INTERNSHIP REPORT

ON

MANUFACTURING PROCESS OF SUBSTATIONAL EQUIPMENTS AT ENERGYPAC ENGINEERING LTD

By

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&

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Submitted to

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

In partial fulfillment of the requirements
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CERTIFICATE OF COMPLETION

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EELF/Admin/EWU/TR/2011-02 (01)
Date: 13th Feb'2011

TRAINING CERTIFICATE

This is to certify that **Md. Mahmudur Rahman Sheikh Rony**, Bearing Roll No. 2006-2-80-017, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. He was attended an Industrial Practice, which was programmed from 27th Dec'2010 to 6th 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.

14/02/11

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

First ISO 9001:2008 & 14001:2004 Power Engineering Company in Bangladesh

See us at : www.energypac-bd.com

ENERGYPAC ENGINEERING LTD.

WORKS : BARUIPARA, SAVAR, DHAKA

ENERGYPAC
এনার্জিপ্যাক

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Date 13th Feb 2011

TRAINING CERTIFICATE

This is to certify that **Md. Mahbub Uzzaman,** Bearing Roll No. 2006-3-80-016, a Student of Electrical and Electronic Engineering Department of East West University of Bangladesh. He was attended an Industrial Practice, which was programmed from 27th Dec'2010 to 6th Jan'2011 at Energypac Engineering Ltd, Barulpara, 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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ACKNOWLEDGMENT

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

At the very beginning, we will mention the name of our internship academic supervisor Dr. Khairul Alam and Tahseen Kamal . We feel lucky and honored to get the chance of completion our project under the supervision of them.

We spent two weeks there in the factory from 27.12.10 to 06.01.11. We started our work at 10.00AM in the morning and ended at 5.00PM. It was an exciting as well educative memory for us. What we read in the book that we saw practically in the factory. It was a wonderful experience. The work environment was excellent and we received outstanding cooperation from all concerned officials of EP. Specifically we want to mention the name of Engr. Moniruzzaman, Manager for his support and guidance during the time of industrial training.

We would like to thank to Mr.Enamul H Chowdhury Managing Director, EnergyPac engineering Ltd. We thank Mr. Monirul Huda, Sr. Engineer (Breaker & Quality control) EnergyPac engineering Ltd. We were worked under his supervision. We would like to thank Engr.Md. Asaduzzaman, Deputy General Manager, EnergyPac engineering Ltd., and Mr. Asif. Senior engineer, EnergyPac engineering Ltd. for give time to discuss about transformer, Switchgear and Breaker. We also would like to thank to all the respected officers and employees of EnergyPac engineering Ltd., for their support.

Special thanks to Dr. Anisul Haque, Chairperson, Dept. of Electrical and Electronic Engineering, East West University for his guidelines, support and care. We are also very grateful to all of our teachers for their encouragement and cooperation throughout our Internship and academic life.

As There three groups in the EnergyPac limited to complete their internship including our group, so there will be some similarities in our internship reports. As we work together as a team there.

Last but not the least, we wish to express our appreciation to our parents for their encouragement and patience.

EXECUTIVE SUMMARY

In this report we discussed about our observations at the factory of EnergyPac Engineering Ltd. EnegyPac mainly produces substational equipments, which are basically four types. These types are: Breaker & Isolator, Instrument transformer (CT/PT), Transformer (Power & Distribution), Switchgear. we have also visited some supporting sections, these are: Fabrications, CNC, Powder coating & paint and M/C shop.

Breakers and Isolators are used for tripping the system. EnergyPac manufactures only Vacuum circuit breaker (VCB). The name of a breaker is determined by the medium in which the arc is extinguished. By using the vacuum interrupter VCB is produced. When the breaker is tripped, for high voltage arc is created. But as the medium is vacuum so the arc is extinguished. EnergyPac manufactures three types of Isolators. These types are pantograph, centre break and double break.

In the transformer section we discussed our observations in the power & distribution transformer section. A transformer is a device that can transfer energy from one circuit to another by electromagnetic induction. Basically the main part of transformer is core and coil. In this section we discussed about the selection and formation of core and coil, assembly of core and coil, protections and tests of transformer.

In the switchgear section of the report we discussed our observations in the switchgear section of EnergyPac. Switchgear is used for protection and controlling of a system. EnegyPac manufactures two types of switchgears, one is LT switchgear and the other one is HT switchgear. In LT switchgear, relay senses the over current and sends trip signal to breaker. Then the beaker is tripped. If the power factor (PF) is decreased, then power factor improvement (PFI) capacitors are added to the load to improve PF of the system. In HT switchgear, microprocessor based relay senses all things and if fault occurs it sends a signal to general relay. Relay sends trip signal to VCB. Then the VCB is tripped.

There are two types of instrument transformers, current transformer (CT) and potential transformer (PT). The manufacturing process is almost same. The raw material of core is cold rolled grain oriented (CRGO) silicon steel and the raw material of coil is copper enameled wire. After the assembly the core and coil, these are tanked up. For insulation process of the system insulation paper, oil and varnish is used. This CT and PT are used for measurement.

When we worked on the EnergyPac, we got opportunities to observe the entire manufacturing processes of substational equipments. We tried our best to learn and know everything from the honorable engineers of EnergyPac.

TRAINING SCHEDULE

Table-1: Training schedule

Date	Section	Duration	Contact Person
27.12.10 – 28.12.10	Isolator & Breaker	2 days	Engr. Moniruzzaman , Manager Engr. Ataul Goni, Asst. Engr. Tauhidul Islam , Asst. Engr
29.12.10 – 30.12.10	CT/PT	2 days	Engr. Mozaharul Islam, DGM Assistant Engineer Zahid
01.01.11 – 03.01.11	Transformer & Impulse	3 days	Engr. Asaduzzaman, Ad. GM Engr. Asim Kumar Bhakta,Manager Asif Islam, Asst. Engr.
04.01.11 – 05.01.11	Switchgear	2 days	Engr. Syed Muztaba Ali, DGM Engr. Mahbub
06.01.11	Fabrication, CNC, M/C Shop, Powder Coating & Paint.	1 day	Engr. M.A. Wazed AGM Mr. N.M Habibullah, Dy. Manager Engr. Azimussan Abbasi, Asst.Engr. Engr. Jewel

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter-1

Company Profile

1.1. Company Overview

EnergyPac is one of the leading power engineering companies in Bangladesh. Continual research and development, state of the art production facility, quality products, competent services, and countrywide operations have made it warmly 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 BSC engineers. The relentless efforts and dedication of these people are providing continual help to improve technology and develop new products. They provide pre and post sales services to maintain a long term business relationship with the customers. To meet countrywide demand of its products and services, EnergyPac has extensive distribution network throughout Bangladesh with full-fledged offices in 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. Their product range includes power transformer up to 50 MVA (any rating), 230 kV class, 12 kV-indoor type vacuum circuit breaker (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 and all sorts of substation switches used in rural type substation and distribution system and disconnector switches up to 36 KV Systems.

Vision: The vision of EnergyPac is to become country leader as well as to establish credibility in the international market.

Mission: The mission of EnergyPac is to minimize deficit of the power generation system & to improve the quality of lives of the employees & the community

Strategy: The strategy of EnergyPac is to achieve this mission through best quality products & excellent service.

Board of Directors:

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

Achievements:

- Successful sales of largest B-Engine in Bangladesh which is first in Asia
- Largest market share of power business in the private sector
- Total O & M contract of 9.99 MW Plant
- Guascor genest sales crossed 150 Units
- FG Wilson DEG sales crossed record 2300 Units
- Get the recognition of Central Power Research Institute (CPRI) of India and Bangladesh University of Engineering and Technology (BUET).

1.2. Objective of the internship:

The main objective of internship is to fulfill the partial requirement of EEE program and to get the practical knowledge beside theoretical knowledge. The other objectives are:

- To know the duty and responsibilities of an Engineer in real life job.
- To gather knowledge about the transformer, switchgear and breaker and isolator.
- 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.
- To earn working experience in the company/factory environment.

1.3. Scope and Methodology

Scope:

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

Methodology:

This report has been prepared on the basis of:

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

Chapter-2

Breaker

2.1. **Introduction:**

We went to EnergyPac on 27th December as it was our first day of internship training. We reached there at 8.45 am. Then we were taken to Engineer Monirul Haque Huda who was our supervisor for the training. He gave us the training schedule of our overall internship. The first day according to our schedule was in the transformer section but as the engineers of that section was busy for the shipments we were taken to the breaker section. In the breaker section Assistant Engineer Tauhidul Islam instructed us. Before going to the practical work he briefed us about circuit breakers. He told us 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. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset to resume normal operation. There are various types of circuit breakers but he told us that EnergyPac normally manufacture vacuum circuit breakers (VCB) of both indoor and outdoor types.

He also told us that the name of a breaker is determined by the medium in which the arc is extinguished. So when we say vacuum circuit breaker we can understand that in these breakers arc is extinguished in place where there is no medium. He said that in the interrupter of VCB there are two contacts. These contacts are electrical contacts and they are enclosed in a vacuum. One contact is fixed contact and another one is movable contact. When a problem occurs the moveable contact move and breaks the circuit. After some time by auto reclosing mechanism the breakers will reclose. If there are still some problems it will open again. The contacts will reclose and open several times to check whether the problems are removed or not. If not the contacts will be opened up and has to be closed manually. He also told us about the current and voltage ratings of vacuum circuit breakers. He said that, vacuum circuit breakers with rated current up to 3000 A, these breakers interrupt the current by creating and extinguishing the arc in a vacuum container. These are generally applied for voltages up to about 35,000 V, which corresponds roughly to the medium-voltage range of power systems

Out instructor told us that there are no significant differences between outdoor and indoor type VCBs. They both have some common parts such as:

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

After the briefing of our instructor he showed us practically the formation of VCB, the working principle of VCB. We also saw structure and the working mechanism of the vacuum interrupter. We came to know a lot of informations about vacuum circuit breakers.

2.2. Vacuum Circuit Breaker

2.2.1 Introduction:

Vacuum Circuit Breaker is a medium and high voltage circuit breaker. These breakers interrupt the current by creating and extinguishing the arc in the vacuum container. The vacuum circuit breaker is one of the breakers by which the circuit can be 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. Vacuum circuit breakers are generally used in electric power systems having low surge impedances.

Fig 2.1: Indoor and outdoor type VCB

EnergyPac Engineering Limited manufactures following types of Vacuum Circuit Breaker:

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

2.2.2. Working Principle of VCB:

Vacuum Circuit Breaker is very simple in operation and construction. Mechanism is designed for operation of very short stroke required in vacuum interrupter and is normally charged up 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 the other one 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.

If the breaking button is pushed accidently, any problem can be occurred. So there should be some safety systems by which faults can be controlled. We came to know that EnergyPac uses three types of safety process in VCB. These are:

- Mechanical lock.
- Electrical lock.
- Socket.

Mechanical lock: It is the locking system of the machine or device. If the system is mechanically locked, the device cannot be operated.

Electrical lock: It is the locking system of the Breaker part. If the system is electrically locked, the Breaker part cannot be operated.

Socket: Socket is used to on/off the Breakers. If the socket is not connected the breaker remains shut off.

2.2.3. Indoor Vacuum Circuit Breaker, up to 33KV:

After learning the operating principle and basics of VCB we went to see the structure, operating systems, and safety measures of VCB practically. At first we saw the Indoor Vacuum Circuit Breaker. EnergyPac manufactures Indoor Vacuum Circuit Breaker normally up to 33 kV. The figure of an indoor type VCB is given below:

Fig 2.2: Indoor type VCB

EnergyPac is the first and only company in Bangladesh to introduce horizontal isolated, horizontal draw out type vacuum circuit breaker in the country in 1998. Large numbers of these circuit breakers are in operation in Bangladesh and other parts of the world. The vacuum circuit breaker is designed to meet the requirement laid down by IEC 60056.

EnergyPac indoor type vacuum circuit breaker offers following concepts:

- Customer friendly
- High degree of safety
- High operational reliability
- Strong and compact design
- Simplicity in construction
- Extensible with high degree of customization

2.2.4. Outdoor Vacuum Circuit Breaker, up to 33KV:

We saw outdoor type vacuum circuit breaker at EnergyPac in breaker section. Normally EnergyPac manufactures up to 33KV outdoor type vacuum circuit breaker. We were told by our supervisor that, pioneering passion of EnergyPac created the first outdoor porcelain clad vacuum circuit breaker in the country.

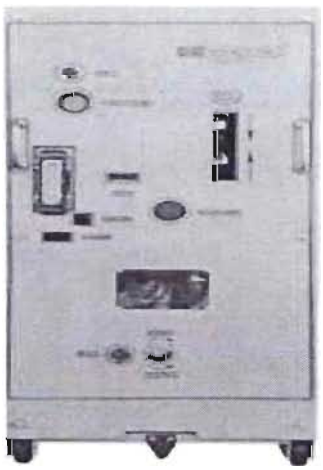

Fig 2.3: Outdoor type VCB

We observed the operating system of a VCB. The circuit is broken when a spring pulls the movable conductor of the vacuum interrupter. It can be done automatically and manually. There is a relay which senses problems in the transmission line. If relay detects any problems, through the VCB it breaks circuit. For auto reclosing the spring is compressed by a motor. We also saw that the VCB is mechanically locked by special key. Without this particular key the VCB cannot be unlocked. For electrically lock mechanism there is a switch inside steel frame of the VCB

2.2.5. Vacuum interrupter:

We asked our supervisor to show us the construction section of vacuum interrupter. Our supervisor told us that, EnergyPac does not manufacture vacuum interrupter. Because the construction of vacuum interrupter is complex, involving carefully selected contact materials and contact geometry. The interrupters are imported from most renowned and the best quality manufacturer of the world, CUTLER-HAMMER (EATON), USA.

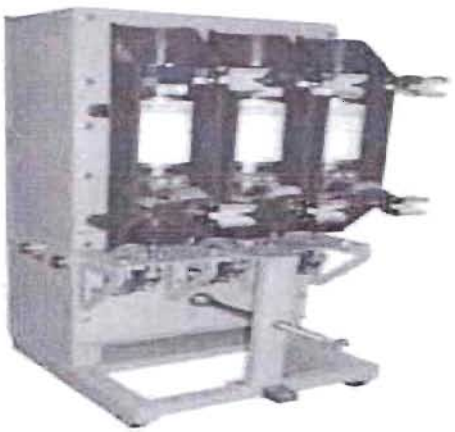

Fig 2.4: Vacuum interrupter external view

Then he showed us a figure which provides internal view of a vacuum interrupter. We saw that 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.

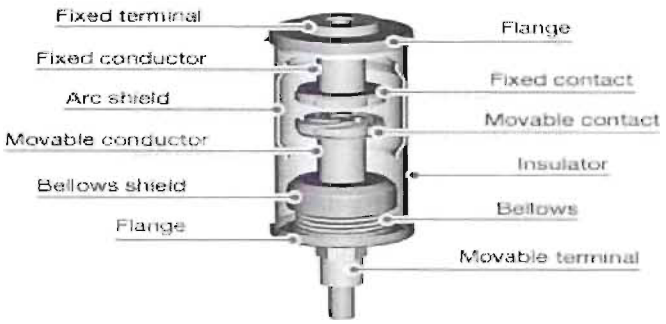

Fig 2.5: Vacuum interrupter internal view

We asked our supervisor why EnergyPac uses VCB instead of other circuit breakers. He told us that VCB is used for some unique characteristics and special features. He told us about those characteristics and features. These are stated below:

2.2.6. Special Characteristics of Vacuum Interrupters:

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

2.2.7. Features of VCB:

- 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

2.2.8. Applications of VCB:

- Power stations
- Transformers
- Industry
- Airport power supply
- Cold storage power supply
- Building power supply

2.2.9. Testing for Breaker:

For testing, EnergyPac follows the standard of International Electrotechnical Commision (IEC), American National Standards Institute (ANSI), CPRI and BUET. EnergyPac has got certificate from the mentioned organizations. EnergyPac follows different types of test for breaker. We did not see any test for breakers. But Engineer Tauhidul Islam briefly discussed about some tests. The tests are as following:

- **Physical test**: At first our supervisor told us about physical test of breakers. He told that, this test is also known as Mechanical Endurance test. He told us that the breaker should be in a position to open and close satisfactorily. In this test the breaker is opened and closed about 1000 times. He told us that this test is done when there is no current and voltage in the main circuit. Out of 1000 operations about 100 operations are made by connecting the main circuit in series with the trip circuit. During repeated operation of circuit breaker, the weaker parts in the assembly may fail. The circuit breaker is then considered unfit for operation.

- **Insulation Resistance test**: Our supervisor told us that this test is used to check the insulation level. This test is also known as Megger test. Insulation resistance is measured by megohm-meter or meggar. In megger there is a megohm-meter and a built in DC generator. The minimum reading is zero and maximum is infinity. The scale is in megohms. He told us that to do this test the two terminals of meggar are connected across the insulation on the conductor and other to earth body. Then the handle of the meggar is rotated by hand or motor. Then the insulation resistance can be seen in the display of meggar.

- **Contact Resistance test**: We came to know that in a circuit breaker, the terminal and interrupting part have 6 to 7 contacts. The contact resistance for this test is 25 to 35μΩ. By this test the contact resistance of terminals and interrupting part are checked. The highest range can be considered up to 65 μΩ. If the contact resistance is more than 65 μΩ then contacts are rebuilt.

- **High voltage test:** Our supervisor told us that high voltage test is done to check if the circuit can handle the lightening. In this test, normally 2.5 times of rated voltage is applied for 1 minute and it is observed that the breaker can sustain the voltage or not. This test is also one kind of insulation test. By this test defective insulation or small creapage are brought to notice. When the breaker ON, then there should be no voltage in the breaker body.

Chapter 3

Isolators

3.1. Introduction:

28th December, 2010 was the second day of our internship training. As we started from breaker section we went to isolator section on that day. Our supervisor was Sub-Assistant Engineer Bulbul Islam. He took us to the isolator section and told us about isolators. He said that, isolator is an off load device which is used for isolating the downstream circuits from upstream circuits for the reason of any maintenance on downstream circuits. It is manually operated and does not contain any solenoid like circuit breaker. He told us that it should be operated at no load. The main objective of using isolator is to isolate one portion of the circuit from the other. Isolators used on both sides of circuit breakers so that the repairs and replacement of circuit breakers can be done in a safe manner.

Fig 3.1: Various types of disconnectors manufactured by EnergyPac

EnergyPac manufactures outdoor offload isolators. The rated voltage is 12-245KV; rated normal current is up to 3150A and short time (150 μs) current rating up to 50 kA for outdoor offload isolators.

Our supervisor told us about some features of isolators that EnergyPac produces. The main features of isolators are:

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

Our supervisor Mr. Bulbul Islam told us that the size of isolators depends on the KV. He told us that the length of isolator should be 25 mm per KV. He also told us isolators are used to make diaconnectors. Disconnectors or isolator switch is used to make sure that an electrical circuit can be completely de-energized for service or maintenance. The disconnectors that EnergyPac manufactures contain the following assemblies:

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

3.2. Disconnectors:

We came to know that EnergyPac manufactures three types of outdoor offload disconnectors. They are:

- Pantograph type
- Centre Break type
- Double Break type

Our supervisor told us about the basics of a disconnector. He said that 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 and disconnectors can be supplied suitable for horizontal upright mounting on support structure or underhung mounting on substation gantry structure and can be manually operated or motor operated type. Then he showed us the disconnectors and their operating mechanism. The main features of those three disconnectors are stated below:

3.3. Pantograph Type:

At first we saw the pantograph type disconnector. Our supervisor told us about the construction and the operating mechanism of the pantograph disconnector. He told us that the pantograph disconnector consists of three poles. Each pole consists of one support insulator, one rotating insulator, the pantograph mechanism and a counter contact. The disconnectors are equipped with insulators. The pantograph mechanism is installed on the support insulator and transfers the movement of the rotating insulator to the arms of the pantograph disconnector. Each pantograph

is equipped with four aluminium arms to ensure a rigid construction with a very high short circuit rating. The counter contact is a horizontal silver-plated copper bar which has to be connected to the busbar system. The technical data of the pantograph disconnector is given below:

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

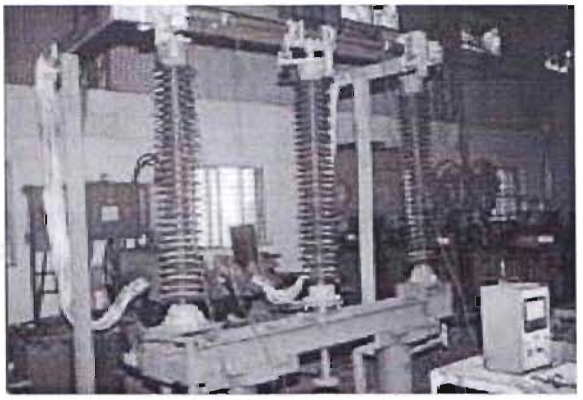

Fig 3.2: Pantograph Isolator

The basic features of pantograph type isolators are:

- 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.

3.4. Centre Break Type:

After the pantograph disconnector we saw the centre-break disconnector which consists of three poles. Each pole consists of a frame, two rotating support insulators and a main blade that moves in a horizontal plane. The frame is made of a square tube in which the bearing housings and the turntables are installed. All steel parts of the disconnector are galvanized. The main blade consists of a U-shaped tube, in which the main contacts and the rotating contacts are installed. The rotating contact consists of a silver-plated copper pin and a bronze housing. This contact construction is sealed and maintenance free. The main contacts are installed inside the main blade. They are made of copper, with a silver plated surface. The technical data of centre-break disconnector is given below:

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

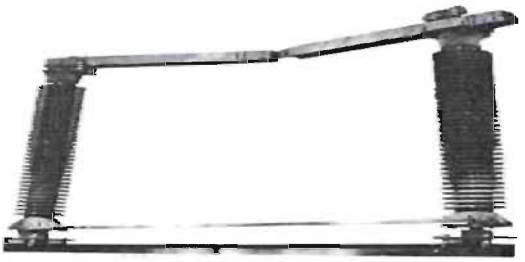

Fig 3.3: Centre Break Isolator

The basic features of Centre break type disconnectors are:

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

3.5. Double Break Type:

Finally we saw the double-break disconnector. The double-break disconnector consists of three poles. Each pole consists of a frame, two supporting insulators at each end and one rotating insulator in the centre. The frame is made of a square tube in which the bearing housing and the turntable are installed at the centre. The main blade consists of two fixed contacts, mounted on the supporting insulators, and a moving blade mounted on the rotating insulator. The main contacts are installed inside the main blade. The technical data is given below:

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

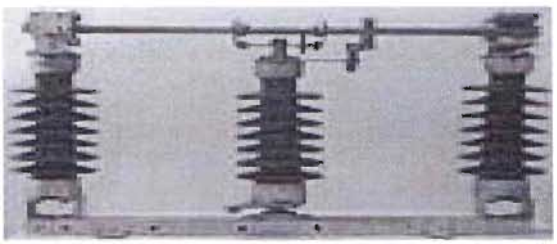

Fig 3.4: Double Break Isolator

The basic features of Double break type disconnectors are:

- 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.

3.6. Parts of the Disconnector:

We observed that in all disconnectors there are some common parts. These parts are:

Base Frame: For all sizes up to 245 KV, the base frame is of welded design and has minimum four fixing holes.

Earthing Switches: Earthing switch can be supplied for mounting as an integral part of the disconnector or for separate mounting as an independent unit operated either by a manual or by motor operating mechanism.

Insulators: A wide range of insulators meeting the requirements of IEC-168 of the stack type are available with various cantilever strengths, creepage distances and insulation levels to meet the customer specifications.

Terminal Connectors: Terminal connectors of rigid or flexible type suitable for horizontal/vertical take offs offered to meet specification.

Interlocks: Mechanical constructional interlock is provided between the disconnector and earth switch to ensure that the disconnector cannot be closed when the earth switch is closed and vice versa.

3.7. OPERATING MECHANISM:

EnergyPac currently offers the following operating mechanisms:

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

3.8. Routine Tests:

EnergyPac follows the standard of ANSI, CPRI, IEC and BUET for testing isolators. EnergyPac normally performed four different types of test for isolators, which are:

- **Insulator Test**: This test is same as the insulation resistance test of breaker. This test is performed to check the insulation level of the insulator. It is also known as megger test. Our supervisor told us that this test is used to check the insulation level. This test is also known as Megger test. Insulation resistance is measured by megohm-meter or meggar. In megger there is a megohm-meter and a built in DC generator. The minimum reading is zero and maximum is infinity. The scale is in megohms. He told us that to do this test the two terminals of meggar are connected across the insulation and other to earth body. Then the handle of the meggar is rotated by hand or motor. Then the insulation resistance can be seen in the display of meggar.

- **Contact resistance of main circuit Test**: our supervisor told us that by this test the contact resistance of disconnectors is measured. For 11KV the maximum resistance can be considered up to 40μΩ and for 33KV maximum resistance can be considered up to 60 μΩ. This test is done to check whether the contact resistance is in the permissible range or not.

- **Power frequency voltage withstand Test**: Our supervisor told us that in this test high voltage is applied on the isolators. According to IEC standard for 11KV isolators up to 28 KV is applied for 1 minute and for 33KV isolators up to 70KV is applied to check the sustainability of the isolators. This test is also known as high voltage test.

- **Mechanical operation Test**: Under this test, the temperature rise test and lighting impulse withstand test is performed. In temperature rise test the temperature of the isolator is observed. If in every one hour temperature rises up to 2 degree Celsius then it is considered that the isolators are ok. Lighting impulse withstand test is performed by applying up to 70KV for 11KV isolators and 170KV for 33KV isolators for 50μS.

Chapter 4

Transformers

4.1. Introduction:

On the fifth day **(01/01/11)** of our internship we have visited the Transformer section. In this section our in charge was Engr. Asaduzzaman, Ad.GM. When we reached in the transformer section we were introduced with. Mr. Asif Islam, Assistant Engineer (Transformer, Production). At first he gave us some theoretical summary about their working principle and then he showed us different section in a brief. He told us that the transformer is one of the most reliable pieces of electrical distribution equipment. It is a static device which transforms power from one circuit to another circuit without changing frequency. This is an electrical device for step up or step down the voltages. He also mentioned EnergyPac manufactures the largest power transformers in the South-East Asian region.

4.2. Types of transformer:

EnergyPac Engineering Limited manufactures three types of transformers. These are:

- Power transformer.
- Distribution transformer.
- Instrumental transformer.

In this chapter we will discuss about power transformers and distribution transformers.

4.2.1. Power Transformer:

At first we saw the power transformers. Mr. Asif Islam told us that, a power transformer is transformer which transfers electric energy in any part of the circuit between the generator and the distribution primary circuit.

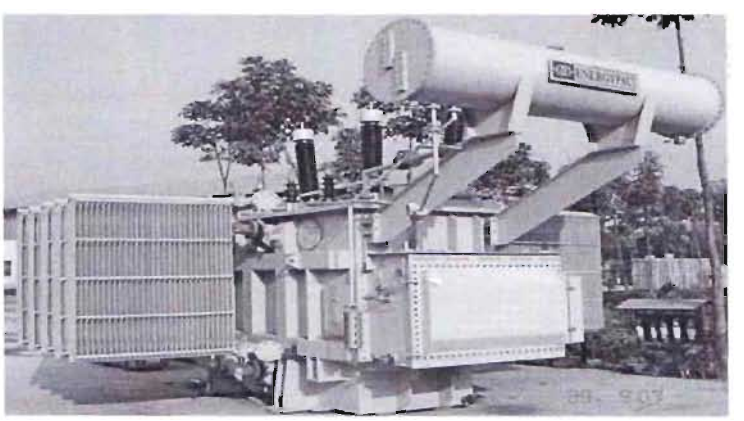

Fig 4.1: Power transformers

4.2.2. Distribution Transformer:

A distribution transformer in a neighborhood power grid may distribute electricity to several homes. A distribution transformer in a TV set may produce several different voltages to power different circuits.

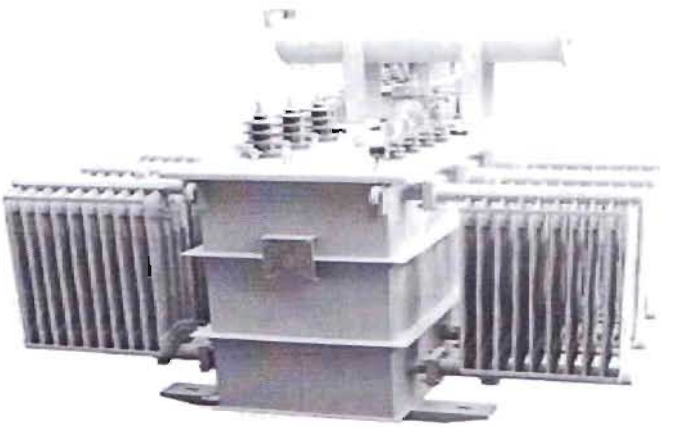

Fig 4.2: Distribution transformer

Table 2: Difference between power transformer and Distribution transformer

Distribution transformer	Power transformers
Low voltage rating	Higher voltage ratings.
A distribution transformer would usually be a 3 phase step down transformer in a delta star configuration.	A 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 maximum Efficiency at 60% to 70% load. Normally it doesn't operate at full load.	It is designed for maximum Efficiency at 100% load as it always runs at 100% load being near to generating station.
Ratings: 11kVA, 4.5 kVA, 3.3 kVA	Ratings: 75 MVA, 50 MVA, 33 kVA

We learned that both power and distribution transformers are used for transmission and distribution. The difference between power and distribution transformers refers to size & input voltage. Distribution transformers vary from 25 KVA to 10 MVA, with input voltage between 1 and 36 kV. Power transformers vary from 5 to 500 MVA, with input voltage above 36 kV.

4.3. Designing of Transformer:

We observed that EnergyPac maintain some processes to design a transformer. The processes that EnergyPac maintains to design the transformers are as stated below:

- Manufacturing process of transformer.
- Ending of transformer
- Protection system of transformer.
- Testing system of transformer.

4.4. Manufacturing process of transformer

At first we saw the manufacturing processes. Our supervisor told that manufacturing processes of a transformer is a very crucial part for designing a transformer. In that process the basic structure of a transformer is created. This process contains series of sections. These sections are described below:

- Design section.
- Core Section
- Coil Section
- Tap changing section.
- Tank Section
- Assemble Section
- Tanking up section
- Mechanical section.

4.4.1 Design section:

At first we went to the design section as designing is the most important issue of a transformer. A transformer is created by following a design. EnergyPac also follows some design. The design depends on customer's choice. According to the customer's requirement the designers of EnergyPac design the Transformer. The designers design the Structure, Core diameter, insulation label, cooling system, tapping system, Coil thickness, tank and conservator and other things. The R&D Department of EnergyPac is always working on the development of the product.

4.4.2 Core Section:

After observing the design section we went to the core section. The core is also an important part of a transformer. Mr. Asif Islam told that there should be some processes to create a core. So EnergyPac follows some processes to create a core of a transformer. These processes are divided in three parts. These are:

- Core material selection.
- Core design selection.
- Core cutting machine.

Core material selection:

Core material selection is one of the major parts of transformer. We came to know that for the selection of core material two things must be considered. These are:

- Conductivity.
- Magnetic field.

Our supervisor told us that conductivity means the rate of current flow through the core. When current passes through the coil a field is created around the coil, it is called magnetic field. By considering those things Silicon steal sheet is used for coring. The major properties of silicon steal sheet are good conductivity and good magnetic field.

Core design selection:

The next thing we observed that engineers has to select a particular design among various designs. The core can be designed in different way. We saw EnergyPac uses automatic core cutting machine. It is operated by computer. The machine divides the core in three classes. These class are A, B and C.

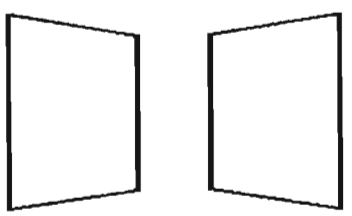

Fig 4.3: Class A

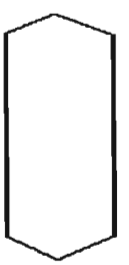

Fig 4.4: Class B

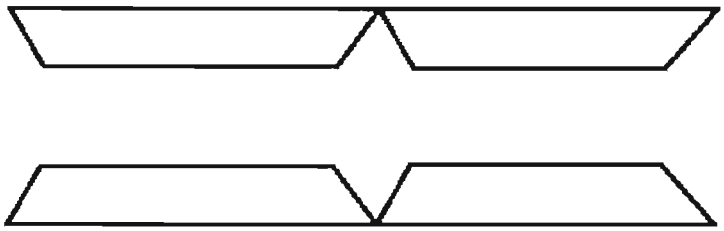

Fig 4.5: Class C

After joining this part, the core structure is created. The structure looks like as the picture given below:

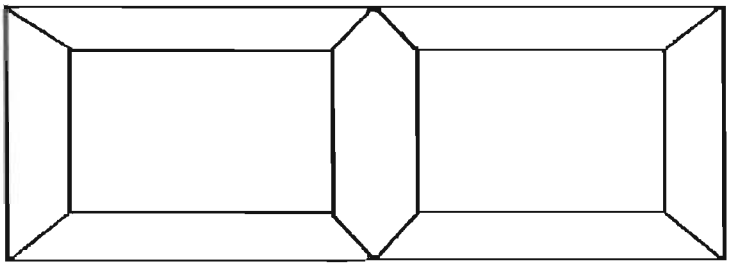

Fig 4.6: Core

Core cutting machine:

In EnergyPac core is cut by a computerized machine. the name of that machine is "Auto core cutting".

The working steps of the machine are given below:

- At first the silicon steal sheet is chosen by thickness and grade for a fixed design.
- By using the power stress, the machine cuts the big pieces in A, B and C dimension's by following the design.
- By following the design the pieces are cut with 45 degree angle. That is called auto core cutting. If the pieces are cut with 90 degree angle it is called normal core cutting.
- By following the design some time core punch may be required.

We saw that during this core cutting process some precautions are taken. They are:

- The machine should be operated in a manner so that the insulation of silicon sheet is not damaged.
- The size of each dimension has to be correct.

Our supervisor told us about the differences between Normal core cutting and Auto core cutting methods. These differences are stated below:

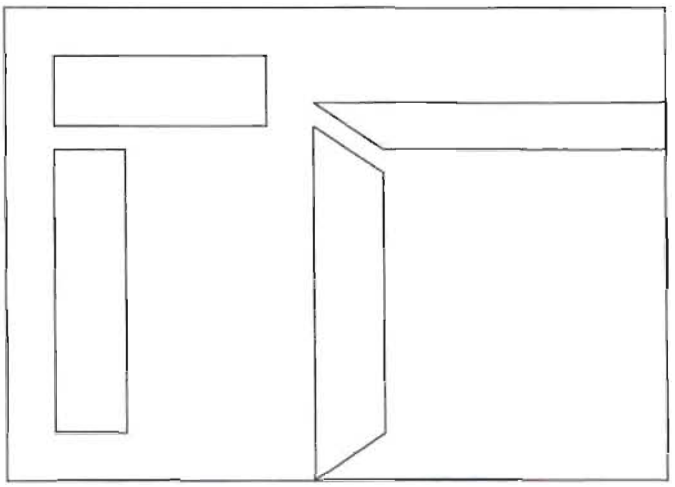

Fig 4.7: Normal Core cutting & Auto Core cutting

Table 3: Difference between normal and auto core cutting machine

Normal core cutting	Auto core cutting
The machine cuts the core by an angle of 90 degree.	The machine cuts the core by an angle of 45 degree.
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.

4.4.3 Coil Section:

On 02/01/11 (2nd day of our transformer section), Mr. Asif Islam took us to the coiling section. Coil means the wire which is winded with the core. In a transformer there are two types of coil. One is used for primary side and the other one is used for secondary side. In this section of our report we discussed about the coil of a transformer. The coiling section is divided into three parts. These are:

- Coil selection.
- Coil winding
- Insulation

Coil selection:
Mr. Asif Islam told us that the selection of coil depends on customer's choice. EnergyPac uses two types of coil. These two types of coils are:

- Spiral coil.
- Disk coil.

Spiral coil: At first we were told about spiral coil. Spiral coil is used for both HT and LT coil of distribution transformer or power transformer. It depends on customer choice. The ratings of spiral coil are below 2000kV.

We saw some working steps by which spiral coils are prepared for High Tension (HT) side of a transformer. The Working steps for Spiral coil for HT side are stated below:

- At first the copper wire is made carbon and dust free by using sandpaper.
- Then it is straightened which is free from bend.
- Using HT DPC machine, coil is insulated in several layers by DPC Paper.
- A solid cylindrical forma of predetermined diameter and length is being used.
- The coils are made in number of layers.
- The starting and finishing leads of each coil are terminated on either side of the coil.

We saw some working steps by which spiral coils are prepared for Low Tension (LT) side of a transformer. The Working steps for Spiral coil for LT side are stated below:

- Copper strips are made carbon and dust free using sandpaper.
- Using LT DPC machine it is insulated.
- A wooden cylindrical forma is used.
- Several layers of coils are made depending on transformer power.

Disc coil: After the spiral coil we learned about disc coil. Disc coil is used only for HT side of power transformer .The ratings of spiral coil is above 2000kV.

The working steps by which the disc coil is prepared are given below:

- The copper strip that is used for this type of coil is made dust free by using sand paper.
- Then it is straightened by using roller.
- Using DPC paper the copper strip is insulated.
- A large wooden forma is used to make a coil.
- The size of the coil is calculated by the transformer power.
- Starting and ending point of the coil should be bended separately.

Coil winding:

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. There might be different number of layers according to the voltage rating, KVA or MVA rating and design issues. 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.

Insulation:

In HT side high voltage and low current is flowed. So here the insulation must be higher than LT side insulation. For coil insulation at HT side, HT insulation paper or Carret paper is used.

In LT side a low voltage and high current is flowed. For LT side coil insulation, LT insulation paper or DPC paper is used.

All these things are written by our observation and some data is collected from Engr Asif. We also got some data by questioning the technicians.

After Lunch break, Engr Asif showed us the tap changing section and told us about the importance of mechanical design of a transformer.

4.4.4. Tap Changer and Tap Switch

After completing the coil section we were taken to the tap changing section. Tap changing means the changing of voltage by a switch. Generally for changing tap, taps are providing in HT coil. To vary voltage level in both High Tension and Low Tension side, tapping is provided in transformer. The design of tap changing depends on customer choice. Sometimes taps are made from HT coil; sometimes an extra coil is used for taps.

There are two types of tap changing options provided by EnergyPac. These are:

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

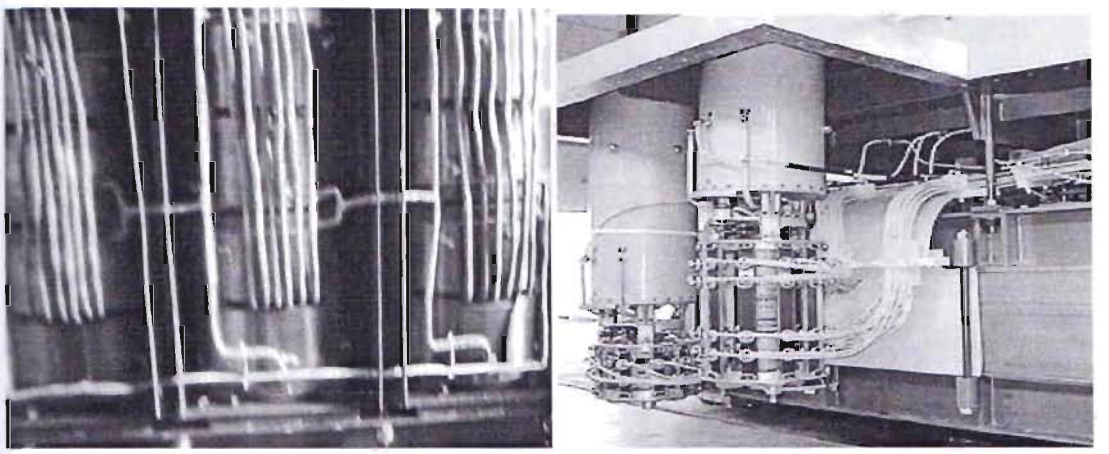

Fig 4.8: Physical View of Tap Changer.

Our supervisor told us that motor driven mechanism is used for 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 of tap changer are spring loaded to ensure proper pressure and good contact. 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.

4.4.5 Tank section:

After observing the tap changing mechanism we went to see how the tanks of transformer are made. Our supervisor told us that, the size and shape of a transformer tank depends on the ratings of transformer.

The length of tank can be long or small. But the length of tank is an important issue for a transformer. If the length is long, it is best for cooling system of transformer. It also increases the life time of transformer. The raw material of the tank is steel sheet. To make the tank of the transformer, at first the steel sheet is tested. If the result is satisfying then it is cut by the cutting machine. Then by welding machine the shape of tank is made. After that the radiator for cooling of the transformer is connected with the tank. A conservator is also connected with the tank to store the oil. Then after painting and testing, this tank will be ready.

When the tank is completed then it is sent to paint section. The entire procedure of painting is done under two stages:

- 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.

4.4.5 Assemble section:

We saw how the core, coil and tanks are made in the above sections. When the above sections are completed, 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.

Core assembles:

We saw that to assemble the core, silicon steel sheet is cut by designed shape. These sheets are sliced for decreasing eddy current loss. By adding those sliced sheets the core is created. After that, the limbs of the core are tightly wrapped by cotton tape. Then an insulating press board is wrapped on all the three limbs. Then the core becomes ready to use.

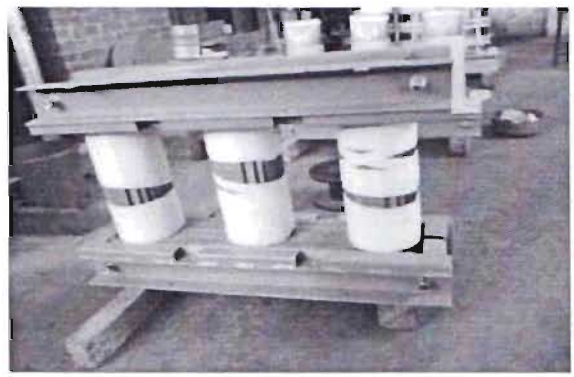

Fig 4.9: Core assemble

Coil assembles:

Spiral coil or disc coil is used for HT or LT coil. The shape of the coils can be cylindrical or rectangular, it depends on customer demand. The size of HT and LT coils are different. In HT coil the voltage is high but the current flow is less than LT coil, so the size of HT coil is smaller than LT coil. But in LT coil the current flow is high and the voltage is lower than HT coil so the LT coil size is higher. This coil is winded by a machine. For the insulation of coils insulation paper is used.

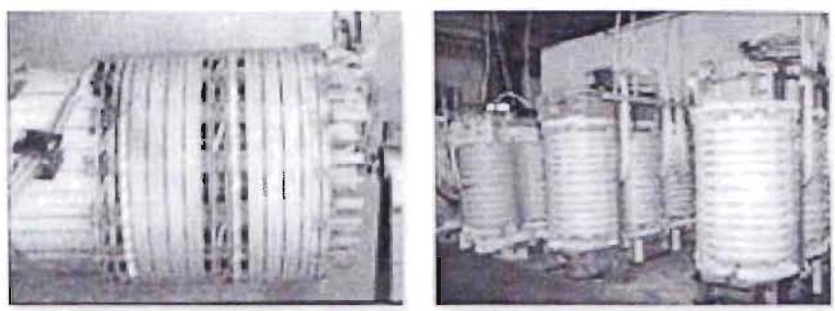

Fig 4.10: Coil winding

Core-Coil assembles:

At assemble section at last we saw, how the core and coil are assembled together. At first LT coil is placed on the insulated core limbs. An insulation paper is used to create insulation between LT and HT coil. Here brize board is used for insulation. After that HT coil is placed on the outside of the insulated LT coil. Some time tap changing coil is placed outside the HT coil. It depends on customer's choice. For example, DESCO's requirement is this type of tap changing coil. Now from where the HT connection wire is got out, the LT connection wire is got 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 got out from HT coil or tap changing coil. Now by using a centrifugal machine, oil and moisture is cleared. Finally, the whole setup is placed in the heating chamber.

Fig 4.11: Core and coil assemble

4.4.7. Tanking up:

On this day after the launch we observe the total tanking up process of the transformer. After completing the core and coil assemble process the whole core and coil setup is placed in a transformer tank. Then other parts are added with the tank. This is not so easy work to do. Some steps must be followed. 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 by pure transformer oil

4.4.5 Mechanical section:

Mechanical stress is very important issue for designing a transformer. If the center of the mass is not balanced, that means the center of the mass of core, coil and tank must be placed in same point otherwise the transformer will explore.

We know,

$$W=F\ S$$

Where, F= force, S= distance, W= work.

If the center of the mass is in same point, S=0,

So, W=0.

The height of LT coil is greater than the height of HT coil for balancing the mechanical stress.

4.5. 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 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.

4.6. Protection:

On 03/01/11 (3rd day of our transformer section), Mr. Asim Kumar Bhakta, showed us some protection parameter of the transformer. Every transformer must have a protection system otherwise it will be damaged. So for the protection purpose of a transformer EnergyPac uses some systems and machineries. These are:

- Cooling system
- Bushing
- Gas insulation relay
- Thermal protection
- Oil level indicator
- Silica gel

4.6.1. Cooling system:

We saw, in transformers, the cooling has a special importance to ensure safe operation and to increase the lifetime of the transformer. The heat generated in the transformers is dissipated at the cooling unit by the help of oil. The simplest and mostly used cooling systems are ONAN (Oil natural and air natural). ONAF (Oil natural and air forced), OFAF (Oil forced and air forced). Cooling systems, in which cooling air is blown to the radiators by fans, is also used.

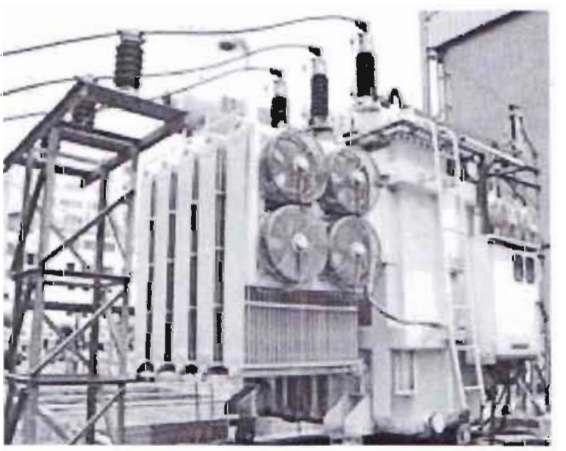

Fig 4.12: Cooling system

4.6.2. Bushing:

Bushing is used for external insulation. High voltage and low voltage bushings are manufactured by BISF in Bangladesh or imported from reputed manufacturer with terminals suitable for copper conductors. Both HV and LV sides are terminated with bare bushing. All the bushings are top mounted, but side mounted bushing can be provided on request.

Fig 4.13: Bushing

4.6.3. Gas insulation relay:

Our supervisor told us that 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 the Bucholz relay. Depending on the volume of gas it 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 to the contacts on it.

4.6.4. Thermal protection:

We saw that, EnergyPac uses two types of thermal protection. These are:

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

Oil Temperature indicator: By using a thermometer it indicates the temperature of oil. If any fault occurred the temperature rises too high.

Winding Temperature indicator: These indicator indicates 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.

4.6.5. Oil level indicator:

Oil level indicator indicates the oil level in the conservator and gives too low or too high indications by the contacts on it.

4.6.6 Silica gel:

Silica gel is used for reducing moisture. At night when the oil goes to transformer from the conservator some air also enter or exists 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 it changes color.

Fig 4.14: Silica gel

Oil refining:

We saw that, after completing the tank up process the tank is filled by moisture free oil. A special type of oil is used for this oil refining. This oil is known as transformer oil. It creates insulation between tank body and coil, and also creates insulation between HT and LT coil. EnergyPac imports this oil from India. 2.5 mm oil can block 60K voltage. This is better to refuel oil after approximately five years. After completing the whole process the tank is inserted in vacuum plant for removing the moisture.

4.7. Testing of Transformer:

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

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

EnergyPac follows four types of test. But these four type test are not always performed. That means the type test and the special test depends on customer choice. If the customer doesn't want then these are not performed. All these tests are described below:

- In process test.
- Routine test.
- Type test.

4.7.1. In process test:

When a transformer is in process that time step by step the transformer is tested by this type of test. These tests are:

- Magnetic balance test.
- Excitation current test

4.7.1.1 Magnetic Balance Test:

Engr. Asim Kumar Pal at first told 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.

4.7.1.2 Excitation Current Test:

In this test, the magnetic balance and eddy current loss is checked. Engr. Asim Kumar Pal told us that this test is performed to monitor the exciting current in any available winding. To check the exciting current in any available winding in this very important test, 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.

4.7.2. Routine test:

When the transformer is complete then it is send 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:

- 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

Among these tests Engr. Asim Kumar Pal told us about following tests:

4.7.2.1. Measurement of winding resistance:

Our supervisor told us that this test is done to measure the resistance of the HV & LV winding. The values of resistance should be balance for all three phases and should match the designed values. This is nothing but the resistance measurement of the windings by applying a small DC voltage to the winding and measuring the current through the same. The ratio gives the winding resistance. The resistance is checked by digital resistance meter.

4.7.2.2. Measurement of insulation resistance:

This test is done to measure the resistance of HV & LV windings with respect to earth. In this test the resistance between LV & HV winding is also measured. For measuring this resistance Insulation tester or Megger is used.

4.4.2.3. Turn Ratio:

Our supervisor told us that this test is also called Voltage ratio test. This test measures the voltage ratio as per the customer's requirement.

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

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

4.7.3 Type test:

There is only one test in this section. This test depends on customer demand. After that test the life time of a transformer is decrease. This test is Impulse test.

Impulse test:

Actually during our internship we did not see this test but we gathered some theoretical knowledge about this type test of transformer. This is a type test, so from 1000 transformers this test is done to only five or six transformers.

In this test Impulse generator is used to produce the specified voltage impulse wave of 1.2/50 micro seconds wave. One impulse is of a reduced voltage between 50 to 75% of the full test voltage and subsequent three impulses at full voltage. For a three phase transformer, impulse is carried out on all three phases in succession. The voltage is applied on each of the line terminal in succession, keeping the other terminals earthed.

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

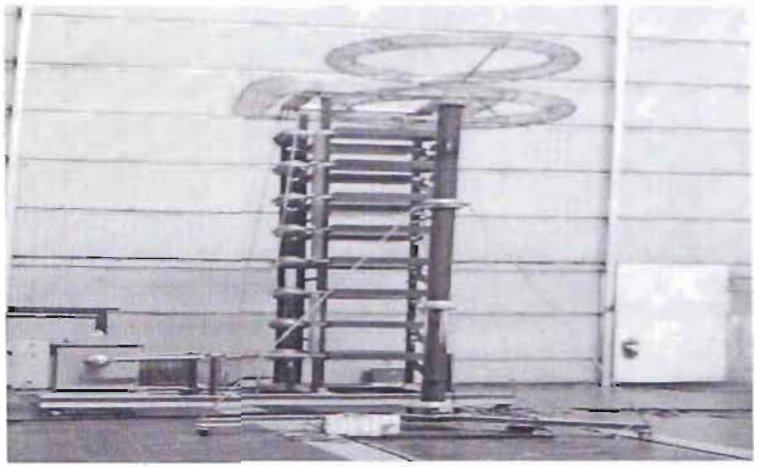

Fig 4.15: Impulse tester

Chapter 5
Switchgear

5.1 Introduction:

It is known to all that electrical energy is one of the major integral parts of our modern civilization. Electrical Energy Measurement system ensures supply of energy to every consumer at all times at rated voltage, rated frequency and specified wave form, at lowest cost and with maximum environmental degradation. For this purpose, means must be provided to switch on or off generators, transmission lines, distributors and other equipment under both normal and abnormal conditions.

To learn about switchgear, we had to spend 3 days in Switchgear section during our internship along with Engr. Syed Muztaba Ali, DGM of Energypac Engineering Ltd, and got help from him about this section. We got some fundamental ideas about Switchgear is one of the important parts in the electric power or grid system. 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, control, monitoring and automatic switching during abnormal and faulty operating conditions such as short circuits, under voltage and overloads.

5.2 Switchgear Panel:

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

- High Tension Panel
- Low Tension Panel

5.3 Switchgear components:

We were asked to ran the Switchgear section after we got the basic idea of Switchgears. An engineer explained us that the Switchgear section of a company is associated with experience and skills as well as machineries, machining facilities and test equipments. The switchgear section of Energypac consists the following:

- Low Tension metering panel
- High Tension metering panel
- Power factor improvement plant (PFI)
- Control metering and Relay panel

- Load Break Switch.
- Distribution Panel AC Distribution Box (ACDB)
- Distribution Panel DC Distribution Box (DCDB)

These products were very essential for our learning and Engr. Syed Muztaba Ali and other associated engineers extended their hands to help us for the purpose of our learning. On the following section we discuss each of the product that were introduced to us.

Energypac Engineering Limited manufactures two types of switchgear panel:

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

5.3.1 Low Tension metering panel:

While visiting the Low Tension (LT) Metering Panel (fig 5.1) Engr. Syed Muztaba Ali told us that these panels are very reliable in performance, easy to install and low on maintenance. It was found that Energypac Engineering Limited manufactures low voltage switchgear which is applied for power control and distribution systems of AC 50Hz, rated working voltage up to 440V. The design meets with the standard of IEC439, GB7251.

Fig 5.1: LT switchgear panel

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

- Molded Case Circuit Breaker (MCCB)
- Miniature Circuit Breaker(MCB)
- Ring CT from EnergyPac
- Bus Bar
- Ammeter, Voltmeter
- Indicator flags
- Relay
- HRC Fuse

The details of each component are described below

5.3.1.1 Molded Case Circuit Breaker:

MCCB are used for protection and control of electrical machineries from

- Overloads
- Short-circuits
- Ground fault protection

5.3.1.1a Current ratings:

Current ratings of MCCB are usually from 16Amp to 1600Amps

5.3.1.1b Structure of Molded Case Circuit Breaker:

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

5.3.1.1c Operating Mechanism of Molded Case Circuit Breaker:

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

Fig 5.2: Molded Case CB

The following operating cycles are possible without recharging the springs:

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

5.3.1.1d Application:

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

5.3.1.2 Miniature Circuit Breaker:

The Miniature Circuit Breaker is very small in size and it can be operated easily. Its operating voltage is 230V-440V; during overloads or faults it automatically trips off. The tripping mechanism is actuated by magnetic and thermal sensing.

(i) (ii) (iii)

Fig 5.3: (i) single phase (SP) (ii) double phase (DP) (iii) three phase (TP)

5.3.1.3 Ring type CT:

The ring-type current transformers are mounted so they slip over the bus or line side primary bushings, which are located in the main bus compartment and line compartment, respectively. There is a space for maximum number of ring-type CTs as follows: Bus Side Bushings: 2 Sets of standard accuracy or 1 Set of high accuracy, Line Side Bushings: 3 Sets of standard accuracy or 1 Set of standard and 1 Set of high accuracy. The CTs are mounted such that they can be reached from the rear of the enclosure. It is not possible to add or to change transformers until high voltage connections are removed. The polarity marks on the transformers show the relative instantaneous polarity in the primary and secondary windings. The diagrams show how to connect the transformers to give polarity needed to operate relays and instruments.

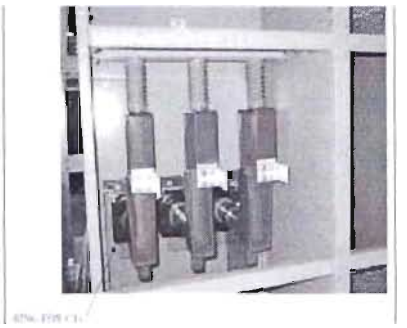

Fig 5.4: Ring type ct

5.3.1.4 Bus-bar:

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

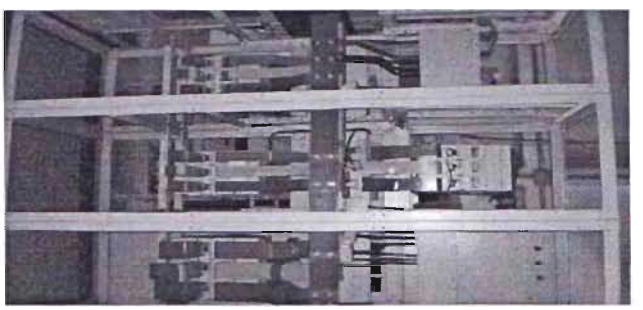

Fig 5.5: Bus-bar

5.3.1.5 Operating Mechanism of LT Switchgear Panel:

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

Technical Data of LT switchgear panel:

Technical data means the nameplate value or the ratings. EnergyPac LT switchgear panel has the following technical data:

- 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

5.3.1.6 Testing for LT Switchgear:

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

5.3.2 High Tension Panel (HT Panel):

We observed that in manufacturing and supplying of High Tension Switches and Panel Board, which offer both overload & short circuit protection. The products' vital components i.e. contactor, relay and rectifier all are housed in an elegant sheet steel enclosure. We observed that EnergyPac manufactured high voltage switchgear panel (HT panel) and used for power control and distribution systems of AC 50Hz and rated voltage up to 230KV according to the standard of IEC. We were informed by our supervisor that, EnergyPac's HT Switchgear equipped with Load Break switch (LBS), Vacuum Circuit Breaker (VCB), Disconnect or etc. He also said that, to meet individual requirement, it has features of long service life reliability and high degree of quality, safety and HT switches are suitable for inexpensive electrical sub-station with transformer feeder, measuring, sectionalizing Auto change over and motor protection. We saw the all equipment of HT switchgear panel and their working mechanism. We asked the worker how they are assembling the equipments. After our observation, we found the following information about HT switchgear panel, which are given below:

The supervisor informed us, EnergyPac's HT switchgears are used for two types of voltage class:

- Medium voltage (1KV to 33 KV)
- High voltage (more than 33 KV)

EnergyPac's HT switchgears consist of:

- Load Break Switch (for 11KV substation)
- Vacuum Circuit breaker (Indoor-Outdoor, up to 33KV)
- Control, Metering, and Relay Panels, Up to 230 kV

EnergyPac's HT Panel of HT switchgear consists of:

- Bus Bar
- Ammeter
- Voltmeter
- Magnetic coil
- Counter
- Indicator flags
- Vacuum Circuit Breaker (VCB)
- Relay
- Ring CT (current transformer)Potential Transformer

5.3.2.1 Working principle of HT switchgear:

HT panel consists of three numbers of CT and PT from the main bus-bar for measuring current and voltage respectively. We saw that, there are also three ammeters through CT, since ammeter cannot measure more than 5A current and one voltmeter through PT from the main bus bar, because voltmeter can not measure voltage in KV range. The supervisor told us that, when any faults occurs in the line, then the relay first sense the fault. Then the relay send trip signal to the circuit breaker. There are three relay which energized the magnetic coils to trip the breaker. Magnetic coils are used to trip separate load connection. Here, EnergyPac used vacuum circuit breaker. Then the breaker trips and the whole system become disconnected from services. If any error occurs in any phase, the whole phase will disconnect immediately. We also found that, in HT panel, there are some selector switches, trip signal, spring charge lamp and indicating lamps, which indicate the panel ON or OFF and are mounted on the upper portion of the front cover of the HT panel Box.

5.3.2.2 Relay:

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

Field of application of HT switchgear:
We know that HT switchgear is used in different sectors, for example in power station, Industrial enterprise and it is used in Commercial industry and Transmission which control, protect and inspect the circuit.

5.3.2.3 POWER FACTOR IMPROVEMENT PLANT (PFI):

After discussion of LT and HT panels Engr. Syed Muztaba Ali told us about Power Factor Improvement Plant. From his discussion we learn that this plant is designed for improving the degraded Power Factor and angle between actual power and power being utilized with digital power factor display of the system. The power factor plays an important role in A.C circuits since power consumed depends upon this factor,

$P = VLILcos\theta$

$IL = P/\sqrt{3}VLcos\theta$

It is clear that from above that for fixed power and voltage, the load current is inversely proportional to the power factor. Lower the power factor, higher is the load current.
PFI Plant is used to improve the power factor of the inductive loads of the system's network by Capacitor Banks. All control & indicating devices are located on the front door of the panel for easy viewing from the operator's desk.

Fig 5.6: PFI Plant

We found that EnergyPac manufacture PFI Panel of LT switchgear to improve power factor of the system, which consists of:

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

- Breaker
- Indicator flags

5.3.2.4 PFC Relay:

We have come to know that Power Factor Control relay is used by Energypac, and it is manufactured by ABB, German. Its function is to sense lower power factor. But the power factor should not be less than 0.95. Then, manually it should be set in the relay. When pf will be less than 0.95 the relay starts operation. Microprocessor- based control relay for intelligent control of capacitor bank. It can automatic identification of threshold current, phase angle, connected capacitor stages and switching sequences.

Fig 5.7: PFC Relay

5.3.2.5 H.R.C Fuse:

It was observed that Energypac Engineering Limited uses HRC fuse, and it is manufactured by ABB. The function of the fuse in electrical system is to act as protection device and depending on application different types of fuse is to select. Out of these different types of fuses HRC is also one of the parts and it stands for "High Rupturing Capacity". These types of fuses are normally used where some delay is acceptable for protecting the system.

Fig 5.8: H.R.C fuses

HRC fuse link is a very common, simple and effective electrical protection device against over load and short circuit current. HRC is used when a fault current condition occurs,

and a tremendous amount of heat is created within the fuse. That heat melts the silica sand filling of the fuse into glass. Glass, being an insulator, suppresses any arc-over and breaks the circuit instantly.

5.3.2.6 Magnetic Contactor:

We found that Energypac Engineering Limited uses magnetic contactor which is manufactured by ABB. When electricity flows through the magnetic contactor, it causes the electromagnet to generate a strong magnetic field. This field pulls the iron core into the coil, and creates an electrical arc. Electricity passes in through one contact and as a result, the moving contact and fixed contacts become together.

Fig 5.9: Magnetic contactor

5.3.2.7 Capacitor Bank:

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

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

Fig 5.10: Capacitor Bank

5.3.2.8 Operating Mechanism of PFI Plant:

When pf (power factor) starts 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.

Chapter 6
Instrument Transformers

6.1 Introduction:

In Instrument Transformers sector we had to spend two days from 29 December 2010 to 30 December 2010. Engr. Mozaharul Islam extended his hands to help us and he took great care of us. He is a DGM of instrument transformer section of ENERGYPAC ENGINEERING LTD. He gave us some important ideas about CT and PT. The transformers which are used in conjunction with measuring instruments, protective relays and control circuits; these are called instrument transformer. Instrument transformers include measuring and protective current transformers and voltage transformer. The structure and the use of Instrument Transformers are quite different from that of well known power transformers. Typically we witnessed that this transformers are used for two basic works:

- Resin casting (Dry type) CT/PT
- Oil type CT/PT

Instrument transformers are used for two purposes:

- Measuring voltage and current in electrical power systems,
- Power system protection and control.

Low value is a voltage or current which is too large to be conveniently used by an instrument and can be standardized. Instrument transformers isolate measurement, protection and control circuitry from the high currents or voltages present on the circuits being measured or controlled.

6.2 Current Transformer

6.2.1 Principle:

Current Transformer is one of the Instrument transformers and its works is to make conjunction with ammeters, over current relays etc. Its function is to step down current from high value to a low value. Their current ratio is substantially constant for given range of primary current and phase angle error is within specified limits. The Power Transformer is large compared to VA rating of current transformers. The main functions of current transformer's are:

- To reduce the line current to a value which is suitable for standard measuring instruments, relays, etc.
- To isolate the measuring instruments namely meters, relays, etc from high voltage side of an installation.

- To protect measuring instruments against short circuit currents. To sense abnormalities in current and to give current signals to protective relays to isolate the defective system.

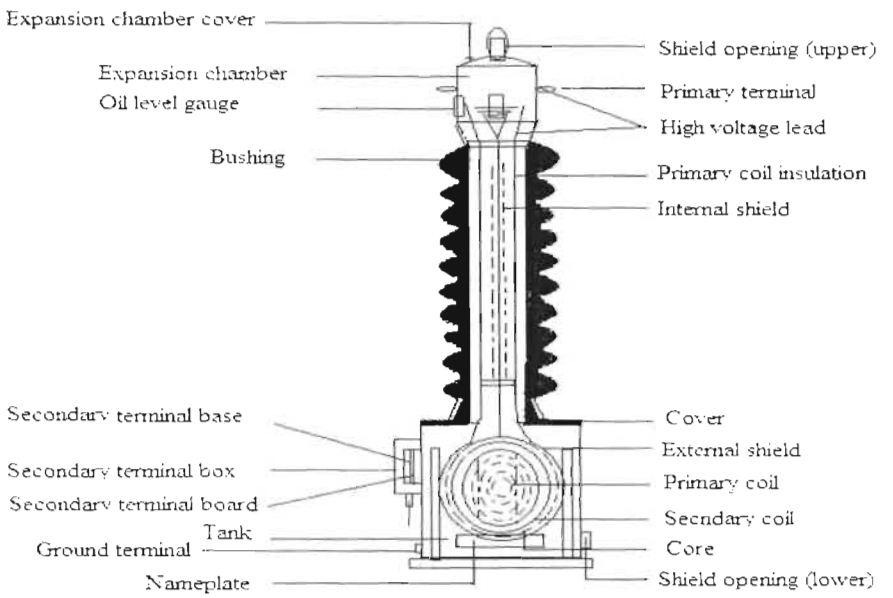

Fig 6.1: Construction of HV (High Voltage) outdoor Current transformer

Fig 6.2: indoor and outdoor HV (High Voltage) Current transformer

Current transformers must be further classified into two groups:

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

6.3 Potential Transformer:

6.3.1 Principle:

An instrument transformer is used for stepping down of voltage in measurement and monitoring circuits. If a voltage transformer is used, the circuits of voltmeters, frequency meters, electric meters, and automatic control and monitoring devices can be isolated from high-voltage circuits; this makes possible the standardization of the rated voltage of monitoring and measurement apparatus, which is most commonly 100 volts (V). Basic functions of potential transformers are:

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

PT may be single phase or three phase units; it is essential for voltage, directional, distance protection. The primary side of PT is connected to power circuit between phase and ground. Power Transformer is large compared to the VA (volt ampere) rating of PT.

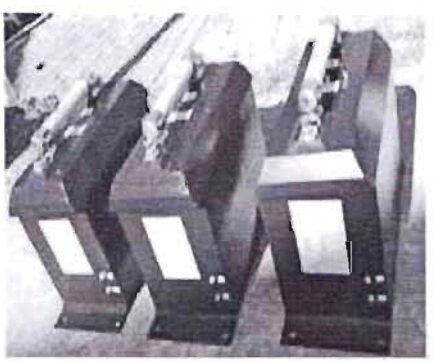

Figure 6.3: Dry type PT (www.energypac.com)

Figure 6.4: HV outdoor PT (www.energypac.com)

6.4 Manufacturing:

Energypac manufactures two types of CT and PT based on construction

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

Current transformers

Energypac manufactures two types of CT:

- Live tank.
- Dead tank

Potential transformers:

Single phase electromagnetic PT is manufactured in two types:

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

6.4.1 Manufacturing process:

We observed the manufacturing process of Instrument Transformers by EnergyPac. And the manufacturing processes of Instrument Transformer are given below:

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

6.4.2 Electromagnetic core:

We found that, EnergyPac electromagnetic core consists of:

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

6.4.3 Primary and Secondary Windings:

Epoxy resin cast type:

The entire process of casting was shown to us by Mr. Mijanur Rahman, the in charge person of Resin casting dept. The design of LT winding is structured 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 work for secondary windings which are insulated with high quality, synthetic resin based insulation varnish. The chemical used in mixing chamber in according serial:

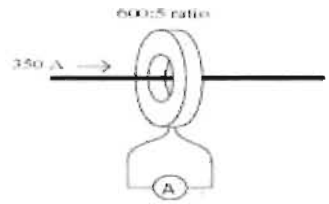

Fig 6.5: primary and secondary winding

- Harder aniline
- Rob coat Brown (color coating)
- Silica filer
- Plastic merger
- Axoletor

First three processes take 2.30 hrs, no.4 takes 10mins and no. 5 takes 20hrs. Here they used 70-80 degree. The name of the plant is Epoxy Mixing Pouring Plant.

Oil merged type:

30th Dec, 2010 was our second and the final day in instrument transformer dept. the process of making oil merged or outdoor type CT/PT making was mainly observed by us. We found that copper enameled wire is used for winding, and 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. Refining oil is needed for CT/PT, that's why oil is refined in a filter machine. Filtration of transformer oil helps in removing the dirt and any moisture content.

6.4.4 Tank and Oil Expansion Chamber:

Tank which is needed for dry type CT/PT is manufactured by their own manufacturing department. MS sheet is used in making tank and oil expansion chamber; they are made in their fabrication and coating department of EnergyPac.

6.4.5 Porcelain Bushing:

Hollow cylindrical type of bushing is used. EnergyPac import this bushing from India.

Fig 6.6: Bush

6.5 Insulation:

We were told by the supervisor that the most important and the integral part is insulation in any kind of Transformer. Insulation failure is the main cause for failing any Transformer; because there is no other protection system. We found that, EnergyPac used three types of insulation processes for insulating of instrument transformer.

- Insulating paper
- Oil
- Varnish

6.5.1 Insulation paper:

We observed that, two kinds of insulation paper are used by EnergyPac:

- Crepe paper
- 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.

6.5.2 Oil:

We observed that a special kind of oil is used by Energypac which is not going to be burnt in case of fire. Oil - serving many purposes like insulation, coolant, suppressor of arcs etc - in transformers are simply called as "Transformer oil or Insulation oil". The supervisor told us that usually, these oils need to be re-filtered every 4-5 years in case of a normal transformer. However, in case of power transformers, the oil is re-filtered every year and advisable to change every 2-3 years.
Filtration of transformer oil helps in removing the dirt and any moisture content.

6.5.3 Varnish:

We observed that, conductors used for windings are insulated with high quality, synthetic resin based insulation varnish.

6.6 Testing for instrument transformer:

IEC-76, VDE 0537, ANSI C 57.12 and BS 171 standards were followed by Energypac for their testing, and the quality test facility is ensured by them as those standards. EnergyPac must ensure four types of tests. These tests are:

- Routine test
- Partial Discharge test
- High voltage test
- Quality test
- Induced over voltage test
- VK test

6.6.1 Routine test:

We found that Routine test must be performed for every transformer. Actually by performing this test we get idea about a transformer. These tests are:

- Resistance test
- Ratio test
- No load test
- Full load test

6.6.2 Partial discharge:

Partial discharge test is taken in the cherkersplate (Earthling plat) in which the body is connected to the earth. This test is used for checking and decreasing the charge carrier between the winding. If there have any bubble between HT and LT Winding; it creates Charge carrier and this situation is very harmful for a transformer. To avoid this kind of situation at first a high voltage (approximately 200 KV) is applied to the primary side and the secondary side for a short time. Now if we increase the voltage, the capacitance or the charge carrier is discharging between primary and secondary side. This test is continued by following this process. This test is basically used for high voltage (132KV) transformer.

6.6.3 High voltage test:

High voltage is a test which is used for checking the insulation property between Primary to earth. It is 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.

6.7 Observation:

Through observing the value of current we measure the leakage current. We can conclude about the insulation property between Primary to earth, Secondary to earth and between Primary and Secondary winding. The insulation is better if the value of leakage current is low; but it is bad if the value of leakage current is higher.

Chapter 7

FABRICATION PROCESS ASSEMBLY

6th January, 2011 was our last day in Energypac Company and it was the last part of our internship. Engr. Moniruzzaman extended his hands to make us understand fabrication department. We were able to complete our work in a day through the help of M.R Engr. Moniruzzaman.

Engr. Moniruzzaman, at first described us that they powder coated the steel path. Then, after powder coding, the steel part is dipped in the acid tank. Then it is dropped in a rinse tank which is filled with normal water. After these steps the part is put into the drastic tank. Then again the steel path is put into normal water, and it is dropped into a phosphate tank. Finally, it is sent to a dry-off oven. Powder spray is done in dry- off oven, and the spray procedure is done electrically. Generally they spray the Berger powder. The temperature of the dry-off oven must be at 180 degree Celsius. He told us that it would take 13-15 minutes to complete the whole process.

7.1 SAND BLASTING PROCESS:

SAND BLASTING PROCESS is the second part in this section. We were told by Mr. Moniruzzaman that sand blasting is one of the most important things for transformer since it is done to reduce corrosion of the transformer and other electrical equipments. We found that there is a radiator tank where all the processes of sand blasting had taken place. For this process they have to mingle sand with air and put at air blasting tank about 730kg. In the tank there is a nozzle and for finishing the sandblasting they have to spray the sand by nozzle.

7.2 COLORING ASSEMBLY:

Coloring Assembly is a part of this section. This section is an important section which is needed to reduce corrosion. For finishing the coloring of transformer they have to follow following processes:

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

Mixing ratio is 2:1:1 where 2% color, 1% curing and 1% fenile. Also use T7 fenile.

7.3 MACHINE SHOP:

Machine Shop is the last part of this section and we observed different types of machines which were used by the Energypac machine shop. Here is a short description of these machine's name and working operation below according to the explanations of the engineers. Generally Lathe machine, Milling machine, Shaper machine, Chaser machine, Drill machine, Surface grinding machine and last is Power Saw machine are used by them.

Lathe machine: A lathe is one kind of machine which rotates the work piece on its own axis to perform various operations like cutting, sanding, etc. This machine is used for cutting the shaft or steel rod. For cutting the shaft at appropriate size they use Lathe Machine. (such a machine is shown in figure 7.1)

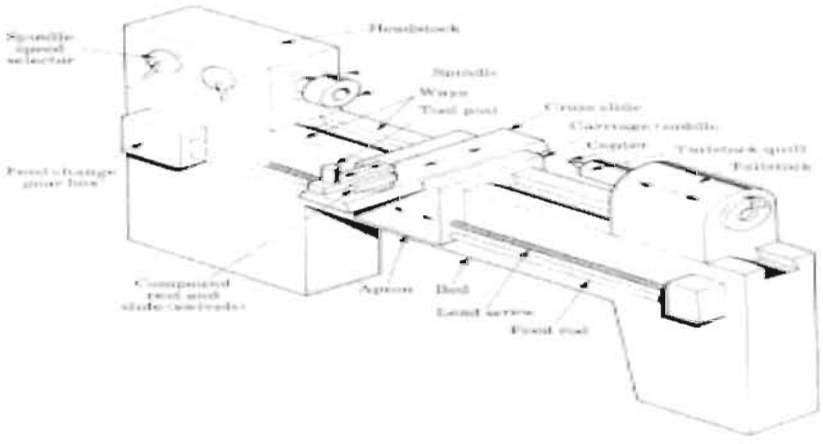

Fig 7.1: Lathe machine (www.Lathemachine-details.info)

Lathe Machines are used by Energypac for various purposes, for example:

- Facing the shaft at appropriate position
- Cutting the shaft on the threat.
- Hole enlarging on the shaft and steel path
- To make tapping on the shaft

7.3.1 Milling machine:

There are a lot of works which can be done by the Milling machines, for example slot and keyway cutting, planning, drilling etc.There are two forms of milling machine:
1. Horizontal milling machine 2. Vertical.

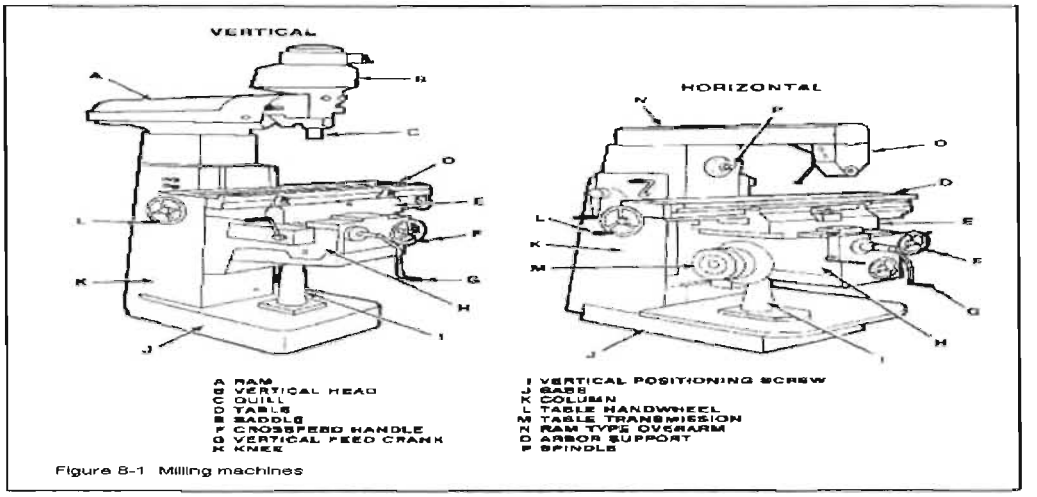

Fig 7.2: Milling machine (www.millingmachine-details.info)

We observed and the engineer told us about various functions of Milling machine; they are:

- To make gear on the shaft
- To make hole on the outside of the shaft

7.3.2 Shaper machine:

A shaper machine is a combination of the work piece and a single-point cutting tool. We found that its cut is analogous to that of a lathe, except that it is linear instead of helical. (Shaper machine is shown in figure 7.3).We were told by the engineer that the Shaper machine is used for following purposes:

- To make hole on the inside of the shaft

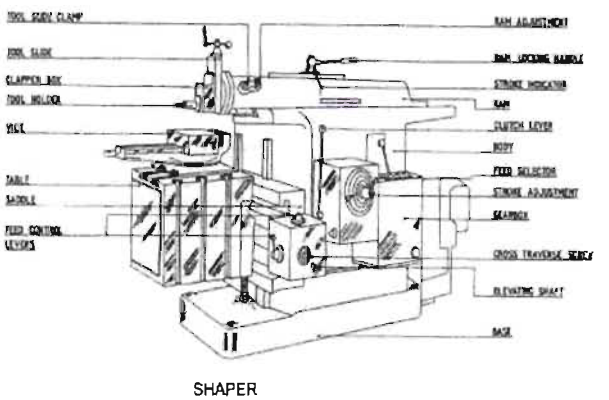

Fig 7.3: Shaper machine (www.roymech.co.uk)

7.3.3 Chaser machine:

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

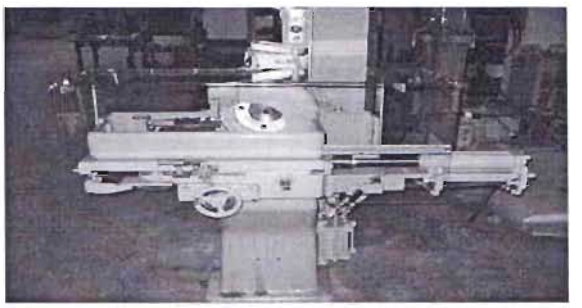

Fig 7.4: Chaser machine (www.rebuildersunlimited.com)

Chaser machines are used for the following purposes:

- This threat only used for cutting the outside of the material that we connect with the shaft.
- Ring type elements are used in a chaser machine.

7.3.4 Drill machine:

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

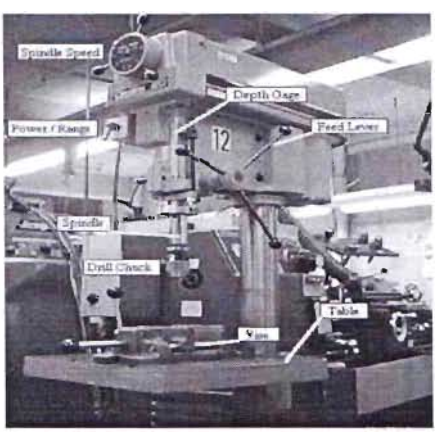

Figure 7.5: Drill machine (www.cuttingtoolssite.com)

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

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

The chaser machine is used smoothing job surface.

Fig 7.6: Surface grinding machine (www. thesurfacegrinder.com)

7.4 CNC machine:

We knew about CNC MACHINE from Mr. Moniruzzaman, he tried to give every single details about CNC MACHINE. He told us the full meaning of CNC, which is computer numerical control, and it is operated electrically. He gave us the following ideas about the CNC machine:

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

Program load procedure:

We knew about the basic about CNC machine and about its working principle. This machine is used for making the hole on the steel plate. For this purpose machine has to remember the size of the hole and measure distance between holes etc. the engineer needs to set the program on the computer before operating the machine.

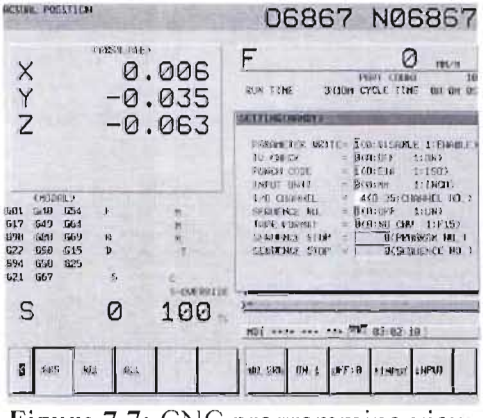

Figure 7.7: CNC programming view

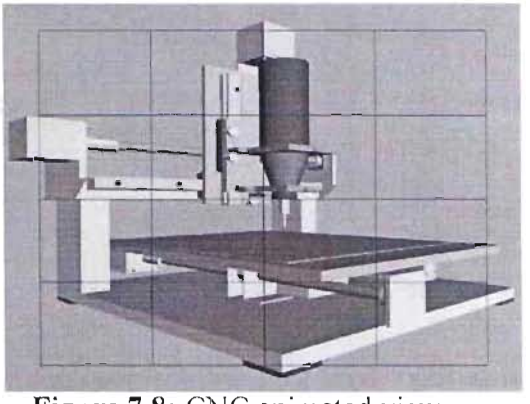

Figure 7.8: CNC animated view

(www.cncblogcommunity.com)

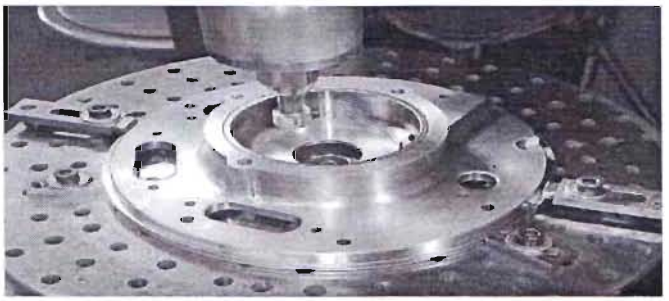

Figure 7.9: CNC machine Cutting point view (www.cncmachine-details.info)

Computer is an integral and most important part of the machine where the software is needed to be installed. For installing this we need huge space or large space since the machine has two parts one is Computer Section where designs are created and the other part is drilling section where machines drilling the sheet by following the designs which are created in the CNC software in the computer. The engineer just make the design and operates the machine from the inside room through using the computer. For running this machine they need to turn on memory by pressing memory button. Then they have to press program soft key for running the program. Then they press Dir key for understanding the direction of the steel path. After completing the procedure they have to type file number and they have to press OSRH key to give input for running the machine. The last key is start key if it is presses then the machine starts working. According to his given information program running process of CNC is given below:

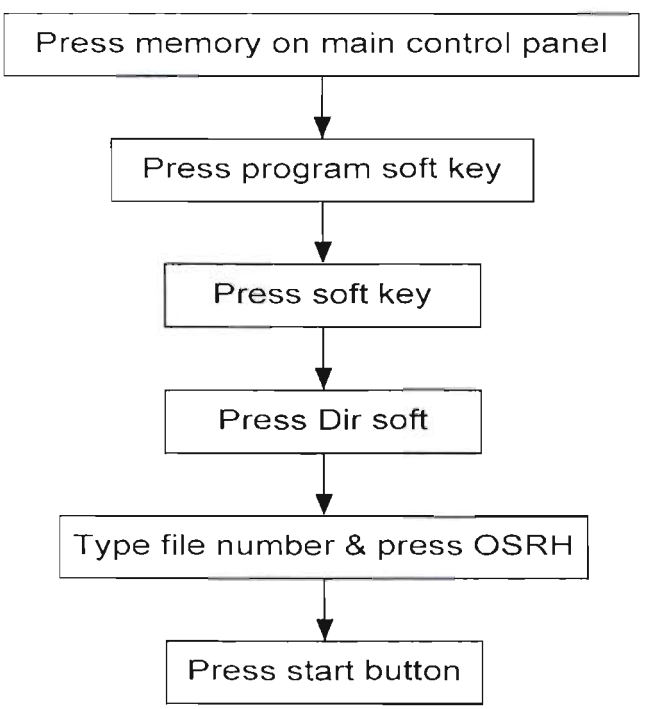

Figure 7.10: Flow chart of how a process on CNC machine works

Chapter 8

PROBLEMS AND RECOMMENDATIONS

Problems:

- The time of internship is too short for the students to learn everything with full devotion.
- Most of the times the internship program conflicts with the university class schedule.
- We hardly had any chance to learn anything practically, but unfortunately it was not within the policy of Energypac. We were just observer.
- The Energypac Company is far way from the residence of the students, and we had to suffer from transportation problems.

Recommendations:

- The length of the internship program should be scheduled at least for 6 months since it is not possible for the students to gather complete knowledge about the 5 departments of Energypac within a very short period. Regarding the benefits of practical exposure, the following recommendations have been put forward for the consideration of the Management of Electric and Electronics Engineering department of East West University.
- The EEE Department should sign MoU (Memorandum of Understanding) with prospective companies like Energypac for ensuring internship program for the students.
- More theoretical and practical knowledge about Power station equipment & Switchgear.

CONCLUSION

In this internship we were able to gather some basic ideas about transformer, switchgear, current transformer, potential transformer, isolator, circuit breaker, and fabrication plant. The manufacturing processes of different types of transformer were observed by us in the transformer section. The Energypac generally make distribution transformer, power transformer, current transformer and the last is potential transformer. We observed several disparities of the working principles of the transformers. For supplying the rated voltage and current distribution transformers are used. On the other hand for generating required power transformers are used. Current and voltage transformer are used for protection purpose of electrical equipments. We observed the full construction of current and voltage transformer.

In switchgear section we saw different types of switchgear panels, such as HT panel, LT panel, PFI panel. We also saw the whole isolator and breaker section. In isolator section we observed three types of isolator: 1. Pantograph 2. Center break 3. Double break. We observed the actual processing mechanism of vacuum circuit breaker. Moreover powder coating, sand blasting, air blasting, and color coding were observed by us in fabrication plant.

In machine shop we observed several kinds of machines and their operating principles. Especially we observed the CNC current pump machine which work completely electrically.

Finally we were introduced with substation. Now we are familiar with substation and its essential equipments. We, think that in future, when we shall begin our carrier in the job sectors, we will be benefited by this internship program.

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