Lathe machine, Shaper machine, Milling machine, Drill machine, Chaser machine, Surface grinding machine and last is Power Saw machine. Some of the machines are described below.

1. Lathe machine: A lathe machine works by rotating the work piece on its own axis to perform various operations like cutting, sanding, etc. Generally for cutting the shaft or steel rod this machine is used. By using this machine they can easily cut the shaft in appropriate size.

Figure 23: Lathe machine

At ENERGYPAC ENGINEERING LTD the lathe machine is used for the following purposes.

- Turning the shaft
- To face the shaft at appropriate position
- For cutting threat on the shaft
- For making tapping on the shaft
- To enlarge the hole on the shaft and steel path

2. Milling machine: Slot and keyway cutting, planning, drilling etc such type various operation are done by milling machine. Milling machines are of two basic forms, one is horizontal and other is vertical.

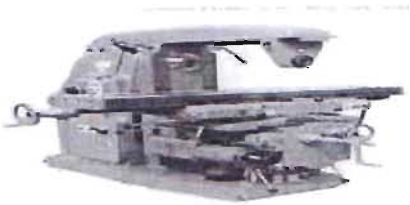

Figure 24: Milling machine

Milling machine is used for following purposes.

- For making gear on the shaft
- To make key way on the outside of the shaft

3. Shaper machine: A shaper machine worked by using linear relative motion between the work piece and a single-point cutting tool. Its cut is analogous to that of a lathe, except that it is linear instead of helical. Shaper machine is used to make key way on the inside of the shaft.

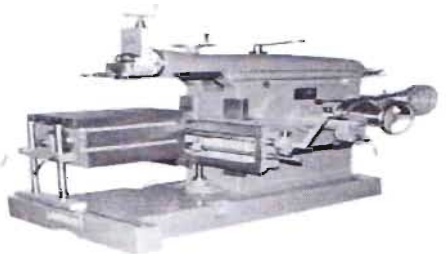

Figure 25: Shaper machine

4. Chaser machine: A chaser is a type of machine that cuts a threat relative motion between the work piece and a single-point cutting tool.

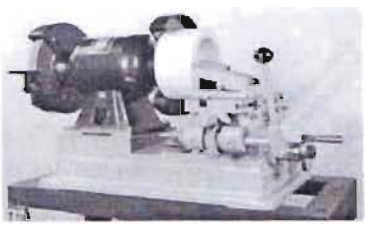

Figure 26: Chaser machine

Chaser machine is used for following purposes.

- Cutting a threat only outside
- Use for ring type elements

5. Drill machine: A drill machine is a machine fitted with a rotating cutting tool, usually a drill bit, used for drilling holes in various materials. The tip of the cutting tool does the work of cutting into the target material.

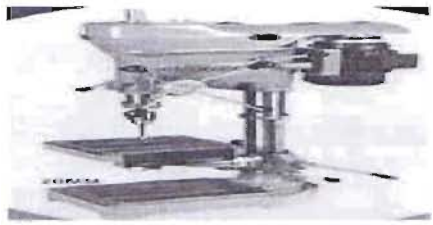

Figure 27: Drill Machine

- The drill machine is used for making a hole on the steel path

6. Surface grinding machine: A surface machine is a tool that smoothes the surface of various materials.

The chaser machine is used for smoothing job surface.

Figure 28: Surface Grinding Machine

7.4. CNC Machine:

CNC means computer numerical control. It is operated electrically. Assembly information about the CNC machine is follows

- Third generation scream manufacturing and fabrication
- Sheet thickness can be punch 1.6 mm to 6mm
- It has hydraulic punch and capacity is 30 ton

7.5. Program Load Procedure:

For making the hole on the steel plate, CNC machine is used. For this purpose machine has to remember the size of the hole and measure distance between holes etc. As a result machine needs a program which is set by engineers on the computer before running the machine.

Figure 29: CNC Machine (Cutting point view)

The computer where the software is installed is an important part of the machine. They need two rooms to operate the machine where one is for CNC machine and other is for computer. From inside the room where computer is, an engineer operates the machine. For running this machine they need to turn on memory by pressing memory button. Then they have to press program soft key for running the program. Then they press Dir key for understanding the direction of the steel path After completing the procedure they have to type file number and they have to press OSRH key to give input for running the machine. The last key is start key if it presses then the machine starts working.

8. Experiences of Internship

The experiences that are gathered from the Internship are hilarious. It has given the idea of punctuality, time cautiousness, manners of the corporate environment and at last but not the least the implementation of engineering concept at the industry. Under this internship program the transformer, switchgear, CT, PT, Circuit Breaker, Isolator, Testing section etc. were visited. Engr. Waliur Rahman Faisal, Engr. MD. Abdus Sattar mahbub, Engr. S. M. AL Masum and Engr. MD. Tawhidul Islam supervised us the CT and PT section, Switchgear section, Transformer section, the Circuit Breaker and Isolator sections respectively of ENERGYPAC ENGINEERING LTD. The concerned engineers of those sections have given sufficient time although they were busy with production. It was really worth, working with those professional engineers. With their physical involvement they have given their best to learn the production of different equipments. There is another important lesson that was learned, if anyone wants to learn something then he has to learn that by himself, no one will make him to learn. These experiences are very vital for professional life and are also felt by us.

9. CONCLUSION

Energy Works Wonder, siding with the phrase, ENERGYPAC is now one of the main companies in Power Sectors of Bangladesh. We are grateful to ENERGYPAC for providing us the opportunity to do our internship in the company. We got enough support from the Engineers and stuffs during our internship program which resulted us in gaining some practical knowledge of engineering which will be fruitful to our future profession.

ENERGYPAC ENGINEERING LTD is a good place to gain practical knowledge for the students of the Department of the Electrical and Electronic Engineering of East West University. We have gained the theoretically knowledge from the University and we are grateful to have got the opportunity to see some practical work at ENERGYPAC ENGINEERING LTD.ENERGYPAC ENGINEERING LTD is an internationally reputed company for its state of the art production facility, quality products, competent services, and countrywide operations. We are very pleased to have got the opportunity to do our internship in a reputed company like ENERGYPAC ENGINEERING LTD. It made us acquainted with practical engineering and also gave us the opportunity to match our theoretical knowledge in practice. ENRGYPAC provided us the opportunity to introduce ourselves with the manufacturing process of various sub-station equipments like Transformer, Switchgear, Current Transformer, Potential Transformer, Breaker and Isolator.

ENERGYPAC ENGINEERING LTD 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 not only in Bangladesh but also to the outside world. We are grateful to have known ENERGYPAC ENGINEERING LTD from close.

References:

1. LT and PFI panels, energypac; URL: http://www.energypac-bd.com/company.php?id=84
2. LT and PFI panels, energypac; URL:http://www.energypac-bd.com/company.php?id=84
3. Control, Metering, and Relay Panels, Up to 230 KV, energupac, URL:http://www.energypac-bd.com/company.php?id=83
4. Circuit breaker ,wiki-eig, URL:http://en.wikipedia.org/wiki/Circuit_breaker
5. Circuit breaker ,wiki-eig, URL:http://www.electrical-installation.org/wiki/Circuit-breaker
6. Miniature Circuit Breaker (MCB), energypac, URL:http://www.energypac-bd.com/sub_details.php?id=102
7. Molded Case Circuit Breaker (MCCB), energypac, URL:http://www.energypac-bd.com/sub_details.php?id=104
8. Vacuum circuit breaker, indiamart, URL:http://catalogs.indiamart.com/products/vacuum-circuit-breaker.html
9. Vacuum circuit breaker, indiamart,URL: http://www.google.com/search?q=vacuum+circuit+breaker&hl=en&client=firefox-a&hs=3oQ&sa=G&rls=org.
10. Vacuum circuit breaker, indiamart,URL:http://encyclopedia2.thefreedictionary.com/vacuum+circuit+breaker
11. Vacuum circuit breaker, indiamart,URL:http://www.google.com/search?q=images+vacuum+interrupter&hl=en&client=firefox-a&rls=org.mozilla:en-US:official&channel=s&biw=1360&bih=578&prmd=ivns&tbm=isch&tbo=u&source=univ&sa=X&ei=dIYqTv7nOcThrAeIm7CyDQ&sqi=2&ved=0CEIQsAQ
12. Vacuum circuit breaker, Electrical & Electronics.org URL:http://electricalandelectronics.org/2008/10/12/vacuum-circuit-breakers-vcb