INTERNSHIP REPORT

ON

"SUBSTATION EQUIPMENT MANFACTURING"

By

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Mahmudul Hasan
Abul Hasnat

Submitted to the

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

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Bachelor of Science in Electrical and Electronic Engineering
(B.Sc. in EEE)

Fall 2010

Approved By

Academic Advisor
Dr. Md. Ishfaqur Raza

Department Chairperson
Dr. Anisul Haque

ENERGYPAC®

এনার্জিপ্যাক®

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Ref: EEL/HR/EWU-05-10
Date: April 10,2010.

To
S I Nusrat A Chaudhury
Associate Professor & Head
Career Counseling Center.
East West University.

Subject: Acceptance Letter of industrial attachment

Dear Sir,

Referenced to your letter on the date of March 15, 2010, with due respect, we, the Energypac Engineering Ltd, would like to inform you that 5(Five) students of Electrical and Electronic Engineering Department of East West University are permitted for the Industrial attachment by instruction of our Director & CEO Engr.Rabiul Alam for a duration of 4 (Four) months from May 02, 2010 to August 31, 2010. Note that for safety reasons within the factory area "**everyone must wear shoes**". Please contact with Mr.Munirul Huda, Sr.Engineer, EMR & QC, Mobile no 01714080789 for details, before commencing the tour.

You are cordially requested to take necessary action accordingly.

Thanking You

Sincerely Yours,

Ahmed Toufique Ahsan
Deputy Manager (HR & Admin)

ACKNOWLEDGMENT

our project work we are grateful to those who contributed us with their valuable times and efforts.

the very beginning, we will mention the name of our Internship supervisor our most respectable d honorable teacher Dr. Md. Ishfaqur Raza. We feel lucky and honored to get the chance of mpletion our project under the supervision of him. He provided us the information and also helps to setup the time schedule of our internship program.

e regards thank to Mr.Enamul Haque Chowdhury Managing Director, Energypac engineering TD. We thank Md. Monirul Huda, Sr. Engineer (Breaker & Quality control) Energypac gineering LTD. We were worked under his supervision. We would like to thank Engr.Md. saduzzaman, Deputy General Manager, Energypac engineering LTD, and Mr. Asif, Senior gineer, Energypac engineering LTD for give time to discuss about transformer, Switchgear and reaker. We also would like to thank to all the respected officers and employees of Energypac gineering LTD, for their support.

ecial thanks to Dr.Anisul Haque, Chairperson, EEE, East West University for his guidelines, pport and care. We are also very grateful to all of our teachers for their encouragement and operation throughout our Internship and academic life.

nally we wish to express our appreciation to our parents for their encouragement and patience.

EXECUTIVE SUMMARY

his report is written on the basis of our visit to Energypac and all the technical details we were troduced to during our visit. The technical content of our visit was centered on Substation quipments that are divided into four parts. These parts are transformer, switchgear, breaker and olator and instrument transformer (CT/PT). In this report we also talk about the manufacturing ocess of these equipments.

transformer is a device that can transfer energy one circuit to another by electromagnetic duction. Basically the main part of transformer is core and coil. Core is made by using different ape. This shape is cut by auto core cutting machine and this shape together the core is created. The w material is silicon steel sheet. The coil has two parts one is LT (low tension) coil and HT (high nsion) coil. The raw material of HT coil is disc coil and LT coil is spiral coil. By using core inding machine coil is created. Then by assembling the core and coil it tank up. For insulate the stem insulation oil, insulation paper etc are used. After adding and other parts the transformer is oduced.

witchgear is used for protection and controlling of a system. Two types of switchgear is anufactured one is LT switchgear and the other one is HT switchgear. In LT switchgear relay sense e over current then send trip signal to MCB breaker. Breaker trip the system. If the PF is decrease en by using PFI capacitor is added to the load to improve PF of the system. In HT switchgear icroprocessor based relay sense all things and if fault occurs it send a signal to general relay. Relay nd trip signal to VCB. Then VCB trip the system.

eaker and Isolator are used for tripping the system. Breaker is used for on load tripping and olator is used for off load tripping. Energypac manufacture only Vacuum circuit breaker. By using vacuum interrupter VCB is produced. If any fault occurred the tripping coil is energized and then the circuit. It is used as high voltage breaker. When the breaker trips the circuit, for high voltage is created. But the medium is vacuum so the arc is extinguished. So this is used in HT itchgear. Energypac manufacture three types of Isolator. Pantograph, Centre break and Double ak. Pantograph is four point contacts. It opens all contacts when breaking. Centre break is three e contacts and Double break is two pole contacts. Vertical or Horizontal terminal take off.

ıment transformer is two type Current transformer and potential transformer. The facturing is almost same. The raw material of core is CRGO silicon steel and the raw material l is copper enameled wire. Then after assemblies the core and coil, tank up it. For insulation ss of the system insulation paper, oil and varnish is used. This CT and PT is used for ırement.

we work on the Energypac got opportunity to see the entire task to make that device and we eted all of the work successfully. We tried our best to learn and know everything from able person of the Energypac.

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1. INTRODUCTION

1.1. Company Profile

Energypac is one of the leading power engineering companies in Bangladesh. Continued research and development, state of the art production facility, quality products, competent services, and countrywide operations have made it widely acceptable to the customers. Energypac was incorporated in 1982 as a private limited business enterprise. It is powered by 1200 skilled manpower of which 150 are graduated engineers. To meet countrywide demand of its products and services, Energypac has extensive distribution network throughout Bangladesh with full-fledged offices in the major cities like Chittagong, Khulna, Rajshahi, Sylhet, and Bogura. In an effort to introduce its products globally, Energypac has established its offices in India, and China. Energypac has already exported its products and service supply to India, Yemen, Ghana, Sudan, Uganda, Nigeria, Saudi Arabia, and United Kingdom.

Their product range includes Power Transformer up to 50 MVA (any rating) , 230 kV class, 12 kV-Indoor type VCB, All sorts of control, metering and relay panels, Current transformer up to 230 KV and 132kV voltage Transformer, Reactor Transformer, Indoor Load Break Switch up to 12 kV, All sorts of substation switches used in rural type substation and distribution system. Disconnector switches up to 36 KV Systems, Low Voltage Distribution, and Metering and control panel.

1.2. Management

Managing Director: Enamul Haque Chowdhury

Director and CEO: Engr. Rabiul Alam

Executive Director: Humayun Rashid

Organization Chart of Factory is shown in Figure 1.

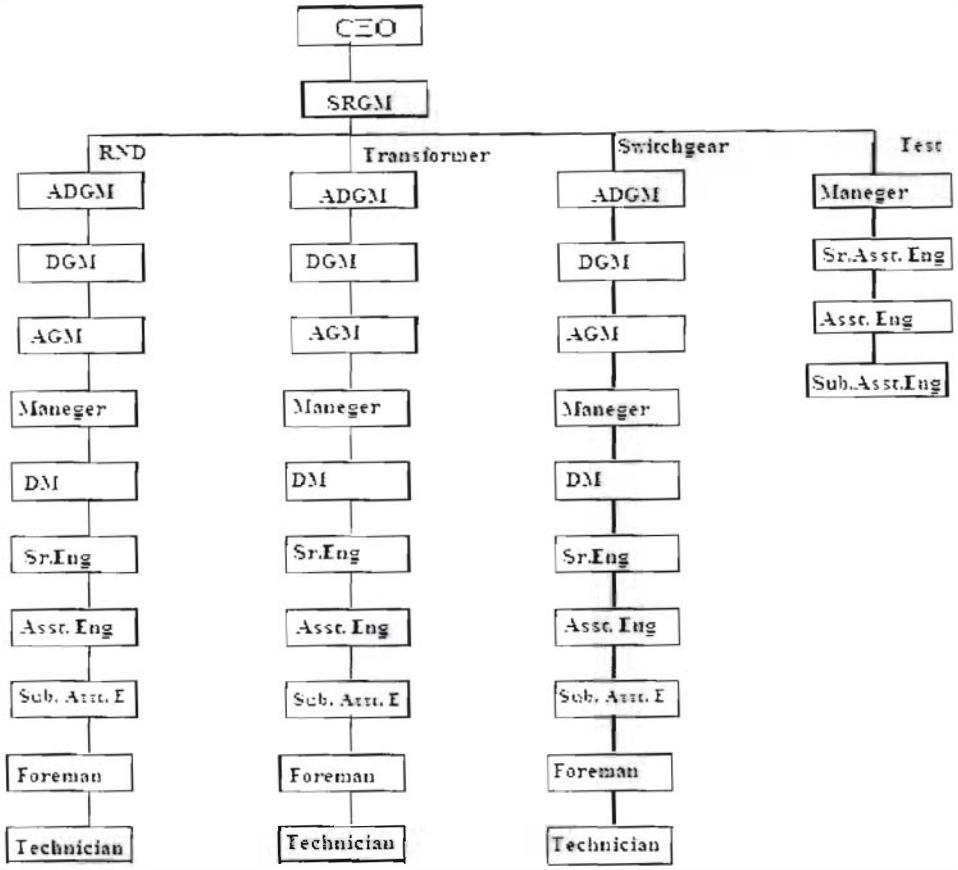


Figure 1: Organization chart

is Energypac's policy to establish and work to processes which ensure the understanding of ustomers' needs and hence to design, produce, deliver and support its products and services to atisfy those needs better than the competitors. Energypac aims to reduce the health, safety and nvironmental impacts of its products and processes and prevents pollution, taking into account the eeds of its customers and society at large. All new activities will be assessed for environmental npact and appropriate health and safety provision. It set its standards to international level and is cognized by the appropriate authorities for ISO 9001:2008 and ISO 14001:2004 certifications

1.3. Company Mission

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

1.4. Company Vision

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

1.5. Company Strategy

The strategic aim of Energypac is to strengthen it's the leading position and ensure continued growth. It's priority is to offer the best efficiency, reliability and value available.

1.6. Motivation

Every university has a requirement to fulfill B.Sc Engineering. This requirement is Thesis or industrial training. Our university has also that type of requirements. To obtain a B.Sc degree in electrical and electronic engineering from East West University, we have chosen the Industrial attachment or internship option. Our chosen internship title is "Substation Equipments Manufacturing". Our major area is Power engineering. Power Substations and its Equipments are critical to our field. Now we must select such an engineering company for our internship. We know Energypac is one of the most leading engineering companies of Bangladesh, the first company whose manufacture transformer and switchgear. They also export their products. They are certified ISO: 9001:2008 and ISO: 14001:2004. They also have received quality and performance certificate from BUET and CPRI. They have good standards for manufacturing. These are IEC and ANSI. Their safety system and transport system is known to be better when compared to the other engineering company. So we requested and were approved for an internship at Energypac Engineering Ltd.

From our internship at Energypac we obtained practical knowledge about Power transformer, Distribution transformer, Instrument transformer (both CT and PT), Isolator, Breaker and Switchgear Items (LT, HT and PFI). We saw the whole process of Manufacturing of the above items. We also saw the testing procedures of the Equipments. In Energypac the engineers were very friendly. They always cooperated with us. Now we can say the decision of internship program and selection of company was best for us. Thanks to almighty Allah to complete the Internship program successfully

1.7. Objective of the Internship

The main objective of writing the report is fulfilling the partial requirement of EEE program. And the other objectives are:

- To gather knowledge about the transformer, switchgear and breaker.
- To know the manufacturing process of transformer, switchgear and breaker and Isolator.
- To understand the design techniques.
- To present basic mechanism of transformer and switchgear.
- To understand the company management.

1.8. Scope and Methodology

ie report is focuses on the manufacturing process of transformer, switchgear, breaker and Isolator. also focuses on organizational structure, background, and other necessary equipments.

is report is written on the basic of three sources of information collection: First source is scussion with technicians and employees, and personal observation. Second source is company eb site and manuals, and third source is journals and books.

1.9. Limitation

here are certain constraints beyond which we cannot write or discuss, simply to respect the company rules and regulations.

- For privacy of the company we don't know about the design selection process. That means why they choose their specific design
- We did't take any photo of the internal part of the company for their privacy.
- We had a very limited time, in spite of our willing to study more details it was not possible to do so.
- When our internship program is running in that time the year closing of the company also running so the engineer could not cover all things completely.
- This whole process is not possible to bind in such a small frame as this report, hence our effort spent on summarizing them.

1.10. Internship group members

Table 1: Student list

Serial No.	Name of the student	Student ID
01.	Mehedi Hasan Rajib	2007-1-80-009
02.	Masud Rana	2007-1-80-019
03.	Tawhid Reazwan	2007-1-80-029
04.	Mahmuduul Hasan	2007-1-80-004
05.	Abul Hasnat	2006-3-80-006

1.11. Training Schedule

Table 2: Internship time schedule

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

Our Internship Program Working Time:

Sunday to Thursday

10:00 AM to 05:00 PM (1 PM to 2PM Launch & Prayer)

2. TRANSFORMER

start our internship program in Transformer section. In this section we were worked five days 05-2010 to 06-05-2010).

First day (02-05-2010)

vent to Energypac Engineering LTD at 9.00A.M. Engineering Monirul Huda called us. We were ducing with Engr. Monirul Huda. He gave us a work plan of internship program, and advised us to Engr. Asaduzzaman. In transformer section Engr. Asaduzzaman, Ad.GM, production, ELF rvised us. When we introduce with Mr. Asaduzzaman, take a little viva about transformer. After ne assigned an Engineer named Mr. Asif for helping us.

Lunch, Engr Asif gave a brief description about transformer, their product of transformer's rtment and also the manufacturing process of transformer.

2.1. Introduction

gypac takes pride in manufacturing the largest sized power transformers in the South-East Asian n. They generally manufacture all types of transformer that means power transformer, bution transformer and instrument transformer. The rating of their largest power transformer is TVA. Their next project is 75 MVA power transformers. They also manufacture 4.5 MVA bution transformers, 28 MVA Power transformers and smaller.

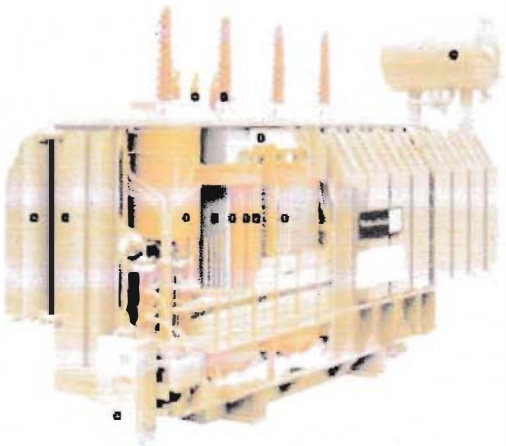


Figure 2: Power Transformer

2.2. Types of transformer

ıergypac manufacture three types of transformer. These are, Power transformer, Distribution ınsformer, and Instrument transformer.

that chapter we only write about the power transformer and distribution transformer of Energypac.

ıwer Transformer:

ɔwer transformer built by Energypac is a transformer which transfers voltage from 11 KV to 33 V. Energypac mainly manufacture step up power transformer and this is delta to star, or star to ılta connected. This transformer is used for power generation.

istribution Transformer:

istribution transformer built by Energypac is a transformer which transfers voltage from 11 KV to 5 V. Energypac manufacture both step up and step down distribution transformer and this is delta star connected. This transformer is used for power distribution [1].

Table 3: Difference between power transformer and Distribution transformer

Distribution transformer	power transformers
Lower power and voltage rating	Higher voltages and higher power ratings.
A distribution transformer would usually be a three phase step down transformer in a delta star configuration.	Power transformer is a 3 phase step up Transformer in a delta delta connection.
It is a home appliance transformer.	It is used to transmit the voltage from Generating station to distribution center.
It is designed for max. Efficiency at 60% to 70% load. Normally it doesn't Operate at full load time.	It is designed for max. Efficiency at 100% load as it always runs at 100% load being Near to generating station.
Ratings: 11kVA, 4.5 MVA,	Ratings: 50 MVA, 28 MVA,

oth power and distribution transformers are used for T&D applications (transmission & stribution). The difference between power and distribution transformers refers to size & input ltage. Distribution transformers vary between 25 KVA and 10 MVA, with input voltage between 1 d 33 kV. Power transformers are typically units from 5 to 500 MVA, with input voltage above 33 V. In Energypac power transformer varies from 28 MVA to 50 MVA with input voltage 11 KV to

33 KV. And distribution transformer varies from 11 KVA to 4.5 MVA; input voltage varies from 11 KV to 415 V.

2.3. Design of Transformer

In Energypac the design procedure of Power and Distribution is almost same. So the basic idea of designing a transformer in Energypac is based on few steps. These steps are, Manufacturing process of transformer, Fittings and Accessories attachment, Protection system, and Testing methods. After completing these steps to build a transformer, it is ready to use.

2.4. Manufacturing processes of transformer

Manufacturing processes of a transformer is a very critical for designing a transformer. In Energypac this process is divided into series of sections. These sections are Design section, Core Section, Coil Section, Tap changing section, Tank Section, and Assemble Section.

2.4.1. Design section

Design is the most important part of building a transformer. In Energypac a transformer is creating by following a design methodology. The design mainly depends on customer choice. The designer have to design the Structure, Core diameter, insulation label, cooling system, tapping system, Coil thickness, tank and conservator and other things .

Second day (03-05-2010)

We went to Energypac Engineering LTD at 9.30 A.M. First we meet with Engr Asif. On that day he first introduced us with some technicians and Engineer who control different sections, such as Testing section and manufacturing section. After that he showed the manufacturing section, which builds core and coil. First time he explained to us the manufacturing of the core section.

2.4.2. Core section

Energypac follow some processes to create a core of a transformer. These processes are divided in three parts. These are, Core material selection, Core design selection, and Core cutting machine.

Core material selection:

Energypac consider some property of the material for selection of core material. These are, Conductivity and Magnetic fields. Conductivity means the rate of current flow through the core and when current pass through the coil a field is created around the coil it is called magnetic field. After considering this property they select Silicon steal sheet (CRGO) for core material.

Core design selection:

Energypac has only one shape for their core design. This is called Benoze shape. In this shape the core is divided in three classes. These are class A, class B and class C. For all Power transformer and Distribution transformer this design is used. The three classes are shown in Figure 3.:

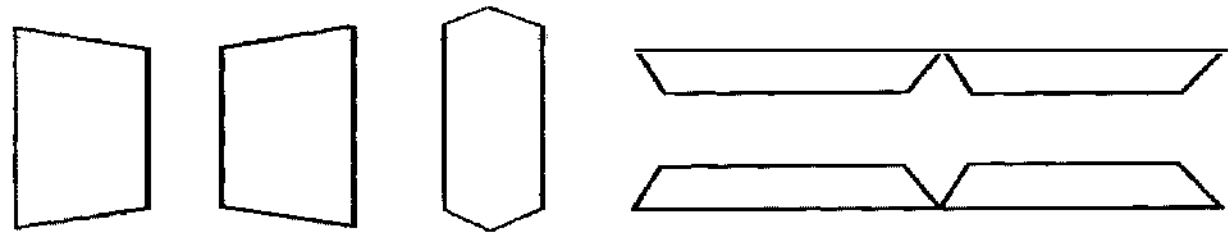


Figure 3: Class A (Left), Class B (center), and Class C (right).

After joining this part, the core structure is creating. This structure is looks like Figure 4.

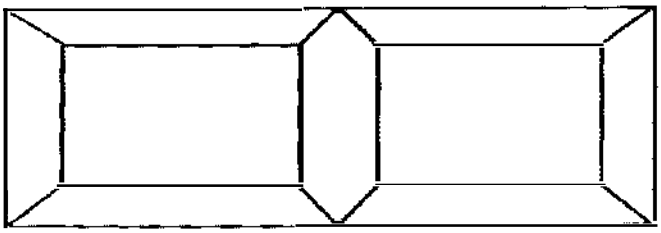


Figure 4: Core

Core cutting machine:

Energypac used automatic core cutting machine. That machine is fully operated by computer. There are some reasons for using auto core cutting machine. These are:

- Core is cutting by 45 degree angle.
- Current can properly pass through the current conductivity drain.
- Flux can properly pass through the current conductivity drain.

We also show here the instructions of auto core cutting machine (as shown on the machine).

Machine name: Auto core cutting.
Working principle of machine:

- First time the silicon steal sheet is chosen by thickness and grade for a fixed design.
- By using the power stress machine cutting the big pieces of A, B, C, D dimension's by following the design.
- By following big piece A, B, C, D's stack small piece should be cut.
- By following the design the pieces is cut using 45 degree angle cutting or normal cutting that means 90 degree angle cutting.
- By following the design some time core punch may be required otherwise do not need any core punch.

Caution:

- Must be considered that the insulation of silicon sheet is not damaged.
- Must be considered that the size of dimension is correct.

ngr. Asif also told us that there is another type of core cutting machine. That is Normal core cutting achine. He also told about the difference between these core cutting machines. The core cuts are own in Figure 5.

ifference between Normal core cutting and Auto core cutting machine are listed in Table 4.

Figure 5: Normal Core Cutting (left) and Auto Core Cutting (right).

Table 4: Difference between normal core cutting and auto core cutting machine

Normal core cutting machine	**Auto core cutting machine**
Core is cutting by 90 degree angle	Core is cutting by 45 degree angle
Current cannot properly pass through the Current conductivity drain.	Current can properly pass through the Current conductivity drain.
Flux cannot properly pass through the Current conductivity drain.	Flux can properly pass through the Current conductivity drain.

2.4.3. Coil Section

or this section, Energypac follow these steps -Coil selection, Coil winding machine, and Insulation

oil selection.

ıergypac mainly used Spiral coil for both HT and LT side of Power and Distribution transformer. ıere have another coil that is Disc coil. The selection of coil is mainly depends on customer choice. ıgr. Asif also told us the major difference between Spiral coil and Disc coil. These are:

Spiral coil is used for both HT and LT Coil but Disc coil is used only for HT Coil.

Ratings of spiral coil used by Energypac are below 2MV but rating of disc coil is above 2MV.

il winding machine:

ergypac uses a machine for coil winding of both Power and Distribution transformer. This is led coil winding machine. We note down the instructions of coil winding machine (see below).

achine name: Coil winding machine.
orking principle of machine:

- First find out the collapsible forma no by observing the KVA ratings of HT coli and LT coil.
- Connect that forma with the machine then add the metal jacket with forma and must be follow that the diameter of its outside is equal to the diameter of HT or LT coil inside diameter.
- By following the design an insulation copper strip is chosen for a fixed size or shape.
- By following the design spiral or disc type winding is start.
- After a fixed turn or Disc a tapping bad must be get out.
- After completing the winding outside diameter is must be measured.

ution:

- The axial length of Inside diameter and outside diameter is followed by the design.
- The Insulation must be in correct form.

2.4.4. Insulation

nergypac for insulation purpose they winded a special type of paper for both HT and LT coil of er transformer and Distribution transformer. This is a highly non conductive paper made from etable fiber. Energypac doesn't manufacture it. They import this paper. For HT side they used et paper and for LT side they used DPC paper. After Lunch break, Engr Asif showed us the tap ging procedure and told us about the importance of mechanical design of a transformer.

2.4.5. Tap changing section

changing means the changing of voltage by a switch. Generally for changing tap, taps are iding in HT coil (see Figure 6). The design of tap changing in Energypac depends on customer e. In Energypac transformers, taps are from HT coil or sometime an extra coil is used for taps. xample DESCO's demand is reverse winding. In that winding taps are obtained from HT coil, both ends of the coil. DPDC's demand is Force find winding. In that winding taps are obtained the HT coil but taps are placed from midpoint of that coil.

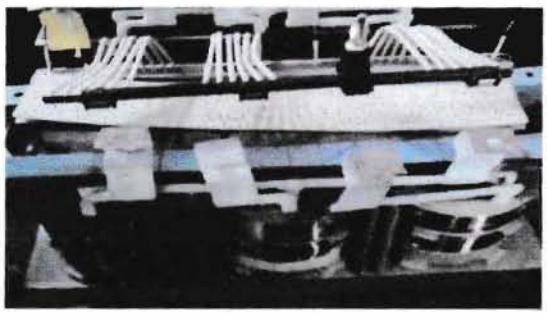


Figure 6: Tap changing

There are two tap changing option in Energypac. These are,

- On load tap changing.
- Off load tap changing.

On load tap changing means the taps are changed during the loading condition. And Off load tap changing means the taps are changed during off load condition. It is dangerous to change off load taps during loading condition, because when it tap moves it can cause sparks and thus fire.

Working principle:

In Energypac 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. All the moving contacts are spring loaded to ensure proper pressure and good contacts. Higher capacity transformers, specially above 3000 KVA ratings, can be supplied with On Load Tap Changer along with necessary controls to make it suitable for manual, local electrical or remote Electrical operation.

Mechanical Design:

Energypac's engineers must consider the mechanical stress for designing a transformer. They told us if the center of the mass is not balanced, that means the center of the mass of core, coil and tank is not placed in a same point the transformer can be broken.

We know, $W=F\,S$, where, F= force, S= distance, W= work.

If the center of the mass is at same point, $S=0$, then, $W=0$.

For this reason, they must follow that height of LT coil is greater than the height of HT coil for balancing the mechanical stress.

Third day (04-05-2010)

We reached Energypac Engineering LTD at 10.00 A.M. On that Day Engr. Asif took us to the tank section, Assemble section and the testing section. We saw Tank section before lunch break. After lunch break we saw the Assemble section but we didn't see any testing on that day. In testing section they told us testing will be performed next day. After observing these sections we met with Engr. Asif. He asked some question about that sections and discussed a few things about those sections.

2.4.6. Tank Section

In this section we discuss about the transformer tank of Energypac. The size and shape of a transformer tank is depending on ratings of the transformer also the demand of transformer. The procedure of tank creation is divided into several parts. These are raw material, tank length and making procedure, and paint.

Raw material:

nergypac used steel sheet as the raw material of tank.

ank length:

n Energypac, they use different sizes of transformer. The length may be long or small. This length is epending on customer's demand. Engr. Asif said that the length of tank is important issue for a ransformer. If the length is long, it is best for cooling system of transformer. It can also increase the fe time of transformer.

Making procedure:

The making procedure of transformer's tank in Energypac is following few steps. These are -

- The steel sheet is tested.
- If the tested result is satisfied then it cut by the cutting machine.
- Then by using welding machine the shape of tank is made.
- After that the radiator for cooling of the transformer is connect with that tank.
- A conservator is also connected with the tank for store the oil.

Paint:

In paint section we saw the painting procedure of the transformer tank of Energypac. When we saw the painting process, done in two stages, they were painting a 50 MVA power transformer's tank. First stage 1 and then stage 2.

- Cleaning of tanks
  - The cleaning of tank is done normally by chipping/grinding.
  - The outside surface of the tank is short blasted to achieve a very fine and smooth finish
- Painting of tanks
  - After cleaning the tanks, a coat of hot oil resistance paint is applied on the internal surface of the tank.
  - The outside surface is painted with a coat of Red Oxide primer and subsequently with one coat of enamel paint as per customer's requirement.

low after the painting and testing this tank is ready to use.

2.4.7. Assemble section

After completing the above section, all things are send to assemble section. Assemble section are divided into three parts. These parts are described below.

- Core assembles.
- Coil assembles.
- Core-coil assembles.

2.4.7.1 Core assembles

Energypac's engineer cut the silicon steel sheet in designed shape by using the auto core cutting machine (see Figure 7). This design depends on customer requirement. Now this sheet is sliced for decreasing eddy current loss. By adding this sliced sheet the core is create. After that the limbs of the core are tightly wrapped with cotton tape. Then an insulating press board is wrapped on all the three limbs. Now the core is ready.

Figure 7: Core assembly

2.4.7.2 Coil assembles

In Energypac Spiral coil is used for both HT and LT coil (Figure 8). The shape of the coil is rectangular. There also have other shape which is cylindrical. If the customer requires this type of coil, Energypac used this type of coil. The size of HT and LT coils is different. In HT coil high voltage is flow but the current is lower than LT coil so the size of HT coil is smaller than LT coil. In LT coil high current flows and voltage is lower than HT coil so the LT coil size is larger. This coil is wound using a machine. For coil insulation, Energypac uses insulation paper discussed earlier.

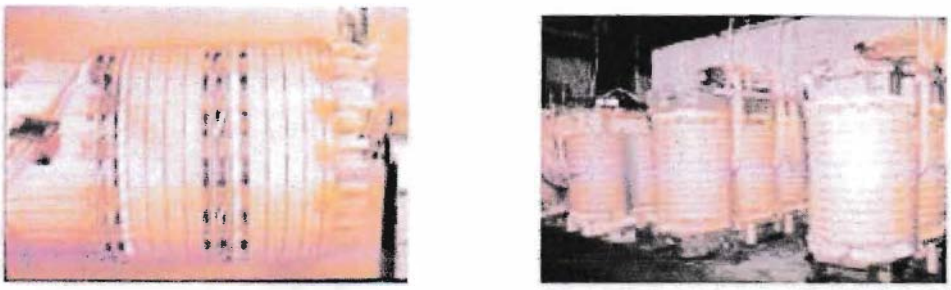


Figure 8: Coil winding

2.4.7.3 Core-Coil assembles

In Energypac, LT coil is first placed on the insulated core limbs (Figure 9). An insulation paper is used to create insulation between LT and HT coil. Here breeze board is used for insulation. After that HT coil is placed on the outside of the insulated LT coil. Sometimes tap changing coil is placed outside the HT coil. This depend on customer's choice. For example, DESCO's requires tap changing coil. Now from where the HT connection wire is taken out , the LT connection wire is taken out from the opposite side of the HT connection wire. This rule is followed for decreasing the probability of dielectric breakdown. The tap changing connection wire is taken out from HT coil or tap changing coil. Then Energypac uses a Vacuum dry plant for decreasing the moisture of core and coil. In that plant high pressure and high temperature is used to clear the moisture.

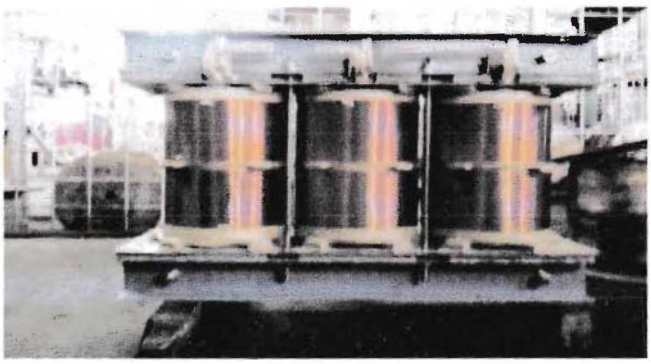


Figure 9: Core and coil assemble

HT and LT connection:

Generally Energypac made two types of connection for LT and HT side. This connection is either Delta to Y or Y to delta. That means if HT side is Delta connected then LT side is Y connected or if LT side is Delta connected then HT side is Y connected. Some special cases they also made Delta to Delta connection for HT and LT side. See Figure 10.

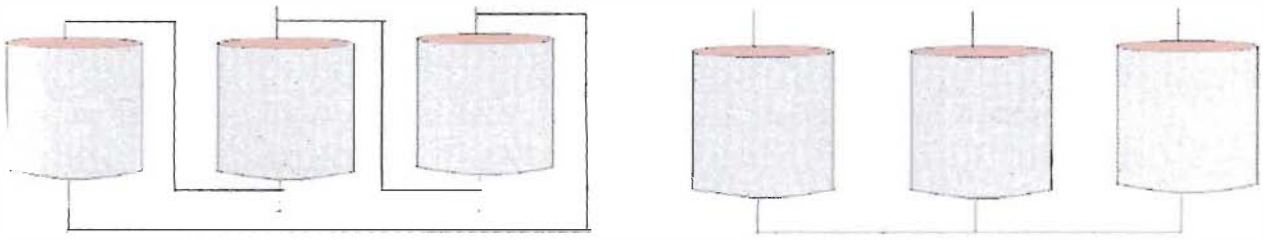


Figure 10: Delta connection (left) and Y-Connection (right)

onnection type is easily identified by name plate vector group. For example in the nameplate they id vector group is Dyn11. That means HT side is Delta connected and LT side is Y connected.

Fourth Day (05-05-2010)

We went to Energypac Engineering LTD at 10.00 A.M. First we meet with Engr. Asif. He told us to observe other section and if any tests perform he will call us. Also he told if any questions are raised we note down after completing all tasks he will answer those questions. In that day a core and coil is tanking up. So luckily we can saw that tanking up process of transformer. After the lunch break Engr. Asif call us. And we saw two tests, the high voltage and double voltage double frequency test

2.4.8. Tanking up

In Energypac, after completing the core - coil assemble process the whole core – coil setup is placed in a transformer tank. Then add other parts with the tank follow some steps. These are:

- The core-coil assembly is taken out from the vacuum dry plant.
- The tank is painted from fabrication department.
- Fittings like drain valves, HV& LV Bushings, conservator, oil level indicator and others are fitted in the tanks.
- The Core-coil assembly is then placed into the tank and properly locked up.
- Connections of primary and secondary to the terminal bushings are made. Operating handle for ratio switch that means tap changing is also fitted with the tank.

After that the tank is filled with pure transformer oil, which they import from India.

Testing of transformer: High Voltage tests on HV & LV:

In Energypac, using this test they check the insulation property between Primary to earth, Secondary to earth and between Primary & Secondary.

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

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

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

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

High Voltage = 2.5 * Rated Voltage

Testing of transformer: Double Voltage double frequency:

In Energypac, using this test they check the inner turn insulation.

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

Equipment used: MOTOR GENERATOR SET.

Fifth Day (05-05-2010)

We went to Energypac Engineering LTD at 10.00 A.M. First we meet with Engr. Asif. He told about the fitting and Accessories of transformer, protection system of transformer and testing about the transformer. He then introduced us to Engr. Bulbul who told us details about testing of transformer.

After Lunch break, we saw the oil refining process of the transformer. At that time Engr. Bulbul called us and showed us two tests. These are Magnetic Balance test and Megger test.

2.5. Fittings and Accessories

Energypac ensures all the standard fittings for their Power transformer and Distribution transformer. Some of these accessories are – (see Figure 11).

Figure 11: Driving box and Marshaling box.

- Driving box: Tap changing (On load or OFF load tap changer)
- Marshaling box: Oil Temperature Indicator (OTI), Winding Temperature Indicator(WTI)
- Cooler: ONAN: Oil Natural Air Natural, ONAF: Oil Natural Air Force.
- Gas insulation relay: Buckholz relay
- Pressure relief valve
- Oil level indicator

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

2.6. Protection

Every transformer must have a protection system otherwise it can be damaged. For protection of a transformer, Energypac uses some system or machineries. These are cooling system, Bushing, Gas insulation relay, Thermal protection, Oil level indicator, and Silica gel.

2.6.1. Cooling system

In transformers, the cooling has a special importance to ensure safe operation and to increase the lifetime of the transformer (Figure 12). The heat occurred in the transformers is dissipated at the cooling unit by the help of oil. Energypac used ONAN (Oil natural and air natural), ONAF (Oil natural and air forced) cooling system.

There have also another cooling system. This is OFAF (Oil forced and air forced) cooling system, in which cooling air is blown to the radiators by fans. If the customer requires that type of cooling system then they used it.

Figure 12: Cooling system

2.6.2. Bushing

Bushing is used for external insulation. In Energypac, high voltage and low voltage bushing are of wet process porcelain manufactured by BISF in Bangladesh or imported from reputed manufacturer with terminals suitable for copper conductors. Both HT and LT sides are terminated with bare bushing. All the bushings are top mounted, but side mounted bushing can be provided on request.

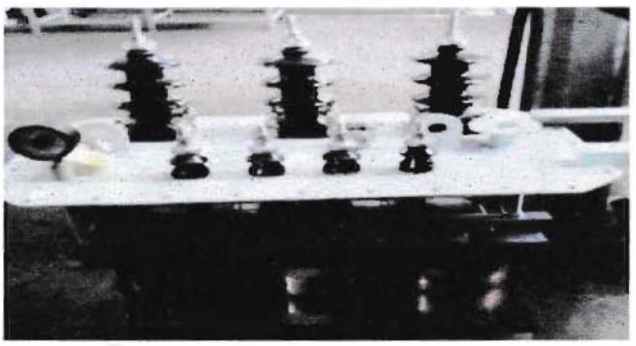


Figure 13: Bushing

2.6.3. Gas insulation relay

Transformers are equipped with various protection and control instruments for the operational security. Gases which occur in the transformer for any reason are collected in a relay. For this purpose Energypac used Buckholz relay. This relay, depending on the volume of gas, gives an alarm or control signal. Pressure relief device replies to the sudden pressure increase that may occur by an arc in the oil of the transformer and gives tripping signal by the contacts on it.

2.6.4. Thermal protection

Energypac use two type of thermal protection. These are, Oil Temperature Indicator (OTI) and Winding Temperature Indicator (WTI)

Oil Temperature indicator:

A thermometer indicates the temperature of oil. If any fault occurred the temperature rises too high.

Winding Temperature indicator:

This indicator gives the temperature of oil and coil, also gives alarm and trip signal to the adjusted temperature limit. It gives start and stop signal for the fans used at forced cooling.

2.6.5. Oil level indicator

Oil level indicator gives the oil level in the conservator and gives low or high readings using contacts.

2.6.6. Silica gel

According to Energypac engineers, Silica gel is used to reduce moisture. At night when oil goes to transformer from conservator some air also enter or exits the conservator depending on expansion and extraction of the oil, so silica gel is used to absorb the moisture from air. Normally the color of silica gel is pink. But when it absorbs the moisture color is changed, becoming brown.

2.7. Oil refining process

After completing the tank up process the tank is filled using moisture free oil. A special type of oil is used in Energypac for this. The oil is known as transformer oil. It creates the insulation between tank body and coil also creates insulation between HT and LT coil. Energypac import this oil from India. Every 2.5 mm oil can block 60K voltage. It is better to refuel the oil after approximately five years.

2.8. Testing of Transformer

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

- CPRI - Central Power Research Institute, India
- BUET- Bangladesh University of Engineering and Technology, Bangladesh

Energypac are in process of getting our products type tested from the following organizations:

- KEMA – KEMA Nederland B.V., the Netherlands
- CESI – Centro Electrotechnico Sperimentale Italiano, Italy
- UL – Underwriters Laboratories, USA.

Energypac follows four types of test. But these four type test are not always performed. That means the type test and the special test are depend on customer choice. If the customer doesn't want that these are not performed. These tests are, In process test, Routine test, Type test, and Special test.

2.8.1. In process test

When a transformer is in process, every step the transformer is tested using these in process tests, Magnetic balance test and Excitation current test. We saw only Magnetic balance test during our internship program.

2.8.2. Routine test

When the transformer is complete then it sends in testing section. In that time this type of test is followed. Without this test a transformer is not ready for use. These tests are, Resistance test, Ratio test, No load test, Full load test, High voltage test, Double voltage double frequency test, Vector group test, and Die- electric strength of oil test.

We saw only Resistance test, High voltage test and Double voltage double frequency test during our internship program. But the Energypac engineer told us about Ratio test and No load test.

2.8.3. Type test

Only one test is done in this section. This test depends on customer demand. With this test the life time of a transformer decreases. It is the Impulse test. Energypac's engineer told about that test but we did not see that test.

2.8.4. Special test

These tests also depend on customer requirement. These tests are Tan-delta test and FRAX test.

general Energypac does the above listed tests but during our internship we could not see all of em. Here we write only the tests that we saw during five days at transformer sections.

agnetic Balance Test:

ıe Magnetic Balance test is conducted on Transformers to identify inner turn faults and checking e magnetic balance. The magnetic balance test is usually done on the star side of a transformer. A 'o phase 440V is applied across two phases, say, phase A and phase B. The phase C is kept open.

ıe voltage is then measured between A-B and A-C. The sum of these two voltages should give the plied voltage. That is, AC + BC will be equal to AB.

ır instance, if the voltage applied is 440V between AB, then the voltages obtained can be

3 = AC + BC

0V = 260V + 180V

ıe voltages obtained in the secondary will also be proportional to the voltages above.

ıis indicates that the transformer is magnetically balanced. If there is any inner-turn short circuit at may result in the sum of the two voltages not being equal to the applied voltage.

easurement of insulation resistance:

easured the resistance of HT & LT windings with respect to earth, and also measured the ıistance between LT & HT winding. For measuring this resistance. Equipment used: Insulation ıter or Megger tester is used.

ırns Ratio:

ıis test is also called Voltage ratio test which measures the voltage ratio.

$$\frac{1}{2} = \frac{N1}{N2}$$

ıe voltage ratio is equal to the turns ratio in a transformer. Using this principle, the turns ratio is easured using a turns ratio meter. If it is correct, then the voltage ratio is assumed to be correct. uipment used: Turns Ratio meter.

easurement of No load loss & current:

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

Impulse test:

During our internship we did not see this test but we learnt how this test of transformer is done. This test is mainly performed for checking the sustainability of transformer during extra high voltage condition. Energypac is the only company in Bangladesh which can perform this test (Figure 14).

In this test an extra high voltage is applied to the transformer that means thousand time rated voltage, and check to see if the transformer can sustain the high voltage or not. The voltage is applied on each of the line terminal in succession, keeping the other terminals earthed. With the test the life time of a transformer decreases, thus only 5 or 6 in 1000 transformers go through this test. Equipment used: Impulse generator is used to produce the specified voltage impulse wave of 1.2/50 micro seconds wave.

Observation: The current and voltage wave shapes are recorded on the oscilloscope and any distortion in the wave shape is the criteria for failure.

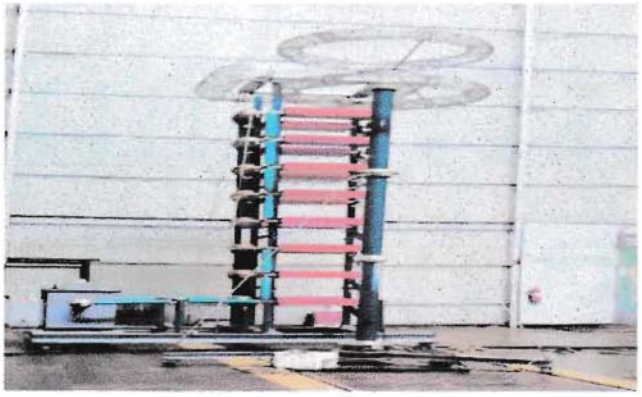


Figure 14: Impulse tester

2.9. Nameplate

The transformer nameplate contains all of the important information of a transformer. Visitors and customers can get knowledge about the transformer by observing the nameplate data.

For example we include the nameplate data of a Power transformer of Energypac.

- Serial number: The serial number is so important for a transformer. It also used for identification of transformer. In a serial number all information of a transformer is recorded
- Rated power: It indicates the apparent power in VA, KVA or MVA for AC.
- Standard: It indicates by which standard following the transformer is produce.
- Class: It indicates the transformer's cooling requirements and increased load capability.

- Rated frequency: Indicates the frequency at which the transformer is intended to work (AC).
- Type of cooling: Indicates which cooling system is used, ONAN or ONAF or OFAF.
- Temperature rise: It indicates the average temperature rise of the winding above the ambient temperature, when the transformer is loaded at its nameplate ratings.
- Insulation level: Indicates which insulation is used in High tension and Low tension side.
- Voltage ratio: it indicates the ratio of input voltage and output voltage.
- Rated current: It indicates the maximum current for which the winding is designed.
- Vector group: It indicates the LT and HT connection.
- Percent Impedance: The impedance percent is the vector sum of the transformer's resistance and reactance expressed in percent
- Lift able weight: In indicates the weight of tank and fittings Weight.
- Oil weight: It indicates the weight of oil.
- Total weight: The complete transformer weight that means core and coil weight, Tank and fittings weight, Oil weight all this weight combined the total weight is count.
- Winding temperature: The temperature of core and coil.
- Year of manufacturing: It indicates which year the transformer is produced.

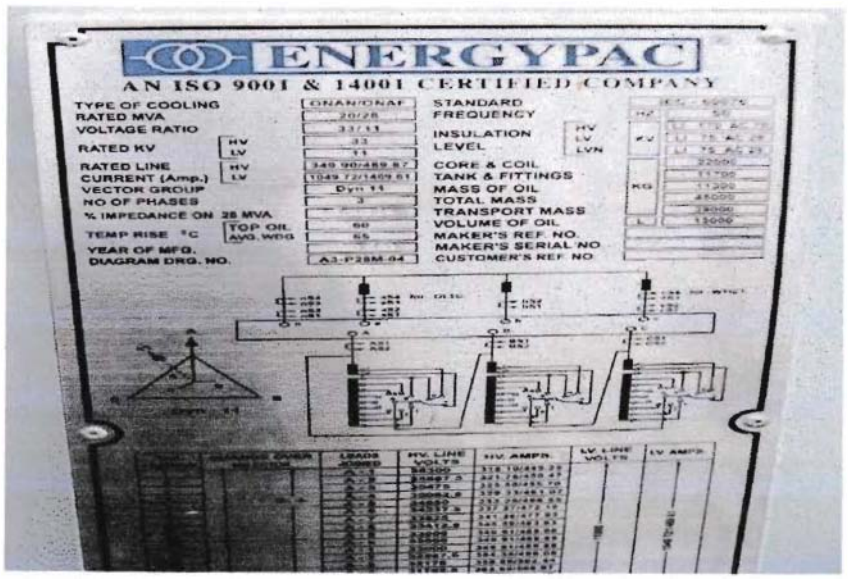


Figure 15: Nameplate

After completing the transformer section, we meet with Engr. Assaduzaman, Again he took a viva about transformer. He asked some question about transformer. One of His questions is "How we identify a transformer's LT and HT side connection that means delta or Y by seeing the outlook of the transformer?" We answered that question. So he is so satisfied with us. And this is the end of our transformer section. We must mention that all data and information was taking from Energypac's Engineer and Technicians.

3. SWITCHGEAR

In this section we were worked four days (09-05-2010 to 12-05-2010).

Sixth day (09-05-2010)

We went to Energypac Engineering LTD at 10.00 A.M. Previous day we complete Power and Distribution transformer department. So that day we first meet with Engr. Monirul Huda. He advised us to go Switchgear department. In switchgear department we meet with Engr. Sayed Muztaba Ali. DGM. He supervised us in that department. He assigned an Engineer named Mahabub for helping us. Engr. Mahabub first time told something about the Switchgear and their product. Then he showed two types switchgear. One is LT (Low Tension) Switchgear and another is HT (High Tension) Switchgear. We saw their Design, operating method, construction etc.

3.1. Introduction

Switchgear is used for controlling any power system. Energypac manufacture the switchgear product for controlling the outdoor power or, indoor power. It is used in substation or any other industry and building. Switchgear is mainly used to isolate electrical equipment [2]. Engr. Mahabub told us about the basic function of switchgear, which is Electrical protection, Electrical isolation of sections of an installation, and Local or remote switching

3.2. Types of switchgear

Energypac manufacture two types of switchgear. These are LT (Low Tension) Switchgear and HT (High Tension) Switchgear [3].

3.2.1. Low Tension (LT) Panel

Energypac Engineering Limited manufactures low voltage switchgear (hereafter called LT Panel) which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 415V (Phase to Phase)and 220 V(Phase to Neutral). See Figure 16.

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

Energypac uses two types of operating method in LT panel- Manually-operated and Motor-operated. Manually operated means by hand and motor operated means it operate using a motor. When we went to the LT switchgear manufacture unit at Energypac we saw how LT switchgear constructs, which material is used, how it work, and its application and so on.

Figure 16: LT switchgear panel

In Energypac, LT switchgear, the following are included - Bus Bar, Relay, Ammeter, Voltmeter, CT, and Breaker, Fuse, and Indicator flags. See block diagram of LT panel in Figure 17.

Working principle of LT panel:

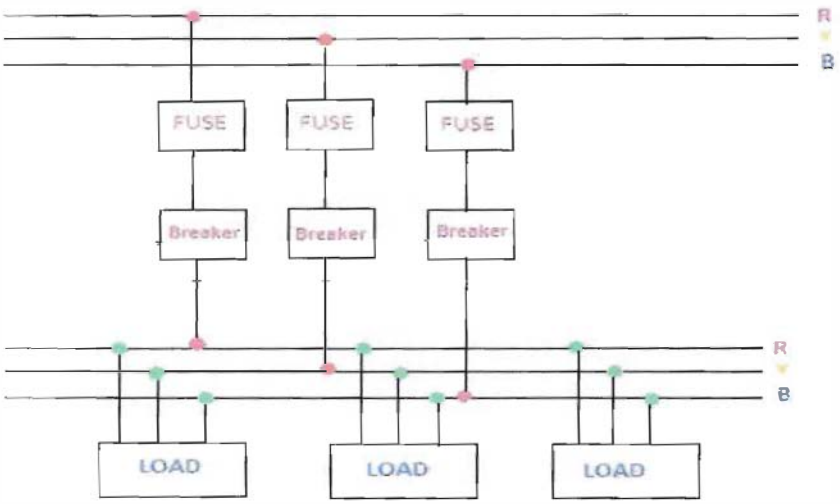


Figure 17: Block diagram of LT panel

In a LT panel ammeter measures current with CT from the main bus bar. Ring CT is used in LT switchgear Panel. Ammeter cannot measure more than 5A current. So CT is mandatory for measuring current. But voltmeter is connected directly with the line in case of LT panel, because the internal resistance of voltmeter is very high. Here generally Miniature circuit breaker (MCB) is used which is spring charge motor controlled breaker. As a protection of MCB, a control switch is used.

When current exceeds 1000A, the control switch (fuse) disconnects and circuit breaker trips. CT, fuses, circuit breaker are connected with bus bar. For 3 phase current display, there are 3 ammeters.

For voltage and current monitoring, voltmeter, ammeter, indicating lamps, selector switch etc. are mounted on the upper portion of the front cover of the LT. panel Box. 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.

The application of LT panel extends to Power station, Industrial enterprise, and Commercial or Residential Buildings for power distribution. It can be used to control, protect and inspect the circuit.

Technical Data of LT panel: Technical data means the nameplate value or the ratings. Here we include the nameplate of LT panel of Energypac. These are:

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

Seventh day (10-05-2010)

On that day we saw PFI plant at Energypac. We saw its construct, material used, how it works.

3.2.2. Power Factor Improvement (PFI) Plant

PFI plant has been designed to meet the needs of all forms of power factor correction by capacitor banks from small unit to a large plant (Figure 18). Energypac's Power manufactures floor & wall mounting auto/manual power factor improvement (PFI) plants. The PFI plant has capacitor Banks, power factor improvement Relay, Contactors, HRC fuses. Manual and Automatic change over switch reactors for large plant comply with IEC and other relevant international standards. The automatic PFI plants are available in steps of 2.5 KVAR to 50 KVAR capacitor Banks.

Figure 18: PFI plant

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

Energypac PFI plant includes Bus Bar, HRC fuse, Relay, CT, PT, Ammeter, Voltmeter, Magnetic il, Breaker, Capacitor, and Indicator flags. See block diagram in Figure 19.

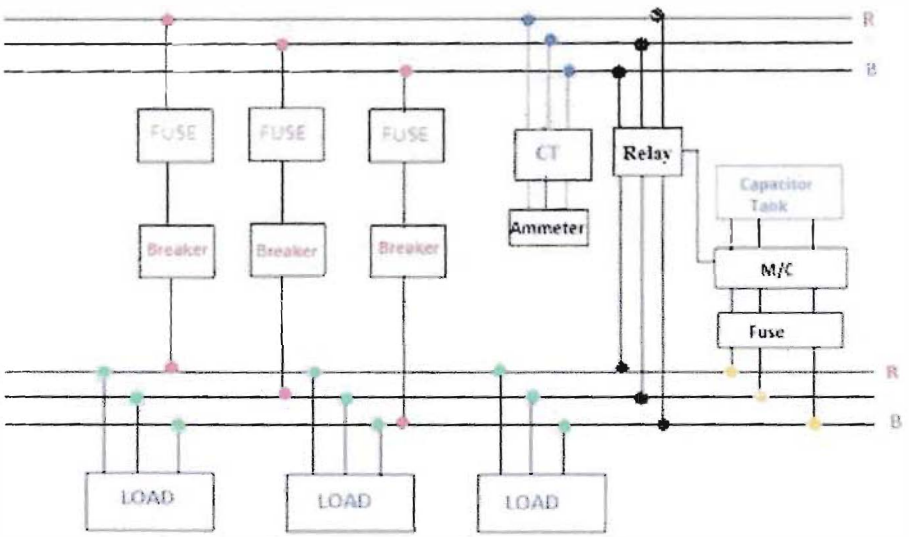


Figure 19: Block diagram for PFI

rking principle of PFI:

ding capacitors is generally the most economical way to improve a facility's power factor. ile the current through an inductive load lags the voltage, current to a capacitor leads the :age. In general all the loads are inductive, so if we add a capacitor bank parallel with the load ı the power factor improves. So our target is unity power factor. In a PFI panel ammeter :sures current by the help of CT from the main bus bar. Ring CT is used in LT switchgear Panel. meter cannot measure more than 5A current. So CT is mandatory for measuring current. By g PT voltmeter measure the voltage. Relay is added with load bus bar. The function of relay is to e power factor of the system and give trip signal to magnetic coil. When magnetic coils are gized it connects capacitor with the system. Here generally Miniature circuit breaker is used h is spring charge motor controlled breaker. As a protection of MCB, a control switch is used. n current exceed 1000A of current, the control switch (fuse) become disconnected and circuit :er will trip. There are three relay which energized the magnetic coils. CT, fuses, circuit breaker onnected with bus bar. By this procedure the power factor is improved.

...ounted on the upper part of the front cover of the PFI panel Box. Copper bus bars of adequate ... with Red, Yellow & Blue marking are mounted on the upper portion of the Box. The bus bars ... firmly supported by insulators having adequate mechanical and electrical strength.

...t be Consider:

... connect power factor correction capacitors at motor terminals on elevator motors, plugging or ...ing applications, multi-speed motors or open transition, wye-delta, auto-transformer starting and ... part-winding start motors.

Eighth day (11-05-2010)

... that day we saw HT switchgear panel at Energypac and It's construct, which materials are used, ... it work and so on.

3.2.3. HT SWITHGEAR

...gr. Mahabub told that Energypac's HT Switch gear equipped with Load Break switch (LBS), ...acuum Circuit Breaker (VCB), Disconnect or etc. To meet individual requirement which comply ...ith IEC and other relevant international standard, it has features of long service life reliability and ...gh degree of quality safety. High Tension Switches are suitable for inexpensive electrical sub-...ation with transformer feeder, measuring, sectionalizing Auto change over and motor protection.

...T switchgears are used for two types of voltage class, Medium voltage (1KV to 33 KV) and High ...ltage (more than 33 KV). In Energy Pac two types of operating method are used in HT, Manually-...erated and Motor-operated.

... Energypac HT switchgear construction, the following are included - Bus Bar, CT, PT, Ammeter, ...oltmeter, Master relay, General relay, Magnetic coil, VCB, Counter, and Indicator flags.

...Working principle of HT switchgear:

...n a HT panel ammeter measures current by the help of CT from the main bus bar. Ring CT is used ... Ammeter cannot measure more than 5A current. Voltmeter measures voltage by the help of PT ...rom the main bus bar. By using a converter a fixed dc voltage is used as input of a master relay. The ...nput voltage is 110 volt (DC).IN this panel the master relay is microprocessor based. It sense all ...hings that means over current , over voltage, oil level of transformer, oil temperature, winding ...temperature of transformers etc. when any fault is occurred master relay give signal to the general ...relay. After receiving this signal general relay give trip signal to the breaker. A master coil is used to trip whole system. Magnetic coils are used to trip separate load connection. Here VCB is used which is spring charged motor controlled breaker. There are three relay which energized the magnetic coils ...trip the breaker. For voltage and current monitoring, voltmeter, Ammeter, Indicating lamps, ...selector switch etc. are mounted on the upper portion of the front cover of the LT. panel Box. ...Copper bus bars of adequate size with Red, Yellow & Blue marking are mounted on the upper ...portion of the Box. The bus bars are supported by insulators.

Application of HT switchgear: Power station, Industrial enterprise, Commercial industry and Transmission can be used to control, protect and inspect the circuit.

Technical Data of HT switchgear: Technical data means the nameplate value or the ratings. We saw the nameplate value of HT panel. These are:

- Rated Voltage: 12KV & 33KV
- Rated Current: 630A, 800A, 1250A
- Short time current rating for 3Sec: 20kA
- Basic impulse level: 75kV
- Making Current: 50kA
- Rated Frequency: 50Hz

Ninth day (12-05-2010)

On that day we saw Metering unit at Energypac and It's Purpose, which materials are used, how it work and so on.

3.3. Metering unit

Energypac is the first company which introduced a new metering unit in 2010. It is used to reduce metering corruption. The Power distribution flow chart of our country is shown below

Figure 20: Power flow chart

First stage, the power is transfer from PDB to PGCB. In this process no metering corruption is occurred. PGCB buy some amount of power from PDB and they get this amount of power from PDB. Second stage, Power transfer from PGCB to DPDC .DPDC buys power from PGCB. There is no metering corruption also in that process. Third stage, Customer buys power from DPDC. In this stage metering corruption occurred. So DPDC decided they use an online metering unit for controlling this metering corruption. DPDC ordered this metering unit from Energypac.

At the Metering unit manufacture section we saw the metering unit construction and how it works. In Energypac metering unit construction process, the following are included with the unit – CT, PT and Ammeter, Modem, and Memory device.

Working principle of metering unit:

For controlling this corruption two metering unit is used. One is placed in DPDC and the other one is placed in REB. When DPDC give power to REB, they measure the current and voltage by through

ammeter and voltmeter by using CT and PT. They record unit of power which amount they send. Then it automatically saved in building memory and by using modem passes this data to the online. Similarly REB record which unit they receive. Then automatically save it by using modem passes this data to the online.

By comparing the two data online they can measure which amount unit is corrupted. If they want data from memory, they can do it. By using this formula the metering corruption can be controlled.

Technical Data of metering unit: Technical data means the nameplate value or the ratings. We saw the nameplate value of metering unit. These are:

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

4. INSTRUMENT TRANSFORMERS

In instrument transformer we were worked three days (13-05-2010 to 15-05-2010).

Tenth day (13-05-2010)

We first meet with Engr. Mozharul Islam, DGM , he supervised us in that section. He introduced us with a Diploma Engineer named Masum for helping us. On that day Engr. Masum showed us CT and PT. He theoretically described about CT, PT and it's basic functions.

4.1. Introduction

Instrument transformers are used for measuring voltage and current in electrical power systems, and for power system protection and control. Energypac manufacture two types of instrument transformer for that purpose. These are, Current transformer (CT) and Potential Transformer (PT).

Current transformer (CT):

It is not possible to measure the current in high voltage of a system is directly because of insulation problem of measuring instruments. So we must need a transformer which takes high input but the output is low. Considering this matter Energypac design a transformer. This transformer is called CT. It can be designed for Single or Multi ratio. In Energypac the ratio selection can be achieved by providing two or four sections or primary for series/parallel connection, the current ratio shall be in proportion of 1:2:4. The advantage of this type of ratio is that output from each secondary remains constant for any selected ratio. There are two types of CT shown in Figure 21.

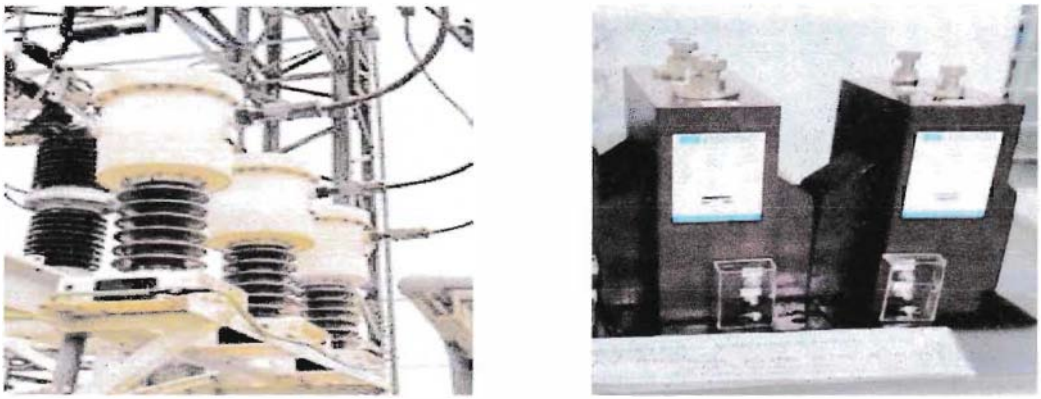


Figure 21: Outdoor type CT (left) & Indoor type CT (right)

Potential Transformer (PT):

Direct measurement of voltage in high voltage system is not possible because of insulation problem of measuring instruments. So we must need a transformer which takes high input voltage but the output voltage is low. Considering this matter Energypac design a transformer. This transformer is called PT. This transformer is used for step-down the high system voltage to low standard value accurately in proportion to their ratio. See Figure 22.

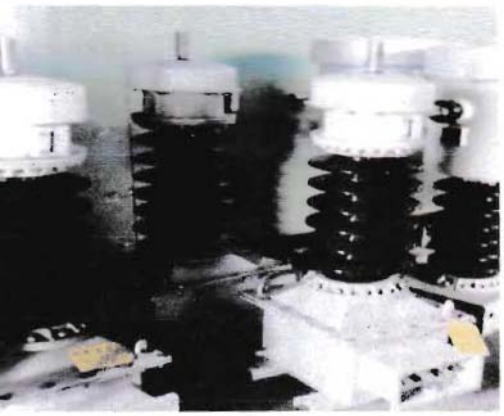


Figure 22: Outdoor type PT & Indoor type PT

4.2. Basic functions

nergypac's engineers explained to us the basic function of CT and PT, which are -

urrent transformers:

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

otential transformers:

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

4.3. Types

Energypac manufactures two types of CT and PT based on construction - Indoor and Outdoor type

Indoor Type: For indoor type transformer Energypac manufacture only one types of transforme This is Epoxy resin cast type. In this transformer there have no oil expansion chamber.

Outdoor type: For outdoor type transformer Energypac manufacture two types of transformer, O merged type or Epoxy resin cast type.

Types of CT and PT based on design:

Current transformers: Energypac produces two types of CT: Live tank or Dead tank.

Potential transformers: In Energypac single phase electromagnetic PT is manufactured in two type Single Pole (between lines & earth) and Double Pole (between line-to-line).

Eleventh day (14-05-2010)

On this day we saw only the manufacturing process of instrument transformer at Energypac.

4.4. Manufacturing process

Energypac divides the manufacturing process of Instrument transformer into four parts. These are

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

4.4.1. Electromagnetic core

Here we were told about the raw material and construction of core of instrument transformer.

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

4.4.2. Primary and Secondary Windings

Here we were told about the winding procedure of coil of instrument transformer in Energypac.

Epoxy resin cast type:

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

Oil merged type:

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

4.4.3. Bottom Tank and Oil Expansion Chamber

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

4.4.4. Porcelain Bushing

Energypac used Hollow cylindrical type of bushing..

4.5. Insulation

Insulation is most important for a instrument transformer, because there have no other protection system. Energypac used three types of insulation processes for insulating of instrument transformer, these are Insulating paper, Oil, and Varnish.

Insulation paper: In Energypac, the engineers used two types of insulation paper, Crepe paper and Kraft paper. High quality crepe insulating paper is used to build up main insulation of the CT and PT. And the craft paper is used to avoid Short circuit between core and coil.

Oil: Energypac often uses oil for insulation, such as Insulating Oil, Transformer oil, and Mineral oil.

Varnish: Winding conductors are insulated with high quality, synthetic resin based insulation varnish.

Twelfth day : 15-05-2010

n that day we saw only the testing process of Instrument transformer at Energypac.

4.6. Testing for instrument transformer

Energypac follow some standards for their testing, and they must ensure quality test facility as those standards. These standards are: IEC-76, VDE 0537, ANSI C 57.12 and BS 171.

Energypac must ensure four types of tests. These tests are - Routine test, Partial Discharge test, High voltage test, Quality test.

During our internship program we saw Partial Discharge test, High voltage test and Quality test.

4.6.1. Partial discharge

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

4.6.2. High voltage test

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

Observation:

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

4.6.3. Quality test

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

- Flow of Current through the transformer in percent.
- Ratio error in percent that means the desire current and the output current ratio in percent.
- Phase error
- Barden at 1A current.
- Barden of Power factor.
- Barden of Impedance.
- Frequency
- Accuracy class.

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

4.7. Nameplate

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

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

5. BREAKER & ISOLATOR

In Breaker section we work two days (18-05-2010 to 19-05-2010)

Thirteenth day (18-05-2010)

This is the day for department change. So we went to Energypac Engineering LTD at 9.30A.M. We again meet with Engr. Monirul Huda. He then advised to go Breaker department and contact with Engr. Moniruzzaman, Manager. After introduction he briefing us on Breaker then he assigned an Engineer for us named Engr. Tawhid. Before lunch break Engr. Tawhid also briefing us on Breaker.

5.1. Introduction

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. In general Energypac used three types of breaker these are - Low Voltage Breaker, Medium Voltage Breaker, and High Voltage Breaker.

Energypac only manufacture the high voltage breaker. Other types of breaker are imported.

5.2. Low Voltage Breaker

For low voltage Energypac used Miniature Circuit Breaker (MCB), see Figure 23. This is imported from Germany. It is used in Switchgear. Voltage Range: from 1 V to 1KV

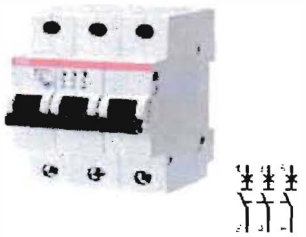


Figure 23: Low voltage breaker

Basic Function:

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

Operating Voltage: **230/440 V**

Types of MCB:

Three types of MCB are used in Energypac. These are: Single Pole (SP), Double Pole (DP), and Triple Pole (TP).

SP: This breaker is used with a typical 120v circuit, having one hot wire and one neutral wire.

DP: The DP breaker is used with 220v circuit (like for a dryer or heater) having two hot wires

TP: A triple pole breaker is used with a typical 415v circuit having three hot wires.

Application of MCB:

- Protection of Resistive loads such as bulbs, heaters etc.
- Protection of Inductive loads such as motors, air conditioners etc.
- Protection of Cables and highly inductive loads which have high starting current such as transformers.

5.3. Medium Voltage Breaker

Is a medium voltage breaker Energypac used Molded Case Circuit Breaker (MCCB) which is imported from Italy. It is used in Switchgear. Voltage Range: from 1 KV to 11KV

Figure 24: Medium voltage breaker

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

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

5.4. High Voltage Breaker

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

breaker Energypac used Vacuum Circuit breaker (VCB). They manufacture the Vacuum circuit Breaker. Voltage Range: 11KV to 33KV.

In manufacturing process they follow two standard, these are:

IEC - International Electrotechnical Commission and ANSI -American National Standards Institute

Types of High voltage breaker:

Energypac manufacture two types of Vacuum Circuit Breaker

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

Special features of High Voltage Breaker:

Outdoor vacuum circuit breakers: Compact design, Low operational load, Low Maintenance, Minimal fire hazard, Low noise level, and extended life.

Indoor vacuum circuit breakers: Customer friendly, high degree of safety, High operational reliability, Rugged design, Simple in construction, and Modular and compact.

After lunch break, Engr. Tawhid saw us the manufacturing process of VCB.

5.4.1. Vacuum Circuit Breaker

Energypac manufacture VCB as high voltage breaker. These breakers interrupt the circuit by creating and extinguishing the arc in a vacuum container. The VCB is one of the breakers by which the circuit is broken rapidly by extinguishing an arc in a vacuum chamber when the circuit is opened or closed and when the circuit is broken by a generation of the accident current. See Figure 25.

Vacuum circuit breakers are generally used in electric power systems having low surge impedances.

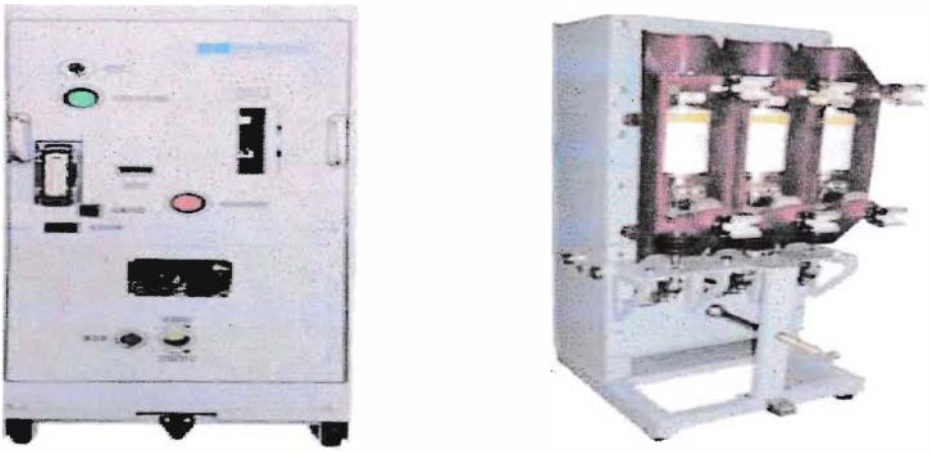


Figure 25: Vacuum Circuit breaker

In Energypac the VCB is divided into two parts – i.e. circuit breaker and Vacuum interrupter.

Circuit breaker part:

The operating mechanism of circuit breaker part is motor controlled spring charger or discharged mechanism. In that mechanism when the fault occurred the spring is discharged so after the fault clear the spring is again charged by motor.

The following features are also provided on the switchgear - Operation counter, Local on/off switch, Local/remote switch, All necessary fuses and wiring,

Vacuum Interrupter

Energypac doesn't manufacture Vacuum interrupter, they import it from CUTLER-HAMMER (EATON), USA. The construction is of metal clad type and uses high grade CRCA steel of adequate thickness ensuring safety and security. (Figure 26)

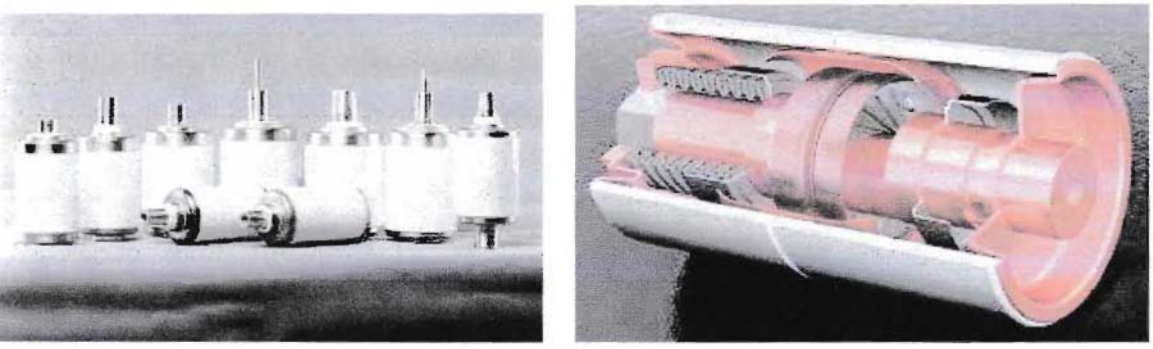


Figure 26: Vacuum Interrupter

In a vacuum interrupter there is a fixed conductor and a moveable conductor. These two conductors are connected through two terminals. There is a bellows at moveable ends. Also there is an Arc shield between the contracts (see Figure 27).

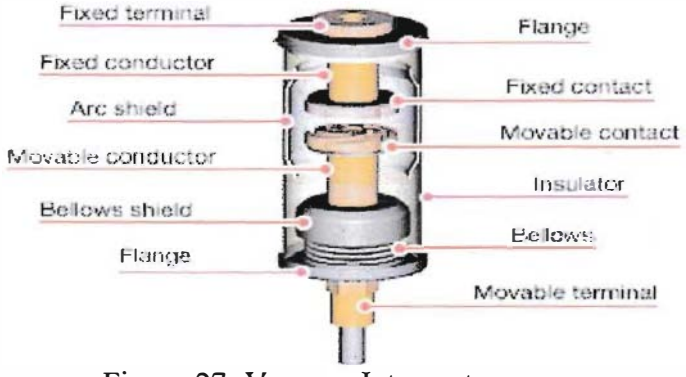


Figure 27: Vacuum Interrupter

ngr. Tawhid also told the special characteristics of Vacuum interpreter and VCB working principle.

pecial characteristics of vacuum interrupters are - Very low arcing time, Quick recovery of ielectric strength, Small contact gap, Trouble free service, and Low energy mechanism

Working Principle of VCB:

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

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

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

Safety:

If someone suddenly pushes the breaking button, a fault or any problem can be occurred so Energypac uses different safety system for avoiding this problem. They use three type of safety process in VCB. These are - Mechanical lock, Electrical lock, and Socket.

Mechanical lock: It means the locking system of the machine or device. If the system is mechanically locked, the device can't operate.

Electrical lock: It means the locking system of the Breaker part. If the system is electrically locked, the Breaker part can't operate.

Socket: This is used for Breaker on/off. If the socket is not connected the breaker remains shut off.

Fourteenth day (19-12-2010)

We went to Energypac Engineering LTD at 10.00 A.M. We again meet with Engr. Tawhid. First time he told something about VCB and its application. We saw few test procedure of VCB this day.

Applications of VCB: Engr. Tawhid also told about the application of VCB. These are: Power stations, Transformers, Industry, and Airport power supply.

Technical data of VCB: Technical data means the nameplate value or the ratings. Every equipment has ratings in that ratings the equipment gives the maximum output. Now we include the ratings of VCB which is manufactured by Energypac.

- Applicable Standard: IEC60056
- Type Designation: OFVp-36
- Normal Voltage: 33kV
- Rated Voltage: 36 kV
- Frequency: 50 Hz
- Normal rated current: up to 1600 Amps
- Short circuit breaking capacity: up to 25 kA
- Rated 1 minute Power frequency withstand voltage: 75 kV rms
- Rated impulse withstand voltage: 170 kV peak
- Nominal creepage of bushings
  Support – 910 mm
  Interrupter housing – 910 mm
- Duty cycle 0 full breaking capacity:
  Normal – 0-3 MIN – CO- 3 MIN-CO
  Auto reclose - --0.3 sec-CO-3 MIN-CO

5.5. Testing for Breaker

For testing Energypac follow the standard of IEC, ANSI, CPRI and also BUET. They have got certificate from the mentioned organizations. Energypac follow different type of test for breaker. These are:

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

During our internship program we did not see any test of Breaker but the Engineer told something about that test.

5.5.1. Physical test

By using this test, it is observe that after hundred time operation the full setup of the device is damage or not. This test is also called Mechanical Endurance test.

5.5.2. Resistance test

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

5.5.3. Insulation test

gh voltage insulation tester is used for insulation test. In this test high voltage is applied to the ice and cheek the voltage of the body.

5.5.4. High voltage test

his test high voltage is applied that means 2.5 times rated voltage is applied and observe that the aker can sustain or not.

5.5.5. Timing test

his test measure the circuit closing time and opening time.

5.6. Isolator

solator Section we work only one day (20-05-210)

Last day (20-05-2010)

went to Energypac Engineering LTD at 9.00A.M. We meet with Engr. Belal Hossain, Manager. er introduction he was briefing us on Isolator and saw us different types of Isolator.

oduction:

ator is an off load device which is used for isolating the downstream circuits from upstream uits for the reason of any maintenance on downstream circuits. It is manually operated and does contain any solenoid unlike circuit breaker. See Figure 28.

Figure 28: Isolator

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

7. Isolator or Disconnectors Types

ufactures outdoor off load disconnectors of the following types: Pantograph, Centre Break

l not see the manufacturing process but we saw that types of isolator and Engr. Hossain told the ratings and the basic functions of those isolators.

5.7.1. PANTOGRAPH TYPE

one types of isolator. In Energypac we saw this type of isolator. This isolator is handle. From our observation we note down the ratings and basic function.

rom 12 kV to 245 kV

p to 3150 Amps

ent rating up to 50 kA

unction:

- Very low civil engineering profile.
- Trapeze contact fixing to suit upper bus arrangement.
- 4 point contact
- Available for flexible / rigid bus bar layouts.
- Current transformer through multifinger hinge contacts.
- Individual pole operation.
- Structure to suit requirements.

s other types of isolator. In Energypac we saw this type of isolator. This isolator is
e handle. From our observation we note down the ratings and basic function.

from 12 kV to 245 kV

up to 3150 Amps

rent rating up to 50kA

functions:

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

5.7.3. DOUBLE BREAK TYPE

s also one type of isolator. In Energypac we saw this type of isolator. This isolator is
o handle. From our observation we note down the ratings and basic function.

from 12 kV to 245 kV

up to 3150 Amp

rent rating up to 50kA

function:

- Turn and twist contacts
- Vertical/Horizontal terminal take off
- Totally enclosed actuator assembly
- Simultaneous operation of 3 poles by single operating mechanism up to 245 kV.
- Structure to suit requirements.
- The disconnectors consist of separate poles which can be arranged for single pole operation or linked together by operating rods to form 2 or 3 pole units.

three type of operating mechanism. It is mainly based on customer demand. These

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

3. Tests for Isolators

rgypac follow the standard of IEC, ANSI, CPRI and also BUET. Energypac must es of tests. These tests are:

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

rnship program we did not see any test of Isolator but the Engineer told something

rnship program we did not see any test of Isolator but the Engineer told something

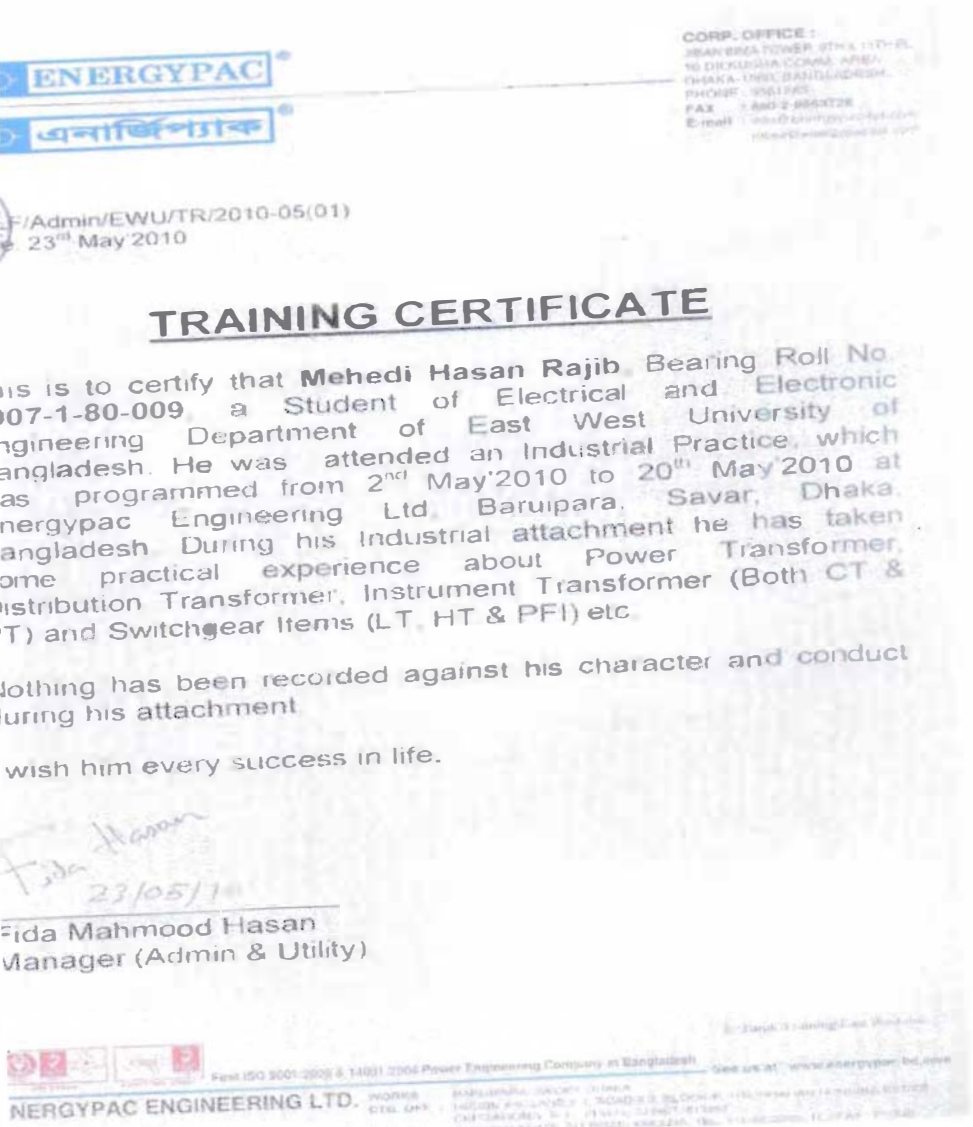
y using this test Insulation is checking.

nce test: This test is used for measure the resistance between two contacts after contacts.

st: By using this test it is checking that the isolator can sustain in high voltage.

his test is used for measure the current through the contacts.

ıg this department we went to Engr. Monirul Huda. We said him our all task is then advised to go Mr. Fida Mahmood Hasan, Manager (Admin & Utility) for ertificate. Mr. Fida gave us the training Certificate. This is the end of our Internship



ENERGYPAC
এনার্জিপ্যাক

CORP. OFFICE :

F/Admin/EWU/TR/2010-05(01)
23rd May 2010

TRAINING CERTIFICATE

This is to certify that **Mehedi Hasan Rajib**, Bearing Roll No. **2007-1-80-009**, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. He was attended an Industrial Practice, which was programmed from 2nd May'2010 to 20th May'2010 at Energypac Engineering Ltd. Baruipara, Savar, Dhaka, Bangladesh. During his Industrial attachment he has taken some practical experience about Power Transformer, Distribution Transformer, Instrument Transformer (Both CT & PT) and Switchgear Items (LT, HT & PFI) etc.

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

I wish him every success in life.

23/05/10

Fida Mahmood Hasan
Manager (Admin & Utility)

ENERGYPAC ENGINEERING LTD.

Figure 29: Training certificate.

Electric Machines," 2nd Ed., South Asia: Pearson Education, 2007. pp 37-127
tchgear Protection and Power Systems," 12th Edition, Delhi: Khanna Publishers,
) and 138-153
pac-bd.com/company.php?id=49 (website of Energypac)

APPENDIX

Glossary

ification ---- Accuracy of an instrument transformer at specified burdens. The indicate accuracy is the maximum allowable error of the transformer for specified ample, 0.3 accuracy class means the maximum error will not exceed 0.3% at stated

--- The load which may be imposed on the transformer secondary's by associated ıds and other connected devices without causing an error greater than the stated ication.

-- Crepe paper is tissue paper that has been coated with sizing and then creped to

In electrical system fuse acts as protection device and depending on application of fuse is to select. This fuse is used where some delay is acceptable for protecting the

strong wrapping paper made from pulp processed with a sulfur solution

--- An electromagnetic coil is a device comprising two distinct elements: a conductor conductor is most commonly made from solid copper wire, which is wrapped around ore. Each time the wire is looped around the core, it is called a turn. Multiple turns are e a coil.

ector ---- A magnetic connector includes first and second connector parts, each having agnet. The second connector part includes an overhanging lip positioned on one side e magnet and a cord loop positioned on the opposite side of the respective magnet.

t ---- The current that an electrical device can carry under specified conditions, without verheating or mechanical overstress

;e ---- The maximum voltage at which an electrical component can operate for extended ɔut undue degradation or safety hazard.

senses the abnormal condition in a part of the power system and gives an alarm or art from the healthy system

el is an iron based alloy containing Carbon, Silicon, and Manganese etc

Abbreviations

Air Circuit Breaker

American National Standards Institute

angladesh University of Engineering and Technology

Centro Elettrotechnio Sperimentale Italiano

Central Power Research Institute

- Cold Rolled Close Annealed

- Core Role Grain Orientation

urrent Transformer

-- Dhaka Electric Supply Company Limited

)ouble Paper Coated

Dhaka Power Distribution Company

Iigh Reputing Capacity

gh Tension

gh Voltage

ternational Electrotechnical Commission

w Tension

w Voltage

Miniature Circuit Breaker

-- Molded Case Circuit Breaker

Oil Force Air Force

Oil Natural Air Force

- Oil Natural Air Natural

il Temperature Indicator

'ower Development Board

Power Grid Company of Bangladesh

wer Factor Improvement

ential Transformer

ural Electrification Board

Short Circuit Current Rating

derwriters Laboratories

Vacuum Circuit Breaker

Winding Temperature Indicator