INTERNSHIP REPORT

ON

SUBSTATIONS EQUIPMENTS MANUFACTURING AT NAVANA

By

Shubho Kumer Bhowmik (2007-1-80-003)

Hossain Mahmud Faisal (2007-1-80-010)

Submitted to the

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

In partial fulfillment of the requirements for the degree of
Bachelor of Science in Electrical and Electronic Engineering
(B.Sc. in EEE)

Summer, 2011

Approved By

Dept. Chairperson	Academic Advisor	Academic Advisor
Dr. Anisul Haque	Sharmin R. Ara	Tahseen Kamal
04.10.2011	03.10.2011	02.10.2011

Approval Letter

To whom it may concern

NAVANA

NAVANA ELECTRONICS LTD.
A NAVANA GROUP COMPANY
[illegible]
Telephone No : [illegible]
E-mail : [illegible]

Corporate Office : [illegible]

Date:16th August,2010
To
Deputy Director
Career Counselling Center
East West University
Mohakhali, Dhaka, Bangladesh

Atten: M. Sayeed Alam

Sub: Regarding Industrial Training

Dear Sir,
As per your application, we are agreed to conduct the program for the following schedule.

Name	ID	Major Field	Date
01.Shubho Kumar Bhowmik	2007-1-80-003	Power Engineering	22nd Aug. -5th Sep. 2010
02. Hossain Mahmud Faisal	2007-1-80-010	Power Engineering	22nd Aug. -5th Sep. 2010

The program would be conducted by our Production Manager with the above major fields.

Thanking with regards

16/8/10

(Sujit Kumar Mondol)
Production Manager
Navana Electronics Ltd.

Chittagong Office : [illegible]
Sylhet Office : [illegible]

NAVANA

NAVANA ELECTRONICS LTD.
A NAVANA GROUP COMPANY
GA-9/2, Progati Sarani, Shahajadpur, Gulshan-2, Dhaka-1212, Bangladesh
Telephone No. : 880-2-8818981, 9892653, Fax : 880-2-9886971
E-mail : nel_navana@yahoo.com, Web : www.navana.com

Corporate Office : 12/5/A, Motijheel C/A, 4th Floor, Dhaka-1000, Bangladesh. Telephone : 880-2-9552212, Fax : 8861-2-9569324

TO WHOM IT MAY CONCERN

This is the certify that Mr. Shubho Kumer Bhowmik has completed Industrial training on Power Engineering (Distribution Transformer, Low Tension and High Tension Switchgear, Power Factor Improvement Plant, IPS, UPS & Industrial Voltage Stabilizer) in Navana Electronics Ltd. from 22nd August to 5th September,2010 with great success.

So far I know, he is honest, sincere & motivated to work. I wish for his future success.

SK Mondol

Production Manager

Navana Electronics Ltd

Chittagong Office : 1694, Sk. Mujib Road, Chowmuhani, Chittagong-4100, Ph : 031-251+423, E-mail: navana_ctg@yahoo.com
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TO WHOM IT MAY CONCERN

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Sylhet Office : 6/7, Smrity Bhaban (1st Floor), Mirza Jangal, Sylhet-3100, Ph.: 0821-813495, E-mail: nelsylhet@yahoo.com

Acknowledgment

We had a memorable time during our internship at NAVANA. We very much acknowledge the encouragement and assistance given to us by the people at NAVANA. We are very grateful to NAVANA Electronics Limited for giving us the opportunity to complete our internship in their organization. We want to specifically mention Mr. Sujit Kumar Mondal, who is the production manager of NAVANA Electronics Ltd. for his support and guidance during the internship program at NAVANA.

We are grateful to our honorable supervisors Tahseen Kamal, Senior Lecturer, Department of Electrical & Electronic Engineering, East West University (EWU) and Sharmin Rowshan Ara, Senior Lecturer, Department of Electrical & Electronic Engineering, East West University (EWU) for providing us much needed assistance and diluting time constraints and also for encouraging us to prepare the internship report on "NAVANA Electronics Limited".

We would also like to mention the name of Dr. Anisul Haque, Chairperson and Professor of the Department of Electrical & Electronic Engineering, East West University (EWU) for being so kind during the period of our internship. Finally, We would like to thank some persons who have given us precious time to collect related data for our report and also helped us to understand many related matters and gave their precious time to us more than once, they are Mr. Barun (Head of IPS section); Mr. Kangkan (Head of UPS section); Mr. Binoy Babu (Head of Transformer section); Mr. Enamul (Head of AVR section); of NAVANA Electronics LTD.

Executive Summary

To fulfill the requirements to be a B.Sc Engineer from East West University, we can choose any one option from Industrial Training or Project work. We have chosen Industrial Training. We did our training at NAVANA Electronics Ltd. We did our major in power engineering.

At NAVANA we have gathered our practical knowledge about Distribution transformer, Breaker and Switchgear items (LT, HT and PFI), IPS (Instant Power Supply), UPS (Uninterruptible Power Supply), IVS (Industrial Voltage Stabilizer). We have seen the whole process of manufacturing of the above equipments and also we have seen some testing procedure of the equipments. Before doing this internship we had limited bookish knowledge about transformer, Switchgear, IPS, UPS and IVS. But now we have knowledge about these equipments comparing to before. In transformer section we have seen the whole process step by step. We learnt how to test a transformer. We gathered knowledge about coil winding, core assembly, core-coil assembly, tank up, transformer tank processing. We have also seen the manufacturing steps of distribution transformer and Switchgear items. We have learnt Low Tension (LT) panel and High Tension (HT) panel, what types of breaker are used for LT and HT panel. It has also been made clear to us that why power factor is important and how we can improve power factor by using Power Factor Improvement (PFI) panel and why we use Circuit Breaker, types of Circuit Breaker available. Also we have seen the paint and fabrication process of these items.

Table of Internship Work

When we received the acceptance letter from NAVANA Electronics we found that Engr. Sujit Kumar Mondol, Production Manager of NAVANA Electronics was our mentor assigned by NAVANA for this internship. Though there were different instructors for different sections that we have visited. The list is given below;

Training schedule

Date	Section	Duration	Instructor
22.08.10 - 26.08.10	IPS + UPS Section	4 days	Mr. Barun Kumar Mr. Khokon
27.08 .10 – 31.08.10	Transformer Section	5 days	Mr. Binoy Babu
01.09.10 – 04.09.10	LT, HT and PFI switchgear	4 days	Mr. Binoy Babu
04.09.10-05.09.10	IVS	2 days	Mr. Enamul Mr. John

Working Time: Thursday to Tuesday
10:00 AM to 04:00 PM (1.30 PM to 2.00 PM Lunch Break)

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1. COMPANY INFORMATION AND BACKGROUND

1.1 Company Profile

Navana Electronics Ltd., a prospective company of NAVANA GROUP is running its business since October 1996 under the prominent leadership of Mr. Shafiul Islam Kamal, the successful Chairman of the group. Formerly, Navana Electronics was part of Navana Computers & Technologies Ltd. upto year 2000. After successful completion of the first step, it emerged into a separate physical entity as Navana Electronics Ltd. from Navana Computers & Technologies Ltd.

Strategy

NAVANA electronics LTD. aims to produce products i.e. electronic applications and service of the highest standard to meet the specification, including safety.

Board of Directors

- Mr. Shafiul Islam Kamal – Chairman
  NAVANA Group
- Mr. Saiful Islam Shumon - Vice Chairman
  NAVANA Group
- Mrs. Khaleda Islam – Director
  NAVANA Group
- Mr. Sajedul Islam –Director
  NAVANA Group

Management

- Brig. Gen. Zahirudin Ahmed, ndc (Retd.)
  Advisor,
  Navana Group
- Pijush Kanti Roy
  General Manger
  Navana Electronics Ltd.

- Engr. Sujit Kumar Mondol
  Production Manager
  Navana Electronics Ltd.

- Engr. Abdul Hasnat
  Manager (Marketing & Sales)
  Navana Electronics Ltd.

- Md. Aminuz Zaman
  Manager (Research & Development)
  Navana Electronics Ltd.

- Md. Ekhlaqur Rahman
  Purchase Manager
  Navana Electronics Ltd.

- Dipok Kumar Roy
  Accounts Manager
  Navana Electronics Ltd.

1.2 Origin of this Report

This report based on the internship program. NAVANA Electronics Ltd provided the opportunity to the interns to gather the practical knowledge about the manufacturing of substation equipments. Everyone must carry out a specific project, which is assigned by authorized supervisor. We started our industrial training in the factory of manufacturing substation equipments, located at Gulshan Notunbazar and successfully completed within a period of two weeks.

1.3 Objective of this Report

The first objective of this report is to submit a detailed write up on the internship in NAVANA Electronics Ltd. The internship was concluded as a requirement of the B.Sc. degree in EEE discipline at East West University. The objectives of the internship are summarized below:

- To understand the company management
- To understand the manufacturing process
- To understand the design techniques
- To understand how NAVANA Electronics Ltd runs its business
- Identifying the problems of NAVANA Electronics Ltd
- Recommending how it can be solved
- To get idea about safety
- To get idea about risk in factory

1.4 Scope and Methodology

Scope

The scope incorporates the structure of the factory, manufacturing process, different departments of NAVANA Electronics Ltd. The report comprises an overview of manufacturing of substation equipments of NAVANA Electronics Ltd.

Methodology

This report has been prepared on the basis of

- Information collected from primary sources (primary information has been procured through personal interview as well as discussion with relevant officials of NAVANA).

- Information from secondary sources (secondary data has been gathered by using company website).

1.5 Products of NAVANA Electronics Ltd.

Basically NAVANA Electronics Ltd. makes substational equipments. But they also manufacture some electrical equipment such as:

- Distribution Transformer
- Switchgear (LT, HT and PFI)
- Instant Power Supply (IPS)
- Uninterruptible Power System (UPS)
- Industrial Voltage Stabilizer (IVS)

2. Instant Power Supply (IPS)

2.1 Introduction

In the manufacturing of IPS section we worked for two days (24-08-2010 to 26-08-2010).

IPS is the ideal solution for continuous power supply facilities during power failure. It has the ability to charge the battery in low voltage so we will get sufficient backup in failure of Power.

2.2 NAVANA IPS

NAVANA Instant Power System (IPS) is the ultimate answer to erratic power supply. NAVANA state of the art IPS will automatically ensure power requirement whenever the main power supply is unavailable. Be it children's study time, unbearable hot weather, immediate professional work or favorite TV program, NAVANA IPS is there to give continuous power.

Figure 2.1: IPS

2.3 Circuit Diagram and Working Principle of IPS

Figure 2.2, shows the internal circuit of an IPS (Instant Power Supply). In this diagram, load is connected with the main power line under normal condition. Also IPS transformer gets 220 AC volts from main power line and converted into the 12V DC which is used to recharge the battery (Shown in figure 2).

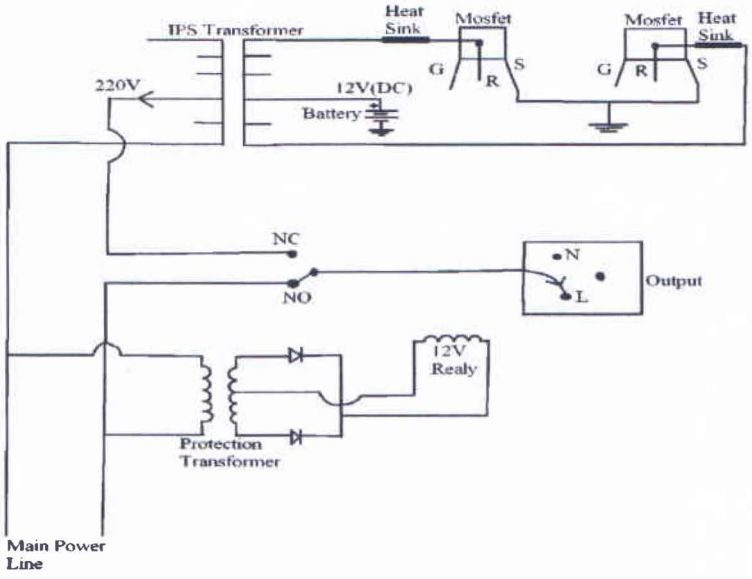


Figure 2.2: Circuit Diagram of an IPS in normal position

Figure 2.3, showed the connection diagram during power failure. The load is disconnected from the main line and connected with the inverter. During in power failure, the battery will provide the power after converting into 220V AC. Mosfet is used for this conversion. Relay is used to sense the normal and abnormal position of the power.

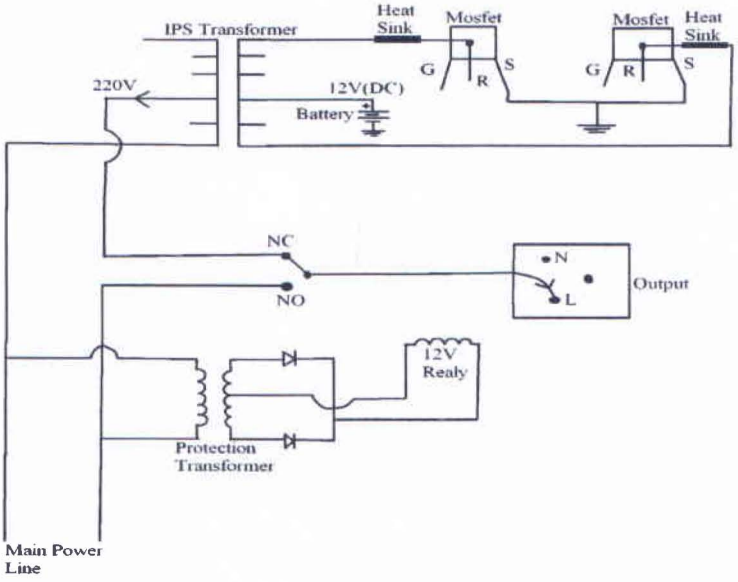


Figure 2.3: Circuit Diagram of an IPS in power failure

2.4 Manufacturing of IPS

Basically IPS consists of six electrical components:

1. **IPS Transformer:** Mainly it converts 12V DC into 220V AC and transfer to the output line when there is no power in main line.
2. **Battery:** Stores the power for use when the power source is interrupted, and determines the length of time the IPS will support the equipment. NAVANA use their own battery.
3. **Relay:** Use to sense the faulty or abnormal position in the circuit and response as early as possible.
4. **Protection Transformer:** Convert 220V AC into 12V DC and supply to the Relay.
5. **Heat Sink:** Use for cooling the circuit and mosfet.
6. **Mosfet:** Use for switching from AC to DC or DC to AC.

2.5 Features of NAVANA IPS

Features of the NAVANA IPS are summarized below

- Built-in-AVR.
- Trouble free back up more than 2 hours.
- Automatic change over.
- Short circuit protection.
- Overload protection system in inverter mode.
- Over charge protection for the battery.
- No need of spare parts or fuel.
- Efficient and reliable.
- Minimum maintenance.
- Silent operation.
- Environment friendly.
- User-friendly.

2.6 Technical Specification

Model		NP301	NP304	NP306	NP307	NP308	NP309	NP313	NP315	NP317
Capacity		200VA	400VA	600VA	750VA	800VA	1000VA	1500VA	2000VA	3000VA
Input	Input Voltage Range	150V-270V								
	Frequency Range	Input Frequency								
Output	Normal O/P Voltage	Same as Input								
	Battery Mode Voltage	220V ± 15%								
	Normal Frequency	Same as Input								
	Battery Mode Frequency	50Hz ± 1%								
	Transfer time	30ms								
	Waveform Distortion	<33%								
Battery	Type	Heavy Duty Battery 12V/50Ah to 155Ah								
	Quantity	1	1	1	2	2	2	2	4	4
	Charging Current	10Amp	10Amp	10Amp	10Amp	10Amp	10Amp	15Amp	15Amp	15Amp
Protection	Overload	Provided								
	Fuse	Provided								
	Short Circuit	Provided								
Others	Operating Temperature	0-45°								
	Operating Humidity	<90% R.H. Non condensing								
	Dimension (LxHxW)	12.5x12 x7.5	20x12 X8	20x12 x8	12x12x 15	12x12x 15	12x12x 15	22x18x 21	20x15.5x 16.5	44x18x 21

2.7 Applications of IPS

NAVANA IPS is designed to meet power requirements of Home/office appliances like light, fan, television, video player, audio- player, fax, PABX, etc and can be plugged-in directly with the mains supply. It is also suitable for households, business centers, offices, conference rooms, restaurants, medical facilities departments, testing labs & apartments etc.

3. UNINTERRUPTIBLE POWER SUPPLY (UPS)

3.1 Introduction

In the manufacturing of UPS section we worked for two days (22-08-2010 to 23-08-2010).

An Uninterruptible Power Supply is a device that connects a device to a power supply, to prevent undesired features of the power source like outages, sags, surges, bad harmonics, etc. The irregularities of supply voltage adversely affect the performance of the device. UPS systems can be set up to alert file servers to shut down in an orderly manner when an outage has occurred, and the batteries are running out.

There are three types of UPS

1. Line Interactive UPS
2. Offline UPS
3. Online UPS

Line **Interactive UPS** – This is a modified form of the original UPS system in which there is a regulator to keep the current coming into the device at a steady flow.

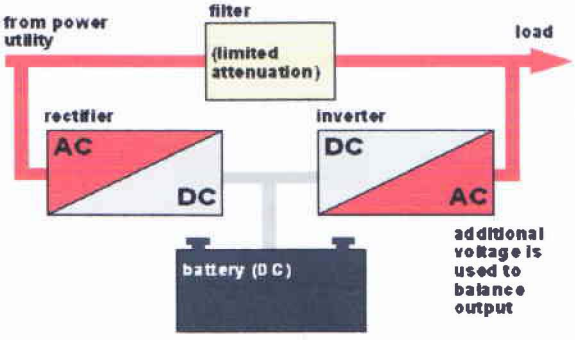


Figure 3.1: Block Diagram of Line Interactive UPS

Offline **UPS**- This is the most common type of UPS found in a computer or office supply store. It draws current from the AC outlet and switches to battery within a few milliseconds after detecting a power failure.

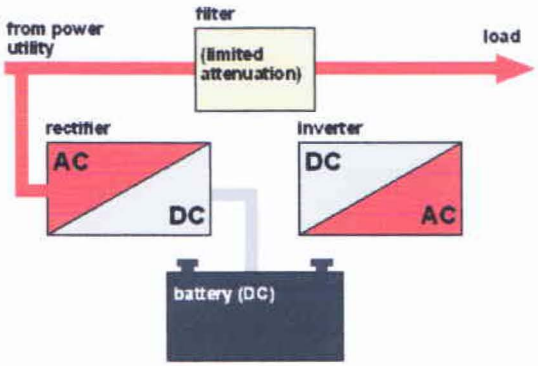


Figure 3.2: Block Diagram of Offline UPS

Online UPS- The online UPS is the most advanced and most costly UPS. The inverter is continuously providing clean power from the battery, and the computer equipment is never receiving power directly from the AC outlet. However, online units contain cooling fans, which do make noise and may require some location planning for the home user or small office.

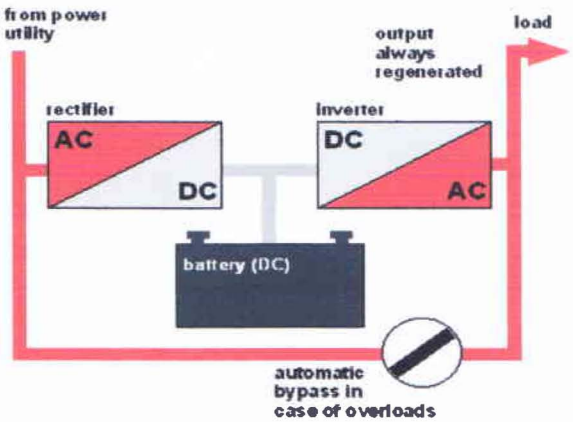


Figure 3.3: Block Diagram of Online UPS

3.2 NAVANA UPS

NAVANA Uninterruptible Power Supply (UPS) gives the uninterruptible power when there is power failure. Basically NAVANA Electronics manufacture the offline UPS. It will protect the computer and others electrical equipment from high voltage or low voltage or short circuit. It will give quality service to protect the PCs from any kind of power failure.

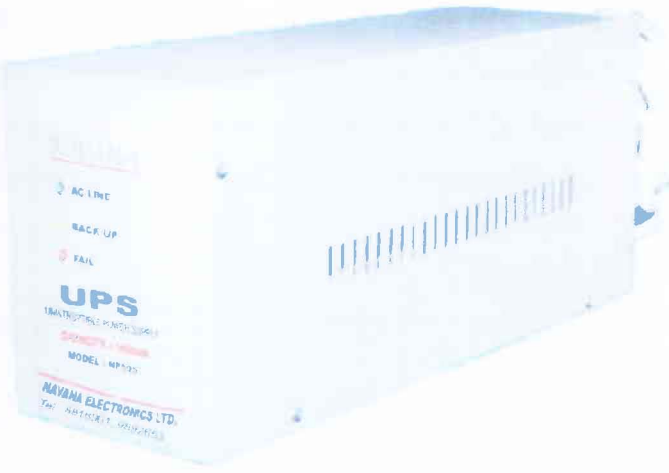


Figure 3.4: NAVANA UPS

3.3 Circuit Diagram and Working Principle of UPS

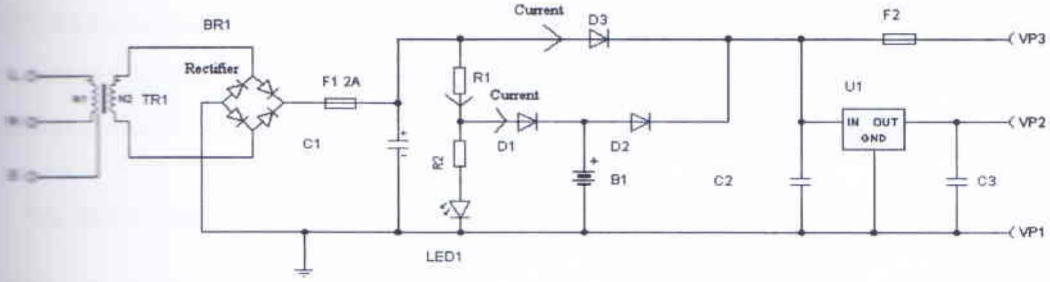


Figure 3.5: Basic Circuit Diagram in normal position

TR1= Transformer

BR1= Rectifier

C1=C2=C3= Capacitor

D1=D2=D3=D4= Diode

R1=R2= Resistance

F1=F2= Regulator

This is the circuit diagram of a simple UPS. This UPS can deliver 12V unregulated and 5V regulated DC. The input to the primary winding of the transformer (TR1) is 220V AC. It steps

down the mains voltage to 12V AC. After that the bridge BR1 rectifies it. The rectified signal is smoothed by the capacitor C1. When the mains supply is available the battery will be charged via diode D1 and the regulator IC gets supply via diode D3 (in figure 7). 12V and 5V DC will be available at the output terminals VP3 and VP2. The presence of electricity will cause the LED 1 to light.

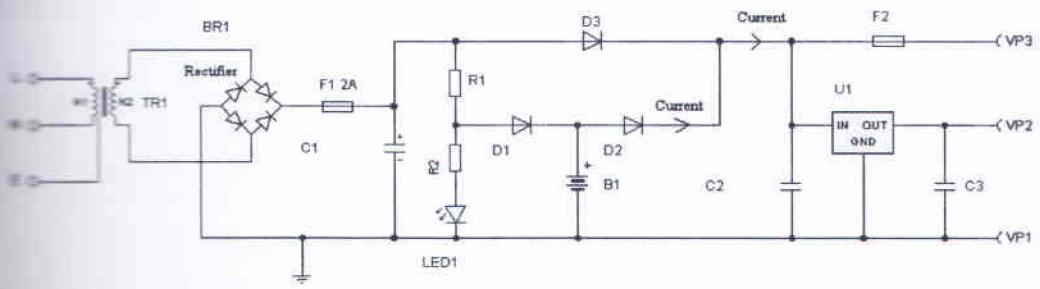


Figure 3.6: Basic Circuit Diagram in no power in main line

When main power supply is turned off, the battery will supply current to the regulator IC and to the 12V DC terminal through diode D2 (in figure 8).Also, the diode D3 blocks reverse flow of current during battery mode. Capacitors C2 and C3 acts as filters. Led1 is turned off when the power line is down.

3.4 Manufacturing Equipments

The UPS consists of three main components:

1. Rectifier: Rectifier converts AC into direct current (DC). It has two main functions: First, the alternating current (AC) into direct current (DC), through the supply of filtered load, or the supply inverter; second, to provide battery charging voltage. Therefore, it also plays a role in charger.

2. Battery: UPS battery is used as an energy storage device, which consists of several cells in series. Its size determines the discharge (supply) time. Its main function is: When the electricity is normal, the electrical energy converted into chemical energy stored in the battery internal; when the electricity fails, the stored chemical energy convert to electrical energy and supplied to the load. HAVANA Electronics use their own batteries which are manufacture in Chittagong factory.

3. Inverter: Converts the battery DC power into AC power for the equipment. The inverter supplies uninterrupted power to the computer just as the battery provides uninterrupted power to the inverter.

Transformer: Primary winding take 240 volt AC from the main line and convert into 12 volts DC for running 2 amp current. Secondary winding voltage ranges from 12V to 15 volt.

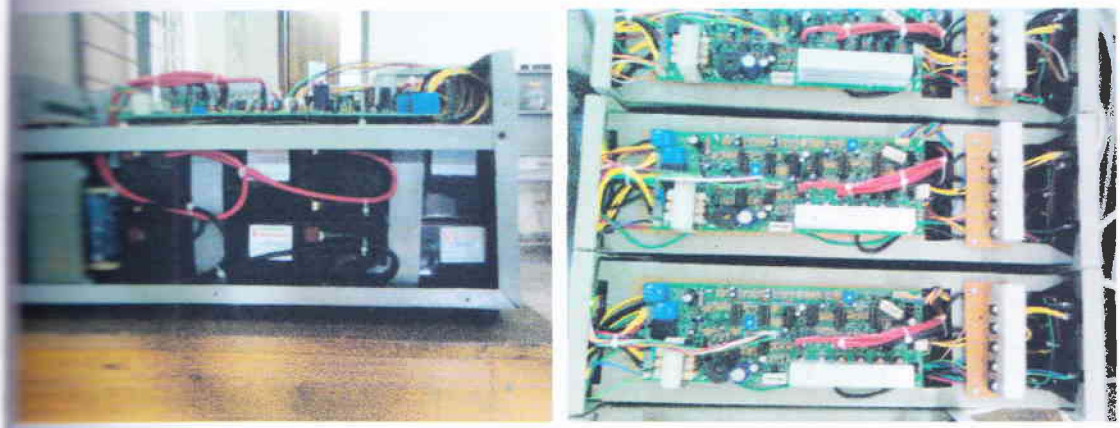


Figure 3.7: UPS Circuit & Battery

3.5 Features of NAVANA UPS

Features of NAVANA Electronics Ltd. are summarized below:

- UPS built in AVR (Automatic Voltage Regulator) gives a wide range of choice of input voltage for PC & LAN.
- Ensure switching on the equipment even in the absence of main power.
- Automatically stops discharging the battery below critical level.
- Back-up supply is automatically disconnected at no load.
- Rate of charging current is automatically adjusted.
- High low voltage protection
- Environment friendly.
- User-friendly.
- Cold Start & smart shut off.

3.6 Technical Specification

MODEL		NP101	NP102	NP103	NP104	NP105	NP106	NP107	NP108
Capacity		500VA	600VA	650VA	800VA	1000VA	1250VA	1500VA	2000VA
Input	Voltage	120V-240V	150V-250V	160V-275V	175V-300V	As requested			
	Frequency	50/60Hz ± 0.5%							
	Voltage (AC)	220V ± 5%-8%							
	Voltage (Inverter)	220V ± 5%							
Output	Frequency	50Hz							
	Waveform	Synchronized Stepped Square							
	Transfer Time	<2ms							
Battery	Type	Sealed Lead Acid Maintenance free							
	Recharge Time	Max. 8 hours (full charge)							
Protection	Overload	AC Mode: Fuse			Inverter Mode: Electronic Circuit and Shut down				
	Short	AC Mode: Fuse			Inverter Mode: Electronic Circuit and Shut down				
	Battery	UPS shut down at 90% discharged battery							
LED Display	Line Normal	Green LED							
	Inverter	Yellow Led							
	Fail	Red Led							
Alarm	Battery Low	High Frequency Beep							
	Normal Load	Low Frequency Beep							
Filter	EMI/RFI Filter	In according with IEC 801-3 RF immunity							
Surge Protection		Maximum energy: 117 joules/2ms, clamped voltage 775V/50A							
Audible Noise		<40db							
Relative Humidity		95% maximum non-condensing							
Dimension	LxHxW	13x6x4	13x6x4	13x6x4	14x7.5x5	14x7.5x5.5	14x7.5x5.5	16x11x9	17x10.5x12
Weight	Gross/Net	8.2/8.1	9.1/9	9.65/9.5	10.65/10.5	12.4/12.25	15.15/15	20.15/20	27.20/20
Standard Backup Time		May be increased as requested							
Full Load		15	15	15	15	15	15	15	15
Half Load		30	30	30	30	30	30	30	30
Special features		Cold Start Smart Shut off			Interfacing Software (Optional)				

3.7 Application of NAVANA UPS

There are lots of applications for UPS which are given below:

- Uninterruptible power for Computer.
- Protect the Computer and electrical equipments from high voltage or short circuit.
- Optimizing Uninterruptible Power for Modern Data Processing Equipment.
- An Uninterruptible Power Supply for the SRS.
- Three-Phase Uninterruptible Power Supply (UPS) for Emergency Lighting Applications.
- Uninterruptible Power for Traffic Signal Applications.

4. INDUSTRIAL VOLTAGE STABILIZER (IVS)

4.1 Introduction

In the manufacturing of IVS section we worked for two days (04-09-2010 to 05-08-2010). NAVANA Industrial Voltage Stabilizer (IVS) is a prime product of NAVAVA Electronics Ltd. This state of the art technology of international repute, is fully automatic and completely reliable, designed with Servo/ Relay control (as per customer's choice / load) type system with necessary protecting circuit. Even in the prevailing erratic power supply scenarios of the country NAVANA IVS will provide a smooth and stable voltage. All possible power hazards like frequent voltage fluctuation, surge, spike, blackout, sag etc will not damage valuable machinery or hamper the production once they are protected by NAVANA IVS. As a result, protection system can run more smoothly, resulting in higher profit.

Figure 4.1: IVS

Nearly ninety percent of our industrial loads are inductive. On the other hand the supply voltage is very erratic and fluctuates between extreme limits, causing a higher draw of load current. This high current produces higher power losses in electric motor, which causes permanent damage in the winding of motor, and also increases the electric bill. This high current in electric motor will not only reduce the life of the motor along with associates cables, switches, transformer and others equipment, it may also cause accidental fire.

4.2 General Operation

The Steady volt units consist of a motorized the variac. The variac either used directly to supply the load or in combination with an isolation transformer in a Buck-Boost configuration. The output of the unit is controlled automatically with a feedback sensing circuit that operates the motor drive unit on the variac to prevent over voltage or under voltage situations. The units respond to input mains fluctuations restoring the output voltage smoothly back within the operating tolerance. Typical Recovery rates are 35V/sec. The units also have under voltage and over voltage tripping to disconnect the output in the event the input fluctuation exceeds the designed limits for more than 5 seconds.

4.3 Circuit Diagram and Manufacturing Equipments:

Basic Circuit Diagram

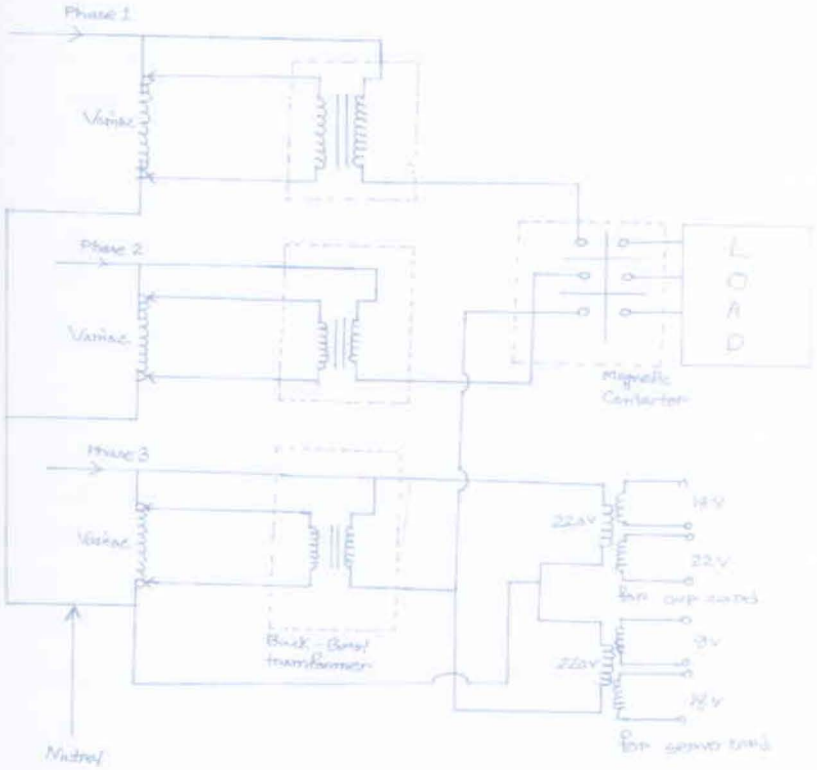


Figure 4.2: Circuit Diagram of an IVS

Manufacturing Equipments

- **Circuit Breakers (Air type & oil type):** In IVS, Two types of circuit breakers are used. Air type circuit breaker and Oil type circuit breaker. Air type circuit breaker is in the circuit and oil type is use in the load.

- **Magnetic Contactor:** A contactor is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. In IVS, there are two magnetic contactors. One is directly connected with main line and other one is connected with stabilizer. When stabilizer is on, the second one is stared.

- **Relay:** Relays are used where it is necessary to control a circuit by a low-power signal. In IVS, relay are use for detect and isolate faults on transmission lines by opening and closing circuit breakers.

- **Synchronous Motor (3 phase):** There are three synchronous motors using in an IVS. It is a 3 phase voltage stabilizer. That's why it needs three synchronous motors. This motor makes the electrical energy which is supplied to the load.

- **Limit Switch:** In IVS, limit switch are using for on/off. If the voltage range is less then 180V, IVS will start working. If the voltage range is greater then 270V then IVS will also start working.

- **Shaft:** Shaft is used to move the motors reverse or forward. If voltage is increases, shaft will move the motors reverse to decrease the voltage. If voltage is decreases, shaft will move the motors forward to increase the voltage.

- **Variac or Auto Transformer:** An autotransformer is an electrical transformer with only one winding. In an autotransformer, same winding act as both the primary and secondary. Auto transformer is the backbone of an IVS.

- **Buck boost Transformer:** A buck–boost transformer is a type of autotransformer used to make small adjustments to the voltage applied to alternating current equipment. In IVS, this buck boost transformer can increase the voltage range. Also decrease the voltage range when it need.

- **Servo Card:** Servo card will command the relay when voltage is up/down.

- **Control Module:** Control module will supply the power in servo card and over voltage protector.

- **Toggle Switch:** Using for control the Magnetic Contactor (MC) in stabilizer mode or main power line mode.

- **Selector Switch:** Selector switch select that device will work in single phase or three phase.
- **Cooling Fan:** Using for cooling the circuit and other equipment and remove the hot air from the machine.

Operating Mechanism

The unit contains a regulator controlled PCB card that continuously senses the output voltage of the unit. The card compares this voltage to a reference voltage using a comparator circuit. The output of comparator is used to switch relays controlling the mains supply to the drive motor on the variac. The reference voltage is adjusted higher or lower by the comparator circuit output to prevent the motor drive from continuously oscillating around a fixed voltage point.

Figure 4.3: Inside of an IVS

Auto Mode

With the unit set in 'Auto-mode, the IVS will senses the parameter and run automatically. The stabilizer continuously controls the output to maintain the output voltage within permisible limits via the regulation control PCB.

Manual Mode

Manual mode is provided as a mean to test and adjust the stabilizer. Manual mode has two switches. First switch is used to increase the voltage. As the output goes high the LED indicator will glow. Repeat the process for decreasing, the voltage and the other phases of a three phase unit. After testing, the switches are returned to the Auto Mode and check the voltage returns to the required level.

Technical Specification

	Single Phase	Three Phase
	1 KVA- 30 KVA As requested (optional)	3 KVA- 1000 KVA As requested (optional)
	160V- 260V/ 140V- 280V/ As requested (optional)	300V- 460V/ 250V- 480V/ As requested (optional)
	220V/ 230V/ 240V (continuous) As requested (optional)	380V/ 400V/ 415V (continuous) As requested (optional)
	50 Hz	50 Hz
	Servo Type	Servo Type/ Magnetic contract switching
accuracy	± 1% To ± 3%	± 1% To ± 3%
speed	30 – 50 V/ S	30 – 50 V/ S
Suppression	Above 270 volt	Above 460 volt
distortion	Nil	Nil
factor effect	Nil	
	Maximum 45° C	
	Maximum 98° C (Non condensing)	
	Natural air/ forced air/ oil cooled	
	100% Continuous	
	High & low voltage (auto restart), Phase Failure, Sag, Surge, Spike, Over Load, Short Circuit, Delay Time for Voltage Fluctuating.	
Other Capacity/ Type (on request)		

of their constant endeavor to improve the quality and design of their products we reserve the right to alter or change any specification/ Technical data/ design without any prior notice.

Features of NAVANA IVS

of the NAVANA IVS are summarized below:

- Fully automatic & solid control.
- Robust and extremely reliable in operation.
- Input & output voltage of each phase is monitored separately.
- Auto/ manual operation (optional).
- LED indication for all modes of operation.
- Very high regulation (±1% to ±3%).
- Maximum protection provided.

- Ensure smooth output with available power.
- Wide range of choice of input voltage (as per customer choice).
- International safety standard.
- Minimum maintenance.
- Environmental friendly.
- User- friendly.

4.7 Advantages of IVS

There are some advantages using the IVS. Those advantages are:

- Automatically corrects voltage on regular intervals.
- When supplied with constant voltage, synchronous motors operate very efficiently.
- Protects expensive electrical equipments from menace of voltage fluctuation thus lowers the cost of maintenance.
- Better efficiency in plant with less production losses.
- Increased productivity rate.
- 100% depreciation as per Income Tax Act.
- Reduces the electricity bills approximately up to 15% (This also depends on the input variation loading and the number of working hours).
- As the generator is not required to run at High/Low input voltage thus it saves on diesel cost.
- The average pay back period of Servo Controlled Voltage Stabilizer owing to its high energy saving capability this is approx. 18 months.

4.3 Application of IVS

There are lots of applications of an IVS. But the important ones are listed below:

- Computer System
- Satellite System
- Defense Equipment
- Plastic Industry
- Textile Industry
- Tannery Industry
- Flours Industry
- Hotels
- Tea state
- Color Lab equipment
- Pharmaceutical Industry
- Scientific & Lab Equipment
- Oil Industry
- Printing Industry
- Cosmetic Industry
- Engineering Industry
- Rubber Industry
- Leather Industry
- Communication Industry
- Lift
- Fertilizer Industry
- Garments Industry
- Cold Storage
- Paper Mills

5. Transformer

5.1 Introduction

We worked in this section for five days (27-08-2010 to 31-08-2010).

To keep pace with the present trend of load growth of electrical power requirement, the existing distribution system and its capacity need to be modified and upgraded, especially in the urban area. With a view to improve the power quality, the electric supply authority has recently introduced a rule for new connection. Any consumer having more than 50KVA demand has to have a separated 11/ .415 KV Indoor/ Outdoor Sub-station. This strategy will enable the supply authority to meet the demand maintaining good power quality during peak and off-peak hour without bring much changes in the existing LT network.

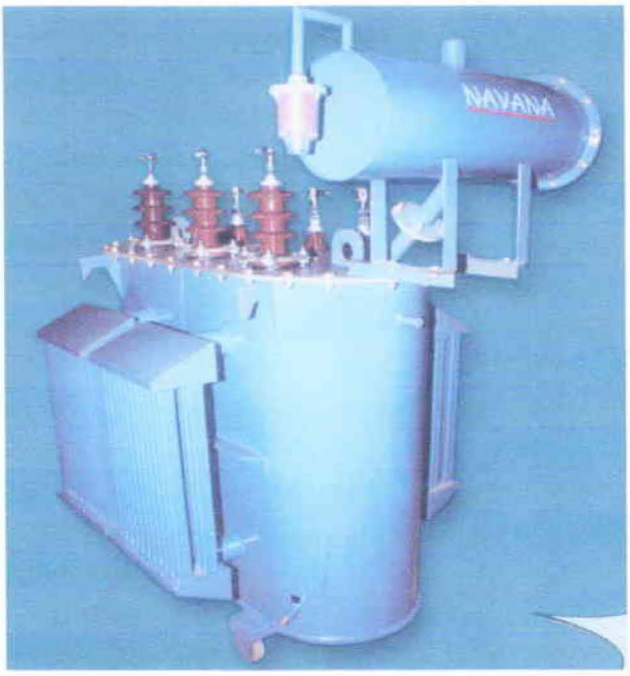


Figure 5.1: Distribution Transformer

5.2 Transformer Manufacturing Process

NAVANA Electronics do not manufacture power transformer, they only manufacture distribution transformer. Transformer is the heart of a Sub-station. It is a static device by means of which electric power is transferred from one end to another at same frequency. For indoor Sub-station, it transfers power from 11 KV to .415 KV, which is usable voltage for the user.

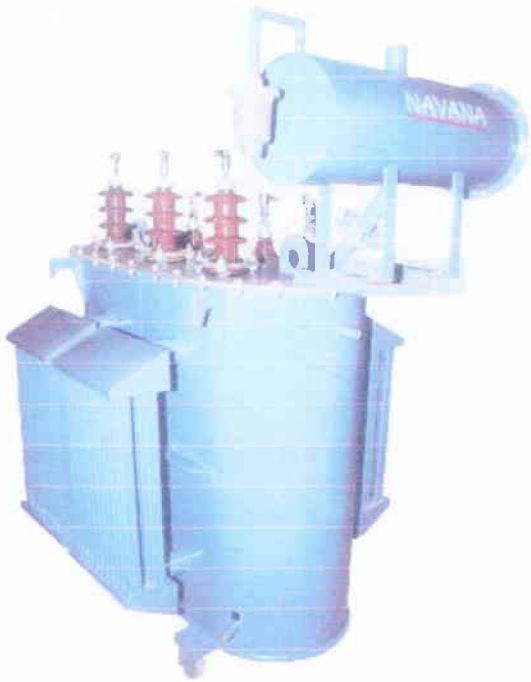


Figure 5.2: Distribution Transformer

5.2.1 Design

To manufacture the first step is to design. A transformer is designed based on customer demand. Suppose DPDC and DESCO are two big customers of NAVANA electronics ltd. Their requirements are different from one another. According to the customer requirement the designers of NAVANA electronics design the transformer. While designing the designer has to design the structure, core diameter, insulation label, cooling system, tapping system, coil thickness, tank and conservator and many other things. The design was not revealed to us because of company privacy.

5.2.2 Coil Winding

Windings are made up to provide rigidity to resist movement and distortion caused by abnormal operating conditions. Adequate barriers are provided between windings and core and between high voltage and low voltage windings. NAVANA uses Low Tension (LT) winding machine to generate coils. Here, three types of coil are necessary High Voltage (H.V) coil, Low Voltage (L.V) coil and Tap Changing coil. H.V coil is thin, because in H.T (high tension) side voltage is high and current is low so, the coil has to carry low rate of current. L.V coil is thick, because in L.T (low tension) side voltage is low and current is high so, the coil have to carry high rate of current. This coil is also used for tap changing. The coil size is of H.V coil, L.V coil and Tap Changer depends on voltage rating. It may KVA or MVA rating and design issues. H.V coil is cylindrical shape where as L.V coil is rectangular in shape.

5.2.3 Bare Bushing

Both High Voltage and low Voltage sides are terminated with bare bushing. The LV bushings are mounted on the top. However side mounted LV bushings can be provided on request.

5.2.4 Core Assembly

The transformer core is a closed magnetic circuit that contains mutual flux which links with both the windows. NAVANA uses the core material of high quality and design the construction in such a manner that both the magnetizing current and core losses are minimum. The cores of transformers are laminated in order to reduce the eddy current losses. NAVANA uses cold rolled grain oriented steel which has the maximum permeability in the direction of grain orientation, which also causes the iron loss and the no load current minimum.

Transformer cores are made of high permeable cold rolled grain oriented (CRGO) electrical steel insulated on both sides mostly imported from Japan, Europe, and USA. CRGO steel is a "delicate" steel to be handled with care. As the magnetic property of the steel and not the tensile strength (as is the case with most other steels) is the important quality required, it is imperative that we understand the hazards in handling, storing and processing of this steel. If these are not done properly, it ultimately leads to higher losses and the results are not as per design.

5.2.5 Manual Core Cutter

In manual core cutting machine the operator just fix the size of class by scale. Then steel sheet is inserted to machine from one side. Then they give pressure to the handle of core cutter and the desired piece of steel is found on the other side. The whole process is fully manual.

Figure 5.3: Manual Core Cutter

Features of Manual Core Cutter are

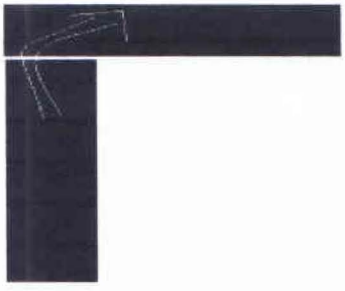
- Razor clean cuts.
- Easy to change disposable utility blades.
- Compact bench top design.
- Core stop and scale for repeatability and accuracy.
- For cutting or recycling a damaged core, it is simply cut around the bad spot.

Cautions for Manual Core Cutting machine are

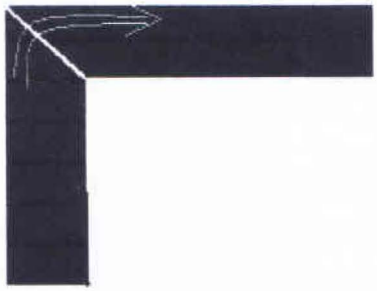
- Must be careful that the design dimension is right.
- Should be careful before punching the core.

5.2.6 Core cutting

NAVANA use normal core cutting for low KVA rating transformer like Current transformer (CT) and Potential transformer (PT), Auto core cutting for Power and Distribution transformer. In Normal core cutting they cut the steel sheet in 90^0 angles. In Auto core cutting they cut the steel sheet in 45^0 angles. Due to the cutting angle the flux passing cross area in auto cutting is bigger than normal cutting. So in normal cutting there is some loss of flux but in auto cutting there is no loss of flux.



(a) Normal core cutting



(b) Auto core cutting

Figure 5.4: The core cutting approaches NAVANA uses

5.2.7 Core and Coil Assembly

Figure 5.5: Core setup process

After cutting the steel sheet with the help of iron frame the sheets are organized. Then it looks like a frame. After doing this insulation tape is rolled around it. The insulation tape is surrounded because it helps the transformer to stay compact so that no loss of flux occurs and if flux gets any released from the system then it can cause an accident.

5.2.8 Insulation Drying

Construction of oil-filled transformers requires that the insulation covering the windings be thoroughly dried before the oil is introduced. NAVANA uses several different methods of drying. Common for all is that they are carried out in vacuum environment. The vacuum makes it difficult to transfer energy (heat) to the insulation. For this they use several different methods. The traditional drying is done by circulating hot air over the active part and cycles this with periods of vacuum (hot-air vacuum drying, HAV). Generally, for larger transformers is to use evaporated solvent which condenses on the colder active part. The benefit is that the entire process can be carried out at lower pressure and without influence of added oxygen. This process is commonly called vapors-phase drying (VPD).

For distribution transformers, which are smaller and have a smaller insulation weight, they use resistance heating. This is a method where current is injected in the windings to heat the insulation. The benefit is that the heating can be controlled very well and it is energy efficient. The method is called low-frequency heating (LFH) since the current is injected at a much lower frequency than the nominal of the grid, which is normally 50 or 60 Hz. A lower frequency reduces the effect of the inductance in the transformer, so the voltage can be reduced.

5.2.9 Setting tap changer

NAVANA uses the tap changer, made of high quality homogenous insulating board or synthetic regain mounted below oil level for changing the connections of taps in primary windings.

5.2.10. LT and HT Connection

Generally the Transformers that are made by NAVANA electronics are either Delta to Y or Y to delta connected. If High voltage side Delta connected then Low Voltage side Y connected and vice versa.

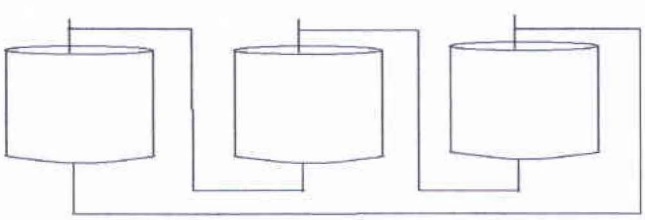


Figure 5.6: Delta connection

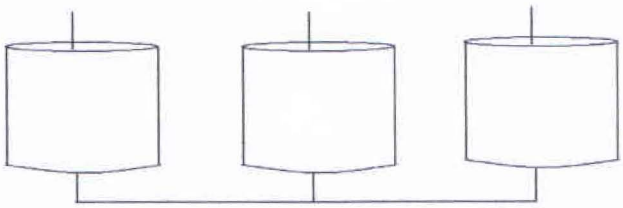


Figure 5.7: Y- Connection

5.2.11. Vacuum Drying Process

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

5.2.12. Transformer Tank Construction

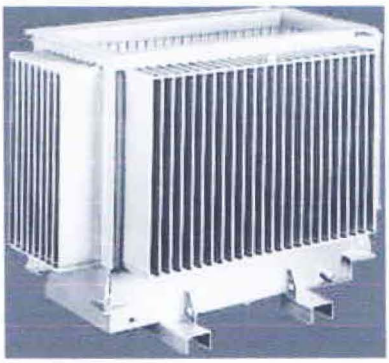


Figure 5.8: Transformer tank

NAVANA tank bodies, for the transformers are made from rolled steel plates which are fabricated to form the container. The tanks are provided with lifting lugs also pipe and valves to direct and control of air flow. During design of transformer NAVANA considers a large number of factors to improve the ability including the weight, stray load losses low.

5.2.13. Tank Paint Process

The following process NAVANA follows during paint the tank

- The surface of the outside tank is achieved a very fine and smooth finish.
- Reduce to particle or powders by crushing from transformer tank.
- 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.

5.2.14. Tank up

The following tank up process followed by NAVANA

- The core-coil assembly is taken out of the oven or vacuum dry process.
- Then they are assembling for tank-up.
- The tanks, supplied by fabrication dept. are brought to tank-up department duly painted.

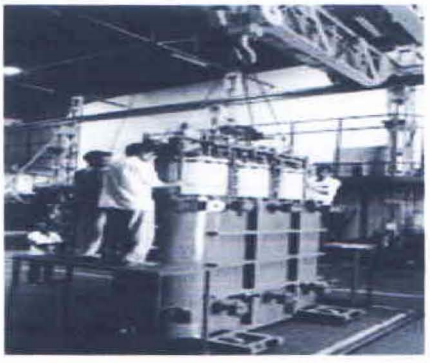


Figure 5.9: Transformer Tank up process

- Fittings like drain valves, HV & LV Bushings, conservator, oil level indicator and explosion vent are fitted in the tanks.
- The Core-coil assembly is then placed into the tank and properly locked up.
- Pure filtered transformer oil is filled in the tank to immerse the assembly only.
- Connections of primary and secondary to the terminal bushings are made. Operating handle for ratio switch is fitted, wherever required.

5.3. Some important steps that NAVANA follows during Manufacturing

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

To keep same circumcircle of the transformer NAVANA uses different sizes of HT and LT Coil. In general they keep HT coil bigger than LT coil.

5.4. Protection of transformer

Protection is for safety of transformer. There are some protection systems that NAVANA use in transformer.

5.4.1. Transformer Oil

One of the most important factors which determine the life and optimum operation of a transformer is the oil, in which it is immersed. The transformer oil having highly dielectric strength is used by NAVANA to assure the following two prime functions:

- Create a required level of insulation
- Provides a cooling medium.

5.4.2. Thermal Protection

In thermal protection we have seen, they used a thermometer to detect the temperature of oil and winding. There are two types of thermal protection

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

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

5.4.3. Bushing

The bushings consists of current carrying part in the form of a conducting rod, bus or cable a porcelain cylinder installed in a hole in the transformer cover and used for isolating the current carrying apart. The bushing is a molded high quality glazed porcelain insulator with a conductor through its centre, manufactured by BISF in Bangladesh.

5.4.4. Oil Level Indicator

Oil is used for insulation so if the oil is not of proper level then insulation does not work properly. There is an indicator that's indicates the oil level inside the transformer. Also the oil quality is checked. If the quality of oil decreases to a certain level then NAVANA refines the oil.

5.5. Testing of Transformer

The following tests are carried out before marketing any NAVANA transformers

- Insulation resistance test
- Winding resistance measurement
- Turn Ratio test
- Polarity test and phase ratio test.
- No load test
- Load losses at 50%, 75% and 100% rated load
- Percentage impedance test
- Temperature rise test
- Power frequency high voltage withstand test
- Dielectric test of transformer oil
- Oil loss factor (tan α test)

5.5.1. Insulation Resistance Test

The winding insulation resistance test (also known as the Meggar test) is a measure of quality of insulation within the transformer. It can vary due to moisture content, cleanliness and the temperature of the insulation parts. All measurements are corrected to 20°C for comparison

purposes. It is recommended that tank and core are always grounded when this test is performed. Each winding should be short-circuited at the bushing terminals. Resistances are then measured between each winding and all other windings and ground. The Megger meter is hold between HT-LTG (LT is grounded), LT-HTG (HT is grounded) and HTLT-G. This test is done by Meg ohmmeter.

5.5.2. Winding Resistance Measurement

This is nothing but the resistance measurement of the windings by applying a small d.c voltage to the winding and measuring the current through the same. The ratio gives the winding resistance, more commonly feasible with high voltage windings. For low voltage windings a resistance-bridge method can be used.

5.5.3. Polarity Test

This is needed for identifying the primary and secondary phasor polarities. It is a must for poly phase connections. Both a.c. and d.c methods can be used for detecting the polarities of the induced emfs. The dot method is used to indicate the polarities.

5.5.4. No Load Test

During our internship we have not seen this test but our instructor gave us some theoretical knowledge about this. The no-load test has the purpose of determining the no-load current (I_0), the power ($P_{0)}$ and the power factor (cosj). The power P_0 represents the no-load losses of the transformer, which are the result of the addition of hysteresis losses and parasitic currents in the core, the thermal effect being negligible. This test can be performed by indifferently supplying the primary or secondary winding of the transformer, but by keeping the not used winding open.

5.5.5. Turns Ratio

Turns ratio test is very important in order to find out that the transformer has the right ratio Corresponding to its rated voltage in primary and secondary.

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's ratio is measured with the help of a turn's ratio meter. If it is correct, then the voltage ratio is assumed to be correct.

Equipment used: Turns Ratio meter.

5.5.6. Temperature Rise Test

The purpose is to check that the temperature rises of the active part of the transformer: oil, windings, core, do not exceed the limits agreed on or by the standards.

The test system is different whether we have to carry out the temperature rise test on one transformer liquid filled (oil or silicone liquid) or dry-type. In fact in this case they use the short-circuit method while in the second case they use the back-to-back method.

5.6. Features of NAVANA Transformer

NAVANA ensures in their distribution transformer low loss and high efficiency by using cold rolled grain oriented silicon steel with high permeability. Transformer tank is filled with oil under vacuum thus improving the complete penetration of insulating liquid. The coil-to-coil and low coil-to-ground capacitance ratio provides distribution of surge voltage over the entire coil. Paraffin based mineral oil is used for best cooling effect. Dual thermometer with or without contacts and Buchholz relay are used as per customer request.

5.7. Technical Specification of Distribution Transformer

The following table depicts the specifications of NAVANA distribution transformers

Table 2.1: Technical specification of Distribution Transformers

Load Power (KVA)	50	100	150	200	250	315	400	500
No Load loss (W)	150	230	280	350	450	520	750	850
Load Loss at 75°C (W)	800	1580	2280	2850	3150	2950	3800	4400
Impedence at 75°C (%)	4.1	4.2	4.3	4.6	4.1	4.4	4.05	4.75
Regulation at p.f=1 (%)	1.75	1.41	1.3	1.10	1.08	1.04	0.987	0.941
Regulation p.f=0.8 (%)	3.54	3.36	3.29	3.17	3.16	3.41	3.37	3.34
Efficiencies at p.f=1								
Load100% (%)	98	98.42	98.6	98.79	98.81	98.89	98.95	99
Load75% (%)	98.31	98.68	98.82	98.98	99	99.06	99.12	99.16
Load50% (%)	98.52	98.85	98.98	99.11	99.13	99.29	99.23	99.27
Load25% (%)	99.3	98.71	98.5/6	98.98	99.02	99.08	99.13	99.17
Efficiencies at p.f=0.8								
Load 100% (%)	97.5	98.03	98.26	98.48	98.51	98.61	98.68	98.75
Load 75 % (%)	97.89	98.34	98.53	98.72	98.75	98.83	98.98	99.95
Load 50% (%)	98.15	98.56	98.72	98.88	98.91	98.98	99.04	98.09
Load 25% (%)	97.88	98.38	98.55	98.73	98.77	98.85	98.91	98.97
Total weight (kg)	400	600	760	4000	4450	1360	1400	1795
Dimention	xwxh 40"x	lxwxh 45"x 40"x 58"	lxwxh 52"x 39"x 63"	lxwxh 50"x 42"x 66"	lxwxh 55"x 43"x 70"	lxwxh		

Load Power (KVA)	630	750	800	1000	1250	1600	2000	2500	3000
No Load loss (W)	910	900	990	1180	1360	1670	1950	2260	2950
Load Loss at 75°C (W)	5100	6400	6800	8200	1000	12400	15000	18000	24500
Impedence at 75°C (%)	6	6	6	6	6	6	6	6	6
Regulation at p.f=1 (%)	0.987	0.9	1.03	1	0.98	0.95	0.93	0.9	0.83
Regulation at p.f=0.8	4.2364	4.27	4.33	4.31	4.3	4.28	4.26	4.24	4.23
Efficiencies at p.f=1									
Load100% (%)	99.05	99.04	99.03	99.06	99.09	99.12	99.15	99.19	99.09
Load75% (%)	99.2	99.21	99.2	99.23	99.25	99.28	99.31	99.34	99.26
Load50% (%)	99.31	99.34	99.33	99.35	99.38	99.4	99.43	99.46	99.4
Load25% (%)	99.22	99.31	99.29	99.32	99.36	99.39	99.42	99.46	99.41
Efficiencies at p.f=0.8									
Load 100% (%)	99.81	98.8	98.78	98.83	98.86	98.9	98.94	98.99	98.87
Load 75 % (%)	99	99.01	99	99.03	99.07	99.1	99.13	99.17	99.08
Load 50% (%)	99.13	99.18	99.16	99.19	99.23	99.25	99.29	99.32	99.25
Load 25% (%)	99.02	99.14	99.12	99.15	9921	99.24	99.28	99.32	99.26
Total weight (kg)	2540	2800	2875	3000	3900	4900	5650	7500	9400
Dimention									

6. Switchgear

6.1 Introduction

In this section we worked for five days (01-09-2010 to 04-09-2010).

The term switchgear, used in association with the electric power system, or grid, refers to the combination of electrical disconnects, fuses and/or circuit breakers used to isolate electrical equipment. Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream. This type of equipment is important because it is directly linked to the reliability of the electricity supply. The basic functions of switchgear is protection, which is interruption of short-circuit and overload fault currents while maintaining service to unaffected circuits. Switchgear also provides isolation of circuits from power supplies. Switchgear is also used to enhance system availability by allowing more than one source to feed a load.

Two types of Switchgear are manufactured by NAVANA

1. Low Tension (LT) Switchgear
2. High Tension (HT) Switchgear

6.2. Low Tension (LT) Panel

6.2.1. Introduction

NAVANA LT switchgear are sheet steel claded with modular system for assembly of cubicles intended to take heavy equipment's, dust mounting indoor type with TPN & E copper/ busbar.

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

Figure 6.1: LT Panel

6.2.2. Different types of interrupting devices

NAVANA uses different types of interrupting device

- Fuses
- Miniature circuit Breaker (MCB)
- Air circuit Breaker (ACB)
- Molded case circuit Breaker (MCCB)

6.2.3. Operating Mechanism

In NAVANA, two types of operating method are used in LT :

- Manually-operated
- Motor-operated

Figure 6.2: Inside of LT Switchgear

6.2.4. Application of LT switchgear

It's mainly used in power station, industrial enterprise, commercial and residential buildings for power distribution. It also can be used to control, protect and inspect the circuit.

6.2.5. Content and Working Principle

The Panel of LT switchgear consists of

- Bus Bar,
- Relay,
- Ammeter,
- Voltmeter,
- CT,
- Breaker,
- Fuse.
- Indicator flags

The panel includes three numbers of rings CT for current measuring purpose. Also, there is an ammeter and a voltmeter to monitor current and voltage value. The ammeters are connected in the bus-bar through CT because the ammeter can measure current from 1A-5A. 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 occurs in the bus-bar then only MCCB trips; then the whole system gets disconnected. If any fault occurs in any phase, the whole phase gets disconnected instantly. In LT panel, there are some indicator lamps which indicate the panel on/off, trip signal, spring charge lamp etc.

6.2.6. Technical Data

Rated peak withstand current.

Rated voltage V	up to 660V, 50 Hz
Rated current	up to 3600A
Rated currents of components	
Circuit- breakers	up to 5000A

DOL contactor starters up to 400V

Contractor type reversers up to 400A

Contactor type star delta starters up to 700A

RATED PEAK WITHSTAND CURRENT

Main busbars up to 176 KA

Dropper bars up to 120 KA

Degree of protection to DIN 40050/

IEC- Publ IP 40

OVERALL DIMENSIONS

Height 1220/1500/1800/2200 mm

Width 400/600/750/800/1000 mm

Depth 400/600/800 mm

Change in dimension: optional

Table 3.1: Busbar sectional areas (in mm) and current carrying capacities

Busbar sectional areas (in mm) and current carrying capacities				
Phases	PE	PEN	N	Rated Current at 40°C Ambient temperature
2× 20× 10	40× 5	40× 5	40× 5	1000 A
2× 40× 10	40× 5	40× 5	40× 5	1600 A
2× 60× 10	40× 5	40× 10	40× 10	2150 A
2× 80× 10	40× 5	40× 10	40× 10	2600 A
2× 100× 10	40× 5	40× 10	40× 10	3100 A
2× 120× 10	40× 5	40× 10	40× 10	3550 A

6.3. HT (High Tension) Panel

6.3.1. Introduction

NAVANA HT switchgear is equipped with Minimum Oil Circuit Breaker (MOCB) or Vacuum Circuit Breaker (VCB) or load Break Switch (LBS) to meet individual requirements which comply with LEC, BS, VDE, ANSI standard. Circuit Breaker and other components are imported from USA, Germany, France, U.K. and Japan or as per choice of their customer valued.

Figure 6.3: HT Panel

6.3.2. HT Voltage Range

High tension switchgear comprises the units designed for rated voltage of 12KV and current range 630A to 1250A.

Technical Data

Table 3.2: Technical data for HT panel

Specification Of HT Switchgear	VCB (Vacuum Circuit Breaker)		MOCB (Minimum Oil Circuit Breaker)		LBS (Load Break Switch)	
	PNN10	PNN11	PNN20	PNN21	PNN30	PNN31
Rated Voltage	12KV	12KV	12KV	12KV	12KV	12KV
Rated Current	630A	800A	630A	800A	630A	800A
Rated Short Time Current for 3 sec.	20KA	20KA	20KA	20KA	20KA	20KA
Basic Impulse Level	75KV	75KV	75KV	75KV	75KV	75KV
Making Current	50KA	50KA	50KA	50KA	50KA	50KA

PNN10, PNN11, PNN20, PNN21, PNN30 and PNN31 are model of the HT switchgear.

6.3.3. Different types of Interrupting Device and Operating Mechanism

HT of NAVANA uses interrupting device which are

- Minimum Oil Circuit Breaker
- Vacuum Circuit Breaker
- Load break switch

In NAVANA electronics, two types of operating method are used in HT

- Manually-operated
- Motor-operated

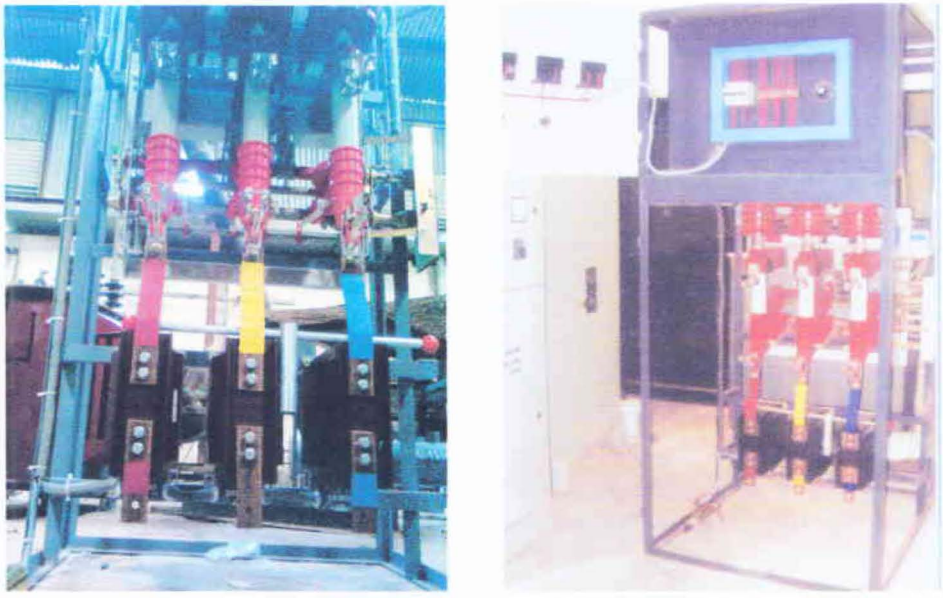


Figure 6.4: Inside of HT Switchgear

6.3.4. Application of HT switchgear

It's mainly used in power station, industrial enterprise; Commercial industry and Transmission can be used to control, protect and inspect the circuit.

6.4. Power Factor Improvement (PFI) Plant

6.4.1. Introduction

NAVANA PFI plants are produced in different capacity depending on the stages needed. These are equipped with P.F. capacitor bank, Automatic Power Factor Correction Relay, PF Meter, Magnetic Conductor, HRC Fuse, Push Button Switch and Indication lamp etc. NAVANA PFI PANNEL is designed and assembled in accordance with IEC-7070 regulation. The components of PFI panels are chiefly imported from UK, Germany, France, Italy, Japan, and from other countries according to customer requirement as well.

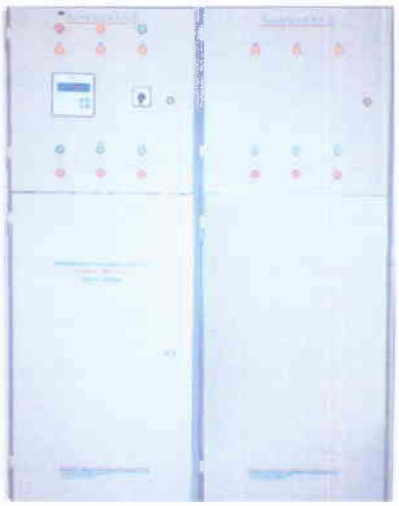


Figure 6.5: PFI Plant

6.4.2. Principle of PFI plant

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

The cosine of angle between voltage and current in an A.C circuit is known as power factor. The power factor plays an important role in A.C circuits since power consumed depends upon this factor, $P = V_L I_L \cos\varphi$. $I_L = P/\sqrt{3}V_L\cos\varphi$; it is clear that from above that for fixed power and voltage, the load

current is inversely proportional to the power factor. Lower the power factor, higher is the load current.

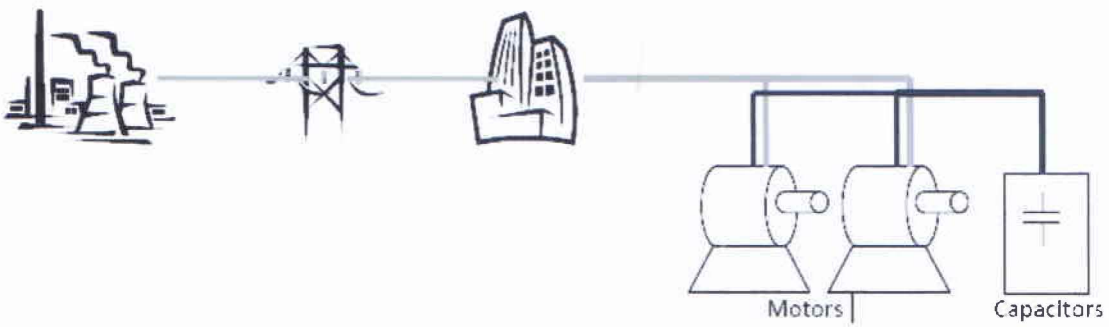


Figure 6.6: Power Factor Improvement

6.4.3. Features of NAVANA PFI

The following are key features of NAVANA PFI

- Using NAVANA PFI, the overall power factor is improved or raised which causes for an existing plant of a given KVA rating to increase its earning capacity.
- It improves the condition of large voltage drop in the supply lines and transformer. This improves the conditions of voltage stabilizer equipment and save the motor from adverse effect. NAVANA PFI improves the voltage Regulation.

6.4.4. Components of a PFI plant

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

Figure 6.7: Inside of PFI plant

6.4.4.1. PFC RELAY

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

6.4.4.2. H.R.C FUSE

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

6.4.4.3. MAGNETIC CONTACTOR

It was found that NAVANA Electronics 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 gets contacted.

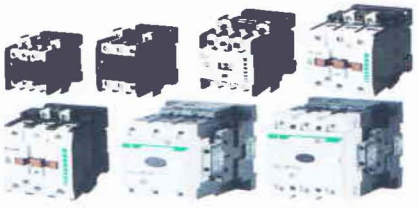


Figure 6.8: Magnetic Contactor

6.4.4.4. CAPACITOR BANK

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

- 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

7. Isolators and Breakers

7.1. Isolators

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 unlike circuit breaker. it should not be operated while it is having load. First the load on it must be made zero and then it can safely operate.

Isolator (disconnecting switch) operates under no load condition. It is manually operated. It does not have any specified current breaking capacity or current making capacity. Its main purpose is to isolate one portion of the circuit from the other and is not intended to be opened while current is flowing in the line. Such switches are generally used on both sides of circuit breakers in order that repairs and replacement of circuit breakers can be made without any danger. Isolators should never be opened until the circuit breaker in the same circuit has been opened and should always be closed before the circuit breaker is closed.

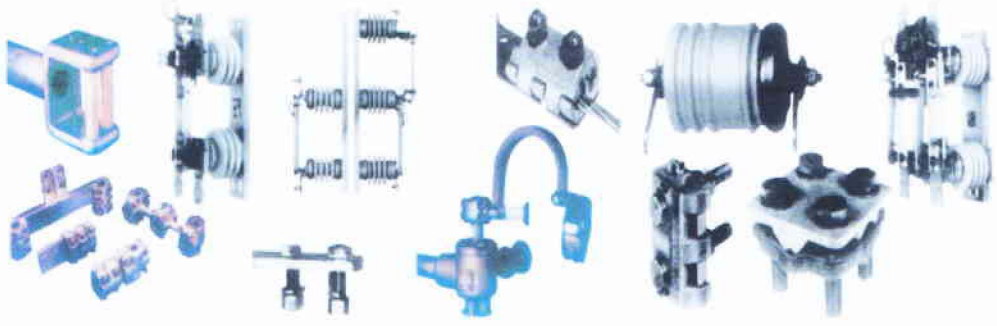


Figure 7.1: Isolator

7.1.1. Brand Features of Isolators

The brand features of Isolators manufactured by NAVANA Electronics Ltd:

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

7.1.2. Main Assemblies

The Isolator comprises of the following main assemblies:

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

7.1.3. Type of Isolators

Isolator or Disconnectors Types:

NAVANA manufactures outdoor offload disconnectors of the following types:

- Pantograph - (type EPG)
- Centre Break- (type ECB)
- Double Break - (type EDB)

Pantograph Type:

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

Centre Break Type:

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

Double Break Type:

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

7.1.4. Operating Mechanism

Currently the following operating mechanisms are

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

7.1.5. Maintenance

While assembling isolators all the bearings provided are sealed for life and they need no further greasing. All contacts are to be checked and appropriately maintained and cleaned during annual maintenance.

7.1.6. Tests for Isolators

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

7.2. Load Break Switch (LBS)

Load break switch generally is the combination of isolator and a switch. In distribution system, for voltages up to 33KV load break switch is used. The fault levels always may not be high enough to justify the use of circuit breakers economically. Load break switches are capable of making and breaking currents under normal conditions. It can carry the specified current of specified values for specified time. It is capable of making but not breaking, short circuit currents.

Figure 7.2: Load Break Switch (LBS)

Load break switches serve the following requirements:

- Breaking rated currents
- Making rated currents
- Making specified short circuit currents
- Carrying specified short circuit currents
- Interrupt small inductive, capacitive currents

This protective equipment is used at 11 kV sub-station. The main Load Break Switch (LBS) mechanism is available for 630A & the over current protection scheme is done through HRC fuse. The panel includes 3 numbers of CT (Current Transformer) & 2/3 numbers of PT (Potential Transformer) for measuring system current & voltage respectively & 3 numbers of HRC Fuses for protection of overload. The scheme is so designed that if fault occurs in any phase it will isolate the whole three phases from the system instantly. The panel also includes 3 numbers of Ampere meters & one number of Voltmeter with selector switch for monitoring system current & voltage. The standard panel size is 900x900x1800 mm & weight is around 450 kg.

7.3. Breakers

7.3.1. Introduction

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. 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 (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

7.3.2. Types of Breaker

In general NAVANA used three types of breaker they are

1. Low Voltage Breaker
2. Medium Voltage Breaker
3. High Voltage Breaker

7.3.2.1. Low Voltage Breaker

NAVANA uses low voltage breaker the range is from 1 V to 1KV

NAVANA used Miniature Circuit Breaker (MCB) as low Voltage Breaker. They don't manufacture this MCB. They import MCB from Germany. They used it in Switchgear.

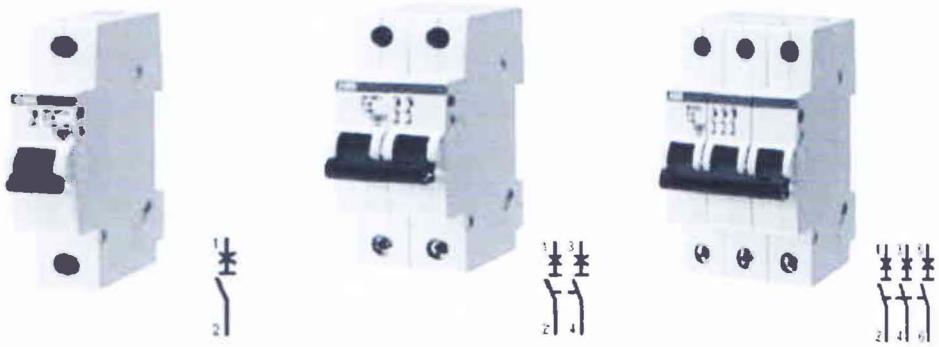


Figure 7.3: MCB (SP, DP and TP)

The function of a low Voltage Breaker is Protection and control of the circuits against overloads and short-circuits, protection of people and big-length cables in TN and IT systems.

Operating Voltage: 230/440 V

Three types of MCB NAVANA used with Breaking Capacity up to 6kA, they are

1. Single Pole (SP)
2. Double Pole (DP)
3. Triple Pole (TP)

7.3.2.2. Medium Voltage Breaker

NAVANA uses medium voltage breaker the range is from 1KV V to 11KV

NAVANA used Molded Case Circuit Breaker (MCCB) as medium Voltage Breaker. They don't manufacture this MCCB. They import MCCB from Italy. They use it in switchgear items.

Figure 7.4: MCCB

The function of a medium voltage breaker is protection and control of electrical machineries against overloads, short-circuits and ground fault protection (Optional).

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

7.3.2.3. High Voltage Breaker

NAVANA uses high voltage breaker the range is from 11KV to 33KV

NAVANA used Vacuum Circuit Breaker (VCB) as high Voltage Breaker. They don't manufacture this VCB. They import VCB from Italy, Germany. They use it in switchgear items.

8. Problems and Recommendations

8.1. Problems

In this section we discuss about the hurdles we faced during this internship. The first thing is we did not receive any help from the department while looking for an internship. We had to arrange the internship all by ourselves. Then the problems we faced in NAVANA while doing internship are:

- NAVANA does not have any strict policy about internees that sometimes left us in ambitious situations.
- Does not publish any recruitment advertisement in the daily newspapers..

8.2. Recommendations

The tenure of our internship program with NAVANA was only for 15 days. This short duration even gave us exposure to the practical aspects of some of the theoretical issues. We studied in our courses considering the benefits of practical exposure; the following recommendations have been put forward for the consideration of the Management of Electric and Electronic Engineering Department of East West University.

- Student should complete relevant courses prior to do their internship.
- In Switchgear course more syllabuses on power system protection.

9. Conclusion

NAVANA is a Bangladeshi brand that's why people do not rely to their products. Some Bangladeshi company imports substation equipment from foreign countries. It is great loss for our country. Though It will take some time to be more reliable in Bangladesh or foreign countries. NAVANA is a Bangladeshi brand that's why people do not rely to their products.

NAVANA could be regarded as the practical ground of the Electrical and Electronic Engineering Department of East West University. The theories that we have learned at the University could be experimented at the NAVANA and being a part of such a company who has high level R & D, state of the art production facility, quality products, competent services, and countrywide operations we consider ourselves very much lucky to have our internship program with NAVANA. It gave us an opportunity to apply our theoretical knowledge in practice.

Theoretical knowledge is not enough for engineers. Practical knowledge is very much important. During our internship one employee said us before establishment of NAVANA, Electrical Engineers does not see the manufacturing process of transformer. So, to be an engineer practical knowledge is very important to broaden their mind.

References

1. http://www.navana.com/index.php?page_id=200
2. http://www.navana.com/index.php?page_id=180
3. http://en.wikipedia.org/wiki/Power_supply#Uninterruptible_power_supply
4. http://en.wikipedia.org/wiki/Circuit_breaker
5. http://encyclopedia2.thefreedictionary.com/load-break+switch
6. http://en.wikipedia.org/wiki/Switch
7. http://www.powercombd.com/products/72-instant-power-supply-ips
8. http://szmaorun.blogspot.com/2010/02/working-principle-of-ups.html