Undergraduate Internship

INTRENSHIP REPORT
ON

TRANSFORMER MAKING AND SWITCHGEAR ASSEMBLING AT ENERGYPAC ENGINEERING LTD

BY

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

In partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

(B.Sc. in EEE)

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22/5/2011

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22/05/2011

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Department Chairperson

22.05.2011

Dr. Anisul Haque

CERTIFICATE OF COMPLETION

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এনার্জিপ্যাক®

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EELF/Admin/EWU/TR/2011-03 (01)
Date: 13th March'2011

TRAINING CERTIFICATE

This is to certify that **Md. Abdur Rahman,** Bearing Roll No. 2007-2-80-007, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. He was attended an Industrial practice, which was programmed from 1st Jan'2011 to 10th Jan'2011 at Energypac Engineering Ltd, Baruipara, Savar, Dhaka, Bangladesh. During his Industrial attachment he has taken some practical experiences about Power Transformer, Impulse, Distribution Transformer, Instrument Transformer (Both CT & PT), Fabrication, CNC, Machine Shop, Paint, Powder Coating, Isolator and Switchgear Items (LT, HT & PFI) etc.

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

I wish him every success in life.

13.03.11

Engr. Md. Shafique Uddin Khan
AGM (Admin & Utility), EELF.

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Date: 13th March'2011

TRAINING CERTIFICATE

This is to certify that **Khondokar Shah Md. Shohidullah,** Bearing Roll No. 2007-2-80-020, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. He was attended an Industrial practice, which was programmed from 1st Jan'2011 to 10th Jan'2011 at Energypac Engineering Ltd, Baruipara, Savar, Dhaka, Bangladesh. During his Industrial attachment he has taken some practical experiences about Power Transformer, Impulse, Distribution Transformer, Instrument Transformer (Both CT & PT), Fabrication, CNC, Machine Shop, Paint, Powder Coating, Isolator and Switchgear Items (LT, HT & PFI) etc.

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I wish him every success in life.

13.03.11

Engr. Md. Shafique Uddin Khan
AGM (Admin & Utility), EELF.

TRAINING SCHEDULE

Date	Section	Duration	Supervisor
01.01.11 – 03.01.11	Transformer	3 days	Engr. Asiful Islam Engr. Asim Kumar Pal
04.01.11	CT/PT	1 days	Engr. Ataul Goni Usmani
05.01.11	Fabrication, CNC, M/C Shop, Powder Coating & Paint.	1 days	Engr. Jewel Hasan
06.01.11-09.01.11	Switchgear	3days	Engr. Mahbub Hasan
10.01.11-11.01.11	Breaker and Isolator	2 day	Engr. Belal Hossain Engr. Arif Islam

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ACKNOWLEDGEMENT

: the very outset, we wish to convey our heartfelt gratitude to Almighty Allah for his help to mplete the Internship successfully. We also thank to the management of ENERGYPAC for oviding us such opportunity to accomplish our industrial training at the factory of NERGYPAC located at SAVAR.

e want to thank those who helped us and provided us with support to make this report. Without eir assistance we could not have completed our Internship. In this process our special thanks es to Engr. Monirul Huda, Senior Engineer, ENERGYPAC ENGINEERING LTD. He ordinated our internship program and helped us to get acquainted with other engineers.

e did our internship from 1st January to 10th January. We started our work at 9.30am in the orning and ended at 4.30pm. That was an enthusiastic as well as educative journey for us. We t the chance to see practically what we had learnt from the book. It was a wonderful perience. The work environment was excellent and we received outstanding cooperation from l concerned officials of ENERGYPAC.

e thank Engr. Asiful Islam, Engr. Asim Kumar Pal, Engr. Mahbub Hasan, Engr. Jewel Hasan, ngr. Belal Hossain, Engr. MD. Ataul Goni Usmani and Engr. Arif Islam for their support, idance and mentorship. They helped us to learn the scheduled topic which was present in our ternship training schedule.

e also want to thank each and every employee of ENERGYPAC ENGINEERING LTD. for eir continual support. Without their support it will be quite impossible for us to complete our ternship program.

e are also very grateful to all of our teachers for their encouragement and support through our ternship program and academic life.

e take this opportunity to extend our sincere thanks and gratitude to our honorable supervisor Khairul Alam, Associate Professor, Department of Electrical & Electronic Engineering, East est University (EWU) and Mahmudur Rahman Siddiqui, Research Lecturer, Department of ectrical & Electronic Engineering, East West University (EWU) for sparing their valuable time r us. With their positive attitude they guide us to complete the report successfully. Their advice orks as inspiration for us.

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

EXECUTIVE SUMMARY

did our internship at ENERGYPAC ENGINEERING LTD, SAVAR, BARUIPARA from 1st 10th January and this internship report is the result of that 2 weeks attachment with that ıpany. We have observed and learned those things practically which our teachers taught us in class. ENERGYPAC primarily manufacture substation equipments, transformers and tchgears. In this report we have focused on various types of machines which are being used to ıufacture the transformer and switchgear.

ious variety of tasks were implicated to make a transformer. Among those most of the tasks e introduced to us. Most of the raw materials come from abroad to manufacture a sformer. We were shown the making of transformer coil, which depends on the transformer ver rating. We were also shown the assembling and internal connection setup of the sformer, including cooling system, tank making and painting.

ERGYPAC assemble different types of switchgear panels like LT panel, HT panel, PFI plant, S, EURO box etc. These different types of panels are assembled in the factory. To ensure the lity of the components used in assembling switchgear panel is vital. Though most of the tchgear elements, such as breaker, relay are imported from abroad, ENERGYPAC make door and indoor switchgear panel.

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

ther important feature is the testing facility of ENERGYPAC. To ensure the best quality they ıll their manufactured equipments. There are various types of test like magnetizing current high voltage test and special type test. These tests are done only at ENERGYPAC. We 't get the opportunity to perform these tests. Among magnetizing current test, high voltage ınd special type test we just got the opportunity to observe a few of then.

1. INTRODUCTION

'e got an opportunity to do our internship at ENERGYPAC ENGINEERING LTD from 1st nuary 2011 to 10th January 2011. ENERGYPAC gave us the opportunity to gain the practical xperience related to manufacturing process of transformer and switchgear. ENERGYPAC is ie of the leading power engineering companies in Bangladesh. ENEGYPAC is contributing to e improvement of Bangladesh. This company is the best place to gain practical knowledge on bstation equipments.

1 Company Profile:

Fig 1: Logo of ENERGYPAC

NERGYPAC is one of the leading power engineering companies in Bangladesh. Constant search and development, state of the art production facility, quality products, competent rvices, and countrywide operations have made it into a leading engineering company, widely claimed by its customers. ENERGYPAC was incorporated in 1982 as a private limited siness enterprise. It is powered by 1200 skilled manpower of which 150 are graduate gineers. The relentless efforts and dedication of these people are providing the opportunity to search and develop technology to innovate and develop new products. It maintains on time livery, pre and post sales services, establishing a long term business relationship with the stomers. To meet countrywide demand of its products and services, ENERGYPAC has tensive distribution network throughout Bangladesh with full-fledged offices in the major ies like Chittagong, Khulna, Rajshahi, Sylhet, and Bogura. In an effort to introduce its oducts globally, ENERGYPAC has established its offices in India, and China. ENERGYPAC s already exported its products and services to India, Yemen, Ghana, Sudan, Uganda, Nigeria, udi Arabia, and United Kingdom.

ie company's businesses initiatives are organized through their Strategic Business Units, which e: ENERGYPAC Engineering Ltd., ENERGYPAC Power Generation Ltd., Tech Advantage d., ENERGYPAC Electronics Ltd., ENERGYPAC Agro Ltd., and ENERGYPAC Fashions d. ENERGYPAC has several business partners, which are ABB, AREVA T&D, and itsubishi Electric.

NERGYPAC is an ISO 9001:2008 and 14000:2004 certified company. While creating better d environmentally compatible technologies, ENERGYPAC focuses on the customer's demand th appropriate products and solutions as well as services.

1.1. Management:

oard 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.

1.2. Accomplishment:

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

.3. Philosophy:

e management philosophy of the ENERGYPAC ENGYNEERING LTD. is "to produce high-ality Engineering that create a positive impression and satisfy customer by applying the local hnologies we have developed throughout our history with the aim of contribution to a more luent way of life".

. Scope and Methodology:

this report we incorporate structure of a factory, manufacturing process of transformer, tchgear, current transformer, and potential transformer. We also focused on the electrical ipments descriptions which are needed to manufacture a transformer and switchgear embling. Also a brief discussion about testing facilities of ENERGYPAC is mentioned in this ort. The report contains relevant information about a substation as was observed during the rnship program. This report has been prepared on the basis of Information collected from nary sources (primary information has been procured through personal interview as well as ussion with relevant officials of ENERGYPAC). Information from secondary sources ondary data has been gathered by using company website).

2. TRANSFORMER

2.1 Introduction:

At the 1st day (01/01/11) of our internship we scheduled by Senior Engineer Engr. Md. Monirul Huda to transformer section. We spent 3 days (01/01/11-03/01/11) in this section. We were sent to the transformer section to get appointed with Engr. Asiful Islam. We went to transformer section and then Engr. Asiful Islam introduced himself. Then he asked about us and we all gave a brief introduction about ourselves. Then he asked why we were interested to do our internship at ENERGYPAC instead of other companies. We told him that we choose ENERGYPAC because it's the leading manufacturing company of power section of Bangladesh. We also informed him that we feel fortunate enough that ENERGYPAC provide us that unique opportunity. After our little discussion Engr. Asiful Islam started his discussion about transformer.

2.2 Transformer:

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

2.2.1. Types of Transformer Produced by ENERGYPAC:

After finishing introductory speech Engr. Asiful Islam sent us to see the types of transformer produced by ENERGYPAC. ENERGYPAC produces three types of transformer, which are distribution transformers, power transformers, and instrument transformers.

2.3. Construction of Transformer:

2.3.1. Coil Section:

Engr. Asiful Islam told us that ENERGYPAC use electrolyte copper coil for winding. He told us that three types of coil are necessary. They are high voltage (H.V) coil, low voltage (L.V) coil and tap changing coil. He showed us the process of winding of H.V coil. He told us that the H.V coil is thin, because in H.T (high tension) side voltage is high and current is low so it has to carry low amount of current. When we went to the coil winding section we found that H.V coils is a solid cylindrical shape. The diameter of this coil is predetermined. (Fig-1) There might be different number of layers according to the voltage rating, KVA or MVA rating and design issues.

Fig 2: High Voltage Coil. [1]

After watching High Voltage coil winding we moved into the Low Voltage coil section. Low Voltage coil is thick, because in Low Tension side voltage is low and current is high so, the coil has to carry high amount of current. This coil is also used for tap changing. We saw that Low Voltage coil winding process is almost same like High Voltage coil. The raw material is also same. Here also number of layers depends on the voltage rating, KVA or MVA rating and design issues.

Fig 3: Low Voltage Coil. [1]

Engr. Asiful Islam also mentioned that for both type coil round and insulated copper strip are used as raw material. Copper strip is prepared to be carbon and dust free using sandpaper. The starting and finishing leads of each coil are terminated on either side of the coil.

Fig 4: Coil Winding Machine. [1]

.3.2. Core Section:

ıfter observing coil winding section we moved at the core section. We saw that cores are ırapped in a giant role. Engr. Asiful Islam told us that cores are made of high permeable cold ɔlled grain oriented (CRGO) electrical steel insulated on both sides mostly imported from ıpan, Europe, and USA. This core is nothing but silicon sheet. This is used because it has good ɔnductivity. . It varies with different grade and thickness. . Generally, the thickness of core ıminations is 0.30 or 0.23mm and it is possible or obtain better results with 0.23mm thick laser eated core sheet. CNC machinery is used for lengthwise and broadways cutting to achieve etter results with these low loss core sheets.

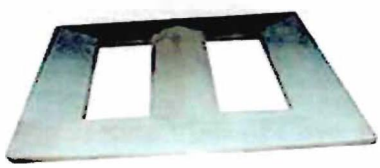

Fig 5: Transformer Core. [2]

.3.2.1. Core Cutting:

ı core cutting section there is a special type of machine called Micro Tool and Machine (MTM) hich is used for core cutting. In this machine cores are cut in three different shapes. The shapes e A, B, C. A shape is called corner shape and B shape is called Benoze shape and adding two shapes C shape core is made.

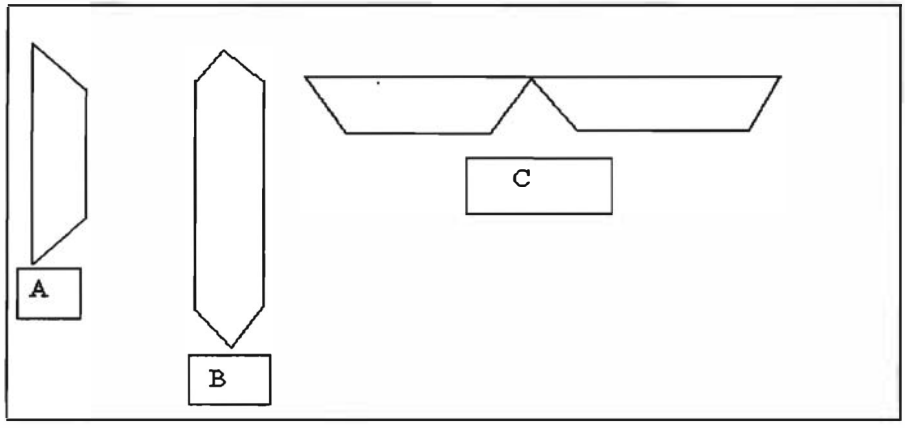

Fig 6: Transformer Core Shape. [2]

After cutting the core, the cores are kept together. It looks like the figure below.

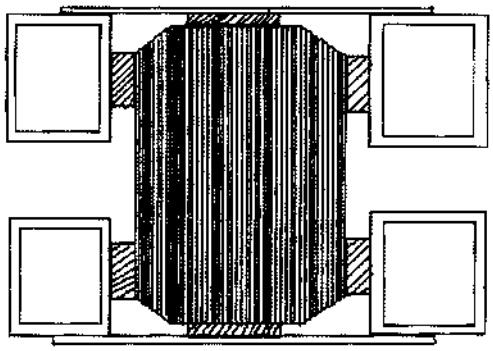

Fig 7: Side View of Core. [2]

Engr. Asiful Islam told us auto core cutting or 45° angle cutting is used only for power and distribution transformer. Otherwise normal core cutting is used for Current Transformer and Potential Transformer because their power rating is not very high. In auto core cutting flux cut is higher than normal core cutting. He told us that an assembled core shape with 45° angle reduce losses and increase the core concentration about the magnetic flux that surrounds a current-carrying conductor into a very small area, and the thickness of the core moving away from the area of the conductor very rapidly has less effect.

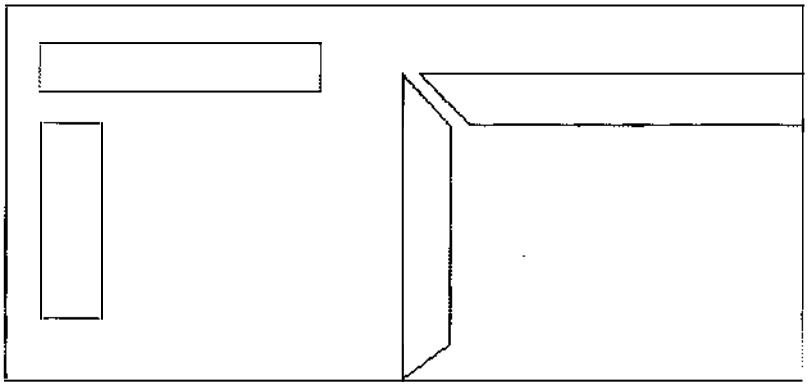

Fig 8: Normal Core Cutting & Auto Core Cutting.

An assembled core is shown below

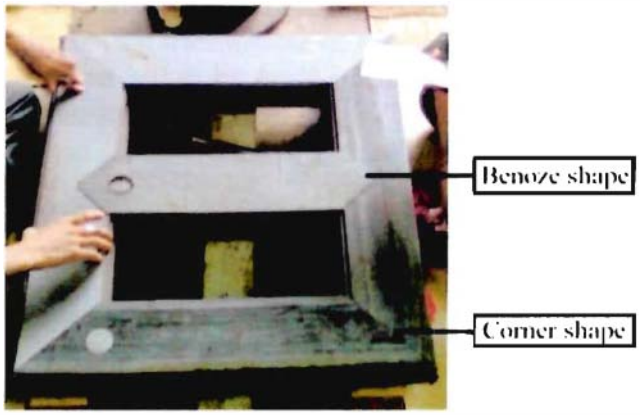

Fig 9: Core Assembling. [3]

2.3.3 Assembly Section:

The next day we moved at the assembly section and Engr. Asiful Islam showed us the process of core and coil assembly. We saw after cutting the silicon sheet it is put in iron frame such way that it looked like a frame. The frame is rolled with a insulation tape to keep all the sheets together. Then the coils are set in the core.

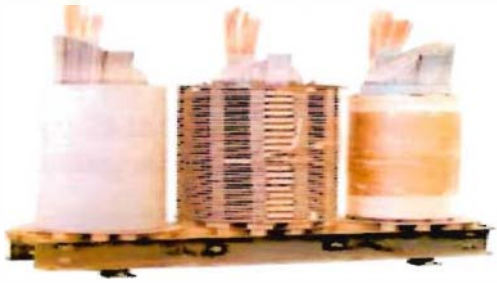

Fig 10: Core and Coil Assembly. [3]

2.3.4. Tap Changer and Tap Switch:

To vary voltage level in High Tension and Low Tension side tapping is provided in transformer. This is done as per customer's choice. Tap changing can be manual or automatic. ENERGYPAC provides two types of tap changer:

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

ap changer provide the benefits to prevent any undesired condition in transformer. On load pping is provided in transformer above 3000KVA. The tap changers are sourced from the best id proven sources of Europe or best manufacturer. Tap changers are compact and mounted on e tap of the tank. Motor drive mechanism is used for the control of on-load tap changer. This ntrol can either be made locally on the transformer or remotely from the control room. The peration of off-load tap changers can either be made on the cover or on the sidewall of the ansformer by manual drive mechanism.

Fig 11: Physical View of Tap Changer. [4]

3.5. Vacuum Drying Process:

clear moister from core, insulation and coil vacuum drying process is used. For this a vacuum ying plant is used. Inside the plant circulated hot air is used to absorb all the moisture. To sure high degree of stability in the insulation structure and early attainment of its mature ndition transformers are kept 15-16 hours in this plant. . Immediately after drying, the ansformers are tanked and insulating oil are filled with a vacuum oil filtering machine.

Fig 12: Vacuum Drying Plant. [2]

2.3.6. Tank Section:

On the next day we moved into the tank section and painting section. Engr. Asiful Islam showed us the tank section first. Engr. Asiful Islam told that the tank of a transformer is made of high quality steel and can withstand vacuum as specified by the international standards. This is manufactured by forming and welding steel plate. The tank is used to hold the insulating oil with coil and core assembly in it. The base and body of tank are connected through bolt. These parts are manufactured in steel plates assembled together with weld beads. The windings and core are fixed together in such a way that no parts can move during vibration.

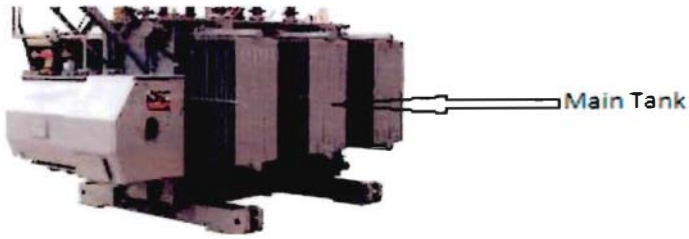

Fig 13: Main Tank [5]

Engr. Asiful Islam also told us about the second part of the transformer tank named conservator (shown in Fig-13). He told us that this conservator is used to contain oil for transformer in total vacuum.

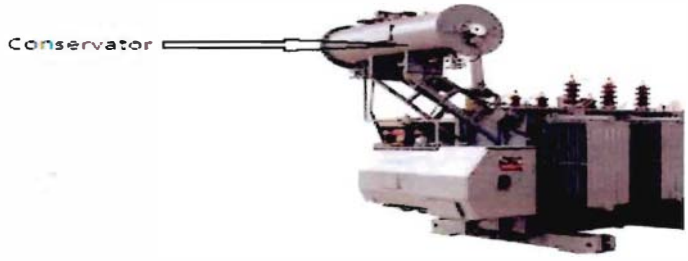

Fig 14: Conservator Tank. [5]

2.3.7. Painting:

We moved at the painting section next. Engr. Asiful Islam told the importance of painting. He said that a good quality painting protects transformer from difficult weather and gives a good look to transformer. After that he briefly explained the whole procedure of painting.

Engr. Asiful Islam told us that to clean the tank sand is blasted according to the international standard. This give tank the ability to stay protected from erosion. But in to order to make sure the best protection facility from erosion the tank should be painted within few hours from sand blasting otherwise it will lose its erosion protection ability. The outside surface of the tank is short blasted to achieve a very fine and smooth finish.

After the cleaning of tank a covering of hot oil resistance paint is applied on the internal surface of the tank. Red Oxide primer is used to paint the outside of the tank. Then the whole tank is colored with shiny gray color. After that the tank is inserted into the heat chamber.

2.3.8. Ending:

We did not see any ending section but Engr. Asiful Islam explained it to us. In this section fitting and accessories are checked as specified in the drawing. Air pressure test is used to detect any leakage or seepage in transformer. Transformer oil is filled to its maximum level. Explosion Vent, Winding Temperature Indicator, Buchholz relay, Oil temperature indicator, Magnetic oil-level indicator, Pressure relief device, Dehydrating breather, and all other equipment is checked. After all of this a transformer is ready for use.

2.3.9 Test:

On the next day Engr. Asiful Islam introduced us to the testing section of transformer. This section is under Engr. Asim Kumar Pal. He told us that ENERGYPAC does two types of test. One is INPROCESS TEST and other is ROUTINE TEST.

2.4 In Process Test:

Engr. Asim Kumar Pal told us that there are 3 types of test among in process test. They are

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

2.4.1. Magnetic Balance Test:

Engr. Asim Kumar Pal at first showed us the magnetic balance test. He told us that to identify inter turn faults and magnetic imbalance this test is done. The magnetic balance test is usually done on the star(Y) side of a transformer. A two phase supply of 440V is applied across two phases. The last phase is kept open. The sum of these two voltages should give the applied voltage.

The voltages obtained in the secondary will also be proportional to the applied voltage. 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.

2.4.2. Excitation Current Test:

In this test, the magnetic balance and eddy current loss is checked. This test was shown by Engr. Asim Kumar Pal.

In this test to monitor the exciting current any available winding with an ammeter 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.

2.4.3. Vector Group Test:

Engr. Asim Kumar Pal told us about vector group test. He told us that 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 the 1U& 2U terminals and give three phase Supply is given to 1U-1V-1W.

Then measure

- ✓ 1U-1V
- ✓ 1V-1W
- ✓ 1W-1U
- ✓ 1W-2W
- ✓ 1V-2W
- ✓ 1V-2V
- ✓ 1W-2V
- ✓ 1U-2N
- ✓ 1V-2N

Then calculate it

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

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

2.5. Routine Test:

A group of tests are routinely performed to detect relatively common disorders. It also establishes a base for further evaluation of a device. Engr. Asim Kumar Pal explained to us the transformer routine tests that are done in ENERGYPAC. They are given below.

- ✓ Measurement of winding resistance
- ✓ Measurement of Insulation Resistance
- ✓ Measurement of voltage ratio and check of vector relationship
- ✓ Measurement of Turn ratio
- ✓ Measurement of impedance voltage and load loss
- ✓ Measurement of no load loss
- ✓ Dielectric tests
- ✓ No Load Test
- ✓ Separate source voltage withstand test
- ✓ Induced over–voltage withstand test
- ✓ Tests on on-load tap changer

During our internship we learned the following routine tests.

2.5.1. Measurement of Winding Resistance Test:

We did not see this test but Engr. Asim Kumar Pal informed us about the method of winding resistance test. He told us that this test measures the resistance of the High Voltage & Low Voltage winding. The values of resistance must be balance for all three phases and should match the designed values. The Digital Resistance Meter is used in this test. The circuit diagram for winding resistance test is given below.

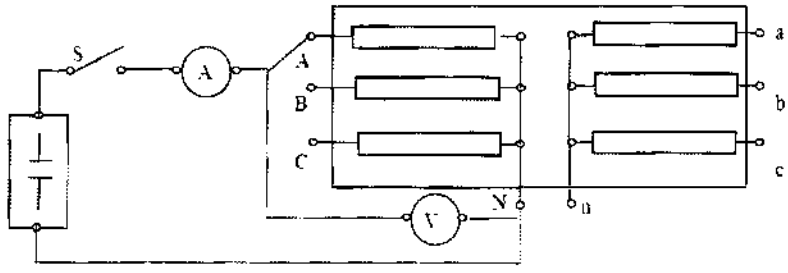

Fig 15: Circuit Diagram of Winding Resistance Measurement.

5.2. Measurement of Insulation Resistance Test:

fter knowing about winding resistance test Engr. Asim Kumar Pal told us about insulation sistance test. He informed us that this test is a measure of quality of insulation used in the ınsformer. It is also known as the Meggar test. He said that insulation resistance can vary due moisture content, cleanliness and the temperature of the insulation parts. All measurements are ırrected to 20° C for comparison purposes. It is recommended that tank and core are always ounded when this test is performed. All windings are short-circuited at the bushing terminals. ɛsistances are then measured between each winding and all other windings and ground. ɛsistances are measured using the Megger; that is why this test is known as Megger Test.

5.3 Measurement of Voltage Ratio and Check of Vector Relationship:

he voltage ratio or the turn ratio of the transformer is determined at no-load condition. This easurement contains the verification of no-load voltage ratios specified by the specification and ɛtection of any problem within the coils or tapping connections. Measurements are carried out ı all taps and on all phases. This test was explained to us by Engr. Asim Kumar Pal.

oltage ratio measurement is generally done with volt-meters. Circuit connection for easurement is shown in Fig-15. For three-phase transformers three-phase AC supply and for ngle-phase transformers single-phase AC supply is applied to the High Voltage side of the ansformer. For measuring input & output voltage the voltmeter is connected to both the High oltage & Low Voltage side. Using the voltage at High Voltage side and inducted voltage on ow Voltage side, voltage ratio is calculated: Voltage Ratio = $\left(\frac{V_{HT}}{V_{LT}}\right)$

Fig 16: Measuring Circuit Connection Diagram.

5.4. No Load Loss Test:

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

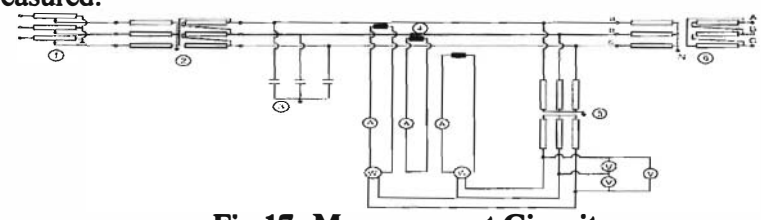

Fig 17: Measurement Circuit.

2.6. Type Test and Special Test:

Type Tests and Special Tests are carried out only on one transformer of a lot. These types of tests are performed at Independent International Labs. Engr. Asim Kumar Pal explained to us only one special test tests that are done in ENERGYPAC which are the Lightning impulse test.

2.6.1. Lightning Impulse Test:

Lightning is one of the unique tests of transformer in ENERGYPAC. No other company in Bangladesh has the facilities to do this job.

The purpose of impulse Voltage test is to confirm that the transformer insulation's can 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

This test uses very high voltages. A randomly selected transformer is used for this test. A huge vibration occurs during the test and therefore the life time of the tested transformer is reduced.

Fig 18: Impulse Voltage Test System. [6]

3. SWITCHGEAR

3.1. Introduction:

In the period of our internship, we expend 3 days (06/01/11-09/01/11) in switchgear section at ENERGYPAC ENGINEERING LTD. Engr. Mahbub Hasan of ENERGYPAC ENGINEERING LTD showed us this section. At first he helped us to be acknowledged with a fundamental idea about switchgear and to summarize. Having learned the basic concepts of switchgears, we observed how ENERGYPAC ENGINEERING LTD runs the switchgear section. He said that it is actually the combination of electrical disconnects, fuses and circuit breakers which is used to isolate electrical equipment. Switchgear is used for normal routing switching, controlling, monitoring and automatic switching during abnormal and faulty operating conditions such as short circuits, under voltage and overloads.

3.2. Switchgear:

Switchgear is a large switch used to turn on or cut off the power in various parts of an electricity distribution network. They use switchgear to isolate a fault in the network to minimize the effects of interruptions. Once a fault has been repaired, the switchgear is operated to turn the power back on. The term switchgear, used in association with the electric power system, or grid, refers to the combination of electrical disconnects, fuses. Switchgear is a general term covering a wide range of equipment concerned with switching and protection.

3.2.1. Switchgear Product:

The switchgear section of ENERGYPAC ENGINEERING LTD makes the following:

- ✓ Low Tension(LT) metering panel
- ✓ Power factor improvement plant (PFI)
- ✓ Control metering and Relay panel
- ✓ High Tension (HT) metering panel
- ✓ Load Break Switch

3.3. Low Tension (LT) Metering Panel:

Firstly, we observed the low tension metering Panel. ENERGYPAC ENGINEERING LTD manufactures low voltage switchgear which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 440V.

Fig 19: LT Metering Panel. [7]

3.3.1. Operating Mechanism of LT:

The panel includes 3 CT for current measuring purpose, 3 ammeters and 1 voltmeter for monitoring the current. Since the ammeters cannot measure a current more than 5A, they are connected from the bus bar through a CT. But the voltmeter is directly connected to the bus bar since the internal resistance of the voltmeter is very high. If a fault like over-current, over-voltage, earth-fault occurs, the MCB trips initially and the MCCB trips after that. But if the fault occur at the bus bar then only the MCCB trips, which disconnects the whole system. If a fault occurs at any phase the whole phase will disconnect instantly. In the LT panel, there are some lamps which indicate the panel on/off, trip signal etc.

3.3.2. Application of LT:

- ✓ power station
- ✓ industrial enterprise
- ✓ Commercial/Residential Buildings for power distribution
- ✓ It can be used to control, protect and inspect the circuit.

3.3.3. The Fundamental Apparatus of LT:

- ✓ Molded Case Circuit Breaker (MCCB)
- ✓ Miniature Circuit Breaker(MCB)
- ✓ Triple pole
- ✓ Double Pole
- ✓ Single Pole
- ✓ Bus-bar
- ✓ Ring CT
- ✓ Ammeter
- ✓ Voltmeter
- ✓ Indicator lamps

3.4. High Tension Metering Panel:

On the 2nd day in switchgear section Engr. Mahbub Hasan acknowledged us about the high tension metering panel. He said that ENERGYPAC ENGINEERING LTD manufactures high voltage switchgear which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 230KV. The design meets with the standard of IEC.

Fig 20: HT Panel. [7]

3.4.1. Operating Mechanism of HT:

The panel includes 3 CT for current measuring purpose and 3 PT for voltage measuring purpose, 3 ammeters and 1 voltmeter for monitoring the current and voltage value respectively. Since the ammeters cannot measure a current more than 5A, they are connected from the bus bar through a CT and the voltmeter is also connected to bus-bar through PT because voltmeter cannot measure voltage in Kilo Volt range. When any kind of fault occurs, initially the relay senses the fault and then send trip signal to VCB; then the VCB trips and the whole system will be disconnected. If a fault occurs at any phase the whole phase will disconnect instantly. In the LT panel, there are some lamps which indicate the panel on/off, trip signal, spring charge lamp.

3.4.2. The Fundamental Apparatus of HT:

- ✓ Vacuum Circuit Breaker (VCB)
- ✓ Relay
- ✓ Bus-bar
- ✓ Ring CT
- ✓ Potential Transformer
- ✓ Ammeter
- ✓ Voltmeter

3.5. Power Factor Improvement Plant:

After discussion of HT panel Engr. Mahbub Hasan told us fundamental idea about PFI and then introduce the power factor improvement plant. He said that ENERGYPAC manufacture power factor improvement plant for improving the degraded Power Factor of the system. Power Factor of the system is degraded due to inductive load of different industries and big apartments.

Fig 21: PFI Plant. [7]

3.5.1. Technical Information of PFI:

We got some of the technical information of this panel from associated engineer and also our own observations. These are given below

- ✓ Modular Design of panel
- ✓ Compact Arrangement of necessary equipment and wire.
- ✓ Dimension of Panel size is 600x600x1700 mm (single unit)
- ✓ Microprocessor based PFC (Power Factor Correction) relay up to 16 stages.
- ✓ Capacitor ratings (2.5, 5, 10, 20, 25, and 50 KVAR.... etc).
- ✓ For suitable stepping of capacitor bank magnetic contactor is used

3.5.2. Operating Mechanism of PFI:

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

3.5.3. The Fundamental Apparatus of PFI:

- ✓ Power factor correction relay
- ✓ H.R.C fuse
- ✓ Magnetic Contactor
- ✓ Capacitor bank from Cali-lab company
- ✓ Ammeter, Voltmeter ,Wattmeter

3.6. Control, Metering and Relay Panels:

On the 3rd day in switchgear section Engr. Mahbub Hasan acknowledged us about the control, metering and relay panels. He said that control, metering and relay panels make easy centralized control of the related controlled equipment in power stations, switching stations and industrial plant. ENERGYPAC designed of control; metering & relay panels are based on the concept of unit assembly from standard parts.

Fig 22: Control Relay Panel. [7]

3.6.1. Technical Information of Control, Metering and Relay Panels:

At first when we observed the Control and Relay panel it looked very complicated as the panel was equipped with a lot of equipments. But associated engineer help us understand its construction and connections. Some of the technical information is given below.

- ✓ Simplex & duplex pattern of the panel
- ✓ Standard dimension panel of height 2350mm, Width 400mm to 900mm and depth 500mm to 1200mm.
- ✓ Enclosure equipped with interior lamp
- ✓ Anti condensation facilities
- ✓ Separate bus bar and cable chambers.
- ✓ Sufficient space for incoming and outgoing cables.
- ✓ Fabricated with 2/2.5/3mm CRCA sheet steel.

3.6.2. Metering Instruments:

- ✓ Ammeter
- ✓ Voltmeter
- ✓ KW meter/KVAR meter
- ✓ Energy meter
- ✓ Frequency meter
- ✓ Power factor meter

3.6.3. Major Components of Control Relay Panel:

- ✓ Metering
- ✓ Window alarm fascia
- ✓ Mimic diagram and control
- ✓ Protection relay

3.6.4. Application of Control, Metering and Relay Panels:

- ✓ To increase energy efficiency
- ✓ It is used for controlling the equipments in the power station, industrial plant and switching station.
- ✓ It is also used for over current and earth fault protection

3.7. Load Break Switch:

Before end of the switchgear section Engr. Mahbub Hasan discussed with us load break switch. He said that ENERGYPAC ENGINEERING LTD manufactures 11KV indoor type load break switch. Load-break switches are required to maintain the capability of interrupting the load current. The main load break switch mechanism is available for 630A & the over current protection scheme is done through HRC fuse.

Fig 23: Load Break Switch. [7]

3.7.1. Construction:

The panel comprises 3 numbers of current transformers & 2/3 numbers of potential transformer which is used to measure system current & voltage respectively & 3 numbers of HRC fuses is used as a protection from overload. The scheme is designed in such a way that in case of any failure in any phase it will instantly isolate the whole three phases from the system. It also includes 3 numbers of ampere meters & one number of voltmeter including selector switch which monitors system current & voltage. The regular panel size is 900x900x1800 mm & weight is around 450 kg.

3.7.2. The Fundamental Apparatus of LBS:

- ✓ HRC fuse
- ✓ Current Transformer (CT)
- ✓ Potential Transformer(PT)
- ✓ Earthing switch

3.7.3. Application of LBS:

- ✓ It can be used for arc quenching by puffer action.
- ✓ It is also used for over current protection.

3.8. Connection System:

When the switchgear panel was introduced, we were confused about the connection of the equipment to the panel. We told Engr. Mahbub Hasan about our confusion and his discussion is described below:

A connection will establish from the transformer to the incoming panel of the circuit breaker which then connect with the bus bar of the switchgear panel. A Current Transformer (CT) is used to reduce for protection and measuring. The rating of the CT is 5A and it is connected to the bus bar. A fuse is used to protect the ammeter from getting damaged by any current in excess of 5A. The fuse will cut off if a high current flows. An ER Voltmeter is connected to the bus bar via a connecting panel for observing the phase voltage. Finally a connection is made from the switchgear panel bus bar to the outgoing panel of the circuit breaker from which the other end of the transformer is connected

3.9. Important Apparatus Used In Switchgear:

Engr. Mahbub Hasan described to us about some necessary equipments which are required in switchgear section. Among them we discuss about some of the equipments in the following section.

3.9.1. IDMT Relay:

During observation period of switchgear panel we saw IDMT relay being used almost in all panels. So the question was why was IDMT relay is so necessary. We asked our guided engineer what is IDMT relay? He said that IDMT relay means inverse definite minimum time relay. In IDMT relay its operating is inversely proportional to fault current and also a characteristic of minimum time after which this relay definitely operates. That means when fault current increases then operating time decreases.

3.9.2. Over Current and Earth Fault Relay:

Another relay that we observed in switchgear section was over current and earth fault relay. An "over current relay" is a type of protective relay which operates when the load current exceeds a preset value. In a typical application the over current relay is connected to a current transformer and calibrated to operate at or above a specific current level. When the relay operates, one or more contacts will operate and energize to trip (open) a circuit breaker. Earth fault protection can be provided with normal over current relays, if the minimum earth fault current is sufficient in magnitude.

Fig 24: Over Current and Earth Fault Protection Relay. [7]

3.9.3. HRC Fuse:

Other important equipment that we observed in switchgear section was High Rupturing Capacity Cartridge Fuse which is used for overload and short circuit protection. In electrical system fuse acts as protection device and depending on application different type of fuse is to select. Out of these different type of fuses HRC is also one of the type. This type of fuses normally used where some delay is acceptable for protecting the system.

Fig 25: HRC Fuse. [7]

3.9.4. Magnetic Contactor:

It was found that ENERGYPAC ENGINEERING LTD uses magnetic contactor which is manufactured by ABB.A magnetic contactor is just a switch. The magnetic contactor is a switch that is activated by the magnet. When current passes through the coil, it energizes and the piece of metal becomes a magnet which in turn attracts the contacts point and pulls the contacts together, allowing current to pass through.

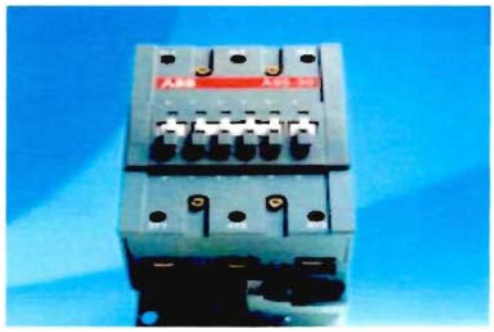

Fig 26: Magnetic Contactor. [7]

3.9.5. Capacitor Bank:

A capacitor bank is a grouping of several identical interconnected in parallel or in series with one another. The banks usually consist of a number of identical components. If the components are not identical, it is usually more difficult to calculate the rating of the combination of components and more difficult to achieve the desired result.

Parallel connected capacitors provide increased capacitance, increased stored energy and increased ripple current capacity for dc applications. For AC applications the KVAR and current ratings are increased. Series connected capacitors provide an increased voltage rating but reduced capacitance value.

Fig 27: Capacitor Bank. [7]

3.10. Testing for Switchgear:

Engr. Mahbub Hasan informed that the following tests are done at ENERGYPAC for switchgear

- ✓ MCCB/ ACB performance Test
- ✓ Insulation Resistance Test
- ✓ Performance Test
- ✓ Wiring Test
- ✓ Vacuum circuit Breaker Test
- ✓ Load Break Performance Test
- ✓ IDMT Relay Test
- ✓ CT & PT Test
- ✓ Ammeter and Voltmeter performance Test
- ✓ Magnetic Contactor Performance Test
- ✓ Relay Operating Test
- ✓ Fuse Test

However some tests are done for observing the associated equipment performance. Such a type is discussed below:

3.10.1.Timing Test:

A test is done to observe the relay performance in the switchgear panel. When a fault occurs, the relay has to trip in 30ms. If it cannot trip in 30ms, then it cannot send the signal to the circuit breaker to trip and thus the fault cannot be properly dealt. So a fault is introduced in this test to check whether the relay respond in time or not.

3.10.2 Contact Resistance Test:

This test mainly involves observing the loss of resistance. During the movement of the contactor of the circuit breaker from incoming bus bar to outgoing bus bar, if the resistance loss is high then the contactor malfunctioned. If the contactor is not maintained properly, carbon may build up due to repeated operation which reduces the ability of the contactor. So to maintain proper contact mechanism it is required to keep low of contact resistance in order to reduce power losses.

3.10.3. Insulation Test:

This test is necessary for observing the insulation condition, which is strongly recommended to prevent electrical shocks. The equipments needed for this testing is a Megohmmeter with a timed test function and temperature indicator. During the test the first thing to be measured is a capacitance and then after 1 minute of absorption, current will be measured and at last after 10 minutes leakage current reading will be noted.

4. CIRCUIT BREAKER

4.1. Introduction:

In the period of our internship, we expend one day (10/01/11) in circuit breaker section at ENERGYPAC Engineering Limited. Engr. Arif Islam of ENERGYPAC ENGINEERING LTD showed us this section. He said that a circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. The circuit breaker must detect a fault condition. He said that the ENERGYPAC made only vacuumed circuit breaker and other Circuit Breaker they buy from abroad.

4.2. Vacuum Circuit Breaker (VCB):

ENERGYPAC is the first and only company where vacuum circuit breaker is manufactured in Bangladesh. In a vacuum circuit breaker, two electrical contacts are enclosed in a vacuum. One of the contacts is fixed, and the other contact 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.

ENERGYPAC manufactures two types of vacuum circuit breakers:

a) Indoor type vacuum circuit breaker.
b) Outdoor type vacuum circuit breakers.

4.2.1. Main parts of The VCB:

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

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

4.3. Indoor Type Vacuum Circuit Breaker:

ENERGYPAC is the first and only company in Bangladesh to introduce horizontal isol horizontal draw out type vacuum circuit breaker in the country way back in 1998.

Fig 28: Indoor Type VCB. [7]

4.3.1. Brand Feature of Indoor Type VCB:

The special features of this equipment are following:

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

4.3.2. Operating Principle:

The operating principle of vacuum circuit breaker was described to us by Engr. Arif Islam. learnt that for operating the circuit breaker in a very short time, Mechanism M-37 is provided al with the conventional design. The machine is charged by a motor at first. When charged, closing spring is held by a latch which can be released either by manual means or by a solenoi close the circuit breaker. To open the spring, the required energy is provided by a spring in drive assembly which is compressed during the closing stroke. The closing mechanism inclu Breaker on/off and spring charged or discharged indications

3.3. Key Features:

- ✓ Long maintenance free operation
- ✓ Fully metal clad design
- ✓ Horizontal isolation
- ✓ Bus bar system fully insulated
- ✓ Manual or motor charged main closing mechanism
- ✓ Fully rated with switches
- ✓ Complete set of interlocks and padlocking facilities
- ✓ Isolatable voltage transformer
- ✓ Ample current transformer accommodation
- ✓ Extensive use in tropical environments
- ✓ Safety interlocks

3.4. Technical Information of Indoor Type VCB:

he characteristics of the indoor VCB interrupter are known by the following tables.

Technical Particulars	11KV	33kV
Applicable standard	IEC 60056	IEC60056
Type Designation	HHV-12	HHV-36
Normal Voltage	11kV	33kV
Rated Voltage	12kV	36 KV
Frequency	50 Hz	50 Hz
Normal rated current	630/1250/1600/2000 Amps	1250/1600/2000 Amps
Short circuit breaking capacity	20kA/25kA/31.5kA	25kA
Withstand Voltage	28 kV rms	75 kV rms
Rated impulse withstand voltage	75 kV Peak	170 kV Peak

Table 1: Technical Information Of Indoor Type VCB. [7]

4.3.5. Application:

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

4.4. Outdoor Type Vacuum Circuit Breaker:

After discussion of indoor type vacuum circuit breaker Engr. Arif Islam told us fundamental idea about outdoor type vacuum circuit breaker. With further innovative skills, ENERGYPAC made the circuit breaker to meet highly demanding needs for performance from all sections of people like consultants, contractors, and industries & utilities.

Fig 29: Outdoor Type VCB. [7]

4.4.1. Brand Feature of Outdoor Type VCB:

The special features of this equipment are following:

- ✓ Compact design
- ✓ Low operational load
- ✓ Low maintenance
- ✓ Minimum fire hazard
- ✓ Low noise level
- ✓ Extended life

4.4.2. Technical Information of Outdoor Type VCB:

The characteristics of the outdoor VCB interrupter are known by the following tables.

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

Table 2: Technical Information of Outdoor VCB. [7]

5. ISOLATOR

. Introduction:

the period of our internship, we expend one day (11/01/11) in isolator section at ERGYPAC LTD. Engr. Belal Hossain showed us this section. He was also very friendly h us. He is a mechanical engineer because this section is related to mechanical engineering. first he helped us to be acknowledged with a fundamental idea about isolator. He said that main purpose of isolator is to disconnect the circuit at no load condition.

. Main Assemblies of Disconnector:

rst he introduced us to disconnector main assemblies, which are given below.

- ✓ The main current carrying parts called 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.

. Rating of Isolator:

gr. Belal Hossain said that we follow different type of rating for these isolator. Such as the ed voltage is 12-245KV, rated normal current is up to 3150Amps and short time current ng up to 50 kA. The isolators are designed to meet the requirement laid down by IEC 129 ANSI 37.30. The isolators consist of separate poles which can be arranged for single pole ration or linked together by operating rods to form 2 or 3 pole units. For all sizes up to 245 , the base frame is of welded design and has minimum four fixing holes.

. Type of Isolator:

ERGYPAC ENGINEERING LTD manufactures outdoor off load Isolators. They made ee types of outdoor off load isolators,

a) Pantograph isolator

b) Double break isolator

c) Center break isolator

.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.

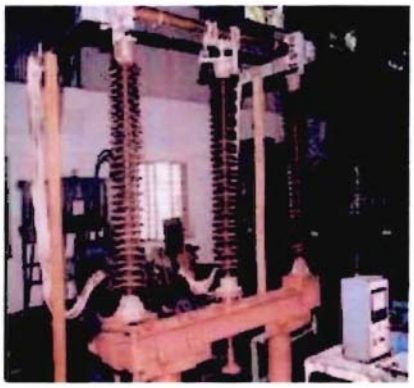

Fig 30: Pantograph Isolator. [7]

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

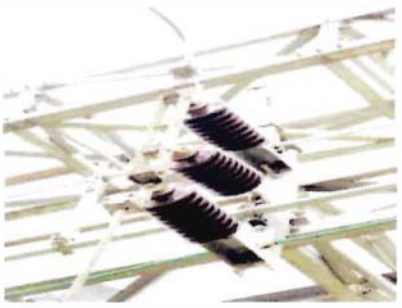

Fig 31: Centre Break Isolator. [7]

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

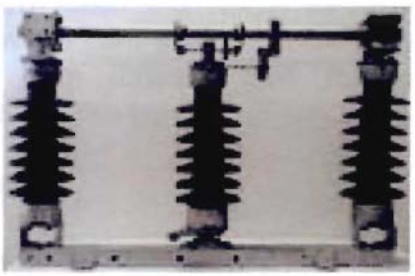

Fig 32: Double Break Isolator. [7]

Test For Isolator:

r. Belal Hossain informed that the following tests are done at ENERGYPAC for isolator . idn't show us the tests. These are

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

6. INSTRUMENT TRANSFORMER

troduction:

period of our internship, we expend one day (04/01/11) in instrument transformer section ERGYPAC LTD. Engr. MD. Ataul Goni Osmani showed us section. Engr. MD. Ataul Osmani is very helpful person and he took great care of us. He gives us some important ıation about CT and PT. He said that ENERGYPAC is the only manufacturer of ment transformers in Bangladesh. Their Instrument Transformers are manufactured in dance with latest IEC/ANSI standards. We are very grateful to him for the time he spent s.

ıstrument Transformer:

ansformers which are used in conjunction with measuring instruments, protective relay ontrol circuits are called instrument transformer. Instrument transformers include ring and protective current transformers and voltage transformer. The design and use of transformers is quite different from that of well known power transformers. GYPAC manufactures two types of CT and PT such as indoor type and outdoor type.

ırrent Transformer:

, we observed the current transformer (CT). Instrument transformers which are used in ıction with ammeters, over current relays etc are called current transformer (CT). CT down current from high value to a low value. Their current ratio is substantially constant ven range of primary current and phase angle error is within specified limits. The VA of current transformers is small as compared with that of a power transformer. He also about oil cooled/cast resin CT with ranges from 11 kV to 230 kV. ENERGYPAC also outdoor/indoor type current transformer.

Fig 33: Current Transformer. [7]

3.1. Basic Functions of Current Transformer:

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

3.2. Manufacture:

NERGYPAC manufactures two types of CT

- ✓ Live tank.
- ✓ Dead tank

4. Potential Transformer:

fter the CT he told us about potential transformers. Direct measurement of voltage in high oltage system is not possible because of insulation problem of measuring instruments. otential transformers are used to step-down the high system voltage to low standard value curately in proportion to their ratio. Potential transformers are used for measurement and otection. It is either measuring type or protective type. PT may be single phase or three phase its. PT is necessary for voltage, directional, distance protection. The primary side of PT is nnected to power circuit between phase and ground. The VA rating of PT is smaller as mpared with that of power transformer.

Fig 34: Potential Transformer. [7]

Basic Functions of Potential Transformers:

To reduce the line voltage to a value which is suitable for standard measuring instruments, relays, etc.

To isolate the measuring instruments, meters, relays, etc. from high voltage side of an installation.

To sense abnormalities in voltage and give voltage signals to protective relays to isolate the defective system.

Manufacture:

phase electromagnetic PT is manufactured in two types:

Single Pole (between lines & earth)

Double Pole (between line-to-line)

ssential Element of Instrument Transformer:

MD. Ataul Goni Osmani said there are some essential elements necessary for the making rument transformers. These are core, coil, insulation, class of accuracy, bushing, oil etc.

Core:

The core is made of high permeability CRGO (core role 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.

Toroidal cores from continuous strips are made there and annealed in controlled atmosphere to achieve best quality secondary cores.

Coil:

The most usable coil is of the super enamel type.

The coil making process is manual.

.5.3. Insulation:

- ✓ The insulation saves transformers from short circuit, fire and transformer explosions.
- ✓ High quality crepe insulating paper is used to build up main insulation of the CT.
- ✓ Main insulation is build up on the primary winding (paper condenser is formed on the pipe) with fine grading of insulation.
- ✓ Varnished fiber glass sleeve is provided as an additional insulation on this conductor.
- ✓ Craft paper is also used for insulation.

.5.4. Bushing:

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

6.5.5. Oil:

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

.5.6. Class of Accuracy:

- ✓ Accuracy is very important for manufacturing.
- ✓ Two reasons for increasing the accuracy of transformer. One is for metering and the other is for protection.
- ✓ For metering, the accuracy points are 0.1, 0.2, and 0.5.
- ✓ On the other hand for protection they follow 5p10, 5p15, and 5p20. (5p10 means class 5, p is protection and 10 is accuracy limit).

Test for Instrument Transformer:

r. MD. Ataul Goni Osmani informed that the following tests are done at ENERGYPAC for ument transformers. But he didn't show us the tests. These are

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

7. FABRICATION PROCESS

the period of our internship we spent one day (05-01-11) at fabrication section. Engr. Jewel ısan was the in charge of this section and he helped us to get acquainted with the work of this ːtion. He said that at first they powder coded the steel path. After powder coding, the steel rt was dipped in the acid tank. Then it is dropped in a rinse tank which was filled with normal ıter. Then the part is put into the drastic tank. Again the path is put into normal water, and ːn it is dropped into a phosphate tank. At last it was sent to a dry-off oven. Powder spray is ne in dry- off oven. The spray process is done electrically. Generally they spray the Berger wder. The temperature of the dry-off oven must be at 180 degree Celsius. He said for mpleting whole process they need 13 to 15 minutes.

.1 Sandblasting Process:

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

.2. Coloring Assembly:

ıis important section is needed to reduce corrosion. For completing the coloring of ınsformer they follow the below process

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

achine Shop:

end Engr. Jewel Hasan showed us the machine shop of ENERGYPAC. We saw various f machine at this machine shop. Each machine has different name and different working ıles. Generally they used Lathe machine, Milling machine, Shaper machine, Chaser ıe, Drill machine, Surface grinding machine and last is Power Saw machine. Some of the ıes are described below.

the machine: A lathe machine works by rotating the work piece on its own axis to ·form various operations like cutting, sanding, etc. Generally for cutting the shaft or steel l this machine is used. By using this machine they can easily cut the shaft in appropriate e. (Such a machine is shown in Fig 34)

Fig 35: Lathe Machine. [8]

ERGYPAC 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

lling machine: Slot and keyway cutting, planning, drilling etc such type various operation done by milling machine. Engr. Jewel Hasan said Milling machines are of two basic ms, one is horizontal and other is vertical. (A milling is shown in Fig 35)

Fig 36: Milling Machine. [9]

ding to the engineer the Milling machine is used for following purposes.

For making gear on the shaft

To make key way on the outside of the shaft

Shaper machine: A shaper machine worked by using linear relative motion between the work piece and a single-point cutting tool. Engr. Jewel said its cut is analogous to that of a lathe, except that it is linear instead of helical. (Shaper machine is shown in Fig 36). He said Shaper machine is used for following purpose.

- ✓ To make key way on the inside of the shaft

Fig 37: Shaper Machine. [9]

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. (Chaser machine shown in Fig 37).

Fig 381 : Chaser Machine. [10]

said Chaser machine is used for following purposes.

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

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. (shown in Fig 38)

Fig39: Drill Machine. [11]

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

ce grinding machine: A surface machine is a tool that smoothes the surface of various ·ials. (Shown in Fig 39).

he chaser machine is used for smoothing job surface

Fig 40: Surface Grinding Machine. [12]

Machine:

wel Hasan helped us to know about the CNC machine. He told us that CNC means numerical control. It is operated electrically. Also he gave us following assembly on about the CNC machine.

Third generation scream manufacturing and fabrication

It has hydraulic punch and capacity is 30 ton

Sheet thickness can be punch 1.6 mm to 6mm

ogram Load Procedure:

d to give us basic idea about CNC machine and about its working principle. He said this machine is used for making the hole on the steel plate. For this purpose machine has to ber the size of the hole and measure distance between holes etc. As a result machine a program which is set by engineers on the computer before running the machine. le of this machine is shown in figure 53, which shows a cutting point view.

Fig 41 : CNC Machine (Cutting Point View). [12]

portant part of the machine is the computer where the software is installed. To operate chine they need two rooms where one is for CNC machine and other is for computer. nside the room where computer is, an engineer operates the machine. For running this e they need to turn on memory by pressing memory button. Then they have to press n soft key for running the program. Then they press Dir key for understanding the on of the steel path. After completing the procedure they have to type file number and ve to press OSRH key to give input for running the machine. The last key is start key if es then the machine starts working. According to his given information program running s of CNC is given below:

Press memory on main control panel
↓
Press program soft key
↓
Press Dir soft
↓
Type file number & press OSRH
↓
Press start button

7. CONCLUSION

ical and Electronic Engineering Department of East West University ENERGYPAC considered as a very good place to gain practical knowledge. We are grateful that we portunity to see the practical work at ENERGYPAC which we learned theoretically University. High level R & D, state of the art production facility, quality products, services, and countrywide operations have made ENERGYPAC an internationally ompany. We are very pleased that we got the opportunity to do our internship in a like ENERGYPAC. It gave us an opportunity to apply our theoretical knowledge in t gave us confidence to face the interview in future. ENRGYPAC provide us the y to introduce with the manufacturing process of various sub-station equipments like er, Switchgear, Current Transformer, Potential Transformer, Breaker and Isolator.

PAC is the leading company in Bangladesh. Its strategic aim is to strengthen the sition and to ensure continued growth which leads it to be the leading manufacturing or leading power engineering company in Bangladesh and start to introduce them not ngladesh but also all over the world.

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