

INTERNSHIP REPORT
ON
POWER GENERATION, TRANSMISSION, DISTRIBUTION AND
PROTECTION SYSTEM OF THE EQUIPMENT
OF
DUTCH BANGLA POWER AND ASSOCIATES LIMITED

By

Md. Raficul Islam [2008-2-80-022]
Rajib Chandra Bhowmik [2008-2-80-029]
Dibendu Singha [2008-2-80-049]

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)

[Spring, 2012]

Approved By

Academic Advisor

[Dr. M. Al. Hakim]

Department Chairperson

[Dr. Khairul Alam]



Dutch Bangla Power & Associates Ltd.

Ref: DBPL/EWU/INT/01

13th December, 2011.

Nahid Hassan Khan
Advisor, Students Welfare & Head
Career Counseling Centre (CCC)
Assistant Professor & Deputy Director

Ref: EWU(CCC) 01/11/Spring-12/80

Sub: Approval of internship Placement under the Dutch Bangla Power & Associates Limited, Orion Group.

Dear Sir,

Orion Group recognizes the importance of firsthand experience that a student requires to have a holistic and practical view of the working environment. We are looking forward to provide your students with enriching learning experiences in a real life situation.

The following students are authorized to carry out their attachment period with Dutch Bangla Power & Associates Ltd, a member company of Orion Group.

ID	Name	Major	Degree
2008-2-80-029	Rajib Chandra Bhowmik	Power	EEE
2008-2-80-049	Dibendu Singha	Power	EEE
2008-2-80-022	Md. Rafiqul Islam	Power	EEE
2008-1-80-031	Arif Ahmed	Power	EEE
2008-1-80-038	Amena Begum	Power	EEE
2008-1-80-006	Deena Farzana	Power	EEE

We look forward to provide your students with a path of intellectual pursuit and self development.

Best Regards,

Abdullah Al Hasan
SVP, Engineering
Orion Group

Cc: M. Sayeed Alam, Assistant Professor & Deputy Director, CCC

Registered Office: Apartment-A4, House-8A, Road-8 Gulshan-1, Dhaka-1212 Phone: 01673773823
Corresponding Office: Orion House, 153-154 Tejgaon Industrial Area, Dhaka-1208, Bangladesh
Phone: (PABX) 9888176, 9888494 Fax:+880-2-885467, E-mail: orion@bol-online.com, Web: www.orion-group.net



Dutch Bangla Power & Associates Ltd.

Date : 16.01.12

TO WHOM IT MAY CONCERN

This is to certify that Md. Raficul Islam SID 2008-2-80-022, Rajib Chandra Bowmik SID 2008-02-80-029, Dibendu Singha SID 2008-2-80-049 have successfully completed their internship from Dutch Bangla Power and Associates Ltd. (DBPAL), the 100 MW QRPP, from 26th December, 2011 to 12th January, 2012. They have completed 105 hours of their internship on Power Generation, Transmission, Distribution and Protection system of the equipment of DBPAL. During the tenure of their training with us all the students put their best effort to comprehend the overall system of Power Station.

The undersigned on behalf of Dutch Bangla Power and Associates Ltd recommending this work as the fulfillment of the requirements of EEE 499 (Industrial Training) of the East West University, Dhaka.

We wish their success in life

MD. Anharul Islam
O & M Manager
DBPAL, Wartsila

Md. Javed Ullah
Maintenance Manager
DBPAL, Orion

Registered Office: Apartment -A4, House-8A, Road-8 Gulshan-1, Dhaka-1212
Corporate Office: Orion House, 153-154 Tejgaon Industrial Area, Dhaka-1208, Bangladesh
Phone: (PABX) 9888176, 9888494 Fax: +880-2-8826374, E-mail: Orion@bol-online.com, Web: www.orion-group.net

ACKNOWLEDGMENT

We wish to convey our heartfelt thanks and gratitude to almighty Allah for letting us complete the internship successfully.

We would like to thank Mr. Md. Abdullah Al Hasan, Senior Vice President of Engineering sector of Orion group and Mr. Md. Anharul Islam, Manager, O&M of DBPAL for giving us the opportunity to do internship at Dutch Bangla Power and Associates Limited.

We would like to thank and express our gratitude to Mr. Shyamal Kumar Das, Executive Engineer of DBPAL . We worked under his generous supervision. Special thanks to all the respected officers and employees of DBPAL for their continuous inspiration and support.

We would also like to thank Dr. Khairul Alam, Chairperson, Department of Electrical and Electronic Engineering (EEE) for his generous guidance. Special thanks to Mr. Mohammad Mojammel Al Hakim, Associate Professor, Department of Electrical and Electronic Engineering (EEE) of East West University for his kind supervision to complete our internship report. We are also very grateful to all of our teachers and fellow students for their encouragement and cooperation throughout our internship and academic life.

Finally, we are forever grateful to our parents for their patience and love.

EXECUTIVE SUMMARY

Dutch Bangla Power and Associates Ltd (DBPAL) is created under the restructuring process of Power Sector in Bangladesh. This report is based on our internship work in Dutch Bangla Power and Associates Ltd, Siddirganj, Narayanganj. A power system has three basic segments, i.e. power generation, power transmission and power distribution. Basically Dutch Bangla Power and Associates Ltd deals with generation and transmission part only. Here they also deals with distribution shortly. We were introduced with various equipment of Power Plant, such as Generator, Relay, Circuit Breaker, Transformer, Bus bars, Cable, DC battery etc.

We worked at DBPAL as intern for 105 hours. Each day our activities were divided into two parts. Firstly our supervisor talked to us about the theory behind our day activity. Then we visited the plant with our supervisor to relate theory with practical implementation.

Here we learnt about power transmission and the behavior of various equipment used in plant. This report contains a detail description about these equipments. As we did not complete any mechanical course related to power prior to doing the internship, we had to face hurdles. It would be beneficial and better for us if we had completed those courses.

Training Schedule

Day No.	Day	Starting time -- Ending time	Day Activity	Mentor
1	Monday 26.12.2011	9 AM to 5 PM	Company overview, overall generation process	Humayun Kabir <i>Superintendent Eng, O&M</i>
2	Tuesday 27.12.2011	9 AM to 5 PM	Power plant electrical system	Shyamal Kumar Das <i>Executive Engineer</i>
3	Wednesday 28.12.2011	9 AM to 5 PM	Switchgear and its practical application	Shyamal Kumar Das <i>Executive Engineer</i>
4	Friday 30.12.2011	9 AM to 5 PM	Reading electrical drawing	Shyamal Kumar Das <i>Executive Engineer</i>
5	Saturday 31.12.2011	9 AM to 5 PM	Operation modes of engine and generator	Shyamal Kumar Das <i>Executive Engineer</i>
6	Sunday 01.01.2012	9 AM to 5 PM	Synchronous generator theory and its maintenance	Shyamal Kumar Das <i>Executive Engineer</i>
7	Monday 02.01.2012	9 AM to 5 PM	Synchronization and generator operation	Shyamal Kumar Das <i>Executive Engineer</i>
8	Tuesday 03.01.2012	9 AM to 5 PM	Protection relays	Shyamal Kumar Das <i>Executive Engineer</i>
9	Wednesday 04.01.2012	9 AM to 5 PM	Protection relays and alternator protection	Shyamal Kumar Das <i>Executive Engineer</i>
10	Friday 06.01.2012	9 AM to 5 PM	Transformer	Shyamal Kumar Das <i>Executive Engineer</i>
11	Sunday 08.01.2012	9 AM to 5 PM	Mechanical power to electrical power	Shyamal Kumar Das <i>Executive Engineer</i>
12	Monday 09.01.2012	9 AM to 5 PM	Mechanical power to electrical power	Shyamal Kumar Das <i>Executive Engineer</i>
13	Tuesday 10.01.2012	9 AM to 5 PM	Wartsila engine control system and communication layout	Shyamal Kumar Das <i>Executive Engineer</i>
14	Wednesday 11.01.2012	9 AM to 5 PM	Basic operating principal of engine, construction parameters of engine, function of built-on system	Shyamal Kumar Das <i>Executive Engineer</i>
15	Thursday 12.01.2012	9 AM to 5 PM	Wartsila engine safety module and main control module	Shyamal Kumar Das <i>Executive Engineer</i>

Lunch break (Everyday): 1.00 PM to 2.00 PM.

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Daily activity reports



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power And Associates LTD.
Name of the student:	Dibendu Singha
ID:	2008-2-80-049

Date:	26-12-11
Start time/End time	9 am. to 5 pm.
Location:	Shiddhirgonj, Narayanganj
Mentor:	Humayun Kabir And Shyamal Kumar Das

General Instructions:

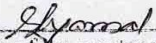
- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.

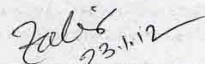


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Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)
 - Introduction
 - Company overview
 - Safety issues
 - Overall power generation process
 - Plant visit.
2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.
 - Introduction with them
 - Details and the motive of the company.
 - Number and units and generators.
 - List of different electrical equipments.
 - Also saw those equipment practically.
 - Safety equipments.
3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.
 - 1. EEE 441 (Power Station)
 - 2. EEE 442 (Switchgear and Protective Relays)


Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749


Signature of academic supervisor with date
Name: MOHAMMAD FARID ALAM
Designation: LECTURER



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power And Associates LTD.
Name of the student:	Dibendu Singha
ID:	2008-2-80-049

Date:	27-12-11
Start time/End time	9 am. - 5 pm.
Location:	Siddhirgonj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lecturer's notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



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East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

→ Introduction to the power plant Electrical System.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- Different types of circuit breakers.
- Single Line diagram of any power plant.
- DC system
- Fuel supply system to engine.
- Plant visit.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

- EEE 441 (Power Station)
- EEE 442 (Switchgear and protective relays)

Skyamal
Signature of the mentor with date
Name: Skyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Falix 23.1.12
Signature of academic supervisor with date
Name: MOHAMMAD FARIR AZAM
Designation: LECTURER



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power And Associates Ltd.
Name of the student:	Dibendu Singha
ID:	2008-2-80-049
Date:	28-12-11
Start time/End time	9 am - 5 pm.
Location:	Siddhirgonj, Narayanganj.
Mentor:	Shyamal Kumar Das.

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



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East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)
 - Switchgear (High voltage, medium voltage and Low voltage)
2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.
 - Low voltage switchgear.
 - Medium voltage switchgear
 - Incoming from generator
 - metering panel
 - Outgoing Feeder
 - Station transformer.
 - Transformer Rating, HV Switchgear
 - Plant visit (Switchgear System).
3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.
 - EEE 442 (Switchgear and Protective Relay)

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Zakir
23.1.12
Signature of academic supervisor with date
Name: MOHAMMAD ZAKIR AZAM
Designation: LECTURER



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Duteh Bangla Power And Associates Ltd
Name of the student:	Dibendu Singha
ID:	2008-2-80-049

Date:	30-12-11
Start time/End time	9 a.m. to 5 p.m.
Location:	Siddhirgonj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



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Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

- Reading Electrical Drawing.
- Troubleshooting Technique using Electrical Drawing.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- visited high voltage switchyard.
- Power circuit of a system
- Overall control circuit of a system
- Process to read the drawing
- Operating principle of relay.
- Different types of relay.
- Practical application of the drawing.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

- EEE 442 (Switchgear And Protective Relay)

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Zaki
23.1.12
Signature of academic supervisor with date
Name: MOHAMMAD ZAKIR AHAM
Designation: LECTURER



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Duteh Bangla Power And Associates Ltd.
Name of the student:	Dibendu Singha
ID:	2008-2-80-049

Date:	31-12-11
Start time/End time	9am to 5 pm
Location:	Siddhirganj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



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East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

→ Operation Modes.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

→ Classification of operation modes.

→ Operation modes of DG sets.

→ Solo operation mode.

→ Island parallel mode.

→ Grid parallel mode.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

→ This practical activity and theoretical knowledge is not related with any academic course.

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Zakir
Signature of academic supervisor with date
Name: MOHAMMAD ZAKIR AHAM
Designation: LECTURER



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla power and Associates LTD
Name of the student:	Rajib chandra Bhowmik
ID:	2008-2-80-029
Date:	01-01-2012
Start time/End time	9am - 5pm (Lunch Break - 1.00pm - 2.00pm)
Location:	Siddesgonj, Narayan gonj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



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Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

- Alternator maintenance
- Synchronous Generator Theory

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- Rotor
- Stator
- Inductive Load
- Reactive Load
- Design and Dimensioning
- Motor operation
- Generator operation

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

- EEE-301
- EEE-304

Sk. Jamal
Signature of the mentor with date
Name: Sk. Jamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Rizvi Ahmed
Signature of academic supervisor with date
Name: Rizvi Ahmed
Designation: RL



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power and Associates LTD
Name of the student:	Rajib chandra Bhownik
ID:	2008-2-80-029
Date:	02-01-12
Start time/End time	9.00am - 5.00pm (Lunch: 1.00pm - 2.00pm)
Location:	Siddirgonj, Narajgonj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The main objective of this day is to ~~do~~ introduce the generator operation and synchronization.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- Synchronization
- Phase sequence
- Frequency
- Phase angle
- Synchronous meter
- Stator core and frame
- Rotor
- Varistor
- Exciter Alternator

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

- EEE - 301
- EEE - 304

Skymal
Signature of the mentor with date
Name: Skymal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Rizvi
23-01-12
Signature of academic supervisor with date
Name: Rizvi Ahmed
Designation: RL



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power and Associates LTD
Name of the student:	Rajib chandra Bhawmik
ID:	2008-2-80-029
Date:	3-1-2012
Start time/End time	9am-5pm (Lunch - 1.00pm to 2pm)
Location:	Siddhigonj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
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Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of this day is protection Relays and generator protection

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- protection Relays
→ Radial network and meshed Network
- Generator protection with generator protection relay VAMP 210.
→ The network frequency
→ Measurement of VAMP 210 generator protection Relay.
- Differential protection generator protection

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

I got the theoretical knowledge from
EEE - 442 (Switchgear and protection Relays)

Skyamal
Signature of the mentor with date
Name: Skyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Ahmed
23-01-12
Signature of academic supervisor with date
Name: Rizvi Ahmed
Designation: RL



Department of Electrical and Electronic Engineering
 East West University
 EEE 499
 Industrial Training
 Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bargla Power and Associates LTD
Name of the student:	Rajib chandra Bhownik
ID:	2008-2-80-039
Date:	04-1-12
Start time/End time	9am - 5pm (Lunch - 1.00pm to 2.00pm)
Location:	Siddirgonj, Narayanganj
Mentor:	Skjamael kumar Das

General Instructions:

- a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- d. In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

- Protective Relays
- Different types of protection.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- over and under voltage protection
- over and under frequency protection.
- over current protection
- Thermal overload protection.
- Loss of Excitation and under excitation protection
- Reverse power protection
- Earth fault protection

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

EEE - 442 (Switchgear and protective relays)

Skyamal
Signature of the mentor with date
Name: Skyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912 059749

Ahmed
23-01-12
Signature of academic supervisor with date
Name: Rizvi Ahmed
Designation: PL



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power and Associates Ltd.
Name of the student:	Md. Raficul Islam
ID:	2008-2-80-022

Date:	06-01-12
Start time/End time	9.00am - 5.00pm (Lunch: 1.00pm - 2.00pm)
Location:	Siddisganj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of today's activity was to study about transformer.

* From the theoretical discussion and the plant visit to observe possible objectives fulfill my objective.

2 List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- Safety instruction.
- Different parts of transformer.
- Maintenance procedure.
- Routine checks
- Charging or switching on procedure.
- Testing of transformer.
- Protection of transformer.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

I gained theoretical knowledge from,
EEE-301 (Machine I) |

EEE-304 (synchronous machine and power system fundamentals)

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

M. Al-Hakim
Signature of academic supervisor with date
Name: DR. M. AL-HAKIM
Designation: Associate professor



Department of Electrical and Electronic Engineering
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Industrial Training
Daily Activity Report

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Name of the company:	Dutch Bangla Power and Associates LTD
Name of the student:	Rajib chandra Bhowmik
ID:	2008-2-80-039

Date:	08-01-12
Start time/End time	9-00am - 5-00 PM (Lunch: 1-00 PM - 2-00 PM)
Location:	Siddisgonj, Narajangonj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of today's activity is to study about mechanical power to electrical power

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- Mechanical power in the rotating engine.
- Adjustment of mechanical power
- Electrical power
- Adjustment of electrical power.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

I gained the theoretical knowledge from
EEE-301 (Machine I)

Sayanmal
Signature of the mentor with date
Name: Sayanmal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

Ahmed
23-01-12
Signature of academic supervisor with date
Name: Rizvi Ahmed
Designation: RL



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report


Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power and Associates Ltd.
Name of the student:	Md. Raficul Islam
ID:	2008-2-80-022

Date:	09-01-12
Start time/End time	9.00am - 5.00pm (Lunch: 1.00pm - 2.00pm)
Location:	Siddiganj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
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- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of today's activity was also to study about mechanical power to electrical power.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

* Also worked in substation

- Isolator
- Lightning Arrester
- Breaker (SF6)

- Relationship between mechanical and electrical power.
- Generator control methods
 - Island system
 - Utility system (connected to the grid)

* These activities helps to me to know the relationship between mechanical and electrical power, conversion of mechanical to electrical power and application in different systems.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

I gained the theoretical knowledge from, EEE-301 (Machine I)

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

M. Al-Hakim
Signature of academic supervisor with date
Name: DR. M. AL-HAKIM
Designation: Associate professor



Department of Electrical and Electronic Engineering
 East West University
 EEE 499
 Industrial Training
 Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power and Associates Ltd.
Name of the student:	Md. Raficul Islam
ID:	2008-2-80-022
Date:	10-01-12
Start time/End time	9:00am - 5:00pm (Lunch: 1:00pm - 2:00pm)
Location:	Siddirganj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
- The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
- The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of today's activity, was to know the Wartsila Engine Control System (WECS) and communication Lay-out.

* The theoretical description and the observation of every panel fulfill our objectives.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- MCM (Main Control Module) → speed control
→ Load control
- ESM (Engine Safety Module)
 - Lube oil low pressure shut-down [Normal pressure = 6 bar, Alarm pressure = 3 bar, Shut down " = < 2.5 bar]
 - High temp. shut-down [Normal value = 96°C, Alarm limit = 105°C, shut down " = 110°C]
 - Over speed shut-down [113% and 117%]
- PDM (Power distribution Module)
- CFC Pannel
- CFE "
- BJA " and • BAO pannel

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

There is no relation of today's activities with any of my academic course.

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

M. Al. Hakim
Signature of academic supervisor with date
Name: DR. M. AL. HAKIM
Designation: Associate professor



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	Dutch Bangla Power and Associates Ltd.
Name of the student:	Ma. Raficul Islam
ID:	2008-2-80-022

Date:	11-01-12
Start time/End time	9.00am - 5.00pm (Lunch: 1.00pm - 2.00pm)
Location:	Siddinganj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
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- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of today's activities was to know the basic operating principle of engine, construction parameters of engine and the function of built-on system.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

• 4 stroke engine →

- Suction
- Compression
- Expansion
- Exhaust

- Fuel system.
- Lubricating oil system.
- Cooling water system.
- Starting air system.
- Exhaust gas and air intake system.

* The theoretical explanation, ~~electrical~~ mechanical drawing and plant visit to observe possible activities helps me to fulfill my objectives.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

I gained the theoretical knowledge from, EEE-3441 (Power station)

Shyamal

Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

M. Al. Hakim

Signature of academic supervisor with date
Name: DR. M. AL. HAKIM
Designation: Associate professor



Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

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Name of the company:	Dutch Bangla Power and Associates Ltd.
Name of the student:	Md. Raficul Islam
ID:	2008-2-80-022

Date:	12-01-12
Start time/End time	9.00am - 5.00pm (Lunch: 1.00pm - 2.00pm)
Location:	Siddiganj, Narayanganj
Mentor:	Shyamal Kumar Das

General Instructions:

- It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
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- In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.



Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of today's activity was to study about the Wartsila Engine Safety Module and Main Control Module. And finally we saw the overall generation process again.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

- ESM (Engine Safety Module)
 - Lube oil low pressure shut down
 - High temp. shut down.
 - Over speed shut down.
 - * - Necessity of ESM
 - ESM hardware.
- MCM (Main Control Module) → speed control
→ Load control

* By the theoretical discussion ~~out over~~ about those activities, our objectives are fulfilled.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

There are no relation of today's activities with any of my academic course.

Shyamal
Signature of the mentor with date
Name: Shyamal Kumar Das
Designation: Executive Engineer
Contact Phone #: 01912-059749

M. Al. Hakim
Signature of academic supervisor with date
Name: DR. M. AL. HAKIM
Designation: Associate professor

Chapter 1. Introduction

We completed our industrial training as internship at Dutch Bangla Power and Associates Limited (DBPAL). We spent fifteen (15) working days there. We trained there total 105 hours (everyday seven hours). This report is on about those fifteen days activity.

1.1 Company Profile

Dutch Bangla Power and Associates Ltd (DBPAL) was established to make progress of power sector in Bangladesh. DBPAL's Commercial Operation Date (COD) was 20th July, 2011 with an authorized capital of taka 6.14 billion. After the erection, commissioning and reliable run test (RRT) in which date the plant is started to generate the power known as COD. DBPAL is a 100 MW rental power plant. This plant is owned by Orion Group. Wartsila Bangladesh Ltd. operates and maintenances this plant. This company is a brand name of Finland. This is one of the biggest engine manufacturers in the world. This company has five years contract with Orion Group. It is a HFO (Heavy Fuel Oil) based power plant. Furnace oil is used as fuel. There are total twelve (12) units or alternators. Each unit produces 8.9 MW power. Total= $(12 \times 8.9) = 106.8$ MW

It means they have 106.8 MW power generation capabilities but the supply 100 MW continuously according to BPDB (Bangladesh Power development Board) power factor (0.8) requirement. Every engine is mainly diesel engine but for cost effectiveness they use furnace oil as fuel. As a quick rental power plant they sell the power to BPDB. The selling cost per unit is around 8 BDT.

Wartsila follow ISO14001:2004 standard and for occupational health and safety management they follow OHSAS18001:2007 standard. OHSAS represents Occupational Health Safety Assessment System.

1.2 Objective of the Internship

In the class room we have only gathered the theoretical knowledge about different topics, but in the internship we gathered the practical knowledge about those topics. On the other hand we have a course EEE499 which is industrial training. To fulfill the requirement of this course is also the purpose of this internship. We accrued the knowledge about following topics.

- Understanding company management.
- Understanding industrial environment.
- Acquiring practical knowledge about power generation
- Acquiring practical knowledge about switchgear protection.
- Idea about safety

1.3 Future Plan

Orion group is generating 200 MW from two power plants. Another 100 MW plant is under construction named Digital Power & Associates Ltd. which is at Muktarpur, Mushiganj. Soon this power plant will be in power generation. Recently Bangladesh Government Purchase committee has passed the $2 \times 300\text{MW}$ & $1 \times 650\text{MW}$ COAL fired power project of ORION Group their total power generation will be 1550 MW. They are hopeful to complete their all project within 2013.

Chapter 2. Power Plant Electrification

The main objective of a power plant is to generate the power that means to convert the mechanical power to electrical power. But it is more important to electrify the whole power plant. That's why a system is essential for the electrification of the power plant. This system is called power plant electrification system. We can also get the whole overview of the plant. We are discussing the details about the system.

2.1 Single Line Diagram

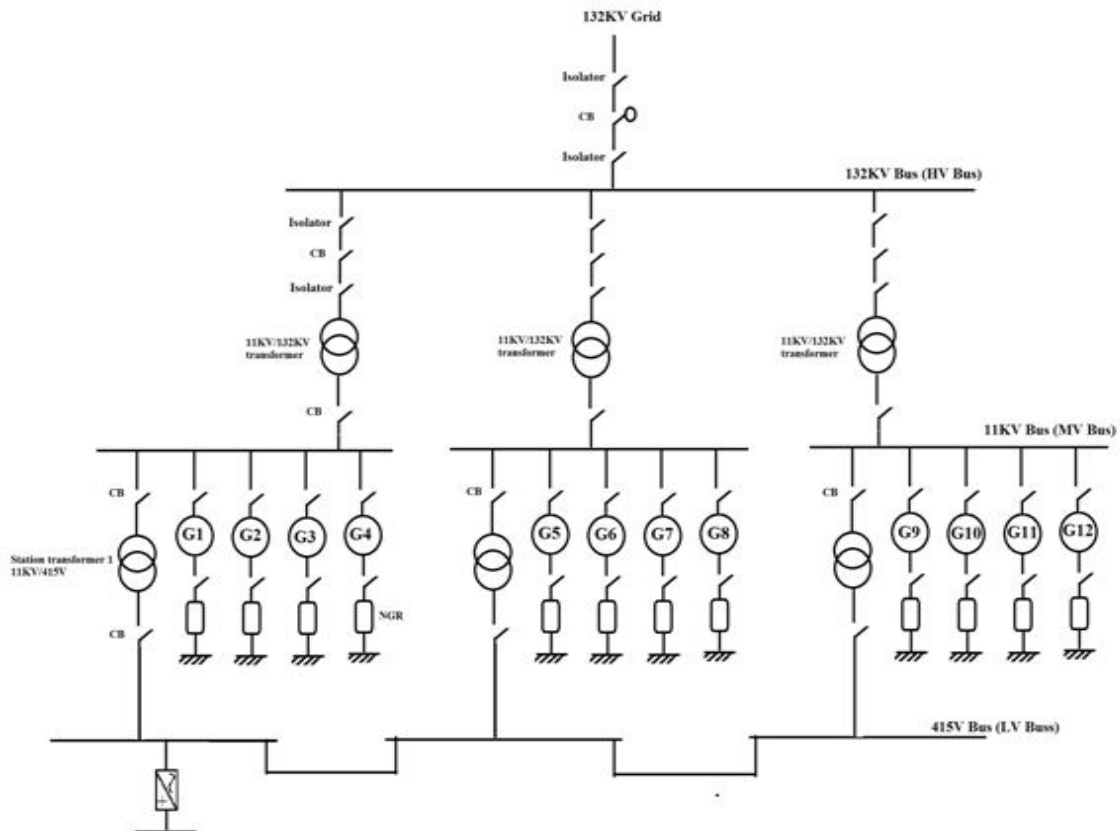


Figure 2.1: Single Line Diagram of the Plant

The upper portion of the single line diagram is 132KV grid. Then lightning arrester, circuit breaker, isolator and then 132KV bus or high voltage bus. After that again there are isolator, circuit breaker, isolator and then 132KV to 11KV transformer. After the transformer there is a circuit breaker and then 11KV bus or medium voltage bus. Here we have three MV bus and after each bus there are four generators. In the one portion of medium voltage bus there is a circuit breaker and then generator. Generator is grounded through NGR (Neutral Grounding Resistance, which is described in section 2.3.1). On the other side, there is a circuit breaker and then 11KV to 415V transformer. After that there is another circuit breaker and then low voltage bus.

2.2 Grounding

Grounding is a particular type of security system that is designed to protect the devices from any kinds of abnormalities or internal fault in the system which can damage devices. Grounding

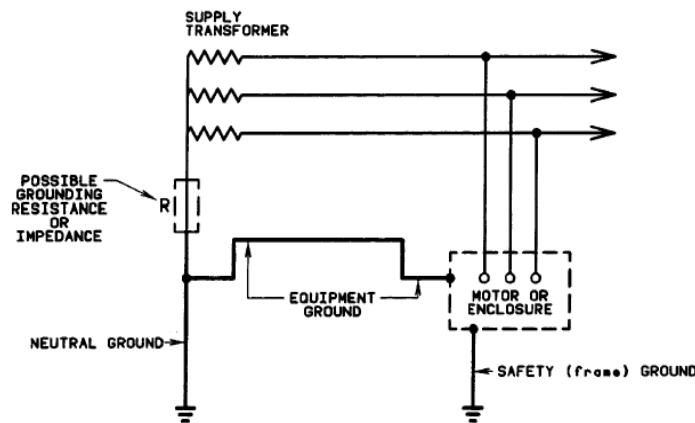


Figure 2.2: Grounding system

is often used as a way of coping with flashbacks or dissociation. In this way, grounding can be considered a variant of mindfulness. The main purpose of grounding is to protect the devices from any kinds of internal faults in the system.

Grounding techniques often use the five senses (sound, touch, smell, taste, and sight) to immediately connect people with the here and now. For example, listening to loud music, holding onto a piece of ice, or biting into a lemon are all grounding techniques that produce

sensations that are difficult to ignore, thereby directly and instantaneously connecting you with the present moment.

The grounding can be divided into the following three areas with respect to purpose:

1. Neutral Point
2. Ground Safety Ground
3. Equipment Ground

2.2.1 Neutral Point Ground

NGR is employed in AC distribution networks to limit the fault current which would flow from the transformer or generator neutral star point in the event of an earth fault in the systems. It is used when the neutral of supply transformer is accessible and its own impedance is not enough to limit fault current. The rating of the protection relays within the required time.



Figure 2.3: NGR

For Grounding Neutral of Transformer or Generator, Resistors upto 33 K Ω are offered for fault of short duration like 10 sec., 30 sec., 60 sec., continuous etc. Material of resistor is normally Stainless Steel, FeCrAl, Cast Iron, Copper Nickel or Nichrome.

Temperature rise is normally $375^{\circ}\text{C}/760^{\circ}\text{C}$ or as required by customer. The purpose is to establish the ground reference of the system. The neutral ground connection is usually made to the neutral of equipment like generators & transformers.

2.2.2 Safety Ground

This is made for protecting personnel from injury. These connections are made to parts of the system that are usually not energized but may become under abnormal or fault situations.

2.2.3 Equipment Grounding

Grounding is made to ensure a low impedance return path for ground current should an electrical fault occur. Between conductors and equipment enclosure, in order to secure that a trip of a faulty circuit is made in a short time.

In this power plant we observed those three types of grounding. The ground grid design was made by CITEC, using the autogrid program following the IEEE 80-2000 standards.

Most important items of grounding are:

- Design criteria is safe & touch voltage is not a absolute Ohm value
- Soil resistivity measurement need to be made
- Network configuration should be known
- Maximum earth fault current should be known
- Station layout should be known
- Number of incoming lines and earthling wires

2.3 DC System

The DC-system consists of a free standing cubicle including Chargers, batteries, and distribution.

Normally the rectifier supplies the load. The battery bank supplies the load for a limited time if

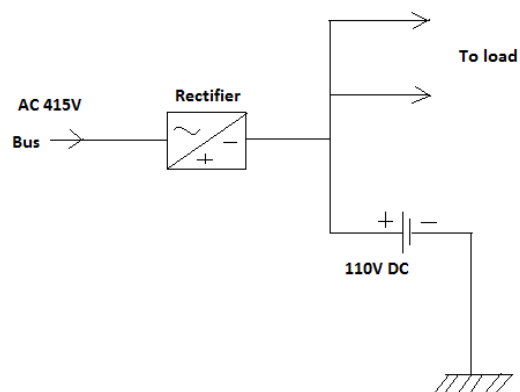


Figure 2.4: DC system

The main supply is interrupted. The DC system shall provide 110V (125V), 24 V DC \pm 10% to the consumers in the power plant. The batteries are typically sized for 5 or 10 hours or: capacity is C10/5 at 1.8V end voltage and 20°C ambient. Normally current is gone through B-bus to load

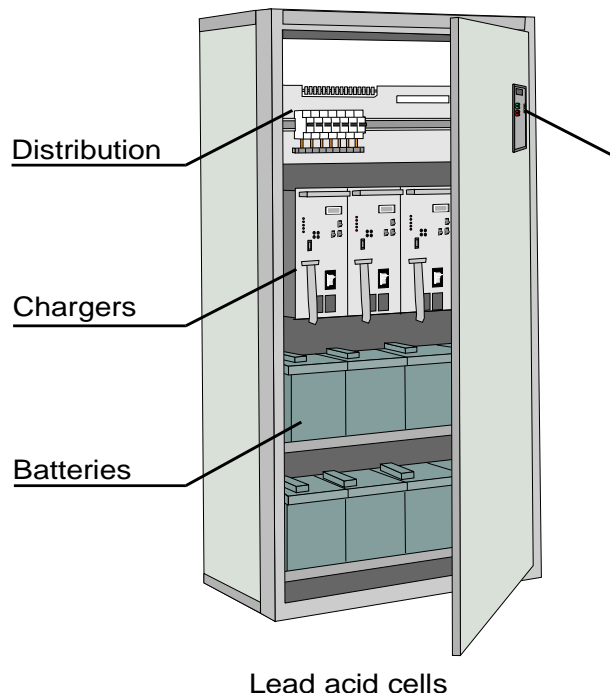


Figure 2.5: Lead acid cell

and battery. During this time batteries are being separated from the load and the battery uses as supplier. It means the loads get power from the battery.

There are 9 batteries in each station transformer. Every batteries voltage rating is 12V. When all the batteries are fully charged then it gives approximately 120V (DC). These batteries can supply 6 to 10 hours continuously.

Typical consumers

PLC engine wise cabinet:	100 W
PLC common cabinet:	100-200 W
Pipe module with RIO	30 W
Gas ramp:	100 W
WECS	380-470 W



Nickel-Cadmium cells

Figure 2.6: Nickel-Cadmium cell

110 V (125V) systems

High resistance grounded

Batteries sizing to be typically for 10 hours consumption

24V system

(-) grounded mainly for supply to the WECS system

Battery sizing to be typically for



Figure 2.7: DC system of the plant

2.4 Operation Mode

All the generators are not same in power generation. Different power plants use different types of generator according their needs. The selection of generator actually depends on the efficiency, setup cost, maintenance facilities and many other reasons. There are three types of operation mode:

1. Solo mode
2. Island parallel mode
3. Grid parallel mode

2.4.1 Solo mode

In this mode only one generator operates. The capacity of the generator depends on the demand of load. Here the voltage label and the frequency label are not fixed. They are independent because there is not any sharing available in this mode. System voltage is determined by generators and their voltage control system. Here the main parameter is voltage and it is a stable system. We use this mode in marine applications, domestic activities, some industries and many other places.

2.4.2 Island Parallel Mode

In this mode more than one generator sharing common load but it is not parallel with grid. The capacity of generator is independent but the voltage label and the frequency label is fixed. That means it will be same among the generators. Here also the system voltage is determined by generators and their voltage control system.

2.4.3 Grid Parallel Mode

In this mode more than one generator is parallel with grid. The capacity of generator is independent but the voltage label and the frequency label depend on the grid. That means it parallel with grid. The system voltage is determined by the grid.

In DBPAL Grid Parallel Mode is used.

Table 2.1: Modes of Operation of Diesel Generator Sets

Control options	Solo	Island Parallel	Grid Parallel
DG load	No	Yes	Yes
Total plant load	No	No	Yes
Voltage	Yes	Yes	No
Frequency	Yes	Yes	No

2.5 Power Factor Control

Power factor control is an important factor of the power plant. The power grid company consumes power to the power plant at power factor of 0.8. Consumer only has to pay for the active power.

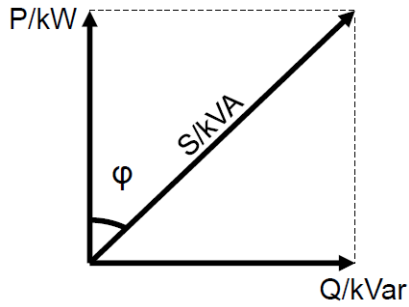


Figure 2.8: Power factor control

$S^2 = P^2 + Q^2$, where

- S = Apparent Power, kVA
- P = Active Power, kW
- Q = Reactive Power, kVar
- $\cos \phi = P/S$
- During normal operation we have to take care both:
 - active power and
 - reactive power control

2.6 DG set control at base load system

There are two types of DG set control at base load system. It is situated in the control room of the power plant. It is individual for each generator.

- **Auto**
 - Engine control
 - kW enable
 - Generator control
 - P.F. enable
 - PLC takes care via prime controllers Woodward 721,723 and Unitrol 1000 that kW and P.F. setpoints are maintained.

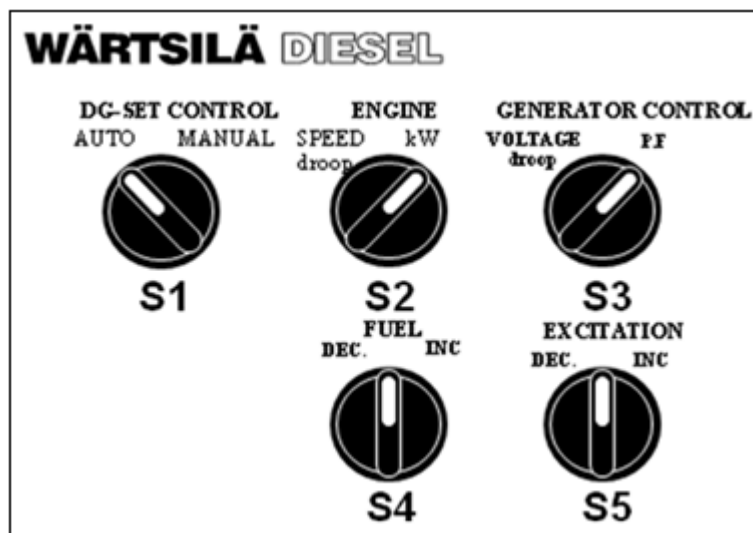


Figure 2.9: DG set control at auto mode

- **Manual**

- Engine control either SPEED DROOP or kW mode:
 - active load reference is changed by S4-button, FUEL increase / decrease command
- Generator control either VOLTAGE DROOP or P.F. mode:
 - reactive load reference is changed by S5-button, EXCITATION increase / decrease command

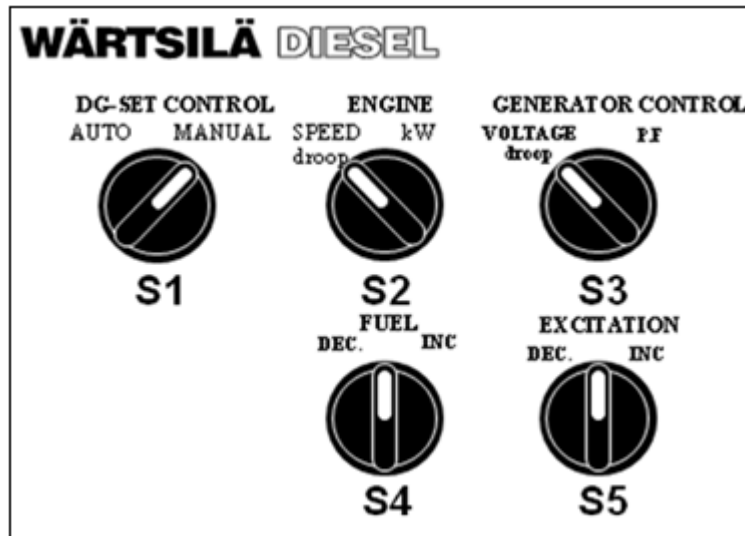


Figure 2.10: DG set control at manual mode

Speed Droop: Speed droop is the reduction in speed from no load speed to full load speed. In parallel generator system all generators speed droop must be equal. Expressed as percentage of rated speed

$$\% \text{ Droop} = \left(\frac{\text{No load value} - \text{Full load value}}{\text{Rated value}} \right) * 100\%$$

Speed Droop setting in Generator is normally 4%

2.7 Speed droop or KW control

- » When in kW control the speed reference is following, i.e. bump less change over to droop control
- » parallel with utility always use kW control

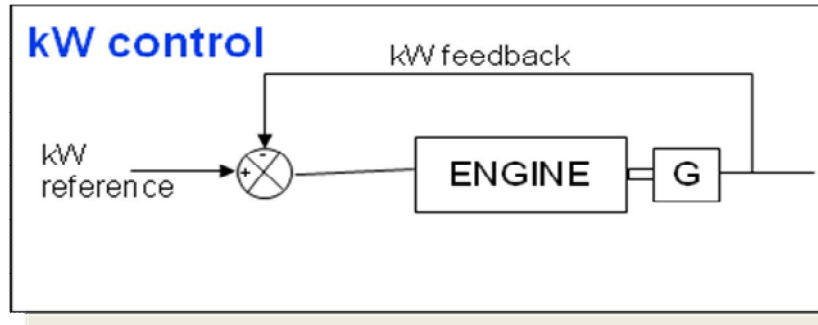


Figure 2.11: KW control

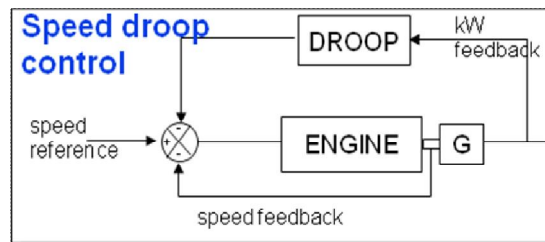
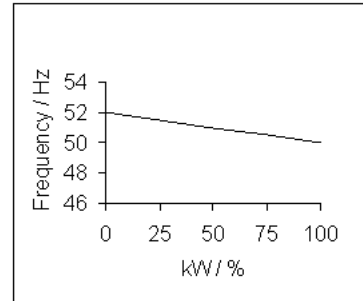
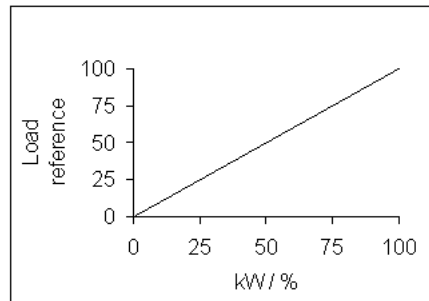


Figure 2.12: Speed droop control



2.8 Emergency generator

Power plant generates the power through generators. All the electrification is done by its own generator. In rear condition because of any serious kind of fault if all the generators fail to generate the power, then an alternate generator automatically start to generate a small amount of power to continue the electricity in the control room and in office. This generator is called the Backup generator. In the plant it is situated on the backward side of the plant. In DBPAL's backup generator (fig: 2.13) is 220V rated.



Figure 2.13: Backup Generator

2.9 Switchgear

A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy. The apparatus used for switching, controlling and protecting the electrical circuit's equipments is known as switchgear. This is used in association with the electric power system, or grid, fuses or circuit breakers are usually employed to protect the system during maintenance or faulty condition. Switchgear is used both to de-energize equipment to allow work to be done and to clear faults downstream. Importance of this protection is enormous because the reliability of the operation depends on this system.

2.9.1 Structure of Switchgear

There are three compartments in the switchgear. These are

- Control & monitoring
- Breaker
- Cable connections and Transformers

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Breaker cubicle is the cable connections from generator in down compartment through cable current transformers used for earthing disconnector, breaker unit in the middle compartment, control & monitoring circuits in top compartment, & mechanical interlocking and tripping 19 unit in connection with middle compartment.

Feeder cubicle is the cable connections to step-up transformer in down compartment used for earthing disconnector, feeder breaker in middle compartment, control & monitoring circuits in top compartment, mechanical interlocking and tripping unit in connection with middle compartment, & usually equipped with fans for forced ventilation.

Circuit breaker is dimensioned for different breaking capacity, generator & feeder. These are withdrawable type & vacuum or filled with SF₆ gas. These are spring operated. The auxiliary devices of circuit breaker are auxiliary contacts, pumping device, control contactor of charging motor, limit switch & charging motor (DC).

The protection and measuring for MV switchgear's are: In the busbars there are over / under voltage protection, over / under frequency protection, voltage measuring, frequency measuring, and current measuring. In the feeder and bus-tie breakers there are over current protection, earth fault current protection, voltage / current measuring, and active / reactive power measuring.

Classification:

Voltage differs from device to device and also in generation and transmission system. 1V to 1KV is low voltage level, then 2KV to 35KV is medium voltage level and above 35KV is high voltage level. According to the voltage level there are three types of switchgear.

1. Low voltage switchgear
2. Medium voltage switchgear
3. High voltage switchgear

2.9.2 Low Voltage Switchgear

The Low Voltage switchgear can be called the station service switchgear since it serves all the auxiliary power needs, such as motors (pumps), fans, heaters, complete units etc consumers.

2.9.2a Lay-out

- Copper busbars for power distribution
 - 1) Aluminium plates
 - 2) Compartments
 - 3) Ducts for cable distribution
 - 4) Compartment separation
- Efficient air circulation
- Arc pressure directed away to the rear
- Bus bars with insulators
- Different dimensions of compartments

2.9.2b Compartments

- Standard structure
- Withdraw able structure
- Both structures equipped with necessary breakers and meters
- Each compartment dimensioned according to needed output



Figure 2.14: LV switchgear

Standard Low Voltage switchgear:

Assembly:	Metal enclosed totally type tested assembly (TTA) according to IEC/EN 60439-1
Degree of protection:	IP31 (IP54)
Compartmentalization:	Form 4A
Internal compartment protection:	IP20
Wiring:	4 wire (3 ph+PE) or 5 wire 3ph+PE+N
Earthing:	TN-S (neutral and protective conductor is separate)
Busbar:	Cu or AL
Main breaker	Air circuit breaker / MCCB / fuse-switch 3 or 4 pole
Distribution:	MCCB, MCB, Fuse switch
Bus-tie breaker	Air circuit breaker / MCCB / fuse-switch 3 or 4 pole
Altitude:	2000 m
Ambinet:	40 °C (35° 24h)

Electrical ratings:

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Nominal operational voltage:	380-480V
Insulation voltage:	1000 V
Lightning impulse withstand	12 kV
Short time withstand current	up to 100 kA
Peak withstand current:	up to 230 kA
Arc withstand:	50 kA, 300ms
Temporary voltage variation:	+10/-15 %
Earth quake tested:	Yes

Manufacturer

- ABB

- Unipower

- Rated voltage max. 690V 50 /60 Hz

- Rated currents 1600 - 5000 A

- Short-circuit withstand busbars 50 - 100 kA 1s

- Arc withstand

• 50kA 300ms

- Degree protection

• IP 31 - 52

- Ambient conditions

• Maximum +40 C (air conditioning - tropics)

- Standards

• SFS; EN; IEC; BS; DIN

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2.9.3 Medium Voltage Switchgear

MV switchgear distributes the electric power from generators. It supplies power to step-up transformers for grid connection and station transformers for internal consumption. MV switchgear is used for the safety of breakers and alternators. In MV switchgear, the breaker type is SF6 and vacuum. The nominal voltages are 12kV, 17.5kV, 24kV. The nominal currents are (630 – 4000) A & (630– 1200) A. The Short circuits withstand are 40 kA 3s & peak currents 100 kA. Arc withstand are 40 kA. The construction of MV switchgear is metal-clad or cubicle type. There are different cubicles or panels. These are Generator breakers, Station transformer breakers, Feeder breakers, Bus tie breakers and Measuring panels. These cubicles are bolted together for rigid and solid construction. There is a mechanical interlocking system for safe operation.



Figure 2.15: MV switchgear

In the Dutch Bangla Power & Association Limited (DBPAL) at MV switchgear section we saw there are 4 panels. These are

- Incoming from generator
- Outgoing feeder
- Station transformer
- Metering or measuring

Bus tie breaker is not there because there is no interconnection between the buses.

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Manufacturers

- ABB
- Unipower

2.9.3a Incoming from Generator

In the incoming from generator panel, there are three potential transformers and three 0-CTs transformer behind the voltage transformers. Three potential transformers are for three phase. 0-CT transformer works in balance condition. In unbalanced condition it will trip. The shape is square and the wires come from the generator and output in the metering panel.



Figure 2.16: Incoming from generator panel

2.9.3b Metering Panel

Measuring cubicle is only use for measuring, no breaker installed. In the down compartment, there are current transformers and voltage transformers. In the top compartment there are control circuits, connectors, relays and auxiliary equipments and protection relays. Only in this panel frequency transducer exists.



Figure 2.17: Metering panel

2.9.3c Station Transformer

In the Station transformer, there is a voltage and current transducer, PLC and magnetic conductor. Monitoring the ratings of the station transformer is the job of this panel.



Figure 2.18: Station transformer panel

2.9.3d Outgoing Feeder to Generator

In the Outgoing feeder to generator transformer there is an active power (KW) meter, reactive power (KVAR) meter & current transducer. A current transducer is a device that converts one form of energy to another. Energy types include electrical, mechanical, electromagnetic, chemical or thermal energy. It is widely used in measuring instruments. Here the transducer rating is (4-20)mA.

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Figure 2.19: Outgoing feeder to generator panel

2.10 Frequency Converter

Frequency converter is an electronic or electromechanical controlled device which will convert alternating current (AC) of some frequency to alternating current of another frequency.

An electromechanical frequency converter is used within motor generator sets or rotary converters. Frequency converter may also be solid state electronics. Solid state electronics devices normally employ a rectifier (producing direct current) which is inverted to produce AC of the desired frequency. The inverter may use thyristors or IGBTs. A battery may also be incorporated within the DC circuit to improve the converter's demand performance during short input power outages. Frequency converters are available in much power handling capacity from a few watts to megawatts, as well as, different frequency ranges.



Figure 2.20: Frequency converter

Application: Frequency converters are used to convert power from one distribution standard to another, frequency converters are also used to control the speed and the torque of AC motors. In this application, the typical frequency converter is a three-phase two-level voltage source inverter. The phase voltages are controlled by using power semiconductor switches and a Pulse Width Modulation (PWM). Semiconductor switching devices and anti-parallel connected freewheeling diodes are combined to form a bridge, which is used to connect all motor phases to the positive or negative dc-link voltage. The PWM changes the connections of the phases between the positive and the negative DC-link voltage so that the wave voltage has the desired frequency. Frequency converters are commonly used to control the speed of pumps and fans. Significant energy and power savings are achieved in many applications.

Standard industrial, aviation, and European frequency converters operate at 50 Hz, 60 Hz, and 400 Hz (Aircraft and Shipboard).

2.11 Reading Electrical Drawing

Every machine and electrical system has its individual drawing. It is very important to read the drawing for maintenance and troubleshooting. We can detect the fault very easily and quickly through this electrical drawing. In the first portion there the introduction of different elements of this existence system. Then the main diagram appears. There are three different points cases-

1. One number pointing to the same sheet. (i.e. 3B)

2. Two number pointing to a different sheet. (i.e. 24B)
3. Pointing to a different drawing number. (i.e. 18-92C)

2.11.1 One number pointing to the same sheet

There are two parts of the number. One is numerical letter and another is alphabetic letter. The numerical number showing the number of column and the alphabetic number is showing the number of row. Here the two diagrams will be in a same sheet.

2.11.2 Two number pointing to a different sheet

It will be in same drawing number but only page number is different. First number indicates the number of sheet and the second number's first part indicates the number of row and the second part indicates the number of column.

2.11.3 Pointing to a different drawing number

In this case the drawing sheets are different. The page number also can be different. First number indicates the number of drawing, the second number indicates the number of sheets and the last number indicates the row and column.

2.12 Oil Supply System

Heavy fuel oil is the main component of this plant. They are using heavy Furnace oil. This is imported from foreign countries. It brings through barge. From the barge, the oil stored in storage tank. After several processes, the oil is used in generator. Here is an overall diagram of the processes.

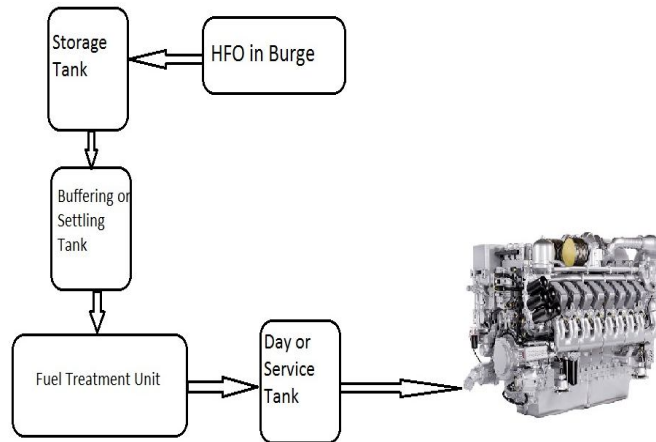


Figure 2.21: Overall Oil Supply System

2.12.1 HFO (Heavy Fuel Oil)

Heavy fuel oils are blended products based on the residues from various refinery distillation and cracking processes. They are viscous liquids with a characteristic odour and require heating for storage and combustion. Heavy fuel oils are used in medium to large industrial plants, marine applications and power stations in combustion equipment such as boilers, furnaces and diesel engines.

Heavy fuel oil is a general term and other names commonly used to describe this range of products include: residual fuel oil, bunker fuel, bunker C, fuel oil No 6, industrial fuel oil, marine fuel oil and black oil. In addition, terms such as heavy fuel oil, medium fuel oil and light fuel oil are used to describe products for industrial applications to give a general indication of the viscosity and density of the product.

This dossier on heavy fuel oils collates the currently available data on all grades of heavy fuel oils and covers the health, safety and environmental properties of these products as sold for the industrial and marine markets.

2.12.2 Storage Tank and Buffering/Settling Tank

From the barge the furnace oil is inserted into the storage tank through unloading pump. Each storage tank's capacity is 4000 gallon. There are two storage tanks in DBPAL. In the storage tank the oil temperature is 30°C-33°C.



Figure 2.22: Storage Tank

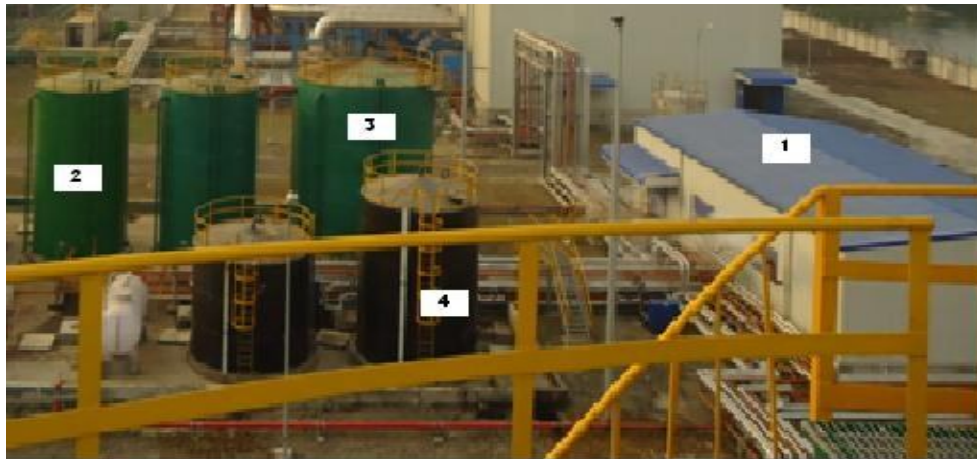
From the storage tank oil is transferred to the buffering tank using transfer pump. Here water is being separated from the oil and the oil temperature contains 60°C-65°C.

2.12.3 Fuel Treatment Unit

After buffering, fuel is transferred to the fuel treatment unit. Fuel is purified here by separating the foreign particles and rest of water. By the oil separator oil is being separated. Each separator's capacity is 15m³/hr. Then the oil is transferred to the day tank or service tank.

2.12.4 Day/Service Tank

After separation, the oil is stored in day tank and then it supplied to the engine using supply pump and boost pump. Normally oil pressure is 5.5 bar here, but by boost pump the pressure increases at 8-9 bar.



- 1= Fuel Treatment Unit
- 2= Day Tank
- 3= Buffering Tank
- 4= Lube Oil Tank

Figure 2.23: Different Tanks

2.12.5 Unloading Pump

The main fuel HFO comes through the ship. Every ship has their own pump for unloading the oil. If the pump of ship fails to transfer the oil from the ship to storage tank then unloading pump is used. It is one kind of reserve pump.



Figure 2.24: Unloading Pump

There are MCB breakers, magnetic conductors, PLC and other equipments are on this unloading pump. When the breakers being close the magnetic conductors are being energized and the contacts in the conductor are being closed and then the pump operates. This is the operating principle of the unloading pump. There are two unloading pumps in this plant.

2.12.6 Lubricating Oil (Lube Oil)

Lubricating is oil which forms a film between the moving surface to reduce the friction and wears. In DBPAL Mobilgard M: 50 is used as lubricating oil. The specification of M: 50 is given below,

Table 2.2: Specification of Lube oil (Mobil M50)

Test Parameter	Unit	Method	Limit
Specific Gravity @60/60°F	-	ASTM 1298	Max: 0.922
Kinematic Viscosity@ 40°C	cSt (mm ² /s))	ASTM 445	Min: 116.0, Max: 169.0
Kinematic Viscosity@ 100°C	cSt (mm ² /s))	ASTM 445	Min: 13.7, Max: 16.1
Viscosity Index	Calculated	ASTM 2270	Min: 80.0
Water Content	% V/V	ASTM 95	Min: Nil, Max: 0.20
Total Base Number(TBN)	Mg KOH/g	ASTM 2896	Min: 25. Max: 50.0
DAC (Asphaltenes)	% m/m	Unknown	Max: 1.0
Sulfate Ash Content	% m/m	ASTM 874	Max: 6.5
Oxidation	Ab/cm	Unknown	Max: 20.0
Nitration	Ab/cm	Unknown	Max: 20.0
Soot Content	% m/m	Unknown	Max: 20.0
Flash Point (Open Cup)	°C	ASTM 92	Min: 228.0
Pour Point	°C	ASTM 97	Max: -12
Silver (Ag) Wear Element	ppm	AAS-6200	Max: 30.0
Aluminium (Al) Wear Element	ppm	AAS-6200	Max: 10.0
Chromium (Cr) Wear Element	ppm	AAS-6200	Max: 30.0
Copper (Cu) Wear Element	ppm	AAS-6200	Max: 15.0
Iron (Fe) Wear Element	ppm	AAS-6200	Max: 60.0
Molybdenum (Mo) Wear Element	ppm	AAS-6200	Max: 30.0
Nickel (Ni) Wear Element	ppm	AAS-6200	Max: 30.0
Lead (Pb) Wear Element	ppm	AAS-6200	Max: 30.0
Tin (Sn) Wear Element	ppm	AAS-6200	Max: 30.0
Boron (B) Contaminant Element	ppm	AAS-6200	Max: 30.0
Potassium (K) Contaminant Element	ppm	AAS-6200	Max: 30.0
Sodium (Na) Contaminant Element	ppm	AAS-6200	Max: 90.0
Silicon (Si) Contaminant Element	ppm	AAS-6200	Max: 10.0
Vanadium (V) Contaminant Element	ppm	AAS-6200	Max: 198.0

Chapter 3. Generator and Engine

Alternative current (ac) generators are commonly referred to as synchronous generators or alternators. Synchronous machine, whether it is a generator or a motor, operates at synchronous speed, that at which the magnetic field created by the field coil rotates. Here an expression for the synchronous speed N_s in revolutions per minute (rpm) as

$$N_s = 120f/p$$

Where f is the frequency in hertz (Hz) and p is the number of poles in the machine. The stationary member (stator) of a synchronous generator is commissioned as an armature, and the rotating member (rotor) carries the field winding to provide the required flux.

3.1 Main component of Alternator

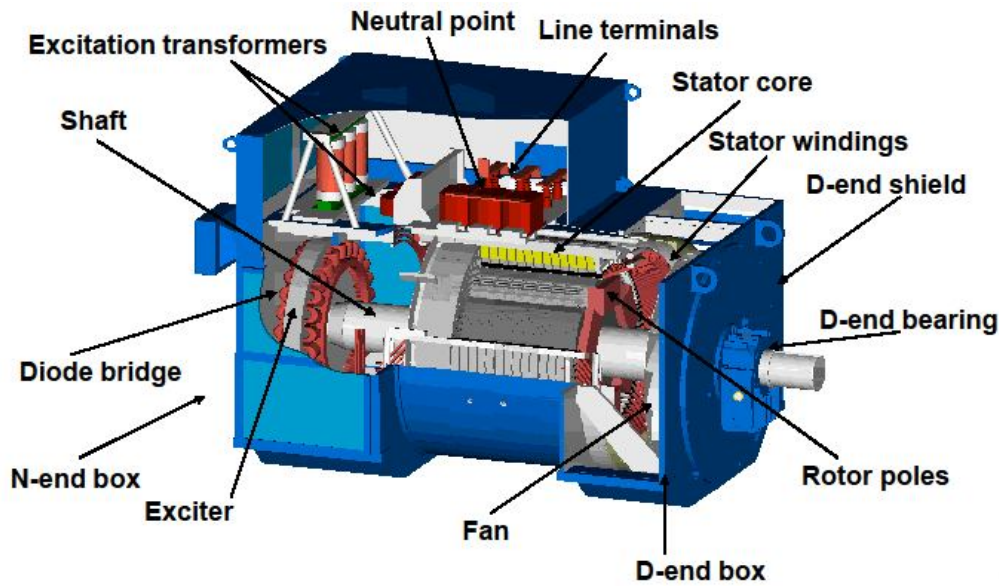


Figure 3.1: View of an alternator

3.2 Construction of a Synchronous machine

The basic components of a synchronous machine are the stator core, which houses the armature conductors, and a rotor, which provides the necessary field.

3.2.1 Stator core and Frame

In DBPAL we saw the stator core and frame in generator. The stator core is made of punched, stacked, high-grade, low-loss silicon steel sheets. Sheet thickness is 0.5 mm (insulated on both sides). The stator laminations are held together by a stator frame. The frame may be cast iron or fabricated from mild steel plates. The frame is designed not to carry the flux but to provide mechanical support to the synchronous generator. The inside of the stator has a lot of slots that are intended to accommodate thick armature conductors (coil or windings). The armature conductors are symmetrically arranged to form a balanced polyphase winding.

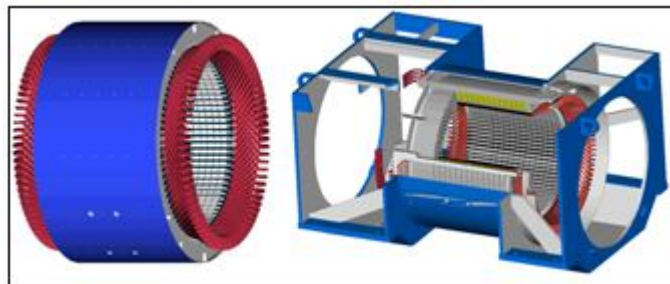


Figure 3.2: Stator Core and Frame

3.2.2 Rotor

In DBPAL we also saw the rotor in generator. The rotor is designed to withstand the vibration caused by the prime mover and stresses appearing up to 120 % of rated speed. Here critical rotational speed is at least 1.5 times the nominal speed. Shaft is made of forged steel. The rotor is rotated at the synchronous speed by a prime mover such as a steam turbine. provided with damper winding.

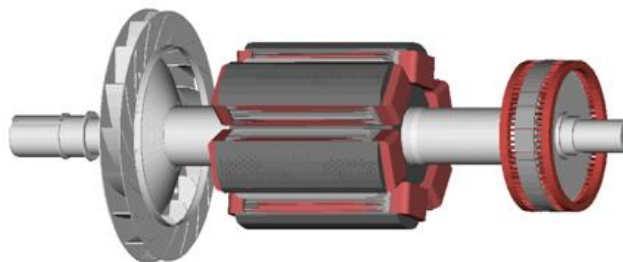


Figure 3.3: Rotor

The cylindrical rotor is employed in a 2-or 4-pole, high-speed turbo-generator. It is made of a smooth solid forged steel cylinder with a number of slots on its outer periphery.

The cylindrical construction offers the following benefits:

1. It results in a quiet operation at high speed.
2. It provides better balance than the salient-pole rotor.

3. It reduces the wind age loss.

3.3 Generator operation

In Dutch Bangla Power and Associates Ltd (DBPAL), Generator generating voltage is 11 KV, winding temperature is maximum 120°C and winding current flow is maximum 600A. When generator is full load then it provides 600 A .

Synchronous generator is a rotating machine whose speed of rotation is fixed to the ratio of the supply frequency and the number of pole pairs.

$$n = 120 \times f / p \text{ speed (rpm)}$$

f = frequency (Hz)

p = number of pole pairs

In DBPAL, Generator rpm = 750 rpm

Frequency = 50 Hz

$$n = 120 \times f / p$$

- $P = 120 \times f / n$
- $P = 8(\text{pole})$

3.3.1 Synchronous generator at no-load

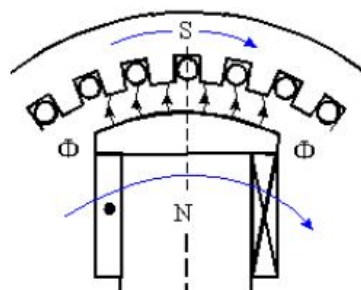


Figure 3.4: No load synchronizing

Rotating, magnetized rotor pole will create magnetic flux through conductors of stator coil. Voltage will be induced to each conductor of the coil multiplied by the number of effective turns. The number of coil sides within a coil group and also the number of series connected coil groups. Rated voltage will be generated in the generator terminals.

3.3.2 Synchronous generator at reactive load

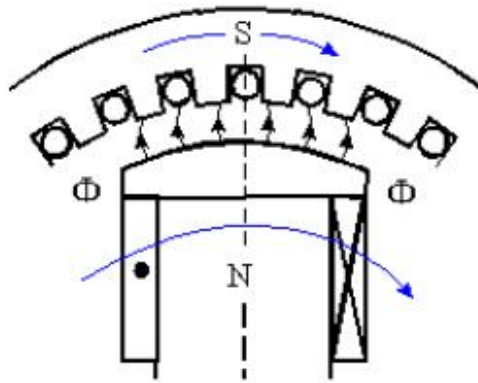


Figure 3.5: Reactive load synchronizing

The current being at 90 phase angle (angle between voltage and current) with the voltage will create magnetic flux in the same axis as field current. No active power is needed to rotate generator except losses of the generator.

Phase angle +90 (current behind the voltage) => inductive load

Phase angle -90 (current ahead the voltage) => capacitive load

Inductive current creates flux affecting opposite direction to flux created by field winding. In order to prevent voltage decreasing, field current shall be increased. Capacitive current creates flux affecting same direction to flux created by field winding. In order to prevent voltage rising, field current shall be decreased.

3.4 Design and Dimension

In DBPAL generators are designed using following criteria.

Power: The Generator has to be dimensioned so, that it is able to produce the required apparent (SN) power without warming too much.

Frequency & Speed: With equal power, the slower the speed, the bigger generator is needed. In other words, the needed torque defines the size and speed affects also to the mechanical design of the rotor.

Voltage level: Defines the insulation class of the winding as well as air insulation distances. The more insulation in slots less space for copper.

3.5 Cooling

In DBPAL the generator is cooled with a shaft mounted fan. The cooling air is drawn in through air filters and blown out to the environment on standard arrangement. As current flows in a conductor, heat is generated. A generator has a lot of conductors and a lot of current flowing through the conductors, generating a lot of heat. If that heat isn't "removed" then the windings will be damaged. In addition, in a synchronous generator (alternator), there are high currents flowing in the rotor windings, which also generate heat which must be removed. Air can be used to cool a generator, by circulating it through the generator to absorb heat and then exhausting the air to another area outside the generator. A continuous flow of air from outside the generator, through the generator, to another area outside the generator will cool the generator and rotor.

3.6 Synchronization

When two or more electrical generating sets or systems are paralleled to the same power distribution system, the power sources must be synchronized properly. Without proper synchronization of the system, power surges and mechanical stress will result when the generator breaker is closed. If there is no synchronization then circulating current will flow.

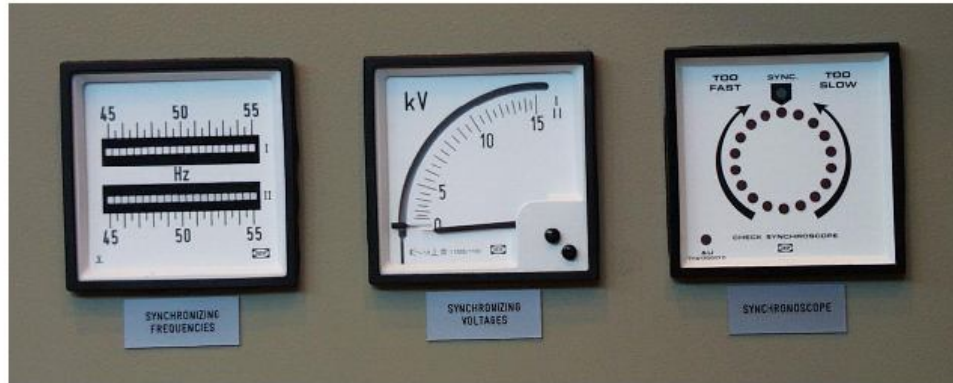


Figure 3.6: Synchronization Meters

3.6.1 Synchronizing Frequencies

This meter is used for frequency synchronization. In synchronization, frequency has to match with the grid. The grid frequency in Bangladesh is 60Hz. Here speed is needed and fuel is increased or decreased for adjust frequency.

3.6.2 Synchronizing Voltages

This meter is used for voltage synchronization. Here voltage has to match with the grid. And voltage change is needed for adjustment. Under the worst conditions, the voltages between the two systems can be twice the peak operating voltage of one of the systems, or one system can place a dead short on the other. Extremely high currents can result from this which put stress on both systems.

3.6.3 Synchroscope

This indicates the instantaneous angle of phase displacement (error angle) between two voltage waves. If the voltages have different frequencies, the angle between the two waves, called the error angle, will always be changing, causing the pointer to revolve. When properly connected, a synchroscope indicates the electrical speed of the incoming machine with respect to the bus. If the synchroscope revolves in the direction marked slow, the incoming machine has a lower

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frequency than that of the bus. If the synchroscope revolves in the direction marked fast, the incoming machine has a higher frequency than that of the bus. If the frequency of the incoming machine is equal to the bus frequency, the pointer will not revolve, and position of the pointer will indicate the error angle.

3.7 Alternator maintenance

Table 3.1: Alternator maintenance

Serial no.	Activity	Interval
1	Check air filter cleanliness change if necessary	Daily
2	Pressure and flow/level of bearing lubrication	Daily
3	Tightness of high tension and other cables	Monthly
4	Rotating diodes and surge suppressor inspection	6 months
5	Insulation resistance value measurement	6 months
6	Polarization index measurement	6 months
7	NGR value measurement	6 months

3.8 Protection Relay

In DBPAL, for generator protection the relay VAMP 210 is used. Previously different types of relay were used for different protection, but now a day's VAMP 210 relay is used for all types of protection. It is software based.

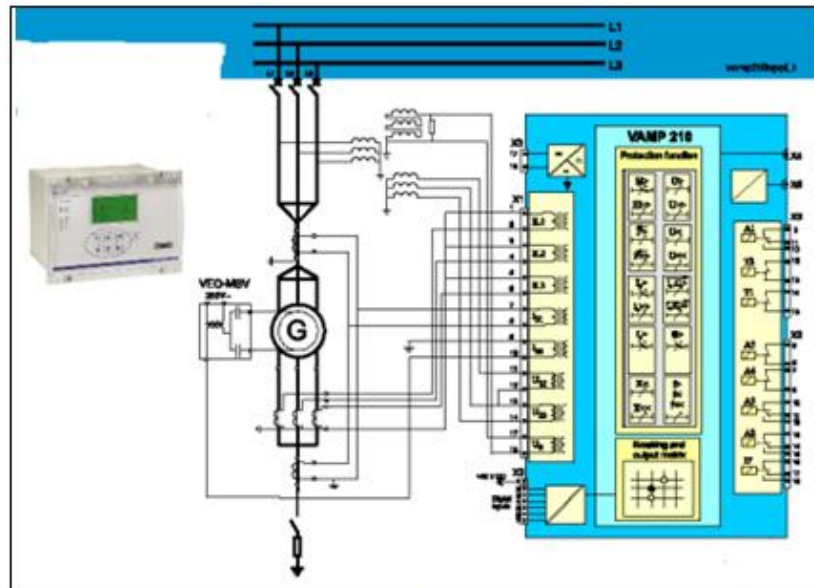


Figure 3.7: Generator Protection Relay VAMP 210

By using VAMP 210 relay following protections are provided,

- Differential Protection
- Over & Under Voltage Protection
- Over & Under Frequency Protection
- Over Current Protection
- Thermal Overload Protection
- Loss of Excitation Protection
- Reverse Power Protection
- Earth Fault Protection

3.9 Engine

The principal characteristic of an engine is its capacity to deliver appreciable mechanical power, as contrasted to a mechanism such as a clock, whose significant output is motion. By usage an

engine is usually a machine that burns or otherwise consumes a fuel, as differentiated from an electric machine that produces mechanical power without altering the composition of matter. Similarly, a spring-driven mechanism is said to be powered by a spring motor; a flywheel acts as inertia motor. By definition a hydraulic turbine is not an engine, although it competes with the engine as a prime source of mechanical power.

3.9.1 Mechanical to Electrical power

Mechanical energy used per unit time is called mechanical power. Mechanical power is the rate at which work is done. Mechanical power is expressed in units of joules/sec (joules/s) or a watt (W).

$$P = \omega T, T = \text{Torque}$$

$$\omega = 2\pi n, \omega = \text{angular speed, rad/s}$$

Where 2 and π are constants by nature and the n (speed) we like to keep as constant as possible. The goal of course is the stable grid frequency (50 or 60 Hz) which leads to the stable engine speed (rpm \gg 1/s).

3.9.2 Control module

A control unit in general is a central part of the machinery that controls its operation, provided that a piece of machinery is complex and organized enough to contain any such unit. One domain in which the term is specifically used is the area of computer design. In the automotive industry the control unit helps maintain various functions of the motor vehicle. In engine there is a control system in DBPAL which is divided into three parts, these are

1. Main control module (MCM)
2. Engine safety module (ESM)
3. Power distribution module (PDM)

3.9.2a Main control module (MCM)

This control module is used for speed control and load control. In MCM output is going to be actuator. In actuator fuel is to be increasing or decreasing. Here is current is varying 20mA to 160 mA. When full load current is 160mA and stop load then current is 20 mA. In DBPAL, current range is 95mA. MCM

shutdown input intended for the engine main controller. It is possible to configure for single or dual wire operation.

- single wire operation
- dual wire operation

3.9.2b Engine safety module (ESM)

It needs for an independent “stand-alone” safety system, to replace old, outdated systems and needs for standardised solutions. Here common working principles for all engine applications, unified marine and power plant solutions. It needs for a compact, certified and classified solution and for specific I/O's and functions not available in other systems.

3.9.2c Power distribution module (PDM)

Power distribution module is needed to produce the power of MCM and ESM.

3.10 Maintenances and safety

3.10.1 Maintenances

In DBPAL, use HFO for running the plant. So we have to give special care at fuel quality. Also with fuel, we have other duties for maintenance purpose. These is given below:-

- **Check tightening of the connecting rod screw**
We have to check tightening of the connecting rod screw after the first 50 operating hours on a new engine and, after overhaul those screws that have been opened.
- **Check tightening of the counterweight fastening nuts**
We have to check tightening of the counterweight fastening nuts after the first 50 operating hours on a new engine.
- **Check oil level in governor**
We have to check oil level, and look for leaks
- **Check pressure drops**

The cartridges are to be replaced when the pressure difference indicator shows too high pressure drop.

- **Check pressure drop over lubricating oil filter**
We have to clean or change filter candles if high pressure drop is indicated.
- **Check oil level in sump oil/tank**
We have to check oil level by means of dip stick. It is very important for an engine.
Without checking oil level in sump oil the engine may be in danger.
- **Check tightening of injection pipe connections**
We have to check the tightening of injection pipe connections on a hot engine after the first after 50 operation hours on a new engine and, after overhaul, those connections which have been opened. Also we have to check the tightening of the nuts.

3.10.2 Safety

There are three basic safeties in engine for the protection .These are :

1. Over speed shutdown
2. Lubricating oil pressure shutdown
3. High temperature shutdown

3.10.2a Over speed shutdown

This safety is very important for an engine. Normally the engine runs at 750 rpm. There are two over speed shut down speed these are 847.5 rpm (113%) and 877.5 (117 %).When the speed of the engine increases from normal speed the engine will be shut down. When engine speed increases by 113% then it gives an alarm and when it increases by 117% then it will be shut down.

3.10.2b Lubricating oil pressure shutdown

Lubricating oil pressure shut down is the basic safety of a diesel engine. Lube oil is needed for engine as we need blood in our body. The pressure exist here is 6 bar (normal engine).When pressure decreases and comes to 3 bar then it gives ESM alarm. But when pressure decreases and comes to 2.5 bar the engine will stop automatically.

3.10.2c High temperature shutdown

High temperature shut down is another basic safety for a diesel engine. The normal temperature of a diesel engine is 96°C . If the temperature of the engine will increase by any reason then the engine will give alarm at 105°C . The engine will stop when the engine goes to 110°C . Its shut down levels are shutdown levels are 105°C , 110°C and 115°C .

Chapter 4. SUBSTATION

Electric Substations are the part of the power system and used for transferring power from generating points to load centers. It is a part of an electrical generation, transmission, and distribution system. Substations transform voltage from high to low, or the reverse, or perform any of several other important functions. Electric power may flow through several substations between generating plant and consumer, and its voltage may change in several steps. Some of the important components of substation are discussed following.

4.1 Transformer

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

4.1.1 Classification

Mainly two different types,

- Dry-Type transformer
- Liquid immersed transformer

In DBPAL power plant, liquid immersed transformers are being used.

4.1.1a Liquid Immersed Transformer

Liquid immersed transformers, such as that shown in Fig. 6.2, have hermetically sealed tanks filled with insulating liquid to provide both insulation and cooling. Cooling fins on the tank provide for convection cooling of the insulating liquid. Forced cooling with pumps and/or fans is also provided on large power transformer. The insulating liquids used are mineral oil and silicone oil. Polychlorinated biphenyls (PCBs) called askarels were used in earlier construction but are no longer permitted.



Figure 4.1: Liquid Immersed Transformer used in Dutch Bangla Power and Associates Limited (DBAPL)

Transformer is two types according to its usability,

- Auxiliary/station transformer (Step-down) or distribution transformer
- Power transformer (Step-up)

4.2 Auxiliary/station transformer (Step-down) or distribution transformer

A distribution transformer is a transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer.

There are three auxiliary transformers for each four (4) alternator. Every transformer is rated 1600KVA. These are step-down transformers. This transformer also called “Distribution Transformer”. The voltage ratio is 11KV/433V. These are also liquid immersed transformer.

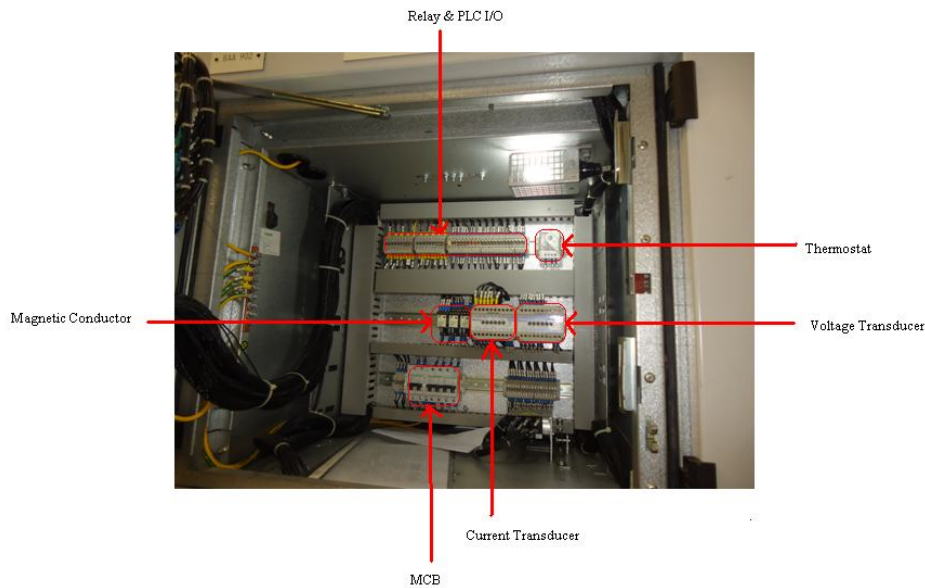


Figure 4.2: Auxiliary/Distribution Transformer (1600KVA) panel in MV switchgear

4.2.1 Controls of distribution transformer

4.2.1a Thermostat

A thermostat is a component of a control system which senses the temperature of a system so that the system's temperature is maintained near a desired set point. The thermostat does this by switching heating or cooling devices on or off, or regulating the flow of a heat transfer fluid as needed, to maintain the correct temperature. It acts like a heater. When temperature is down then thermostat is switched on and maintain provide correct temperature.

4.2.1b Voltage and Current Transducer

Voltage and current transducer converts the voltage and current between 4-20 mA range respectively and its output connect with the PLC (Programmable Logic Controller). Because PLC can read mA range data easily.

4.2.1c Circuit Breaker

A circuit breaker is an automatically operated electrical switch which protects an electrical circuit from damage due to overload or short circuit. When a fault occur in the circuit then the
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breaker automatically open to immediately disconnect the electrical flow. There are various types of circuit breaker according to its size and voltage or current ratings. In low voltage side of the distribution transformer Miniature Circuit Breaker (MCB) is being used.

4.2.1d Magnetic Conductor

After getting power from the DC system the magnetic conductor is charged and the transformer gets power.

4.3 Power transformer (Step-up)

A transformer that is used to transform AC power in power system networks, radio apparatus, and automatic systems. A power transformer operates with a constant effective voltage. The frequency of power-transformer current in most countries is 50 hertz (Hz); in the USA and some other countries it is 60 Hz. Power transformers are the most common class of transformers. Transformers have been built (1975) for a power of 1300 megavolt-amperes and a voltage of 750 kilovolts.

There are three power transformers (Fig 6.2) for each four (4) alternator. The transformer ratings given below,

Table 4.1: Power Transformer Ratings

40/50MVA
ONAN/ONAF
140/11KV
± 15%
Z=12.0%
yND11

Representation of rating,

40/50MVA = When cooling fan don't operate then it produces 40MVA and when cooling fan operate then it can produce upto 50MVA

ONAN = Oil Natural Air Natural

ONAF = Oil Natural Air Force

140/11KV = voltage can step-up up to 140KV from 11KV

$\pm 15\%$ = grid voltage $\pm 15\%$ is tolerable

Z=12.0% = impedance

yND11 = primary side is star connected and secondary side is Delta connected and 11 represents the phase difference between primary and secondary side. (1=30°, 2=60° and 11=330°)

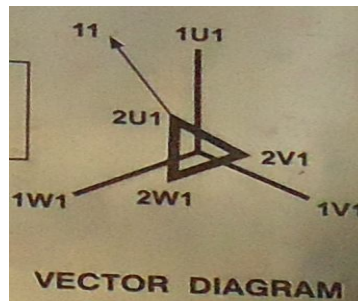


Figure 4.3: Vector Diagram of the Transformer

4.3.1 Controls of Power Transformer

4.3.1a Tap Changer

A transformer tap is a connection point along a transformer winding that allows a certain number of turns to be selected. This means, a transformer with a variable turns ratio is produced, enabling voltage regulation of the output. The tap selection is made via a tap changer mechanism.



Figure 4.4: Tap changer module at DBPAL

Here, on-load tap changer is being used with the transformer. There is no control about grid voltage, which means there load is always present. For any fluctuation of grid voltage secondary side voltage (11KV) will not be changed, it will be same.

4.3.1b Automatic Voltage Regulator (AVR)

Automatic Voltage Regulator (AVR) is the control of tap changer. It helps to maintain 11KV at secondary side. Details about AVR is discussed in chapter 5.

4.3.1c Silica Gel Breather

If the air enters into the transformer, silica gel breather absorbs the moisture of the air. The sole function of Silica Gel Breather is to dehydrate (remove moisture) the air & to remove dust particles of the air breathed in by the transformer.



Figure 4.5: Silica Gel Breather

For measurement purpose there uses another two types transformer. These are,

- Current Transformer (CT)
- Potential Transformer (PT)

4.3.1d Current Transformer (CT)

A current transformer (CT) is used for measurement of electric currents. When current in a circuit is too high to directly apply to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer also isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays.

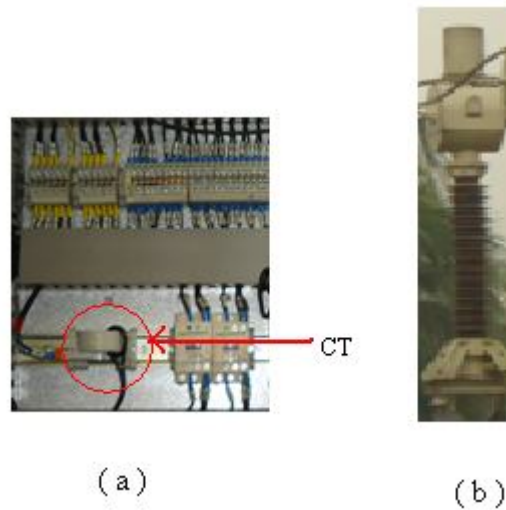


Figure 4.6: CT at outgoing feeder (a) and 132 kV bus (b)

CT secondary is short circuited; basically a CT is a step up transformer. Think of the CT as a transformer, with a 1 turn primary and many turns on the secondary. Normally in the primary of a ct high currents are flowing. If the secondary is opened then as it's a step up transformer. A high voltage is induced in the secondary, the induced secondary voltage is very high which may damage the instrument itself or it may damage the observer or the insulation may break down. So it must be shorted with an ammeter of suitable range or must be shorted.

4.3.1e Potential Transformer (PT)

Potential transformers are instrument transformers. They have a large number of primary turns and a few numbers of secondary turns. It is used to control the large value of voltage. The potential transformer works along the same principle of other transformers. It converts voltages from high to low. It will take the thousands of volts behind power transmission systems and step the voltage down to something that meters can handle. These transformers work for single and three phase systems, and are attached at a point where it is convenient to measure the voltage.

4.4 Testing of Transformer

Three types of test are to be tested. These are,
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4.4.1 Routine Test

- Measurement of winding resistance
- Measurement of Insulation Resistance (IR)
- Separate source voltage withstand test (High Voltage tests on HV & LV)

HV high voltage test: LV winding connected together and earthed. HV winding connected together and given 28 KV (for 11KV transformer) for 1 minute. After 1 minute if the transformer don't damage then it means that the transformer is protected from high voltage.

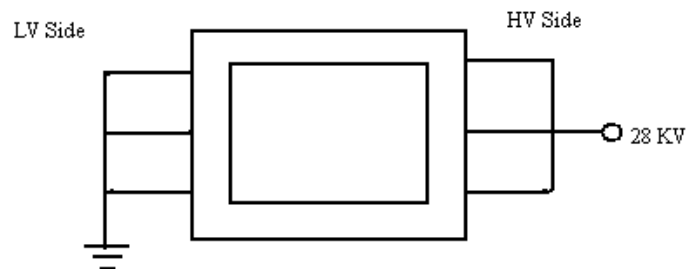


Figure 4.7: High Voltage Test

LV high Voltage test: HV winding connected together and earthed. LV winding connected together and given 3 KV for 1 minute. After 1 minute if the transformer don't damage then it means that the transformer is protected from low voltage.

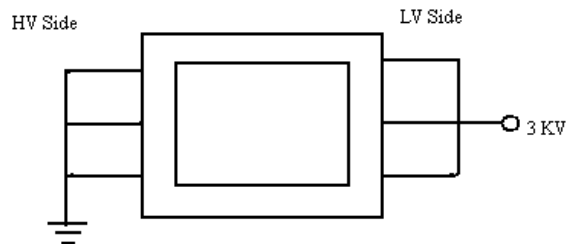


Figure 4.8: Low Voltage Test

- **Induced Over Voltage Withstand Test**

Used to test the insulation between turns of coils, layer to layer, terminals of windings, windings and earth of Transformers

This test set provides a continuously variable output voltage at double frequency (100Hz) to test the insulation between turns of coils, layer to layer, terminals of windings with either uniform or graded insulation and also between the windings and earth, with graded insulation of both Distribution and Power transformers.

An alternating voltage of sine wave form (as much as possible) at double frequency (100 Hz.) and double in amplitude can be applied at one side of the transformer under test while the windings, which are not connected to the source of excitation, are left on open circuit. This higher frequency is considered to avoid excessive excitation current during the testing for an 11KV/433V transformer, 866 Volts are applied at the 433V winding with the help of a generator for 1 minute. This induces 22KV on 11KV side. The frequency of the 866V supply is also increased to 100HZ.

Equipment used: motor generator set

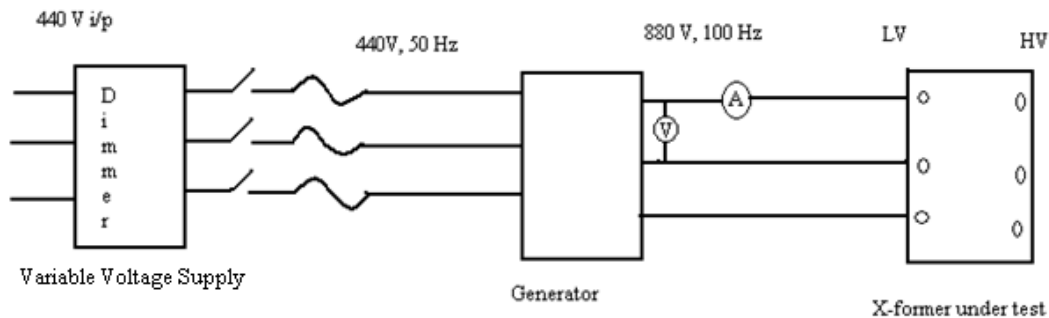


Figure 4.9: Induced Over Voltage Withstand Test

- Measurement of voltage ratio
- Measurement of no load loss and current
- Vector Group Verification
- Oil Break Down Voltage (BDV) test

4.4.2 Type Test

This test is carried out only on one transformer of the lot. The tests are discussed following:

- Lightning impulse test

All the dielectric tests check the insulation level of the job. Impulse generator is used to produce the specified voltage impulse wave of 1.2/50 micro seconds wave. One impulse of a reduced voltage between 50% to 75% of the full test voltage and subsequent three impulses at full voltage are applied.

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.

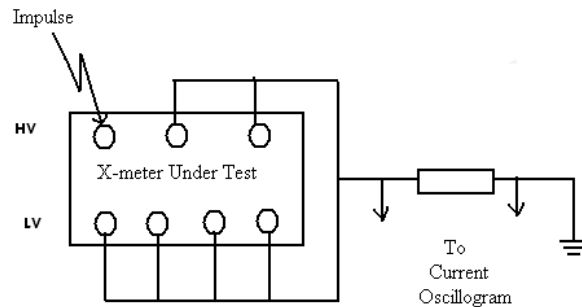


Figure 4.10: Block Diagram of lightning impulse test

For, 11KV = 75KVP

22KV = 125KVP

33KV = 170KVP

- Temperature rise test
- Special Test
- Short Circuit test
- Open Circuit Test
- Short circuit withstand ability test
- Measurement of zero phase sequence impedance test
- Measurement of acoustic noise level

Table 4.2: The correction factor for the back ground noise level's effect on transformer's noise level

Difference between the background noise and the transformer noise	Difference between the background noise before measurement and after measurement	Comment
≥ 8 dB	-	Measurement Ok
< 8 dB	< 3 dB	Measurement must be repeated
< 8 dB	> 3 dB	Measurement must be repeated
< 3 dB	-	Measurement must be repeated

- Measurement of harmonics of the no load current
- Magnetic balance test

4.5 Maintenance of Transformer

Transformer is the heart of any power system. Hence preventive maintenance is always cost effective and time saving. Any failure to the transformer can extremely affect the whole functioning of the organization. So, the transformer is always has to be maintained properly.

There are many functions to maintain the transformer. These are,

- **Oil**

Oil level is checked using magnetic oil level gauge. Oil break down voltage & acidity is checked at regular intervals. If acidity is between 0.5 to 1mg KOH, oil should be kept under observation.

- **Sludge, dust, dirt, moisture can be removed by filtration**

If any foreign particles like sludge, dust, dirt, moisture are inserted into the transformer oil then those are being removed by filtration using silica gel breather.

- Bushings
- Periodic checking of any loose connections of the terminations of HV & LV side
- Breather examination. Dehydration of Silica gel if necessary
- Conservator to be cleaned from inside after every three years
- Regular inspection of oil and winding temperature meter readings
- Cleanliness in the Substation yard

4.6 Protection of the Transformer

The best protection of the transformer is to have good preventive maintenance schedule. If the transformer is properly maintained then it will be the best protection. But some protective elements are also needed to give better and safe protection of the transformer. This section is the discussion about those elements.

4.6.1 Oil Temperature Indicator

The Oil Temperature Indicator (OTI) measures the Top oil Temperature. It is used for control and protection for all transformers. Oil temperature indicator provides local temperature of top oil. Instruments are provided with temperature sensing bulb, temperature recording dial with the pointer and maximum reading pointer and resetting device. Electrical contacts are provided to give alarm or trip at a required setting (on capillary tube type thermometer).

4.6.2 Buchholz Relay

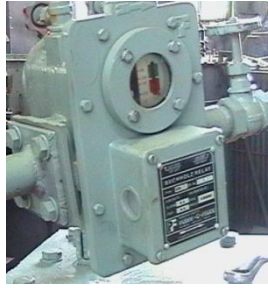


Figure 4.11: Buchholz Relay

A Buchholz relay is an instrument used to detect unusual incident inside a power transformer. Such unusual incidents are;

- i. Accumulation of gasses inside the transformer. It could indicate partial discharges or fault inside.

Response:

The gas in the liquid moves upwards, accumulates in the Buchholz relay and displaces the insulating liquid level. The moving float actuates a switch contact (magnet contact tube). An alarm signal is tripped. The lower float is not affected as from a certain gas volume the gas flows through a piping to the conservator.

- ii. Sudden surge of pressure through spontaneous flow of oil o the conservator due to fault inside the transformer. (Buchholz is connected between the oil tank and the conservator)

Response:

The liquid flow reaches a damper arranged in the liquid flow. If the flow rate exceeds the operating threshold of the damper, the latter moves in flow direction. Due to this movement a switch contact is actuated so that the transformer is disconnected.

- iii. Detects low level of oil. But in DBPAL Buchholz relay is not use as low level oil detector. Because total empty conservator is not allowed here, that's why in conservator another protection is being used. Here use magnetic oil level gauge for measuring level of oil to protect from low level of oil which is discussed next section.

Response:

As the liquid level falls the top float moves downward. An alarm is tripped. If the liquid loss continues, conservator and piping as well as the Buchholz relay will be emptied. As the liquid level falls, the lower float moves downward. The moving float actuates a switch contact so that the transformer is disconnected.

4.6.3 Magnetic Oil level Gauge

This is a dial type gauge, mounted directly on the conservator to indicate oil level. This is supplied with low level alarm contacts (if asked for) and the electrical connections of which are brought out to a terminal box of the oil gauge. Suitable alarm circuit may be connected to these terminals. This oil gauge is not dispatched separately, but is mounted on the conservator, with float arm adjusted to correct length.

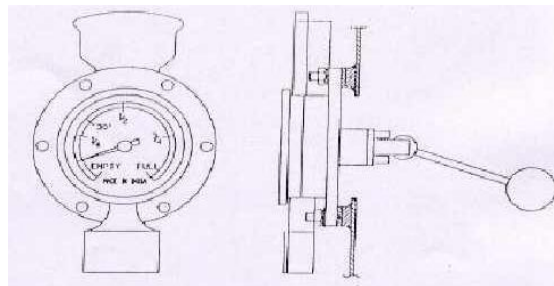


Figure 4.12: Magnetic Oil Level Gauge

4.6.4 Explosion Vent

Explosion vents are one of the most economical, practical and convenient solutions to preventing explosions from reaching their potential maximum pressures. An explosion vent is designed to be the weakest part of the external structure. As the explosion vent experiences the pressure rise, it opens quickly allowing the rapidly expanding heated gases to be released to the outside. By doing so, the internal walls, floor, and ceiling are spared from the damaging overpressure experienced during a deflagration.

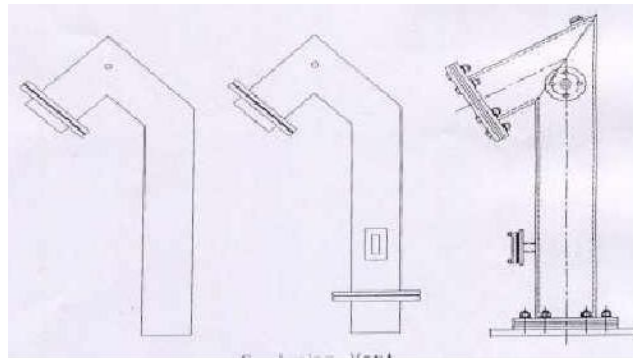


Figure 4.13: Explosion Vent

4.6.5 Lightning Arrester

An electric discharge between cloud and earth or between the charge centers of the same cloud is known as lightning.

A lightning arrester is a device used on electrical power systems to protect the insulation on the system from the damaging effect of lightning. The typical lightning arrester also known as surge arrester has a high voltage terminal and a ground terminal. When a lightning surge or switching surge travels down the power system to the arrester, the current from the surge is diverted around the protected insulation in most cases to earth.

But a lightning arrester does not absorb and stop the lightning.

4.6.6 Isolator

An isolator Fig.6.29 is a switch that does not have arc interruption capability. In electrical system an isolator is used only for isolating the circuit and maintenance.



Figure 4.14: Isolator used in DBPAL

Such switches are often found in electrical distribution and industrial applications where machinery must have its source of driving power removed for adjustment or repair. High-voltage isolation switches are used in electrical substations to allow isolation of apparatus such as circuit breakers and transformers, and transmission lines, for maintenance.

The major difference between an isolator and a circuit breaker is that an isolator is an off-load device intended to be opened only after current has been interrupted by some other control device. For this reason an isolator is also called “off-load isolator”.

4.6.7 Earthing Switch

Earthing switch connect the live parts/ line conductors and earth. This switch is normally open.

Earthing switch is used to earth the live parts during maintenance and during testing. During maintenance although circuit is open still there are some voltages on line , due to which capacitance between line and earth is charged. Before proceeding to maintenance work the voltage s discharged to earth, by closing the earth switch.

4.6.8 Sulphur Hexaflouride (SF₆) Circuit Breaker

In such circuit breakers, sulphur hexaflouride (SF₆) gas is used as the arc quenching medium. The SF₆ is an electro-negative gas and has a strong tendency to absorb free electrons. The

contacts of the breaker are opened in a high pressure flow of SF₆ gas and an arc is struck between them. The conducting free electrons in the arc are rapidly captured by the gas to form relatively immobile negative ions. This loss of conducting electrons in the arc quickly builds up enough insulation strength to extinguish the arc. The SF₆ circuit breakers have been found to be very effective for high power and high voltage service.

Advantages:

Due to the superior arc quenching properties of SF₆ gas, the SF₆ circuit breakers have many advantages over oil or air circuit breakers. Some of them are listed below:

- i. SF₆ circuit breakers have very short arcing time for its arc quenching properties.
- ii. Since the dielectric strength of SF₆ gas is 2 to 3 times that of air, such breakers can interrupt much larger currents.
- iii. The SF₆ circuit breaker gives noiseless operation due to its closed gas circuit and no exhaust to atmosphere unlike the air blast circuit breaker.
- iv. The closed gas enclosure keeps the interior dry so that there is no moisture problem.
- v. There is no risk of fire in such breakers because SF₆ gas is non-inflammable.
- vi. There are no carbon deposits so that tracking and insulation problems are eliminated.
- vii. The SF₆ breakers have low maintenance cost, light foundation requirements and minimum auxiliary equipment.
- viii. Since SF₆ breakers are totally enclosed and sealed from atmosphere, they are particularly suitable where explosion hazard exists e.g., coal mines.

Disadvantages:

- i. SF₆ breakers are costly due to the high cost of SF₆.
- ii. Since SF₆ gas has to be reconditioned after every operation of the breaker, additional equipment is required for this purpose.

4.7 Allowed and Not Allowed

There are some different tasks for transformer which are allowed or not allowed. These are following,

4.7.1 Allowed

- Check and thoroughly investigate the transformer whenever any alarm or protection is operated.
- Check oil level in breather sealing cup.
- Attend oil leakage immediately if noticed.
- Examine the bushing for dirt deposits and coats and clean them periodically.
- Check the oil in transformer and OLTC for dielectric strength and moisture content and take suitable action for restoring the quality.
- Check the oil in transformer and OLTC for acidity and sludge.
- Check the pointers of all gauges for free movement.
- Check the protection circuit periodically.
- Check the OTI and WTI pockets and replenish the oil if required.
- Check the breathing of Transformer.

4.7.2 Not Allowed

- Do not re-energize the transformer unless the buchholz gas is analyzed.
- Do not leave the marshalling box door open.
- Do not leave any loose connection.
- Do not allow conservator oil level to fall below one third level.
- Do not change the settings of WTI and OTI alarm and trip.
- Do not allow dirt and deposits on bushing, they should be periodically cleaned.
- Do not allow unauthorized entry near transformer.
- Do not leave ladder unlocked, when the transformer is 'ON' in service.
- Do not continue with pink silica gel, this should immediately be changed or regenerated

Chapter 5. Problems and Recommendation

5.1 Problems

- We didn't do any mechanical course in our university. So we felt in problem to work in engine section, because engine is mainly operated according to mechanical principle.
- For safety purpose, they didn't give to touch all equipment.
- Because of company limitation we didn't able to take photographs according to our wish.

5.2 Recommendation

- At least one mechanical course should be offered in our university. It will help the students to improve their performance in internship.
- The duration of internship program should at least two months to achieve better knowledge from there. Because 100 hours are very short time and within this time acquiring all the informations completely are very tough.

Conclusion:

We realized that theoretical knowledge and practical knowledge are not same. As our own interest, our major academic side is power and we also interested to do job in power stations. After completing our internship, now we are confident to do job in any power station. They gave not only knowledge about electrical field but also gave other practical things like how to maintain a power plant discipline, safety rules which will help in our job life. We also learnt how to work under pressure which will also help our future life. We learnt to draw single line diagram of any power plant and also learnt how to read an electrical drawing of any equipment.

We passed very interesting 15 days in Dutch Bangla Power and Associates Ltd. Because there was chance to achieve a new knowledge in every moment. The DBPAL officer's behavior was
Department of EEE

Undergraduate Internship Report

very friendly which is very essential to make a comfortable environment in working place. At last we think DBPAL is very good place for internship program.