ELECTRICAL SUBSTATION DESIGN AND ENGINEERING

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A project report submitted in partial fulfilment of the requirements for the award of Master of Engineering (Electrical)

Faculty of Engineering and Science
Universiti Tunku Abdul Rahman

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **"ELECTRICAL SUBSTATION DESIGN AND ENGINEERING"** was prepared by **LIEW YEW SHENG** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Engineering (Electrical) at Universiti Tunku Abdul Rahman.

Approved by,

Signature : _____

Supervisor : Ir. Prof. Dr. Lim Yun Seng

Date : _____

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ELECTRICAL SUBSTATION DESIGN AND ENGINEERING

ABSTRACT

The electrical power substation in power generation plant, transmission or distribution also consist apart of very important in electric power engineering. The objective of carrying out this research are to provide overview of electrical substation, reference and guides to the design information.

To provide some useful information from initial concept of design, data extraction, calculation, material selection, automation, operation method, protection devices and etc. Besides, this research also contain of most recent technology development which related to industry practice, requirement and standards.

During design of an Electrical Substation, some aspects must be taken into consideration:

- Low capital cost
- Reliability of the facilities
- Low operating cost
- High Efficiency
- Simplicity of design
- Reserve capacity for future expansion

TABLE OF CONTENTS

CODES AND STANDARDS

IEC	International Electro Technical Commission
60038	Standard Voltage
60060	High Voltage test technique
60529	Classification of degree of protection by enclosures (IP code)
60044	Instrument Transformer
60076	Power Transformer
60186	Voltage Transformer
60265	High Voltage Switches
62271	High Voltage Switchgear and control gear above 1000V
60422	Supervision and maintenance mineral insulating oils for transformer and switchgear.
60255	Electrical Relay
60947	Low Voltage switchgear and control gear
60146	Battery Charger
60623	Batteries

BS	British Standards
159	Specification for high voltage busbars and busbar connections
3643	ISO metric screw treads
4872	Specification for approval testing of welders when welding procedure approval is not required.
3600	Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes.
7884	Copper and cadmium copper conductors
381 C	Specification for colour for identification, coding and special purposes.
7450	Code of practice for earthing

IEEE	**Institute of Electrical and Electronic Engineers**
80	Guide for safety in substation grounding
32	Neutral grounding devices
ISO	**International Organization for Standardization**
14000, 1	Environment Management Systems
9000, 1	Quality Management Systems
1461	Metallic coatings – Hot dip galvanised coating on fabricated ferrous products – Requirements

ABBREVIATIONS

GIS	Gas Insulated Switchgear
AIS	Air Insulated Switchgear
CT	Current Transformer
PT/ VT	Potential Transformer/ Voltage Transformer
LV	Low Voltage
MV	Medium Voltage
HV	High Voltage
I	Current
V	Voltage
TNB	Tenaga National Berhad
ST	Suruhanjaya Tenaga

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

To design and construct a new electrical substations or expansions of current electrical project are very common practice in several industries. However, not many of the employees are familiar and understand of the complete process to design and construct to successfully complete the projects. This chapter will attempt to provide some basic understanding and knowledge for the process.

There are few main/ major types of electrical substations:

a. The electrical substation in switchyard of a power generation plant. The electrical facilities are connected from the generator to the grid. This generator switchyards is a large installations and normally is by the plant engineer to do the engineering and construction.
b. The substation at customer station. This substation main function as an incoming power supply to the particular business. The technical specification and requirement will depends to the customer requirements.
c. Another type of substation is to receive a big capacity of power from transmission line and transfer the power to distribution stations. This substation must be reliable and integrity.
d. The forth type of substation is electrical distribution substation, this is very common in customer or industry. This normally will located near to the load center.

1.2 Problem Statement

To develop, creating or modification of electric substation, some planning process is necessary. The considering issue in design of electrical substation are includes of load increase, the power system stability, reliability and capacity as well as to determine of the future expansion or improvement in the substation facilities.

The equipment selection, layout, engineering, available site, size and location will be evaluate in the budget consideration and justification. In the engineering and construction of electric substation must identify the nature and future development requirement. The budgeting process will provide an overview of cost and the resources requirement. The details design will develop accurate cost and realistic schedule. Besides, the consideration of the user requirement, the development and the preference into the design criteria.

1.3 Aims and Objectives

The aims of undergoing this research are to identify of electrical material and equipment selection. The area or location has been selected, the final design can be develop with the layout and drawing for construction and commissioning purposes, the flow as shown in figure 1.1.

The objectives of performing this research is to identify and determine the different types of electrical equipment and other material to be prepared in order to have the concept and requirement for electrical substation and further with bidding process.

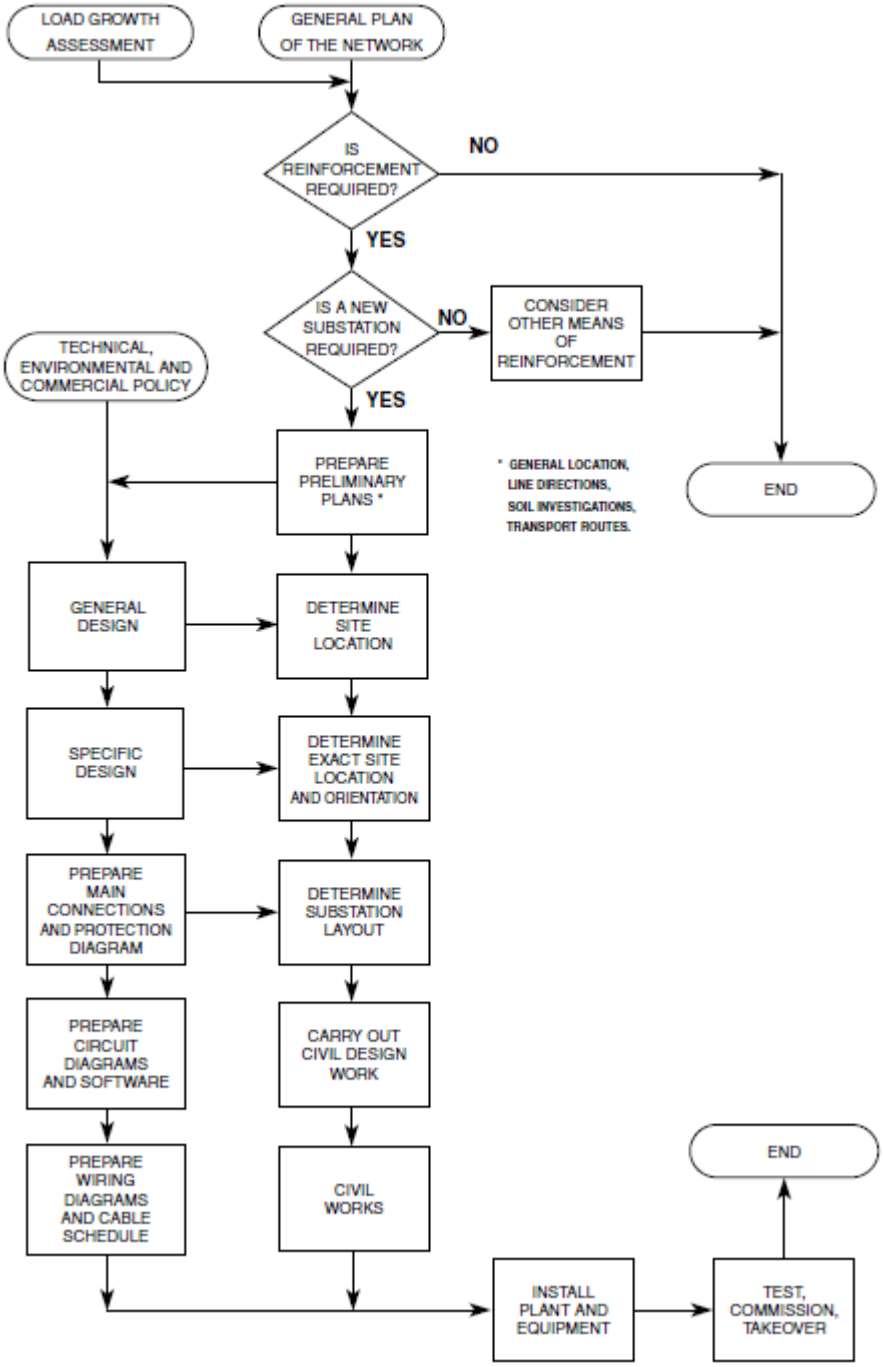


Figure 1.1: New electrical substation design process flow chart

1.4 Structure of the Research Report

This research report consists of five main chapters:

1) Chapter 1: Introduction

   To brief background of the research, the problem statement as the needs to carry out this research, the aims and objectives of this research are stated.

2) Chapter 2: Literature review

   The information and function of the substation design and electrical equipment. To identify the different types of substation design, equipment and discussion.

3) Chapter 3: Methodology

   In this chapter, the engineering specification, data collection and customer requirement, load study and safety factor for the requirement will be identified and discussed.

4) Chapter 4 (Results and Discussions).

   In this chapter, the substation design drawing will generate the concept and modelled by using Autocad software. The results and analyzed and discussed.

5) Chapter 5 (Conclusion and Recommendations).

   In this chapter, the conclusion of engineering design and requirement obtained from the research. Some recommendations are also given.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Start from power generation plan, transmission, and distribution to customer, the voltage need to step up and step down several times in several of power substations.

To ensures the efficiency of power transmission and minimize the power loses, this project is to design a 275kV/33kV primary substation as main intake of incoming power from transmission line and 33kV/6.6kV secondary substations for the distribution system to meet the consumer requirement at the required voltage level. This chapter will be talking about the type of substation and the key equipment:

2.1.1 Gas Insulated Substations

2.1.1.1 Current Transformer

2.1.1.2 Voltage Transformer

2.1.1.3 Disconnect Switches

2.1.1.4 Ground Switches

2.1.2 Air Insulated Substations

2.1.2.1 Single Bus System

2.1.2.2 Double Bus, Double Breaker System

2.1.2.3 Main and Transfer Bus System

2.1.2.4 Double bus, Single Breaker System

2.1.2.5 Ring Bus System

2.1.3 Substation Switching Equipment and Requirement

2.1.3.1 Ambient Conditions and Requirements

2.1.3.2 Vacuum Circuit Breaker

2.1.3.3 Gas Circuit Breakers

2.2.1 Gas Insulated Substations

The Gas Insulated Substation is use of Sulphur Hexafluoride (SF_6) as the insulation and interruption medium for the high voltage conductors, circuit breaker, switches and instrument transformers located in the enclosures. The conventional Air Insulated Substations requires large area air insulation to do and where the SF_6 can make it in a very small area. Therefore the GIS can many times smaller size than AIS, GIS mostly use where the space is limited or expensive. The parts or components in GIS are more reliable because of protected from deterioration which is seal in enclosure and not exposure to ambient conditions such as moisture, dust, contamination and etc. compare with AIS.

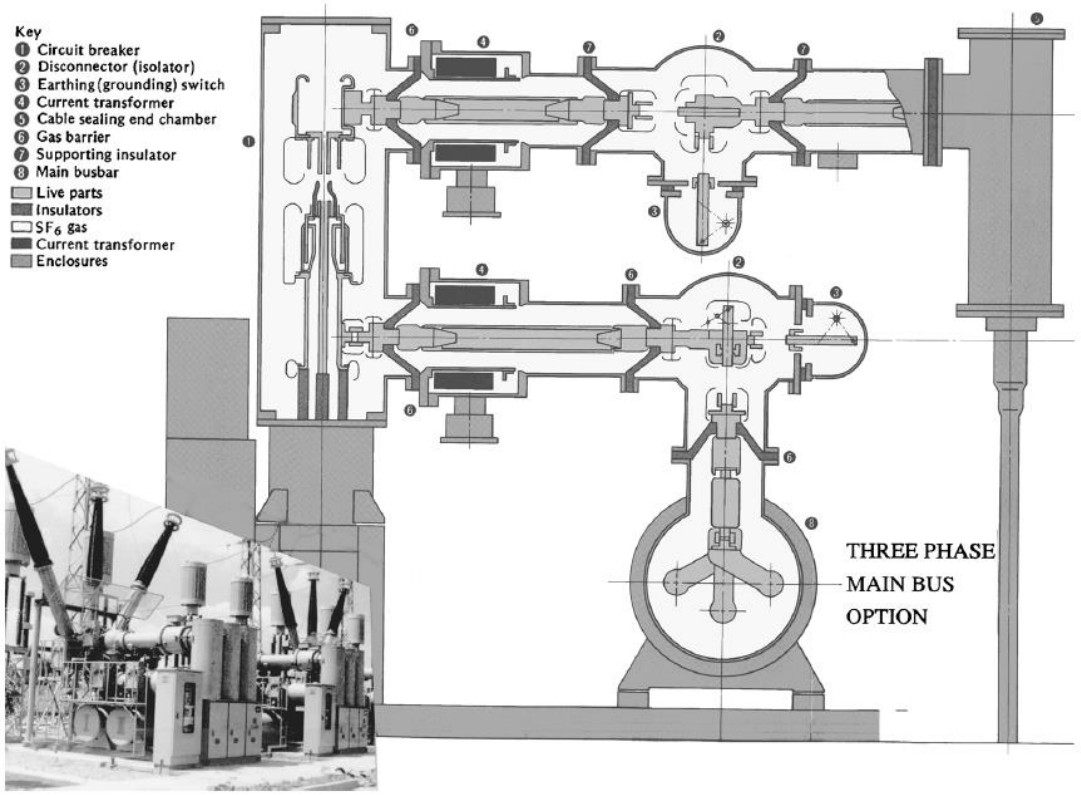


Figure 2.1.1 Single Phase Type with enclosure of GIS

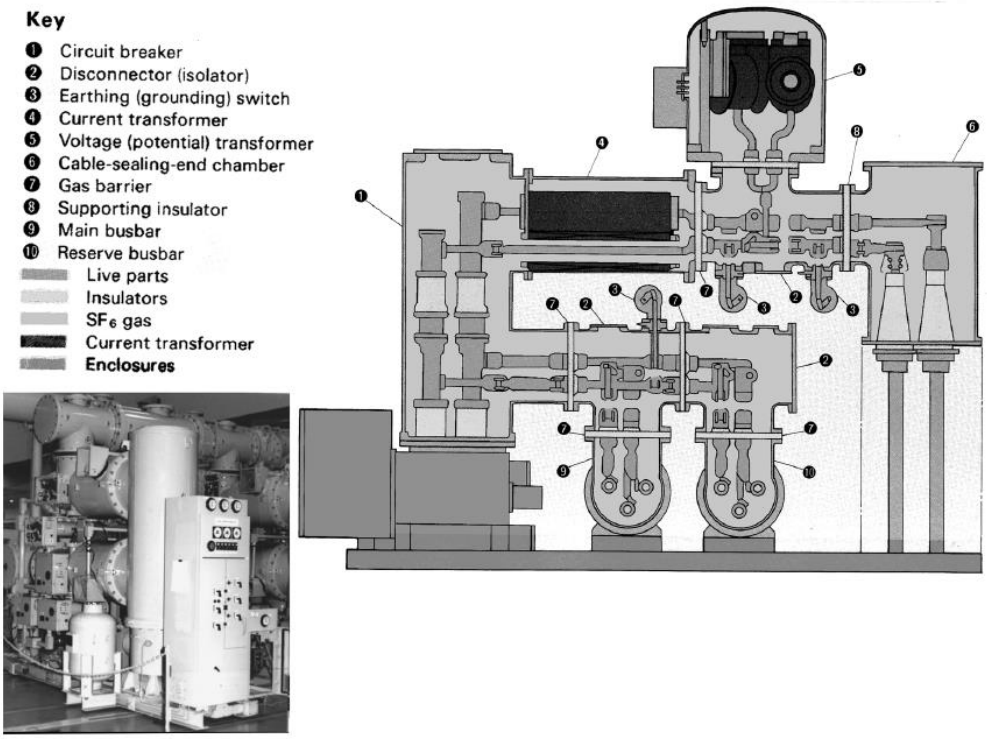


Figure 2.1.2 Three Phase Type with enclosure of GIS

2.2.1.1 Current Transformer

The normal ring types of CTs will install either inside or outside of GIS enclosure and the single turn as primary side of the CT. The CT is shielded inside the enclosure from the high voltage conductor electric field. For the case of the CTs outside of the enclosure, the enclosure must provide an insulating joint in order the currents has shunted from the CT.

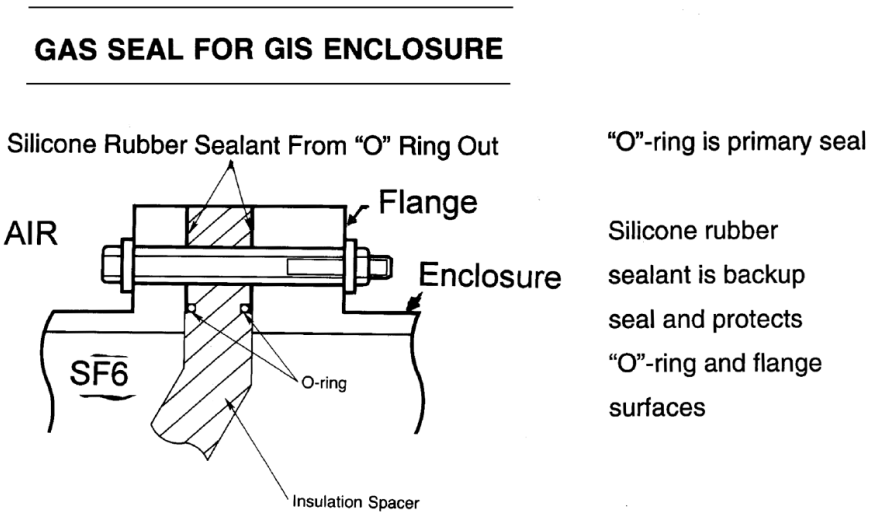


Figure 2.1.3 Gas seal type of GIS enclosure

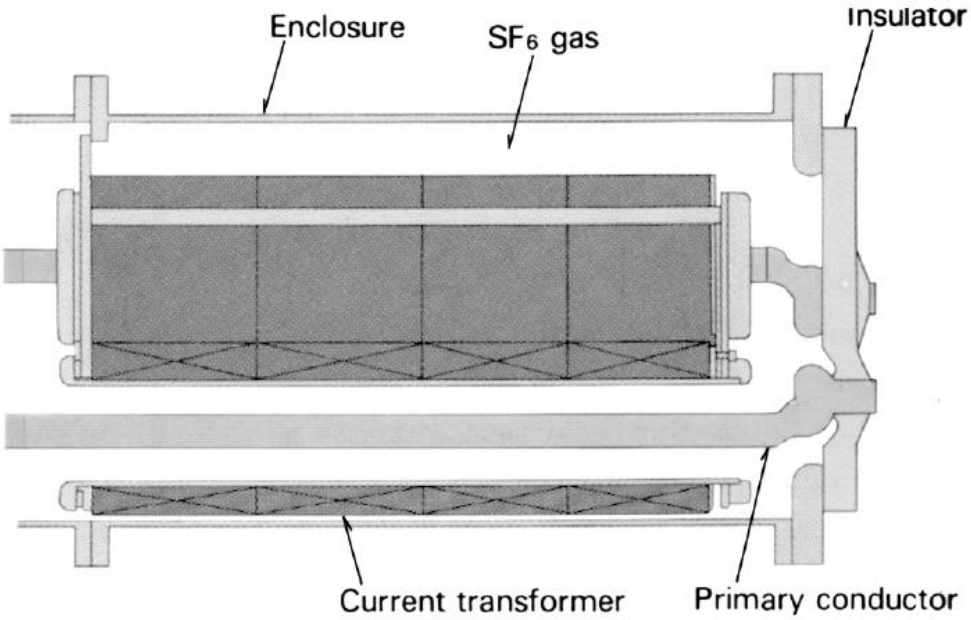


Figure 2.1.4 Current Transformer for GIS

2.2.1.2 Voltage Transformer

The inductive type of Voltage Transformer, the primary winding will located in enclosure with SF6 and supported by insulation materials. The electric field will shielded between of the primary and secondary winding to prevent of transient voltage. The VT should easily removable type or provide disconnect switch or link to allow GIS high voltage testing purposes.

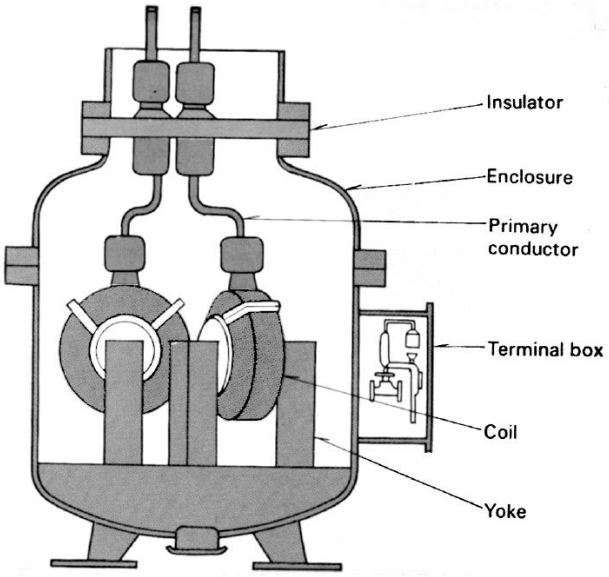


Figure 2.1.5 Voltage Transformer for GIS

2.2.1.3 Isolator or Disconnect Switches

For the Isolator or Disconnect Switches, the insulating operating rod will activate the moving contact to open and close a gap between the contacts. The contact shield will provide the appropriate electric field distribution or dissipation to reduce the surface stress. The movement is much slower compare with circuit breaker, so the disconnect switch only applicable and to interrupt at low capacitive or small inductive currents.

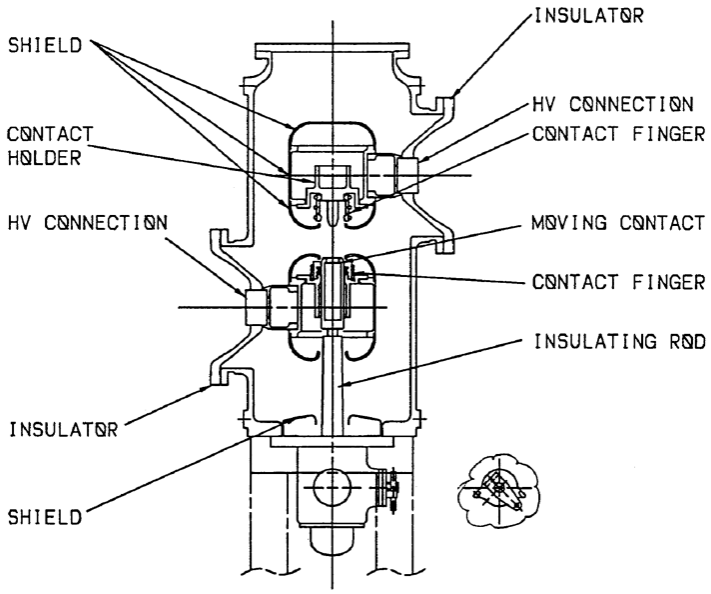


Figure 2.1.6 Disconnect switches for GIS

2.2.1.4 Ground Switch

Ground switches to be closed during installation and maintenance, it is operate by motorize or manually to open and close between the high voltage conductor with the body or enclosure. The ground switch mainly as function to discharge the residual or trapped capacitive or inductive current from the connected line. A measuring function also applicable for contact resistance test by using two ground switches.

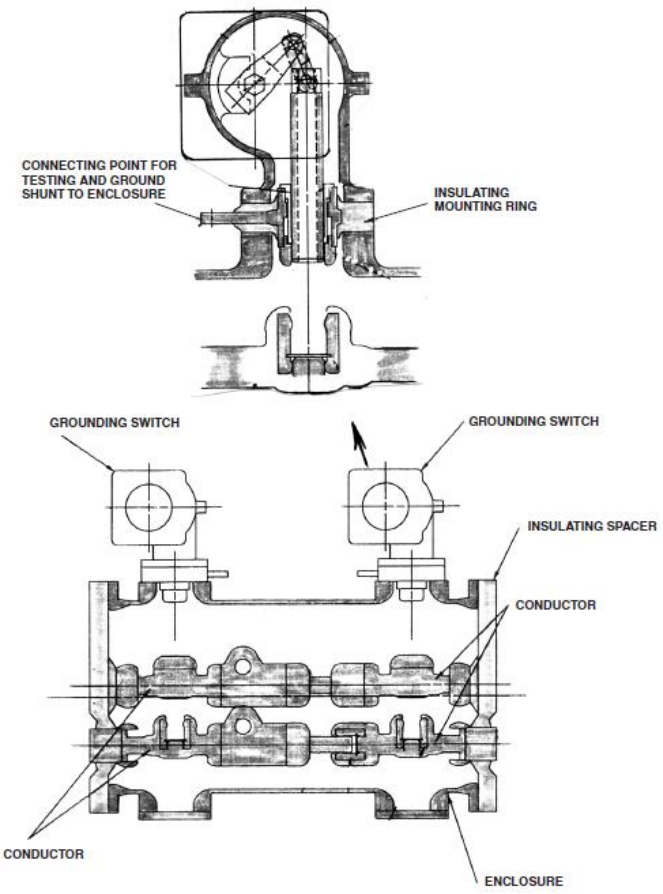


Figure 2.1.7 Ground Switches for GIS

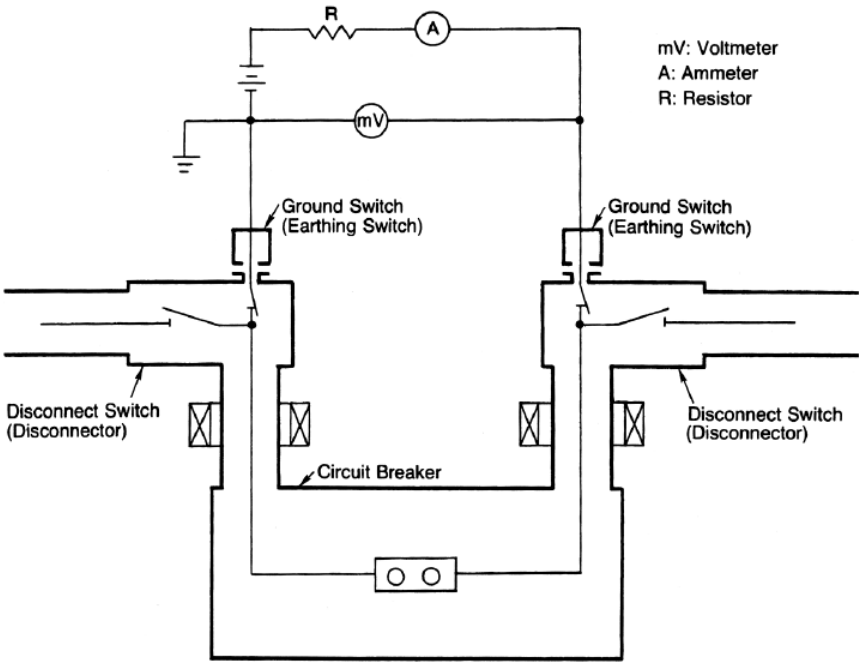


Figure 2.1.8 Contact resistance measuring by using ground switch

2.2.2 Air Insulated Substations

The Substation or switchyard reliability affected by few factors, which the bus arrangement and switching devices. Besides, the switchyard buses and switching devices or equipment type, reliability and arrangement also will affected the maintenance, performance, protection system, substation investment and operating cost.

2.2.2.1 Single Bus System

The Single Bus System arrangement is connected directly of the main bus to the bus. This type arrangement reliability is very low, when a single failure of the bus or any circuit will caused the entire system power outage.

This arrangement is not recommended to apply in heavy load or high availability requirement area. The reliability can be improved by using more bustie breaker to reduce the bus failure.

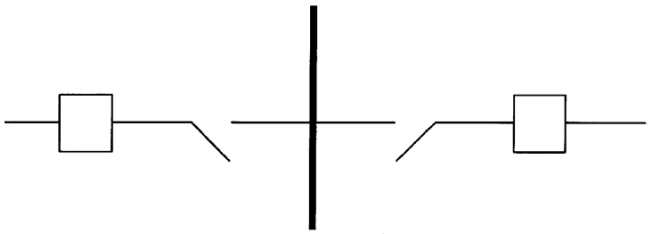


Figure 2.2.1 Single Bus System

Two separate breaker in each circuit will increase and provides higher level of the system reliability, with additional of two separate buses arrangement so if one bus having failure will not impact to another line. This arrangement allows various option to the operation and very useful for any breakdown or maintenance of the bus or breaker without interruption to the circuit.

2.2.2.2 Double Bus, Double Breaker System

This double bus, double breaker system arrangement is a higher cost arrangement, since the reliability with adding additional equipment in line and a larger area requires for the substation.

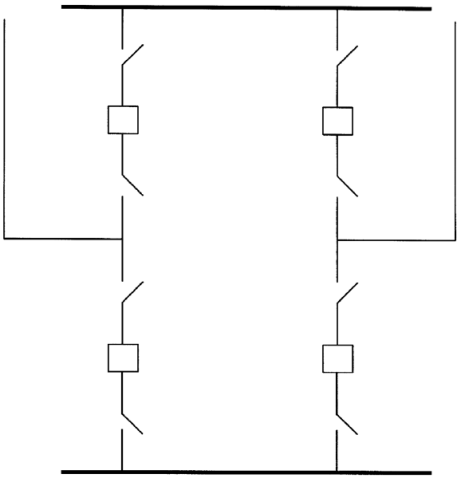


Figure 2.2.2 Double bus, double breaker System

2.2.2.3 Main and Transfer Bus System

The Main and Transfer Bus arrangement system is connected a main bus and a transfer/reserve bus. This arrangement also can avoid of circuit de-energizing during maintenance. When it is necessary, the bustie can be closed and the circuit breaker can off for out of service or maintenance purposes. Each circuit have different type of configuration, so the special relay setting required to be used to operating in this arrangement.

This arrangement will be higher investment cost compare with single bus arrangement system, but this will increase and provide more flexibility and reliability to the system.

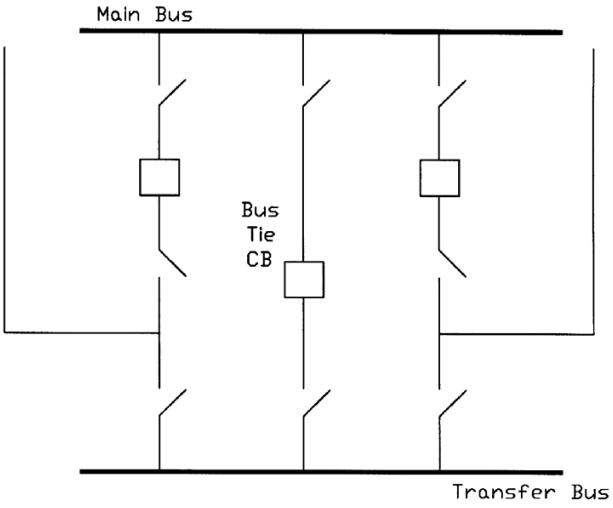


Figure 2.2.3 Main and Transfer Bus System

2.2.2.4 Double Bus, Single Breaker

The Double bus, single breaker system arrangement is connected the two busses with each line circuit breaker and a bustie. This arrangement the operation in either circuit of bus will not affect to the system, however any of the breaker failure will caused the entire system outage. This arrangement is consider as low reliability arrangement.

This arrangement is easy do the maintenance at the bus area, but for breaker and switches maintenance required outage of entire system.

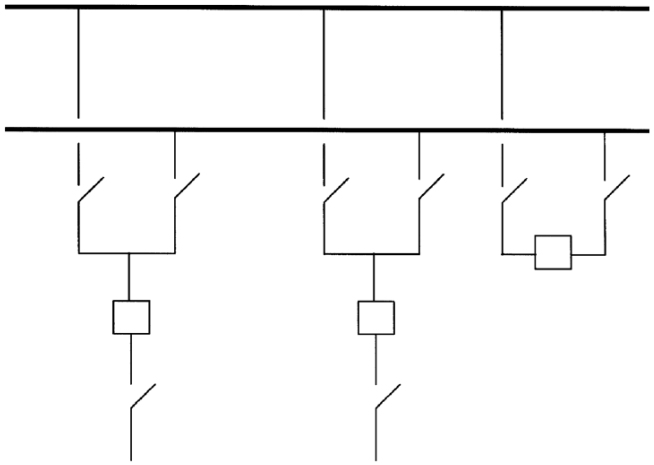


Figure 2.2.4 Double bus, Single Breaker System

2.2.2.5 Ring Bus System

In the arrangement of a Ring Bus System, all the arrangement of the breaker will in a ring type circuits. On a failure of a circuit, the two adjacent breakers will trip and the rest of the system will remained energized.

When maintenance of circuit breaker, without interruption of the circuit. The breaker able to shut down and take out for service and maintenance, the other breaker maintained in service to continue the system operation. However, the expansion of the circuit is limited.

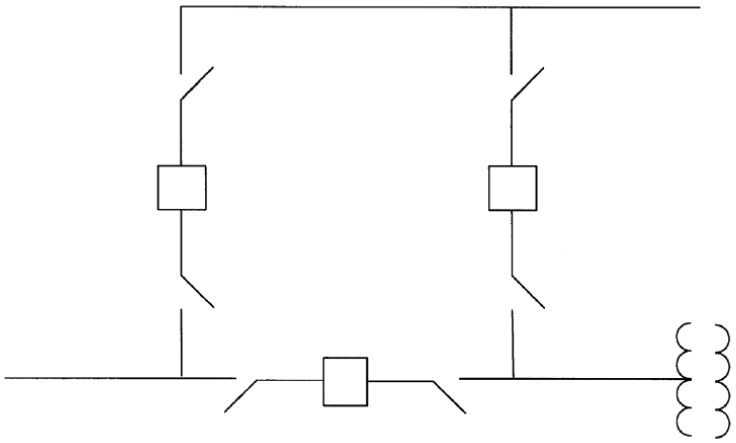


Figure 2.2.5 Ring Bus

An electrical substation or switchyard planning, the main consideration parameter as discussed: reliability, cost and the available space.

As a summary that the highly reliability arrangement are Double bus and Ring Bus, however the required available area are greater since more component are needed.

2.2.3 Substation Switching Equipment and Requirement

For an electrical substation design also required to consider about the safe, reliability and performance of the operation and maintenance with meet the user requirement. The switching equipment is include and consider to provide of system isolation, on load switching, off load switching and occurs of any fault current interruption conditions.

2.2.3.1 Ambient Conditions and Requirements

The air insulated electrical equipment normally is rated at -40^{o}C to +40^{o}C, if the altitudes above 1000meters will derating due to the air density decrease then the dielectric strength also reduced.

A circuit breaker function is a capable device to carry the current flow and to break of the designed current capacity in specified normal and abnormal circuit conditions.

The circuit breaker normally can are classified follow by the interruption medium to be used.

- Air magnetic type circuit breaker
- Oil type circuit breaker
- Air Blast type circuit breaker
- Vacuum type circuit breaker
- SF^6 gas type circuit breaker

2.2.3.2 Vacuum Circuit Breaker

The common and widely use is Vacuum Circuit Breaker and Gas Circuit Breaker. Vacuum circuit breaker moving contact is enclosed in a cylinder with high vacuum. Vacuum Breaker is small size and significant space saving compare to air magnetic type.

2.2.3.3 Gas Circuit Breaker

The gas circuit breaker normally use of SF6 as the interruption medium. The breaker operates typically in pressurized of 6-7 atmospheres for the arc interruption. The gas dielectric strength reduces significantly at low pressures condition, when the event of low gas density monitoring system will block the operation.

CHAPTER 3

METHODOLOGY

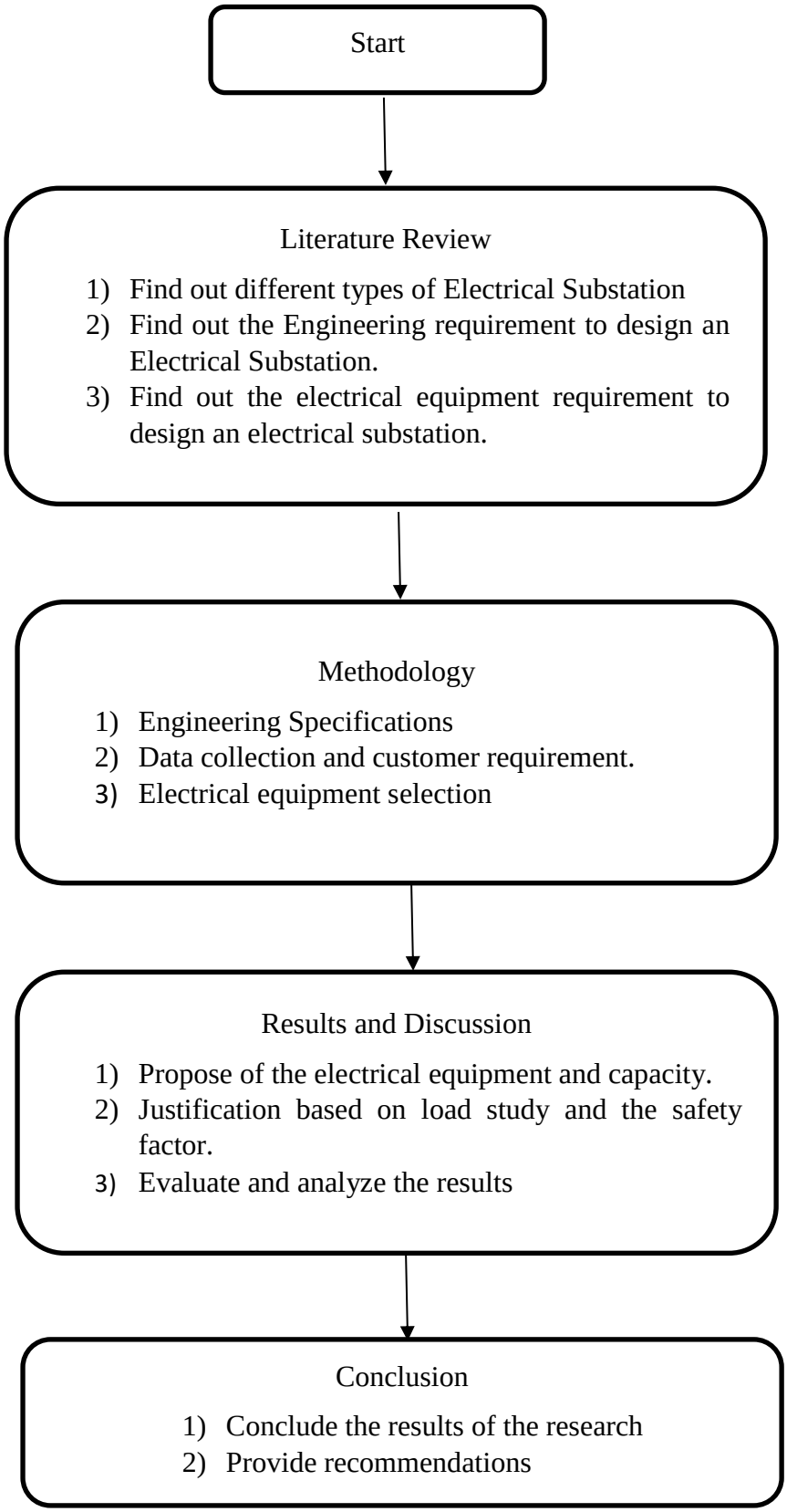
3.1 Introduction

In this chapter, based on sample of load given to study the load, requirement for the engineering to design the electrical substation types and the electrical equipment to be applied. The priority is given to the reliability engineering design for substation and electrical equipment in high power system.

This chapter covers:

1) Project Pathway
2) Engineering Specification
3) Data Collection and Customer Requirement
4) Load Study and Safety Factor
5) Evaluate and Analysis the results

3.2 Project Pathway



3.3 Engineering Specification

Engineering specifications shall consideration of the backgrounds and application for equipment and systems such as:

- Power Distribution System
- Protection Philosophy
- Variable speed drives
- Emergency power systems
- Communication System

These specifications will include all information and requirement to perform the design in a consistent way. The specification will at least include:

- Site conditions specification for electrical
- General power supply system
- Distribution system concept, including voltage level, number of load centers and the short circuit levels.
- Substation construction requirement
- Description of the main equipment and systems
- Basic replay protection system
- Functional design consideration in relation the application for as much as possible standard components, economical designs and maintenance.
- Applicable codes ad standards

3.3.1 Statutory Requirements

- Malaysian Uniform Building By Laws.
- Malaysian Electricity Supply Act-447.
- Relevant Malaysia Occupational Safety and Health requirement
- Requirements of TNB and ST.

3.3.2 Electrical System Design Philosophy

- Personnel and equipment safety of operation and maintenance
- System Service and Functional Reliability
- Ease and convenient of maintenance
- Facilities for limited addition in future loads
- Convenience of operation
- Maximum standardization of equipment and materials
- Maximum interchangeability of equipment
- Minimum fire risk
- Effective utilization of electrical energy

3.3.3 Electrical Loads and Electricity Consumption

All the components of the electrical systems shall be designed and sized to the maximum applied load, which under the most severe conditions in operating conditions, for example: one transformer out of service on a two incomer & one bus coupler system.

The worse conditions for a distribution system can be calculated as:

- 100% of the normal continuous running load +
- 30% of the intermittent and standby +
- 10% of the spare load.

3.3.4 Voltage and frequency variation AC system

The following maximum variations in supply shall considered for equipment:

Voltage : ± 10%

Frequency : ± 5%

3.3.5 System Voltages and Frequency

Voltage selection is based upon economic considerations, taking the following factors into account:

- Size and location of loads
- Provision of future extension

- Short Circuit level
- Availability of switchgear with suitable current rating and rupturing capacity.
- Possibility of keeping the number of different voltage levels to a minimum.

3.3.6 Special Power System Design Consideration

Overall plant safety during main power failure, separate power supply system will be designed. These systems will supply critical consumers in the plant. The special power supply system will also be used for power consumers which are critical for start-up and safety such as:

- Emergency lighting
- UPS System / Battery Charger

3.3.7 Power Factor Improvement

Capacitor banks for overall power system power factor improvement shall be provided and it shall ne through automatic KVAR controlled. Power factor shall be corrected on the given board shall not be less than 0.95 at maximum opening load.

3.4 Data Collection and Customer Requirement

YARD SUBSTATION - SE-1020ML-02										
PANEL TAG	DESCRIPTION	QUIRED POWER / FEATURES OF PROJE				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-1020ML-21 A										
MC-1020ML-21 A	Moveable Head Interloking device # 2 for TR-1040ML-04	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 A	Moveable Head Interloking device # 1 for TR-1040ML-04	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 A	Moveable Head Interloking device # 2 for TR-1020ML-07	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 A	Moveable Head Interloking device # 1 for TR-1020ML-07	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 A	Reversible Belt Stripper # 2 (Head end) for TR-1040ML-04	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-21 A	Reversible Belt Stripper # 1 (Head end) for TR-1040ML-04	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-21 A	Lubrication System head-2 for TR-1010ML-13	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-21 A	Lubrication System head-3 for TR-1010ML-13	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-21 A	Winch for TR-1010ML-13	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-21 A	Lubrication System for distribution board (QD-1020ML-07A)	415.00	0.56	1.06	0.90	1.00	0.90	0.56	1.06	0.85
MC-1020ML-21 A	Magnetic Separator for TR-1020ML-07	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 A	Movable Head for TR-1020ML-07	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 A	Lubrication System for distribution board (QD-1020ML-06B)	415.00	0.84	1.59	1.35	1.00	1.35	0.84	1.59	0.85
MC-1020ML-21 A	Magnetic Separator for TR-1040ML-04	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 A	Movable Head for TR-1040ML-04	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-15	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	DDS Pump - CT-1050ML-15	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1020ML-21 A	Electric Hoist in CT-1020ML-17	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1020ML-17	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	DDS Pump - CT-1020ML-17	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1020ML-21 A	Electric Hoist in CT-1010ML-18	415.00	-	-	-	-	12.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1010ML-18	415.00	-	-	-	-	7.00	-	-	-
MC-1020ML-21 A	DDS Pump - CT-1010ML-18	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1020ML-21 A	Electric Hoist in CT-1050ML-19	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-19	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-19	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1050ML-19	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 A	DDS Pump- CT-1050ML-19	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1020ML-21 A	Potable Water Pump # 1 - YARD AND PELLET	415.00	-	-	-	-	11.00	-	-	-
MC-1020ML-21 A	Electrical Hoist for Potable Water Pump House	415.00	-	-	-	-	6.00	-	-	-
MC-1020ML-21 A	Sewage Lifting Pump # 1 In Lifting Station - 2	415.00	-	-	-	-	7.50	-	-	-
MC-1020ML-21 A	Outgoing Feeder for Transformer Cooling Fans for TF-1020ML-22	415.00	-	-	-	-	5.50	-	-	-
MC-1020ML-21 A	Outgoing Feeder for OLTC of TF-1020ML-22	415.00	0.62	1.18	1.00	1.00	1.00	0.62	1.18	0.85
MC-1020ML-21 A	Outgoing Feeder for Auxilary Supply of 6.6kV Panel QD-1020ML-21	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-1020ML-21 A	Outgoing Feeder for Battery Charger - Float Mode	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-1020ML-21 A	Outgoing Feeder for Battery Charger - Boost Mode	415.00	-	-	-	-	22.00	-	-	0.85
MC-1020ML-21 A	Outgoing feeder for UPS - Normaly Supply	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-1020ML-21 A	Outgoing Feeder for ACDB Panel -QD-1020ML-24	415.00	15.49	29.41	25.00	1.00	25.00	15.49	29.41	0.85
MC-1020ML-21 A	Outgoing Feeder for 240V NON UPS panel QD-1020ML-23	415.00	3.10	5.88	5.00	1.00	5.00	3.10	5.88	0.85
MC-1020ML-21 A	Outgoing Feeder for HVAC Load	415.00	123.95	235.29	200.00	1.00	200.00	123.95	235.29	0.85
MC-1020ML-21 A	Outgoing feeder for Lighting Transformer TL-1020ML-21	415.00	148.74	282.35	240.00	1.00	240.00	148.74	282.35	0.85
MC-1020ML-21 A	Outgoing Feeder # 1 for Future MCC MC-1020ML-22	415.00	-	-	-	-	800A	-	-	0.85
MC-1020ML-21 A	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 A	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 A	DDS Pump - CT-1050ML-15	415.00	-	-	-	-	0.55	-	-	-
MC-1020ML-21 A	DDS Pump- CT-1050ML-19	415.00	-	-	-	-	0.55	-	-	-
MC-1020ML-21 A	DDS Pump - CT-1020ML-17	415.00	-	-	-	-	0.55	-	-	-
MC-1020ML-21 A	DDS Pump - CT-1010ML-18	415.00	-	-	-	-	0.55	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1010ML-18	415.00	-	-	-	-	7.00	-	-	-
MC-1020ML-21 A	Electric Hoist in CT-1020ML-17	415.00	-	-	-	-	17.00	-	-	-
TOTAL			404.82	768.11	652.88		1,024.86	408.44	775.36	0.86
MC-1020ML-21 B										

YARD SUBSTATION - SE-1020ML-02										
PANEL TAG	DESCRIPTION	QUIRED POWER / FEATURES OF PROJE				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	KVA	
MC-1020ML-21 B	Lubrication System for CT-1050ML-15	415.00	0.56	1.06	0.90	1.00	0.90	0.56	1.06	0.85
MC-1020ML-21 B	Magnetic Separator for TR-1020ML-06	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 B	Movable Head for TR-1020ML-06	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 B	Lubrication system for CT-1050ML-19	415.00	0.84	1.59	1.35	1.00	1.35	0.84	1.59	0.85
MC-1020ML-21 B	Overband Magnetic Extractor for TR-1020ML-06	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 B	Movable Head for TR-1020ML-09	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 B	Lubrication System head-7 for TR-1020ML-09	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-21 B	Winch for TR-1040ML-05	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-21 B	Movable Head for TR-1040ML-05	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1020ML-21 B	Lubrication System head-1 for TR-1010ML-54	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-21 B	Lubrication System Tail-1 for TR-1020ML-08	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-21 B	Winch for TR-1010ML-54	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-21 B	Lubrication System Tail-2 for TR-1020ML-08	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-21 B	Winch for TR-1020ML-08	415.00	-	-	-	1.00	28.50	-	-	0.85
MC-1020ML-21 B	Potable Water Pump # 2- Yard And Pellet	415.00	2.05	3.88	3.30	0.30	11.00	6.82	12.94	0.85
MC-1020ML-21 B	Sewage Lifting Pump # 2 In Lifting Station - 2	415.00	1.39	2.65	2.25	0.30	7.50	4.65	8.82	0.85
MC-1020ML-21 B	Outgoing Feeder for Transformer Cooling Fans for TF-1020ML-21	415.00	-	-	-	-	1.10	-	-	0.85
MC-1020ML-21 B	Outgoing Feeder for OLTC of TF-1020ML-21	415.00	0.62	1.18	1.00	1.00	5.50	3.41	6.47	0.85
MC-1020ML-21 B	Outgoing feeder for UPS - Redundant Supply	415.00	9.30	17.65	15.00	1.00	15.00	9.30	17.65	0.85
MC-1020ML-21 B	Outgoing feeder for UPS - Static By-pass supply Supply	415.00	-	-	-	-	-	-	-	0.85
MC-1020ML-21 B	Ougtoing feeder for HVAC Loads of CWA	415.00	-	-	-	-	15.00	-	-	0.85
MC-1020ML-21 B	Outgoing feeder for Lighting Transformer TL-1020ML-22	415.00	148.74	282.35	240.00	1.00	240.00	148.74	282.35	0.85
MC-1020ML-21 B	Outgoing Feeder # 2 for Future MCC MC-1020ML-22	415.00	-	-	-	-	800A	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-3	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-21 B	Reversible Belt Stripper # 1 (Head end) for TR-1020ML-06	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-21 B	Reversible Belt Stripper # 2 (Head end) for TR-1020ML-06	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-21 B	Reversible Belt Stripper # 1 (Head end) for TR-1020ML-09	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-21 B	Reversible Belt Stripper # 2 (Head end) for TR-1020ML-09	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-21 B	Movable Head Interlocking device # 1 for TR-1020ML-06	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 B	Movable Head Interlocking device # 2 for TR-1020ML-06	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 B	Movable Head Interlocking device # 1 for TR-1020ML-09	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 B	Movable Head Interlocking device # 2 for TR-1020ML-09	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 B	Movable Head Interlocking device # 1 for TR-1040ML-05	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 B	Movable Head Interlocking device # 2 for TR-1040ML-05	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1020ML-21 B	Diverter Gate for TR-1010ML-13-M4	415.00	3.10	5.88	5.00	1.00	5.00	3.10	5.88	0.85
MC-1020ML-21 B	Electric Hoist in CT-1010ML-18	415.00	-	-	-	-	17.00	-	-	-
MC-1020ML-21 B	Electric Hoist in CT-1050ML-19	415.00	-	-	-	-	17.00	-	-	-
TOTAL			**262.59**	**498.47**	**423.70**		**589.96**	**273.40**	**519.00**	**0.86**
TF-1020ML-23	MCC Feed		404.62	768.11	652.89		1,024.96	408.44	775.36	0.85
TF-1020ML-24	MCC Feed		262.59	498.47	423.70		589.95	273.40	519.00	0.85
QD-1020ML-21 A	Import stockyard feed conveyor- Motor # 1	6,600.00	371.85	705.88	600.00	0.75	800.00	495.80	941.18	0.85
QD-1020ML-21 A	Import stockyard feed conveyor- Motor # 2	6,600.00	371.85	705.88	600.00	0.75	800.00	495.80	941.18	0.85
QD-1020ML-21 A	Import stockyard feed conveyor- Motor # 3	6,600.00	371.85	705.88	600.00	0.75	800.00	495.80	941.18	0.85
QD-1020ML-21 A	North and Blended Sinter Reclaim Conveyor - Motor # 1	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 A	North and Blended Sinter Reclaim Conveyor - Motor # 2	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 A	Reclaimer for PY-1020ML-06 & PY-1040ML-04	6,600.00	664.37	1,261.18	1,072.00	0.60	1,800.00	1,115.54	2,117.65	0.85
QD-1020ML-21 A	Blended Stockpile Reversible Conveyor - Motor # 1 (Forward Drive Feeder)	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 A	Blended Stockpile Reversible Conveyor - Motor # 1 (Reverse Drive Feeder)	6,600.00	-	-	-	-	-	-	-	0.85

YARD SUBSTATION - SE-1020ML-02										
PANEL TAG	DESCRIPTION	QUIRED POWER / FEATURES OF PROJE				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	KVA	
QD-1020ML-21 A	Blended Stockpile Reversible Conveyor - Motor # 2 (Forward Drive Feeder)	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 A	Blended Stockpile Reversible Conveyor - Motor # 2 (Reverse Drive Feeder)	6,600.00	-	-	-	-	-	-	-	0.85
QD-1020ML-21 A	Stacker Cum Reclaimer for PY-1040ML-04 & Buffer Stockpile-2	6,600.00	819.92	1,556.47	1,323.00	0.50	2,650.00	1,642.32	3,117.65	0.85
TF-1020ML-23	MCC Feed	6,600.00	404.62	768.11	652.89		1,024.96	408.44	775.36	0.85
TOTAL			**4,176.77**	**7,826.83**	**6,737.89**		**10,384.86**	**6,216.46**	**11,798.88**	**0.86**
QD-1020ML-21 B	North and Blended Sinter Reclaim Conveyor - Motor # 1 (Forward Drive Feeder)	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 B	North and Blended Sinter Reclaim Conveyor - Motor # 1 (Reverse Drive Feeder)	6,600.00	-	-	-			-	-	0.85
QD-1020ML-21 B	North and Blended Sinter Reclaim Conveyor - Motor # 1 (Forward Drive Feeder)	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 B	North and Blended Sinter Reclaim Conveyor - Motor # 2 (Reverse Drive Feeder)	6,600.00	-	-	-			-	-	0.85
QD-1020ML-21 B	Stacker Cum Reclaimer for PY-1040ML-04 & Buffer Stockpile-2	6,600.00	819.92	1,556.47	1,323.00	0.50	2,650.00	1,642.32	3,117.65	0.85
QD-1020ML-21 B	North Sinter Reclaim Conveyor - Motor # 1 (Forward Drive Feeder)	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 B	North Sinter Reclaim Conveyor - Motor # 1 (Reverse Drive Feeder)	6,600.00	-	-	-	-	630.00	390.44	741.18	0.85
QD-1020ML-21 B	North Sinter Reclaim Conveyor - Motor # 2 (Forward Drive Feeder)	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1020ML-21 B	North Sinter Reclaim Conveyor - Motor # 2 (Reverse Drive Feeder)	6,600.00	-	-	-	-	630.00	390.44	741.18	0.85
QD-1020ML-21 B	Stacker Cum Reclaimer for PY-1020ML-06 & Buffer Stockpile-1	6,600.00	819.92	1,556.47	1,323.00	0.50	2,650.00	1,642.32	3,117.65	0.85
QD-1020ML-21 B	Blending Cross Conveyor - Motor # 1	6,600.00	232.40	441.18	375.00	0.75	500.00	309.87	588.24	0.85
QD-1020ML-21 B	Blending Cross Conveyor - Motor # 2	6,600.00	232.40	441.18	375.00	0.75	500.00	309.87	588.24	0.85
QD-1020ML-21 B	Temporary Import Stockyard Feed Conveyor - Motor # 1	6,600.00	232.40	441.18	375.00	0.75	500.00	309.87	588.24	0.85
QD-1020ML-21 B	Outgoing Feeder for Distribution Transformer TF-1020ML-24	6,600.00	262.59	498.47	423.70		589.95	273.40	519.00	0.85
TOTAL			**3,770.86**	**7,168.47**	**6,084.70**		**11,168.86**	**6,830.30**	**12,868.06**	**0.86**

YARD SUBSTATION - SE-1020ML-03										
PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-1020ML-03 A										
MC-1020ML-03 A	Reversible Belt Stripper # 4 (Tail end) for TR-1040ML-04	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-03 A	Reversible Belt Stripper # 3 (Tail end) for TR-1040ML-04	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-03 A	Winch for TR-1020ML-06	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-03 A	Lubrication System Tail-1 for TR-1040ML-04	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 A	Winch for TR-1040ML-04	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-03 A	Sewage Lifting Pump # 1 In Lifting Station -1	415.00	1.39	2.65	2.25	0.30	7.50	4.65	8.82	0.85
MC-1020ML-03 A	Outgoing Feeder for Transformer Cooling Fans for TF-1020ML-32	415.00	-	-	-	1.00	1.10	-	-	0.85
MC-1020ML-03 A	Outgoing Feeder for OLTC of TF-1020ML-32	415.00	0.62	1.18	1.00	1.00	5.50	3.41	6.47	0.85
MC-1020ML-03 A	Outgoing Feeder for Auxilary Supply of 6.6kV Panel QD-1020ML-03	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-1020ML-03 A	Outgoing Feeder for Battery Charger - Float Mode	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-1020ML-03 A	Outgoing Feeder for Battery Charger - Boost Mode	415.00	-	-	-	1.00	-	-	-	-
MC-1020ML-03 A	Outgoing feeder for UPS - Normaly Supply	415.00	12.39	23.53	20.00	1.00	15.00	9.30	17.65	0.85
MC-1020ML-03 A	Outgoing feeder for UPS - Static Byspass Supply	415.00	-	-	-	1.00	-	-	-	-
MC-1020ML-03 A	Outgoing Feeder for CCR UPS -1(20 kVA)- Normaly Supply	415.00	13.63	25.88	22.00	1.00	20.00	12.39	23.53	0.85
MC-1020ML-03 A	Outgoing Feeder for CCR UPS -1(20 kVA)- Static Bypass Supply	415.00	-	-	-	1.00	-	-	-	-
MC-1020ML-03 A	Outgoing Feeder for CCR UPS -2 (20 kVA)- Redundant Supply	415.00	-	-	22.00	1.00	22.00	-	-	0.85
MC-1020ML-03 A	Outgoing Feeder for Instrumentation Lab UPS -2(15 kVA)- Redundant Supply	415.00	12.39	23.53	20.00	1.00	20.00	12.39	23.53	0.85
MC-1020ML-03 A	Distribution Panel for HVAC Loads in CCR- QD-0040ML-05	415.00	12.39	23.53	20.00	1.00	20.00	12.39	23.53	0.85
MC-1020ML-03 A	Outgoing feeder for Warehouse DB - QD-6010ML-05	415.00	123.95	235.29	200.00	1.00	200.00	123.95	235.29	0.85
MC-1020ML-03 A	Outgoing Feeder for VAC load for warehouse DB-1	415.00	24.79	47.06	40.00	1.00	40.00	24.79	47.06	0.85
MC-1020ML-03 A	Outgoing Feeder for VAC load for warehouse DB-2	415.00	24.79	47.06	40.00	1.00	40.00	24.79	47.06	0.85
MC-1020ML-03 A	HVAC Load	415.00	24.79	47.06	40.00	1.00	40.00	24.79	47.06	0.85
MC-1020ML-03 A	Outgoing Feeder for Double Girder Crane 30/5T in Worshop	415.00	-	-	-	1.00	30.00	-	-	0.85
MC-1020ML-03 A	Lubrication System Tail-2 for TR-1020ML-06	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 A	Outgoing Feeder for ACDB Panel -QD-1020ML-31	415.00	92.96	176.47	150.00	1.00	150.00	92.96	176.47	0.85
MC-1020ML-03 A	Outgoing Feeder for 240V NON UPS panel QD-1020ML-32	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-1020ML-03 A	Outgoing feeder for Lighting Transformer TL-1020ML-31	415.00	148.74	282.35	240.00	1.00	240.00	148.74	282.35	0.85
MC-1020ML-03 A	Lubrication System Tail-1 for TR-1020ML-06	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
TOTAL			619.47	888.12	880.20		861.06	621.17	888.36	0.87
MC-1020ML-03 B										
MC-1020ML-03 B	Centralized Lubrication System for TR-1020ML-08	415.00	0.93	1.76	1.50	1.00	1.50	0.93	1.76	0.85
MC-1020ML-03 B	Lubrication System Head-1 for TR-1020ML-08	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 B	Lubrication System Head-2 for TR-1020ML-08	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 B	Lubrication System Tail-1 for TR-1020ML-07	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 B	Winch for TR-1020ML-07	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-03 B	Lubrication System Tail-1 for TR-1020ML-09	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 B	Lubrication System Tail-2 for TR-1020ML-09	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 B	Winch for TR-1020ML-09	415.00	-	-	-	-	28.50	-	-	-
MC-1020ML-03 B	Sewage Lifting Pump # 2 In Lifting Station -1	415.00	-	-	-	-	7.50	-	-	-
MC-1020ML-03 B	Outgoing Feeder for Transformer Cooling Fans for TF-1020ML-31	415.00	-	-	-	1.00	-	-	-	0.85
MC-1020ML-03 B	Outgoing Feeder for OLTC of TF-1020ML-31	415.00	0.62	1.18	1.00	1.00	1.00	0.62	1.18	0.85
MC-1020ML-03 B	Outgoing feeder for UPS - Redundant Supply	415.00	9.30	17.65	15.00	1.00	15.00	9.30	17.65	0.85
MC-1020ML-03 B	Outgoing Feeder for CCR UPS -1(20 kVA)- Redundant Supply	415.00	-	-	-	1.00	-	-	-	0.85
MC-1020ML-03 B	Outgoing Feeder for CCR UPS -2(20 kVA)- Normaly Supply	415.00	-	-	-	1.00	-	-	-	0.85
MC-1020ML-03 B	Outgoing Feeder for CCR UPS -2 (20 kVA)- Static Bypass Supply	415.00	-	-	-	1.00	15.00	-	-	0.85
MC-1020ML-03 B	Outgoing Feeder for Instrumentation Lab UPS -2(15 kVA)- Normaly Supply	415.00	9.30	17.65	15.00	1.00	15.00	9.30	17.65	0.85
MC-1020ML-03 B	Outgoing Feeder for Instrumentation Lab UPS -2(15 kVA)- Static Bypass Supply	415.00	-	-	-	1.00	-	-	-	0.85
MC-1020ML-03 B	Outgoing Feeder for Double Girder Crane Workshop & Warehouse	415.00	-	-	100.00	1.00	100.00	-	-	0.85
MC-1020ML-03 B	Lubrication System Tail-2 for TR-1020ML-07	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1020ML-03 B	Outgoing feeder for Lighting Transformer TL-1020ML-32	415.00	148.74	282.35	240.00	1.00	240.00	148.74	282.35	0.85
MC-1020ML-03 B	Pump motor for brake at motor-1	415.00	-	-	-	1.00	1.10	-	-	-
MC-1020ML-03 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1020ML-03 B	Reversible Belt Stripper # 3 (Tail end) for TR-1020ML-06	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-03 B	Reversible Belt Stripper # 4 (Tail end) for TR-1020ML-06	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-03 B	Reversible Belt Stripper # 3 (Tail end) for TR-1020ML-09	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-03 B	Reversible Belt Stripper # 4 (Tail end) for TR-1020ML-09	415.00	0.15	0.29	0.25	1.00	0.25	0.15	0.29	0.85
MC-1020ML-03 B	Lubrication System Tail-3 for TR-1020ML-09	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
TOTAL			170.16	323.00	374.55		468.25	170.15	323.00	1.16
TF-1020ML-33	MCC Feed		519.47	986.12	860.20		951.05	521.17	989.35	0.87

YARD SUBSTATION - SE-1020ML-03										
PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
TF-1020ML-34	MCC Feed		170.15	323.00	374.55		456.25	170.15	323.00	1.16
QD-1020ML-03 A	Stacker Machine for PY-1020ML-05 and PY-1020ML-06	6,600.00	442.37	839.76	713.80	0.70	1,000.00	619.74	1,176.47	0.85
QD-1020ML-03 A	Outgoing Feeder for Distribution Transformer TF-1020ML-33	6,600.00	519.47	986.12	860.20		951.05	521.17	989.35	0.85
TOTAL			961.84	1,826.88	1,574.00		1,951.06	1,140.92	2,166.82	0.88
QD-1020ML-03 B	North and South Sinter Stacking Conveyor - Motor # 1	6,600.00	330.01	626.47	532.50	0.75	710.00	836.29	836.29	0.85
QD-1020ML-03 B	North and South Sinter Stacking Conveyor - Motor # 2	6,600.00	330.01	626.47	532.50	0.75	710.00	836.29	836.29	0.85
QD-1020ML-03 B	Outgoing Feeder for Distribution Transformer TF-1020ML-34	6,600.00	170.15	323.00	374.55	-	456.25	170.15	323.00	1.16
TOTAL			830.18	1,576.94	1,439.55		1,876.25	1,840.74	1,983.59	0.91

YARD SUBSTATION - SE-1040ML-01

PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-1040ML-11 A										
MC-1040ML-11 A	Lubrication system head-2 for TR-1010ML-12	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-11 A	Lubrication system head-2 for TR-1010ML-11	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-11 A	Lubrication system head-7 for TR-1010ML-11	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-11 A	Winch for TR-1010ML-11	415.00	-	-	-	-	28.50	-	-	-
MC-1040ML-11 A	Lubrication system Tail for TR-1010ML-13	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-11 A	Electric Hoist # 1 in CT-1010ML-03	415.00	-	-	-	1.00	5.00	-	-	-
MC-1040ML-11 A	DDS Pump - CT-1010ML-03	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1040ML-11 A	Filteration Unit Pump # 1 (PD-4000ML-01)	415.00	13.94	26.47	22.50	0.30	75.00	46.48	88.24	0.85
MC-1040ML-11 A	Filteration Unit Pump # 2 (PD-4000ML-01)	415.00	-	-	-	-	75.00	-	-	-
MC-1040ML-11 A	Bridge Crane (EOT) in pump house for SW-2, ED-4000ML-04	415.00	-	-	-	1.00	7.50	-	-	-
MC-1040ML-11 A	SW-1 (PD-4000ML-03) Pump # 1	415.00	16.73	31.76	27.00	0.30	90.00	55.78	105.88	0.85
MC-1040ML-11 A	SW-1 (PD-4000ML-03) Pump # 2	415.00	-	-	-	-	90.00	-	-	-
MC-1040ML-11 A	Bridge Crane (EOT) in pump house for RW-1 (ED-4000ML-05)	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 A	Bridge Crane (EOT) in Pump house for RW-2 (ED-4000ML-06)	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 A	Dust Suppression pump # 1 in Recirculation Water Pump House (PD-4000ML-01)	415.00	13.94	26.47	22.50	0.30	75.00	46.48	88.24	0.85
MC-1040ML-11 A	Water Truck Filling Station Pump # 1 in Recirculation Water Pump House (PD-4000ML-01)	415.00	-	-	-	-	5.50	-	-	-
MC-1040ML-11 A	Wharf dust suppression, material unloading and hose down Pump # 1	415.00	8.37	15.88	13.50	0.30	45.00	27.89	52.94	0.85
MC-1040ML-11 A	Sumersible Sump Pump in Recirculation Water Pump House (ED-4000ML-01)	415.00	0.74	1.41	1.20	0.30	4.00	2.48	4.71	0.85
MC-1040ML-11 A	Bridge Crane (EOT) in Pump House for Recirculation Water (ED-4000ML-01)	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 A	Workshop and Warehouse Pump #1 in Storm Water Pump House(ED-4000ML-02)	415.00	2.05	3.88	3.30	0.30	11.00	6.82	12.94	0.85
MC-1040ML-11 A	Hose down and Utility Pump # 1 in Storm Water Pump House(ED-4000ML-02)	415.00	-	-	-	-	15.00	-	-	-
MC-1040ML-11 A	Make up water #1 for Recirculation water Pond in Storm Water Pump House(ED-4000ML-02)	415.00	4.18	7.94	6.75	0.30	22.50	13.94	26.47	0.85
MC-1040ML-11 A	Sumersible Sump Pump in Storm Water Pump House(ED-4000ML-02)	415.00	0.74	1.41	1.20	0.30	4.00	2.48	4.71	0.85
MC-1040ML-11 A	Bridge Crane (EOT) Storm Water Pump House (ED-4000ML-02)	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 A	Fire Fighting Service Jokey Pump # 1	415.00	3.35	6.35	5.40	0.30	18.00	11.16	21.18	0.85
MC-1040ML-11 A	Fire Fighting Service Main Pump # 1	415.00	20.45	38.82	33.00	0.30	110.00	68.17	129.41	0.85
MC-1040ML-11 A	Outgoing Feeder for Battery Charging for Diesel Driven Fire Fighting Pump BA-4080ML-05	415.00	1.55	2.94	2.50	0.50	5.00	3.10	5.88	0.85
MC-1040ML-11 A	Sump Pump # 1 in Fire Water Pump House	415.00	0.74	1.41	1.20	0.30	4.00	2.48	4.71	0.85
MC-1040ML-11 A	Bridge Crane (EOT)- for Fire Water Pump House (ED-4080ML-01)	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 A	Sewage Lifting Pump # 1 in Lifting Station -3	415.00	1.39	2.65	2.25	0.30	7.50	4.65	8.82	0.85
MC-1040ML-11 A	Sewage Lifting Pump # 1 in Lifting Station -4	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 A	Outgoing Feeder for WTP	415.00	3.72	7.06	6.00	0.30	20.00	12.39	23.53	0.85
MC-1040ML-11 A	Rain Water Transfer Pump - PZ4-07	415.00	10.23	19.41	16.50	0.30	55.00	34.09	64.71	0.85
MC-1040ML-11 A	Outgoing Feeder # 1 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-1040ML-11 A	Flash Mixer Agitator (Outgoing Feeder # 1 for Filteration Unit)	415.00	30.99	58.82	50.00	1.00	50.00	30.99	58.82	0.85
MC-1040ML-11 A	Outgoing Feeder for 240V NON UPS panel QD-1040ML-05	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-1040ML-11 A	Outgoing Feeder for Battery Charger - Float Mode	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-1040ML-11 A	Outgoing Feeder for Battery Charger - Boost Mode	415.00	-	-	-	-	-	-	-	0.85
MC-1040ML-11 A	Outgoing feeder for UPS - Normaly Supply	415.00	12.39	23.53	20.00	1.00	10.00	6.20	11.76	0.85
MC-1040ML-11 A	Outgoing Feeder for Transformer Cooling Fans for TF-1040ML-11	415.00	3.41	6.47	5.50	1.00	5.50	3.41	6.47	0.85
MC-1040ML-11 A	Outgoing Feeder for OLTC of TF-1040ML-11	415.00	0.62	1.18	1.00	1.00	1.00	0.62	1.18	0.85
MC-1040ML-11 A	Outgoing feeder for Lighting Transformer TL-1040ML-11	415.00	148.74	282.35	240.00	1.00	250.00	154.94	294.12	0.85
MC-1040ML-11 A	DDS Pump - CT-1010ML-03	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
TOTAL			**339.07**	**643.66**	**547.11**		**1,201.35**	**676.27**	**1,093.94**	**0.85**
MC-1040ML-11 B										
MC-1040ML-11 B	Lubrication System head-1 for TR-1010ML-12	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-11 B	Winch for TR-1010ML-55	415.00	-	-	-	-	28.50	-	-	-
MC-1040ML-11 B	Winch for TR-1010ML-12	415.00	-	-	-	-	28.50	-	-	-
MC-1040ML-11 B	DDS Pump- CT-1010ML-19	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1040ML-11 B	SW-2 (PD-4000ML-04) Pump # 3	415.00	-	-	-	-	90.00	-	-	-
MC-1040ML-11 B	SW-2 (PD-4000ML-04) Pump # 1	415.00	16.73	31.76	27.00	0.30	90.00	55.78	105.88	0.85
MC-1040ML-11 B	SW-1 (PD-4000ML-04) Pump # 2	415.00	16.73	31.76	27.00	0.30	90.00	55.78	105.88	0.85
MC-1040ML-11 B	Bridge Crane (EOT) in pump house for SW-1 (ED-4000ML-03)	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 B	Dust Suppression pump # 2 in Recirculation Water Pump House (PD-4000ML-01)	415.00	-	-	-	-	75.00	-	-	-
MC-1040ML-11 B	Water Truck Filling Station Pump #2 in Recirculation Water Pump House (PD-4000ML-01)	415.00	1.02	1.94	1.65	0.30	5.50	3.41	6.47	0.85
MC-1040ML-11 B	Wharf dust suppression, material unloading and hose down Pump # 2	415.00	-	-	-	-	45.00	-	-	-
MC-1040ML-11 B	Workshop and Warehouse Pump #2 in Storm Water Pump House(ED-4000ML-02)	415.00	-	-	-	-	11.00	-	-	-
MC-1040ML-11 B	Screw Conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85

YARD SUBSTATION - SE-1040ML-01

PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-1040ML-11 B	Hose down and Utility Pump # 2 in Storm Water Pump House(ED-4000ML-02)	415.00	2.79	5.29	4.50	0.30	15.00	9.30	17.65	0.85
MC-1040ML-11 B	Fire Fighting Service Jokey Pump # 2	415.00	3.35	6.35	5.40	0.30	18.00	11.16	21.18	0.85
MC-1040ML-11 B	Fire Fighting Service Main Pump # 2	415.00	20.45	38.82	33.00	0.30	110.00	68.17	129.41	0.85
MC-1040ML-11 B	Sewage Lifting Pump # 2 in Lifting Station -3	415.00	-	-	-	-	7.50	-	-	-
MC-1040ML-11 B	Sewage Lifting Pump # 2 in Lifting Station -4	415.00	1.39	2.65	2.25	0.30	7.50	4.65	8.82	0.85
MC-1040ML-11 B	Outgoing Feeder for STP	415.00	1.86	3.53	3.00	0.30	10.00	6.20	11.76	0.85
MC-1040ML-11 B	Outgoing Feeder # 2 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-1040ML-11 B	Outgoing feeder for UPS - Redundant Supply	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-1040ML-11 B	Outgoing feeder for UPS - Static Bypass Supply	415.00	-	-	-	-	-	-	-	0.85
MC-1040ML-11 B	Outgoing feeder for Lighting Transformer TL-1040ML-12	415.00	148.74	282.35	240.00	1.00	250.00	154.94	294.12	0.85
MC-1040ML-11 B	Outgoing Feeder for ACDB Panel - QD-1040ML-04	415.00	30.99	58.82	50.00	1.00	150.00	92.96	176.47	0.85
MC-1040ML-11 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-11 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-11 B	Pump motor for brake at motor-3	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-11 B	Electrical Hoist # 1 in Maintenance Trolley Patform	415.00	-	-	17.00	1.00	17.00	-	-	0.85
MC-1040ML-11 B	DDS Pump- CT-1010ML-19	415.00	0.10	0.19	0.17	0.30	0.55	0.34	0.65	0.85
TOTAL			**279.49**	**530.56**	**467.98**		**1,118.40**	**498.96**	**947.18**	**0.88**
TF-1040ML-13	MCC Feed		339.07	643.66	547.11		1,201.35	576.27	1,093.94	0.85
TF-1040ML-14	MCC Feed		279.49	530.56	467.98		1,118.40	498.96	947.18	0.88
MC-1040ML-12 A										
MC-1040ML-12 A	Movable Head Interlocking device # 2 for TR-1050ML-10	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1040ML-12 A	Movable Head Interlocking device # 1 for TR-1050ML-10	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-1040ML-12 A	Lubrication System tail-1 for TR-1050ML-22	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-12 A	Lubrication System tail-2 for TR-1050ML-22	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-12 A	Lubrication System for CT-1050ML-08	415.00	0.65	1.24	1.05	1.00	1.05	0.65	1.24	0.85
MC-1040ML-12 A	Winch for TR-1050ML-10	415.00	-	-	-	1.00	28.50	-	-	-
MC-1040ML-12 A	Movable Head Motor - TR-1050ML-10	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-1040ML-12 A	Electric Hoist # 1 in 1050ML-08	415.00	-	-	-	-	17.00	-	-	-
MC-1040ML-12 A	Electric Hoist # 2 in 1050ML-08	415.00	-	-	-	-	17.00	-	-	-
MC-1040ML-12 A	Electric Hoist # 3 in 1050ML-08	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 A	Electric Hoist # 4 in 1050ML-08	415.00	-	-	-	-	17.00	-	-	-
MC-1040ML-12 A	Electric Hoist # 5 in 1050ML-08	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 A	DDS Pump - CT-1050ML-08	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1040ML-12 A	DDS Pump - CT-1050ML-09	415.00	0.41	0.78	0.66	0.30	2.20	1.36	2.59	0.85
MC-1040ML-12 A	Spillage Conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-1040ML-12 A	HVAC Load	415.00	232.40	441.18	375.00	1.00	375.00	232.40	441.18	0.85
MC-1040ML-12 A	VAC Load for Authority Custom Building (ED.3005ML.01)	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-1040ML-12 A	Outgoing Feeder for Auxiliary Supply of 6.6kV Panel QD-1040ML-01	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-1040ML-12 A	Outgoing Feeder for Transformer Cooling Fans for TF-1040ML-12	415.00	3.41	6.47	5.50	1.00	5.50	3.41	6.47	0.85
MC-1040ML-12 A	Outgoing Feeder for OLTC of TF-1040ML-12	415.00	0.62	1.18	1.00	1.00	1.00	0.62	1.18	0.85
MC-1040ML-12 A	Lubrication System head-1 for TR-1010ML-55	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-12 A	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-12 A	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-12 A	Pump motor for brake at motor-3	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-12 A	Pump motor for brake at motor-4	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-12 A	DDS Pump - CT-1050ML-08	415.00	-	-	-	-	0.55	-	-	-
MC-1040ML-12 A	DDS Pump - CT-1050ML-09	415.00	-	-	-	-	0.55	-	-	-
TOTAL			**284.86**	**540.73**	**468.82**		**671.70**	**288.78**	**644.36**	**0.86**
MC-1040ML-12 B										
MC-1040ML-12 B	Lubrication System head-1 for TR-1050ML-11	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-12 B	Winch for TR-1050ML-11	415.00	-	-	-	-	28.50	-	-	-
MC-1040ML-12 B	Lubrication System Tail-3 for TR-1050ML-22	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85

YARD SUBSTATION - SE-1040ML-01

PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-1040ML-12 B	Electric Hoist # 1 in 1050ML-09	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 B	Electric Hoist # 2 in 1050ML-09	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 B	Electric Hoist # 3 in 1050ML-09	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 B	Electric Hoist # 4 in 1050ML-09	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 B	Electric Hoist # 5 in 1050ML-09	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 B	Electric Hoist # 6 in 1050ML-09	415.00	-	-	-	-	12.00	-	-	-
MC-1040ML-12 B	Winch for TR-1050ML-22	415.00	-	-	-	-	28.50	-	-	-
MC-1040ML-12 B	Lubrication System head for TR-1050ML-24	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-1040ML-12 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-1040ML-12 B	MH Quay Load	415.00	210.71	400.00	340.00	1.00	340.00	210.71	400.00	0.85
TOTAL			210.89	400.63	340.45		470.65	210.89	400.63	0.85
TF-1040ML-15	MCC Feed		284.85	540.73	459.62		571.70	286.76	544.35	0.85
TF-1040ML-16	MCC Feed		210.99	400.53	340.45		470.55	210.99	400.53	0.85
QD-1040ML-01 A										
QD-1040ML-01 A	Import Jetty conveyor- Motor # 1	6,600.00	371.85	705.88	600.00	0.75	800.00	495.80	941.18	0.85
QD-1040ML-01 A	Import Jetty conveyor- Motor # 2	6,600.00	371.85	705.88	600.00	0.75	800.00	495.80	941.18	0.85
QD-1040ML-01 A	Import Jetty conveyor- Motor # 3	6,600.00	371.85	705.88	600.00	0.75	800.00	495.80	941.18	0.85
QD-1040ML-01 A	Export Conveyor Motor # 4	6,600.00	330.01	626.47	532.50	0.75	710.00	440.02	835.29	0.85
QD-1040ML-01 A	Import Cross Conveyor	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1040ML-01 A	RW-1 (PD-4000ML-05) Pump # 1	6,600.00	-	-	-		400.00	-	-	-
QD-1040ML-01 A	RW-1 (PD-4000ML-05) Pump # 2	6,600.00	-	-	-		400.00	-	-	-
QD-1040ML-01 A	RW-2 (PD-4000ML-06) Pump # 1	6,600.00	122.09	231.76	197.00	0.70	280.00	173.53	329.41	0.85
QD-1040ML-01 A	RW-2 (PD-4000ML-06) Pump # 2	6,600.00	-	-	-		280.00	-	-	-
QD-1040ML-01 A	RW-2 (PD-4000ML-06) Pump # 3	6,600.00	-	-	-		280.00	-	-	-
QD-1040ML-01 A	Outgoing Feeder # 1 for Sampling System Transformer	6,600.00	198.32	376.47	320.00		320.00	198.32	376.47	0.85
QD-1040ML-01 A	Outgoing Feeder for Distrbution Transformer TF-1040ML-13	6,600.00	339.07	643.66	547.11		1,201.35	744.53	1,413.35	0.85
QD-1040ML-01 A	Outgoing Feeder for Distrbution Transformer TF-1040ML-15	6,600.00	284.85	540.73	459.62		571.70	354.31	672.59	0.85
TOTAL			2,882.71	5,082.82	4,328.78		7,473.06	3,788.63	7,191.82	0.86
QD-1040ML-01 B										
QD-1040ML-01 B	Stockyard Export conveyor- Motor # 1	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1040ML-01 B	Stockyard Export conveyor- Motor # 2	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1040ML-01 B	Stockyard Export conveyor- Motor # 3	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1040ML-01 B	Export Conveyor	6,600.00	330.01	626.47	532.50	0.75	710.00	440.02	835.29	0.85
QD-1040ML-01 B	RW-1 (PD-4000ML-05) Pump # 3	6,600.00	-	-	-		400.00	-	-	-
QD-1040ML-01 B	RW-1 (PD-4000ML-05) Pump # 4	6,600.00	-	-	-		400.00	-	-	-
QD-1040ML-01 B	RW-1 (PD-4000ML-05) Pump # 5	6,600.00	206.99	392.94	334.00	0.84	400.00	247.90	470.59	0.85
QD-1040ML-01 B	RW-2 (PD-4000ML-06) Pump # 4	6,600.00	-	-	-		280.00	-	-	-
QD-1040ML-01 B	RW-2 (PD-4000ML-06) Pump # 5	6,600.00	-	-	-		280.00	-	-	-
QD-1040ML-01 B	RW-2 (PD-4000ML-06) Pump # 6 (Future)	6,600.00	-	-	-		280.00	-	-	-
QD-1040ML-01 B	Import stockyard feed conveyor- Motor # 1	6,600.00	232.40	441.18	375.00	0.75	500.00	309.87	588.24	0.85
QD-1040ML-01 B	Outgoing Feeder # 2 for Sampling System Transformer	6,600.00	198.32	376.47	320.00		320.00	198.32	376.47	0.85
QD-1040ML-01 B	Outgoing Feeder for Distrbution Transformer TF-1040ML-14	6,600.00	290.02	550.56	467.98		1,118.40	693.12	1,315.76	0.85
QD-1040ML-01 B	Outgoing Feeder for Distrbution Transformer TF-1040ML-16	6,600.00	210.99	400.53	340.45		470.55	291.62	553.59	0.85
TOTAL			2,347.24	4,456.79	3,787.43		7,048.95	3,362.17	6,383.47	0.86

PORT SUBSTATION - SE-3020ML-01

PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-3020ML-11 A										
MC-3020ML-11 A	Lubrication System in TR-1010ML-10	415.00	1.02	1.94	1.65	1.00	1.65	1.02	1.94	0.85
MC-3020ML-11 A	Lubrication System head-2 for TR-1010ML-10	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-3020ML-11 A	Magnetic Separator for TR-1010ML-10	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-3020ML-11 A	Electric Hoist # 1 in CT-1010ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 2 in CT-1010ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 3 in CT-1010ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 4 in CT-1010ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 5 in CT-1010ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 6 in CT-1010ML-01	415.00	-	-	-	-	17.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 7 in CT-1010ML-01	415.00	-	-	-	-	17.00	-	-	-
MC-3020ML-11 A	Electric Hoist # 8 in CT-1010ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-11 A	Quick Release Hook # 1	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 A	Quick Release Hook # 2	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 A	Quick Release Hook # 3	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 A	Maintenance Trolley In MAT - Feeder # 1	415.00	-	-	-	-	-	-	-	-
MC-3020ML-11 A	Maintenance Trolley In MAT - Feeder # 2	415.00	-	-	-	-	-	-	-	-
MC-3020ML-11 A	Maintenance Trolley In MAT - Feeder # 3	415.00	-	-	-	-	-	-	-	-
MC-3020ML-11 A	Rain Water Transfer Pump - PZ2-02	415.00	10.23	19.41	16.50	0.30	55.00	34.09	64.71	0.85
MC-3020ML-11 A	Rain Water Transfer Pump - PZ2-03	415.00	-	-	-	-	55.00	-	-	-
MC-3020ML-11 A	Rain Water Transfer Pump - PZ2-04	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-11 A	Rain Water Transfer Pump - PZ2-05	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-11 A	Rain Water Transfer Pump - PZ2-06	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-11 A	Rain Water Transfer Pump - PZ2-07	415.00	13.94	26.47	22.50	0.30	75.00	46.48	88.24	0.85
MC-3020ML-11 A	Outgoing Feeder # 1 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-11 A	Outgoing Feeder # 2 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-11 A	HVAC Load	415.00	61.97	117.65	100.00	1.00	375.00	232.40	441.18	0.85
MC-3020ML-11 A	Outgoing Feeder for Battery Charger - Float Mode	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-3020ML-11 A	Outgoing Feeder for Battery Charger - Boost Mode	415.00	-	-	-	-	-	-	-	-
MC-3020ML-11 A	Outgoing feeder for UPS - Redundant Supply	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-3020ML-11 A	Outgoing Feeder for Transformer Cooling Fans for TF-3020ML-12	415.00	3.41	6.47	5.50	1.00	5.50	3.41	6.47	0.85
MC-3020ML-11 A	Outgoing Feeder for OLTC of TF-3020ML-12	415.00	0.62	1.18	1.00	1.00	1.00	0.62	1.18	0.85
MC-3020ML-11 A	Outgoing Feeder # 1 for Future MCC MC-3020ML-13	415.00	-	-	-	-	800A	-	-	-
MC-3020ML-11 A	Outgoing Feeder for ACDB Panel - QD-3020ML-14	415.00	61.97	117.65	100.00	1.00	100.00	61.97	117.65	0.85
MC-3020ML-11 A	Outgoing Feeder for 240V NON UPS panel QD-3020ML-13	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
TOTAL			237.55	450.94	383.30		1,190.80	464.37	881.53	0.85
MC-3020ML-11 B										
MC-3020ML-11 B	Spillage conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-11 B	Spillage conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-11 B	DDS Pump in - CT-1010ML-01	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-11 B	Quick Release Hook # 4	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 B	Quick Release Hook # 5	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 B	Quick Release Hook # 6	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 B	Quick Release Hook # 7	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-11 B	Rain Water Transfer Pump - PZ3-01	415.00	10.23	19.41	16.50	0.30	55.00	34.09	64.71	0.85
MC-3020ML-11 B	Rain Water Transfer Pump - PZ3-02	415.00	-	-	-	-	45.00	-	-	-
MC-3020ML-11 B	Rain Water Transfer Pump - PZ3-03	415.00	-	-	-	-	45.00	-	-	-
MC-3020ML-11 B	Rain Water Transfer Pump - PZ3-04	415.00	-	-	-	-	45.00	-	-	-
MC-3020ML-11 B	Rain Water Transfer Pump - PZ4-01	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-11 B	Rain Water Transfer Pump - PZ4-03	415.00	-	-	-	-	45.00	-	-	-
MC-3020ML-11 B	Rain Water Transfer Pump - PZ4-05	415.00	10.23	19.41	16.50	0.30	55.00	34.09	64.71	0.85
MC-3020ML-11 B	Outgoing Feeder # 3 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-11 B	Outgoing Feeder # 4 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85

PORT SUBSTATION - SE-3020ML-01										
PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-3020ML-11 B	Outgoing Feeder # 5 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-11 B	Outgoing feeder for UPS - Normaly Supply	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-3020ML-11 B	Outgoing feeder for UPS - Static Bypass Supply	415.00	-	-	-	1.00	-	-	-	0.85
MC-3020ML-11 B	Outgoing Feeder for Auxiliary Supply of 6.6kV Panel QD-3020ML-11	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-3020ML-11 B	Outgoing Feeder # 2 for Future MCC MC-3020ML-13	415.00	-	-	-	-	800A	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-3	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-4	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-3	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-2	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	Pump motor for brake at motor-1	415.00	-	-	-	-	1.10	-	-	-
MC-3020ML-11 B	DDS Pump in - CT-1010ML-01	415.00	0.34	0.65	0.55	1.00	0.55	0.34	0.65	0.85
MC-3020ML-11 B	Electric Hoist # 1 in TR-1010ML-10	415.00	-	-	-	-	17.00	-	-	-
MC-3020ML-11 B	Electric Hoist # 2 in TR-1010ML-10	415.00	-	-	-	-	17.00	-	-	-
TOTAL			104.21	197.82	168.15		619.15	151.93	288.41	0.85
TF-3020ML-13	MCC Feed	415.00	237.55	450.94	383.30		1,190.80	464.37	881.53	0.85
TF-3020ML-14	MCC Feed	415.00	104.21	197.82	168.15		619.15	151.93	288.41	0.85
MC-3020ML-12 A										
MC-3020ML-12 A	Lubrication System for CT-1010ML-01	415.00	1.02	1.94	1.65	1.00	1.65	1.02	1.94	0.85
MC-3020ML-12 A	Magnetic Separator for TR-1050ML-22	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-3020ML-12 A	Lubrication System head-1 for TR-3030ML-01	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-3020ML-12 A	Lubrication System head-2 for TR-3030ML-01	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-3020ML-12 A	Electric Hoist in TR-3030ML-01	415.00	-	-	-	-	12.00	-	-	-
MC-3020ML-12 A	Electric Hoist in TR-3030ML-01	415.00	-	-	-	-	17.00	-	-	-
MC-3020ML-12 A	Winch for TR-3030ML-01	415.00	-	-	-	-	28.50	-	-	-
MC-3020ML-12 A	Maintenance Trolley In MAT - Feeder # 1	415.00	-	-	-	-	-	-	-	-
MC-3020ML-12 A	Maintenance Trolley In MAT - Feeder # 2	415.00	-	-	-	-	-	-	-	-
MC-3020ML-12 A	Maintenance Trolley In MAT - Feeder # 3	415.00	-	-	-	-	-	-	-	-
MC-3020ML-12 A	Quick Release Hook # 8	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-12 A	Quick Release Hook # 9	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-12 A	Quick Release Hook # 10	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-12 A	Outgoing Feeder # 6 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-12 A	Outgoing Feeder # 7 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-12 A	Outgoing Feeder # 8 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-12 A	Distribution Panel for HVAC Load For Port Office	415.00	12.39	23.53	20.00	1.00	20.00	12.39	23.53	0.85
MC-3020ML-12 A	HVAC Load For Control Building	415.00	92.96	176.47	150.00	1.00	150.00	92.96	176.47	0.85
MC-3020ML-12 A	Outgoing Feeder for Transformer Cooling Fans for TF-3020ML-11	415.00	3.41	6.47	5.50	1.00	5.50	3.41	6.47	0.85
MC-3020ML-12 A	Outgoing Feeder for OLTC of TF-3020ML-11	415.00	0.62	1.18	1.00	1.00	1.00	0.62	1.18	0.85
					-					
TOTAL			188.68	358.18	304.45		417.45	188.68	358.18	0.85
MC-3020ML-12 B										
MC-3020ML-12 B	Electric Hoist # 2 in Maintenance Trolley Platform.	415.00	-	-	3.00	1.00	3.00	-	-	0.85
MC-3020ML-12 B	Spillage Conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-12 B	Spillage Conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-12 B	Spillage Conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-12 B	Lubrication System For TR-3030ML-03	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-3020ML-12 B	Quick Release Hook # 11	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-12 B	Quick Release Hook # 12	415.00	-	-	-	-	18.50	-	-	-

PORT SUBSTATION - SE-3020ML-01										
PANEL TAG	DESCRIPTION	REQUIRED POWER / FEATURES OF PROJECT				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-3020ML-12 B	Quick Release Hook # 13	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-12 B	Outgoing Feeder # 9 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-12 B	Outgoing Feeder # 10 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-12 B	Outgoing feeder for Lighting Transformer TL-3020ML-01	415.00	136.34	258.82	220.00	1.00	220.00	136.34	258.82	0.85
TOTAL			180.19	342.06	293.75		349.25	180.19	342.06	0.86
TF-3020ML-15	MCC Feed	415.00	188.68	358.18	304.45		417.45	188.68	358.18	0.85
TF-3020ML-16	MCC Feed	415.00	180.19	342.06	293.75		349.25	180.19	342.06	0.86
QD-3020ML-11 A										
QD-3020ML-11 A	Import Berth Conveyor Motor # 1	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-3020ML-11 A	Import Berth Conveyor Motor # 2	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-3020ML-11 A	Import Berth Conveyor Motor # 3	6,600.00	292.83	555.88	472.50	0.75	630.00	390.44	741.18	0.85
QD-1040ML-01 A	Import Jetty conveyor- Motor # 4	6,600.00	328.45	623.53	600.00	0.75	800.00	495.80	941.18	0.85
QD-3020ML-11 A	Parallel Ship Loader	6,600.00	551.57	1,047.06	890.00		1,270.00	787.08	1,494.12	0.85
QD-3020ML-11 A	Outgoing Feeder for Distribution Transformer TF-3020ML-13	6,600.00	237.55	450.94	383.30	-	1,190.80	464.37	881.53	0.85
QD-3020ML-11 A	Outgoing Feeder for Distribution Transformer TF-3020ML-15	6,600.00	180.19	342.06	293.75	-	349.25	180.19	342.06	0.85
TOTAL			2,176.26	4,131.24	3,584.55		5,500.05	3,098.75	5,882.41	0.87
QD-3020ML-12 A										
QD-3020ML-11 A	Export Conveyor Motor # 1	6,600.00	330.01	626.47	532.50	0.75	710.00	440.02	835.29	0.85
QD-3020ML-11 A	Export Conveyor Motor # 2	6,600.00	330.01	626.47	532.50	0.75	710.00	440.02	835.29	0.85
QD-3020ML-11 A	Export Conveyor Motor # 3	6,600.00	330.01	626.47	532.50	0.75	710.00	440.02	835.29	0.85
QD-3020ML-11 A	Parallel Ship Loader Feed Conveyor Motor # 1	6,600.00	295.83	561.59	477.35		500.00	309.87	588.24	0.85
QD-3020ML-11 A	Parallel Ship Loader Feed Conveyor Motor # 2	6,600.00	295.83	561.59	477.35		500.00	309.87	588.24	0.85
QD-3020ML-11 A	Export Conveyor	6,600.00	92.96	176.47	150.00	0.75	200.00	123.95	235.29	0.85
QD-3020ML-11 A	Outgoing Feeder for Distribution Transformer TF-3020ML-14	6,600.00	104.21	197.82	168.15		417.45	151.93	288.41	0.85
QD-3020ML-11 A	Outgoing Feeder for Distribution Transformer TF-3020ML-16	6,600.00	180.19	342.06	293.75		349.25	180.19	342.06	0.86
TOTAL			1,959.07	3,718.94	3,164.10		4,096.70	2,395.87	4,548.12	0.85

PORT SUBSTATION - SE-3020ML-02										
PANEL TAG	DESCRIPTION	EQUIRED POWER / FEATURES OF PROJEC				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
MC-3020ML-02										
MC-3020ML-02 A	Lubrication System1 at Tail end in TR-1010ML-10	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-3020ML-02 A	Lubrication System for TR-1010ML-16	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
MC-3020ML-02 A	Take up winch for TR-1010ML-10	415.00	-	-	28.50	1.00	28.50	-	-	0.85
MC-3020ML-02 A	Spillage Conveyor	415.00	1.36	2.59	2.20	1.00	2.20	1.36	2.59	0.85
MC-3020ML-02 A	Quick Release Hook # 14	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 15	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 16	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 17	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 18	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 19	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 20	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 21	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 22	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 23	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 24	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 25	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 26	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 27	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 28	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Quick Release Hook # 29	415.00	-	-	-	-	18.50	-	-	-
MC-3020ML-02 A	Rain Water Transfer Pump - PZ1-01	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-02 A	Rain Water Transfer Pump - PZ1-02	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-02 A	Rain Water Transfer Pump - PZ1-03	415.00	-	-	-	-	75.00	-	-	-
MC-3020ML-02 A	Rain Water Transfer Pump - PZ1-04	415.00	13.94	26.47	22.50	0.30	75.00	46.48	88.24	0.85
MC-3020ML-02 A	Outgoing Feeder # 1 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-02 A	Outgoing Feeder # 2 for Cathodic Protection System	415.00	19.83	37.65	32.00	1.00	32.00	19.83	37.65	0.85
MC-3020ML-02 A	Outgoing Feeder for Transformer Cooling Fans for TF-3020ML-21	415.00	-	-	1.00	1.00	1.00	-	-	0.85
MC-3020ML-02 A	Outgoing Feeder for OLTC of TF-3020ML-21	415.00	3.41	6.47	5.50	1.00	5.50	3.41	6.47	0.85
MC-3020ML-02 A	Outgoing Feeder for Transformer Cooling Fans for TF-3020ML-22	415.00	-	-	1.00	1.00	1.00	-	-	0.85
MC-3020ML-02 A	Outgoing Feeder for OLTC of TF-3020ML-22	415.00	3.41	6.47	5.50	1.00	5.50	3.41	6.47	0.85
MC-3020ML-02 A	Outgoing Feeder for Auxliary Supply of 6.6kV Panel QD-3020ML-02	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-3020ML-02 A	Outgoing Feeder for Battery Charger - Float Mode	415.00	13.63	25.88	22.00	1.00	22.00	13.63	25.88	0.85
MC-3020ML-02 A	Outgoing Feeder for Battery Charger - Boost Mode	415.00	-	-	-	-	-	-	-	0.85
MC-3020ML-02 A	Outgoing feeder for UPS - Normaly Supply	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-3020ML-02 A	Outgoing feeder for UPS - Redundant Supply	415.00	-	-	-	-	-	-	-	0.85
MC-3020ML-02 A	Outgoing feeder for UPS - Static By-pass supply Supply	415.00	-	-	-	-	-	-	-	0.85
MC-3020ML-02 A	Outgoing feeder for Lighting Transformer TL-3020ML-02	415.00	61.97	117.65	100.00	1.00	240.00	148.74	282.35	0.85
MC-3020ML-02 A	Outgoing Feeder for ACDB Panel - QD-3020ML-21	415.00	18.59	35.29	30.00	1.00	30.00	18.59	35.29	0.85
MC-3020ML-02 A	Outgoing Feeder for NON UPS Panel - QD-3020ML-22	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-3020ML-02 A	HVAC Load	415.00	6.20	11.76	10.00	1.00	10.00	6.20	11.76	0.85
MC-3020ML-02 A	Lubrication System at Tail-2 end in TR-1010ML-10	415.00	0.09	0.18	0.15	1.00	0.15	0.09	0.18	0.85
TOTAL			181.06	343.71	322.65		1,036.15	300.36	570.18	0.94
QD-3020ML-02 A										

PORT SUBSTATION - SE-3020ML-02										
PANEL TAG	DESCRIPTION	EQUIRED POWER / FEATURES OF PROJEC				FD	RATING POWER			FP
		Vn(V)	kVAr	KVA	kW		kW	kVAr	kVA	
QD-3020ML-02 A	Import Ship Grab Unloader	6,600.00	1,898.90	3,604.71	3,064.00		3,970.00	2,460.39	4,670.59	0.85
QD-3020ML-02 A	Import Ship Grab Unloader	6,600.00	1,898.90	3,604.71	3,064.00		3,970.00	2,460.39	4,670.59	0.85
TOTAL			3,797.79	7,209.41	6,128.00		7,940.00	4,920.77	9,341.18	0.85
QD-3020ML-02 B										
QD-3020ML-02 B	Import Ship Grab Unloader	6,600.00	1,898.90	3,604.71	3,064.00		3,970.00	2,460.39	4,670.59	0.85
QD-3020ML-02 B	Distribution Transformer - TF-3020ML-23	6,600.00	181.06	343.71	322.65		1,036.15	300.36	570.18	0.85
TOTAL			2,079.95	3,948.41	3,386.65		5,006.15	2,760.74	5,240.76	0.86

3.5 Load study and safety factor

From the data collection and the total load study, assuming the main inductive load Power Factor is 0.85 and the load safety factor is 0.77. To consideration of the power system reliability, the load arrangement at upstream will maximize the balance and the total load is able cater by each other side.

3.6 Evaluate and analyse the results

Following is the summary of loading of Power and Distribution transformers of different substations.

Distribution Transformer 6.6kV / 415V:

EQUIPMENT TAG	NOMINAL POWER (KVA)	DEMANDED LOAD (KVA)	LF (%)
TF-1020ML-23	2000	768.11	38.41
TF-1020ML-24	2000	498.47	24.92
TF-1020ML-33	1600	986.12	61.63
TF-1020ML-34	1600	323.00	20.19
TF-1040ML-13	2000	643.66	32.18
TF-1040ML-14	2000	530.56	26.53
TF-1040ML-15	2000	540.73	27.04
TF-1040ML-16	2000	400.53	20.03
TF-3020ML-13	1600	450.94	28.18
TF-3020ML-14	1600	197.82	12.36
TF-3020ML-15	1600	358.18	22.39
TF-3020ML-16	1600	342.06	21.38
TF-3020ML-23	1000	343.71	34.37

Power Transformer 275/33kV & 33/6.6kV:

EQUIPMENT TAG	NOMINAL POWER (MVA)	DEMANDED LOAD (MVA)	LF (%)	SECONDARY SUBSTATION TAG	TOTAL LOAD MW
	ONAN ONAF				
TF-1020ML-21	20/25	7.93	39.63	SE-1020ML-02	10.39
TF-1020ML-22	20/25	7.16	35.79		11.17
TF-1020ML-31	6.3 / 8	1.83	28.98	SE-1020ML-03	1.95
TF-1020ML-32	6.3 / 8	1.58	25.01		1.88
TF-1040ML-11	16/20	5.09	40.74	SE-1040ML-01	7.47
TF-1040ML-12	16/20	4.46	35.65		7.05
TF-3020ML-11	10/12	4.13	41.31	SE-3020ML-01	5.50
TF-3020ML-12	10/12	3.72	37.19		4.10
TF-3020ML-21	12.5/16	7.21	57.68	SE-3020ML-02	7.94
TF-3020ML-22	12.5/16	3.95	31.59		5.01
TF-0050ML-01	40/50	26.19	65.47	SE-0050ML-01	33.26
TF-0050ML-02	40/50	20.86	52.14		29.20
TOTAL	40/50	47.04	94.09		75.27

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the power system in substations is apply in the drawing with Autocad software. The design and protection system is applied into the single line diagram drawing. This chapter covers:

1) Power distribution system
2) 275/34.5kV Power Transformer
3) 6.6/0.433kV Distribution Transformer
4) Various types of HV circuit breaker
5) Various types of protection relay
6) Protection relay function application

4.2 Main Substation

Two 275kV power supply intake from TNB transmission line, two incomer receiver of 275kV at main substation. Two 40/50MVA 275/34.5kV power transformer to step down the voltage to 33kV. This design includes of the overall power factor correction system located at 33kV busbar as well.

33kV power distribution to each secondary substation by two feeder faron 33kV bus A and B each. A bustie apply at between of 33kV bus A and B to enable to make load transformer during maintenance, breakdown or shutdown.

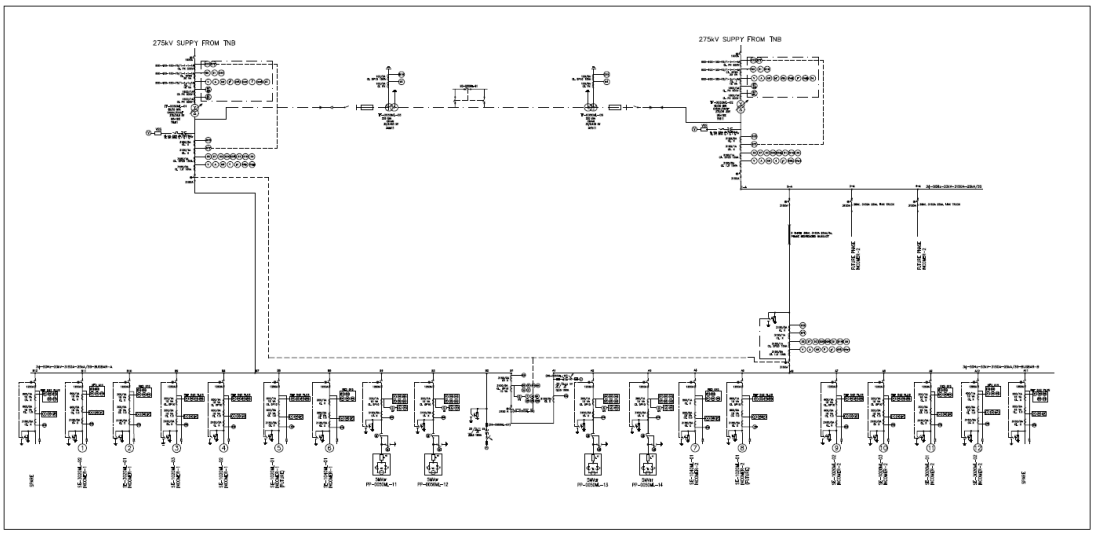


Figure 4.1: SLD of Main Substation Power Distribution by Autocad

4.3 Secondary Substations

This power system consists of total 5 numbers if secondary substation which is located near to the load. All of them also receives two incomer HV 33kV from main substation, then step down the voltage to 6.6kV which is suit to the major load equipment.

In the secondary substation consists of individual HV equipment feeder and distribution transformer to step down the voltage to 415V for LV application.

4.3.1 Secondary Substation 01

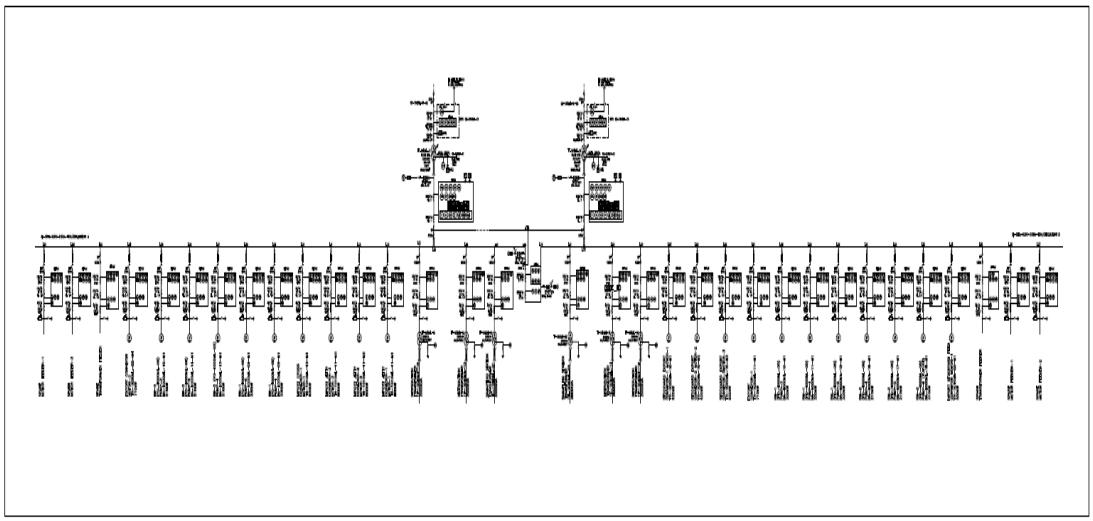


Figure 4.2: SLD of Secondary Substation 01 Power Distribution by Autocad

4.3.2 Secondary Substation 02

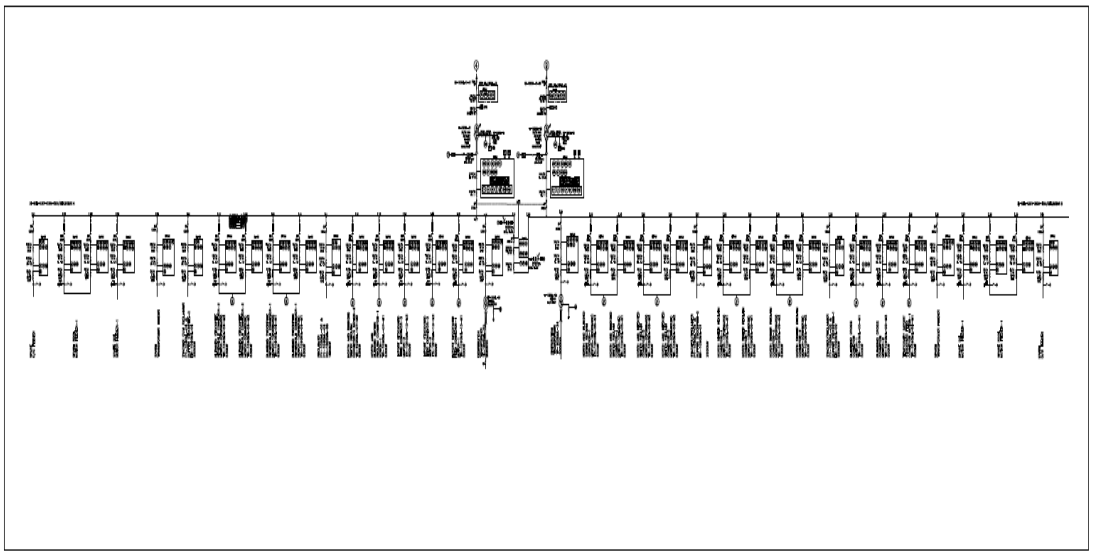


Figure 4.3: SLD of Secondary Substation 02 Power Distribution by Autocad

4.3.3 Secondary Substation 03

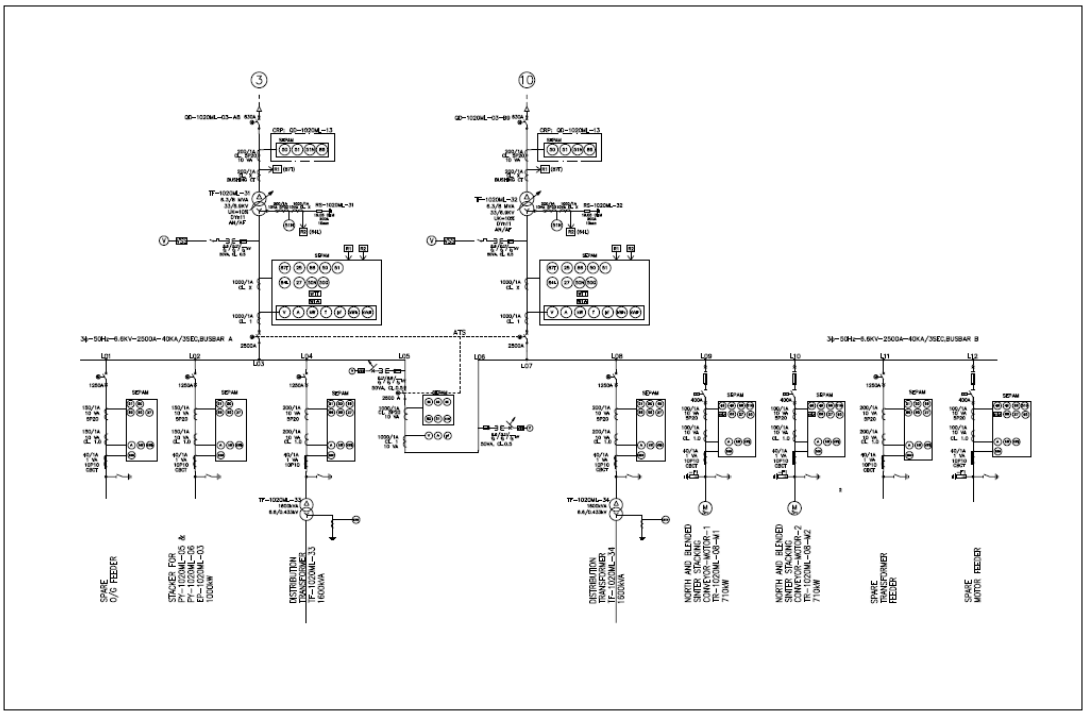


Figure 4.4: SLD of Secondary Substation 03 Power Distribution by Autocad

4.3.4 Secondary Substation 301

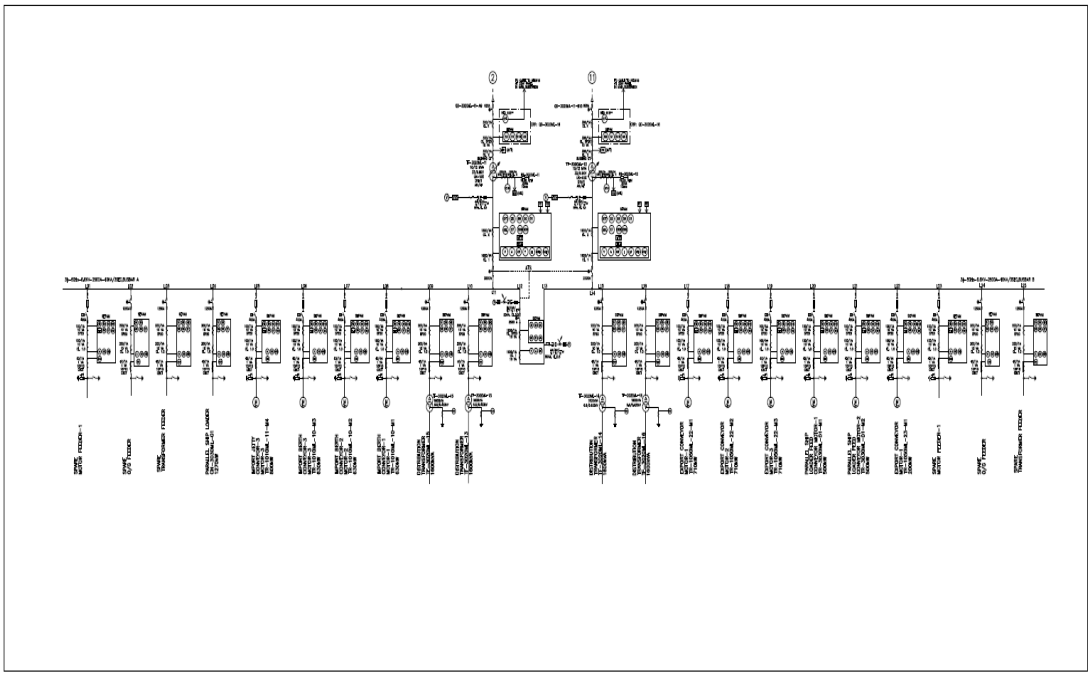


Figure 4.4: SLD of Secondary Substation 301 Power Distribution by Autocad

4.3.5 Secondary Substation 302

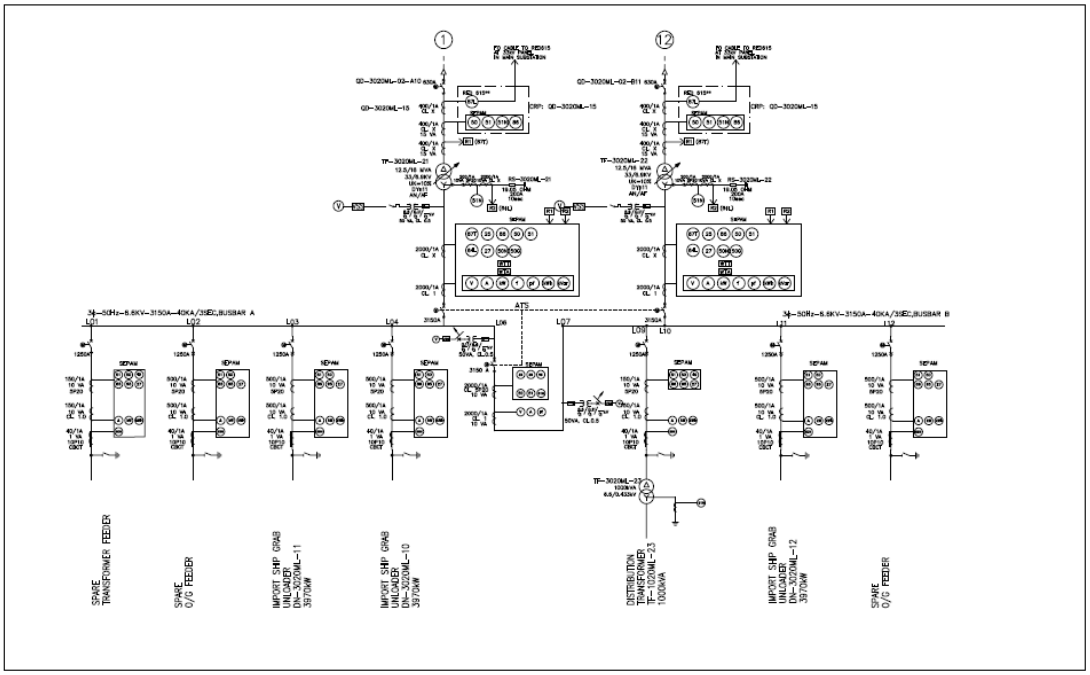


Figure 4.5: SLD of Secondary Substation 302 Power Distribution by Autocad

4.4 Conclusion

Main substation will be fed by two Power transformers with independent operation. In the event of failure of one power transformer, the other is capable of feeding the loads of both the transformers.

Each secondary substation will be fed by two distribution transformers with independent operation. It was not planned operation of the two transformers in parallel. In the event of failure of one distribution transformer, the other is capable of supplying the load of both the transformers.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

After acquiring all the results and undergo analysis, the conclusion is drawn. This chapter covers:

1) Conclusion
2) Recommendations

5.2 Conclusion

As a conclusion, to design of a new electrical substation require to consider the main factor that includes the load increase, power system stability and reliability, operation designed capacity and determine the future expansion possibilities.

The material and equipment selection and engineering design are critical which will direct impact to the overall substation performance and reliability. Therefore, this step is a must and required adequate time and preparation in order to achieve the target.

5.3 Recommendations

This research focused on the engineering study and identifying the types, effect, prevention and protection method for electrical substation. Engineering requirement some standards is used to verify the feasibility of the applicable method. Therefore, in real life, need to refer and compare with existing substation to get the actual data for the suitable requirement and location to be applied.

Thus, more advanced software can be utilized to obtain the more accurate results to verify the feasibility of the equipment and protection method. This will provide the most accurate results, which may prove or counter check on the planning to be wrong.

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APPENDICES

APPENDIX A: IEC 60076-1

INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

Part 1: General

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

This International Standard has been prepared by IEC by technical committee 14: Power transformers.

This consolidated version of IEC 60076-1 is based on the second edition (1993) [documents 14(CO)75 and 14(CO)77], its amendment 1 (1999) [documents 14/344/FDIS and 14/345/RVD] and its corrigendum of June 1997.

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

IEC 60076 consists of the following parts, under the general title: *Power transformers*.

Part 1:1993, General.

Part 2:1993, Temperature rise.

Part 3:1980, Insulation levels and dielectric tests.

Part 5:1976, Ability to withstand short circuit.

Annexes A and E form an integral part of this standard.

Annexes B, C, D and F are for information only.

POWER TRANSFORMERS –

Part 1: General

1 Scope and service conditions

1.1 Scope

This part of International Standard IEC 60076 applies to three-phase and single-phase power transformers (including auto-transformers) with the exception of certain categories of small and special transformers such as:

– single-phase transformers with rated power less than 1 kVA and three-phase transformers less than 5 kVA;
– instrument transformers;
– transformers for static convertors;
– traction transformers mounted on rolling stock;
– starting transformers;
– testing transformers;
– welding transformers.

When IEC standards do not exist for such categories of transformers, this part of IEC 60076 may still be applicable either as a whole or in part.

For those categories of power transformers and reactors which have their own IEC standards, this part is applicable only to the extent in which it is specifically called up by cross-reference in the other standard.*

At several places in this part it is specified or recommended that an 'agreement' shall be reached concerning alternative or additional technical solutions or procedures. Such agreement is to be made between the manufacturer and the purchaser. The matters should preferably be raised at an early stage and the agreements included in the contract specification.

1.2 Service conditions

1.2.1 Normal service conditions

This part of IEC 60076 gives detailed requirements for transformers for use under the following conditions:

a) Altitude

A height above sea-level not exceeding 1 000 m (3 300 ft).

b) Temperature of ambient air and cooling medium

A temperature of ambient air not below –25 °C and not above +40 °C. For water-cooled transformers, a temperature of cooling water at the inlet not exceeding +25 °C.

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* Such standards exist for dry-type transformers (IEC 60726), for reactors in general (IEC 60289), for traction transformers and reactors (IEC 60310), and are under preparation for static convertor transformers.

Further limitations, with regard to cooling are given for:

– oil-immersed transformers in IEC 60076-2;

– dry-type transformers in IEC 60726.

c) Wave shape of supply voltage

A supply voltage of which the wave shape is approximately sinusoidal.

NOTE This requirement is normally not critical in public supply systems but may have to be considered in installations with considerable convertor loading. In such cases there is a conventional rule that the deformation shall neither exceed 5 % total harmonic content nor 1 % even harmonic content. Also note the importance of current harmonics for load loss and temperature rise.

d) Symmetry of three-phase supply voltage

For three-phase transformers, a set of three-phase supply voltages which are approximately symmetrical.

e) Installation environment

An environment with a pollution rate (see IEC 60137 and IEC 60815) that does not require special consideration regarding the external insulation of transformer bushings or of the transformer itself.

An environment not exposed to seismic disturbance which would otherwise require special consideration in the design. (This is assumed to be the case when the ground acceleration level a_g is below 2 m/s.)*

1.2.2 Provision for unusual service conditions

Any unusual service conditions which may lead to special consideration in the design of a transformer shall be stated in the enquiry and the order. These may be factors such as high altitude, extreme high or low temperature, tropical humidity, seismic activity, severe contamination, unusual voltage or load current wave shapes and intermittent loading. They may also concern conditions for shipment, storage and installation, such as weight or space limitations (see annex A).

Supplementary rules for rating and testing are given in other publications for:

– Temperature rise and cooling in high ambient temperature or at high altitude: IEC 60076-2 for oil-immersed transformers, and IEC 60726 for dry-type transformers.

– External insulation at high altitude: IEC 60076-3 and IEC 60076-3-1 for oil-immersed transformers, and IEC 60726 for dry-type transformers.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60076. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60076 are encouraged to investigate the possibility of applying the most recent edition of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(421):1990, *International Electrotechnical Vocabulary – Chapter 421: Power transformers and reactors*

IEC 60068-3-3:1991, *Environmental testing – Part 3: Guidance. Seismic test methods for equipments*

IEC 60076-2:1993, *Power transformers – Part 2: Temperature rise*

IEC 60076-3:1980, *Power transformers – Part 3: Insulation levels and dielectric tests*

IEC 60076-3-1:1987, *Power transformers – Part 3: Insulation levels and dielectric tests. External clearances in air*

IEC 60076-5:1976, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60137:1984, *Bushings for alternating voltages above 1 000 V*

IEC 60354:1991, *Loading guide for oil-immersed power transformers*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60551:1987, *Determination of transformer and reactor sound levels*

IEC 60606:1978, *Application guide for power transformers*

IEC 60726:1982, *Dry-type power transformers*

IEC 60815:1986, *Guide for the selection of insulators in respect of polluted conditions*

IEC 60905:1987, *Loading guide for dry-type power transformers*

ISO 3:1973, *Preferred numbers – Series of preferred numbers*

ISO 9001:1987, *Quality systems – Model for quality assurance in design/development, production, installation and servicing*

3 Definitions

For the purpose of this part of IEC 60076, the following definitions shall apply. Other terms use the meanings ascribed to them in the International Electrotechnical Vocabulary (IEV).

3.1 General

3.1.1
power transformer
a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power [IEV 421-01-01, modified]

APPENDIX B: TNB ELECTRICITY SUPPLY APPLICATION HANDBOOK

TENAGA NASIONAL BERHAD

Supply Application

1.0 TENAGA NASIONAL BERHAD ELECTRICITY SYSTEM

1.1 Introduction

The Tenaga Nasional Berhad (TNB), a public listed company registered under Companies Act 1965, is charged with the following responsibilities:

- To generate, transmit, distribute and sell energy to consumer throughout Peninsular Malaysia.

- To plan, install, operate and maintain electricity installation for the generation, transmission and distribution of electricity.

To achieve the above objectives, the company owns and operate power plants and the National Grid and installed for this purpose are consumer service centres, call management centres, substations and administrative offices throughout Peninsular Malaysia. TNB's core activities are in generation, transmission and distribution of electricity which are being handled by 3 Divisions :

- Generation Division
- Transmission Division
- Distribution Division

1.2 Distribution Division

Distribution Division supplies electricity in strict accordance with the provisions of the TNB Licence, Electricity Supply Act 1990, the Licensee Supply Regulations 1990 and the Electricity Regulations 1994 (and all amendments thereto). Distribution Division is divided into 2 main regional operational areas where operational efficiency is further enhanced through the creation of 2 main regional areas, headed by the respective Senior General Managers which covers :

Area	States
Region 1	Selangor, Wilayah Persekutuan, Putrajaya/Cyberjaya, Negeri Sembilan, Melaka and Johor
Region 2	Perlis, Kedah, Pulau Pinang, Perak, Pahang, Terengganu and Kelantan

The States are comprised of main jurisdiction areas under the care of Area Managers. Some areas have smaller jurisdiction areas and are managed by Branch Managers and Small Branch Managers. All district offices (areas and branches) have one or more Pusat Khidmat Pelanggan under their jurisdiction.

Pusat Khidmat Pelanggan provides functions pertaining to Application for Electricity Supply, Billing & Collection, Upgrading of Services and other consumer related activities.

The technical aspects of the operations of the areas include planning, designing, construction, and system operation and maintenance that delivers electricity supply to the Consumer.

The support departments at the Distribution headquarters include Finance, Asset Management, Human Resource Management, Materials Management, Metering Services, Revenue Maximisation, Strategic Management and Organisational Development and Consumer Services and Marketing.

1.3 Pusat Khidmat Pelanggan

Pusat Khidmat Pelanggan is TNB's Service and Advisory Centre. It provides TNB's consumers with Consumer Service. There are numerous Pusat Khidmat Pelanggan centres throughout Peninsular Malaysia at your service. For complete information on Pusat Khidmat Pelanggan centres throughout Peninsular Malaysia can be obtain via TNB website (www.tnb.com.my). This list is subject to changes and may be reviewed from time to time.

Pusat Khidmat Pelanggan is where TNB as a caring and friendly utility touches base with its consumers. At Pusat Khidmat Pelanggan, you may experience directly our value-added services which we have specially made available to you, our valued consumers. Services provided at Pusat Khidmat Pelanggan include:

a) One stop payment counter for all electricity and other utility bills.

- Payment can be made by cash, cheque, credit card or debit card.
- You can also make arrangements to have your electricity bills paid through banks or ATM cards.
- TNB, being a caring company, shall facilitate and make special arrangement on case to case basis for the payment of bills for elderly and handicapped consumers.

b) Electricity supply application

- At Pusat Khidmat Pelanggan, we offer you advice on all matters pertaining to your electricity supply application.
- For wiring purposes in your premise, you may choose from a varied selection of contractors from our directory of registered electrical contractors.

c) Inquiries pertaining to billing and other related services.

- Pusat Khidmat Pelanggan shall provide clarification on any billing inquiries and it related services to consumers.
- Appointments can be made to have the meter read in case the premises are locked during working hours.
- Testing of meters can be carried out if consumers suspect that the meter is faulty. Consumers are required to submit written application for meter to be tested. A fee will be charge for such testing.

1.4 Electrical System

1.4.1 Voltages

The transmission voltage networks are 500kV, 275kV and 132kV, whilst the distribution voltages are 33kV, 11kV and 400/230 Volts. However, in the case of certain parts of Johor & Perak the distribution voltages may include 22kV and 6.6kV.

1.4.2 Supply Frequency

The supply frequency is 50Hz ± 1%.

1.4.3 Power Factor

Consumers are required to maintain their load power factor to a minimum of 0.85 for voltage level less than 132kV and 0.90 for voltage level 132kV and above.

1.4.4 Earthing System

Medium Voltage (6.6 kV up to 33kV) and High Voltage (66kV and above)

- 3 phase configuration
- solidly earthed or impedance earthed
- overhead lines and underground cable are used extensively for medium and high voltage

Low Voltage 400/230V

- 3 phase 4 wire system
- neutral point solidly earthed mixture of overhead lines, underground cables and aerial insulated cables

1.4.5 Short Circuit Ratings

All equipment proposed to be installed and connected to TNB supply must comply with the following short circuit ratings:

	System	Short circuit rating
i.	500kV	50 kA, 1s
ii.	275kV	40 kA, 3s (50kA , 1s for substation adjacent to Power Station, or within 500kV substation)
iii.	132kV	31.5 kA, 3s (40kA, 3s for substation adjacent to Power Station, or within 500/275kV substation)
iv.	33kV	25 kA, 3s
v.	22kV	20 kA, 3s
vi.	11kV	20 kA, 3s
vii.	6.6kV	20 kA, 3s
viii.	400/230 V	31.5 kA, 3s

TENAGA NASIONAL BERHAD

9 Supply from existing supply sy
4 Submission of applications to t
the Board of Engineers Malays

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actice in Peninsular Malaysia are governed by the

1.4.6 Act, Regulation and Customer Charter

- Act 447
1990

The electricity supply and installation o
following :-

NB website (www.tnb.com.my)

1	Electricity Supply Act 199
2	Licensee Supply Regulations
3	Electricity Regulations 199
4	Customer Charter - refer to T

clared voltages :-

1.4.7 Supply Voltage Options

V, 6.6 kV* and 400/230V. Generally, supplies to
phase 2-wire or three phase 4-wire while for non
Supply may be provided at any of the d
ee phase 3-wire or three phase 4-wire. However, the
ion the individual applicant's load requirements (refer
275 kV, 132kV, 33kV, 22 kV*
aximum Demand levels and supply scheme) :-
domestic premises are given at sing
domestic premises the supply are at v
an the above classifications is not provided by TNB.
actual supply voltage provided depends
n transformation arrangements where necessary.
to Connection Guideline clause 3.1 – M

It should be noted that voltages other
However, consumers can make their ow

* System for certain parts of Johor and Perak only.

1.5 Types of Supply

pply requirement can be classified into two (2) types

1.5.1 Supply Application Based on Load

All new applications and upgrade of s
of supply applications.

To 100 KVA

ins or establishment of new supply system (subject to

1) Supply Application For Load Up
TNB by Electrical Contractor registered with the

9 Supply from existing supply sy
system capability)
4 Submission of applications
Energy Commission

ceeding 100 KVA

ins or establishment of new supply system
NB by Electrical Consultant Engineer registered with

2) Supply Application For Load Exa

Note: Establishment of new supply system may require the construction of a new sub station/substations and its related ancillaries.

Supply Application for Streetlight can be categorize as follows based on TNB's prevailing policies and guidelines:

- Application made by the local authority/government department
- Application by developer
- Application by individual

For any supply involving co-generating, a separate licence need to be obtained from the relevant governing authority.

1.5.2 Consumers Standby Supply

Standby generator(s) may be used by the applicant at their premises, subject to compliance with the relevant laws. The generators shall remain a separate system from TNB distribution system and the applicant shall declare to TNB on the safe installation of the generator(s).

This may be used in place of TNB's supply source through a suitable, approved changeover facility. The Energy Commission and other relevant authorities govern the usage of generators and standby supply.

1.5.3 Alternative Source of Supply

A large consumer may require an alternative source of supply. TNB will provide such alternative supply at an additional cost fully borne by the consumer.

1.5.4 Provision Of Temporary Supply

Application for a Temporary Supply means the electricity supply required is for a non-permanent installation intended for a limited time. When a consumer is requesting for a permanent supply, but a planned supply source is not available at that point of time and temporary connection from another source of supply is constructed, the case is not considered as a Temporary Supply.

Examples of Temporary Supply are, but not limited to, festivals or exhibition sites, circuses and construction sites (inclusive of the worker's quarters).

Tariff for Temporary Supply shall be determined based on the usage of the Temporary Supply premise. For example, Tariff A is for the worker's quarters on construction site, Tariff B, C1 or C2 for construction site, festivals, exhibitions or circuses. A surcharge of 33% of the total bill, shall be charged monthly through out the Temporary Supply term.

The consumer is responsible to construct the respective infrastructure and TNB shall charge the cost of connection and termination of cables. However in isolated cases where the consumer does not have the ability and resources to construct the infrastructure, TNB may provide such service and hence the Connection Charge shall be revised accordingly to include the overall cost of constructing and dismantling. The Connection Charge monies however shall be refunded based on the net book value amount of the returned installations after the Temporary Supply has been dismantled.

1.5.5 Single Tenant Premises

If the supply is for a single tenant only then the entire supply will be metered at the applicant's incoming switchboard. The consumption will be charged at the appropriate tariff rates.

1.5.6 Multi Tenanted Premises

(a) Commercial Premises (excluding shoplots)

Multi tenanted commercial premises except shop lots shall be given bulk supply. It shall be the responsibility of the owner / developer of the multi tenanted commercial premises to obtain independent distribution license from Energy Commission.

(b) Domestic Premises

Multi tenanted domestic premises, the owner / developer / Joint Management Committee shall have the option of taking supply via bulk supply or individual supply to landlord and tenants. If on bulk supply it shall be the responsibility of the owner / developer of the multi tenanted commercial premises to obtain independent distribution license from Energy Commission.

(c) Shop Lots

Shop lots shall be given individual supply.

The design, installation and operating of such electrical systems shall comply with requirements of all the relevant authorities including the Energy Commission's and TNB's.

1.5.7 Turnkey Projects

In certain cases, the applicant may apply to undertake the planning and installation of the electrical systems (including overhead lines, switchgears, cables, according to TNB's specifications and requirements) with the assistance of Electrical Consultant Engineer(s) and Electrical Contractor(s). Under the 'turnkey' concept the applicant will then hand over the entire electrical system to TNB. TNB shall have the absolute discretion in deciding whether the turnkey project to be carried out by the applicant.

1.0 PLANNING AND DESIGN CRITERIA

TNB refers to Grid Code and Distribution Code in developing the connection system or supply infrastructure needs which are included in this section. It is available at the Energy Commission's office.

1.1 STEADY-STATE SUPPLY VOLTAGE PERFORMANCE

(a) Steady-State Voltage Fluctuation under Normal Condition

Under normal condition, when all circuit elements are in service, the distribution network including the points before the consumer metering must be planned to be maintained as is **Table 1-1** below:-

Table 1-1: Steady -state voltage level fluctuation limits under normal conditions

Voltage Level	% Variation
400V and 230V	-6% & +10%
6.6kV, 11kV, 22kV, 33kV	+/- 5%
132kV dan 275kV	-5% & +10%
500kV	-5% & +5%

(b) Steady-State Voltage Fluctuation under Contingency Condition

Under contingency condition, when one or more circuit elements are on outage, the power frequency steady-state voltage at all points in the distributor's distribution system including the points before the consumer metering must be planned to be maintained as follows:

Table 1-2: Steady-State Voltage Fluctuation Limits under Contingency Condition

Voltage level	% variation
400V and 230V	+/- 10%
6.6kV, 11kV, 22kV,33kV	+10 & -10%
132kV & 275kV	+/- 10%
500kV	-10% & +5%

1.2 SUPPLY SECURITY LEVEL

Supply security of a distribution system network defines the availability of supply to consumers following the occurrence of supply interruption. Systems and necessary network management infrastructure may be designed to meet any of the standardized security level definitions currently adopted by TNB as indicated in **Table 1-3**.

1.2.1 Adopted Security Level Definitions For TNB Distribution System

Table 1-3: Security Levels for Distribution Network

Security Level	Average Restoration Period
Level 1	Less than 5 seconds
Level 2	Less than 15 minutes
Level 3	Less than 4 hours
Level 4	Less than 24 hours

1.2.2 Supply Security Level to Consumers

In accordance to Guarateed Service Level (GSL), for supplies to consumers at voltage levels of 11kV, 22kV and 33kV, large part of the network are generally designed to facilitate an average supply restoration of less than 4 hours (Security Level 3). In some instances where alternative feedback source is not available consumers at voltage levels of 11kV, 22kV and 33kV may have supply restoration time of 12 hours.

For supplies at 230V and 400V, the restoration period may vary beyond 4 hours (Security Level 4) depending on the type of network fault.

Time to restore electricity supply following major incident on grid or transmission system except due to natural disaster, and causing partial blackout, restoration time shall be within 8 hours and for total blackout situation it shall be within 18 hours.

1.2.3 Request for Higher Supply Security Level

However, TNB can design the supply scheme to meet higher security level requirement of individual consumer or group of consumers. All additional costs involved in providing the higher security level shall be borne fully by the consumer.

1.3 POWER QUALITY

1.3.1 Power Quality Requirement

1.3.1.1 TNB supplies electricity by the alternating current (ac) system with system frequency of 50 Hz with specified regulated voltage levels. The ranges of voltage regulations available are explained in section 2.1 of this guideline.

1.3.1.2 TNB shall supply electricity to the main incoming terminals or point of common couplings (PCC) between the consumers and TNB with voltage sag performance as indicated in **standards IEC 61000-2-4** and **IEC/TR 61000-2-8.**

1.3.1.4 TNB does not guarantee that the electricity supply will not be interrupted or its frequency and voltage will not fluctuate outside the ranges stated in section 2.1. The reliability of the supply system is evaluated by the Supply Average Interruption Duration Index (SAIDI). And the duration of supply restoration will be dependent upon the determined security levels as stated in section 2.2.

1.3.1.5

1.3.2 The supply voltage and frequency may fluctuate for short duration outside the voltage ranges stated in section 2.1 due to the following:-

1.3.2.1 a) When TNB takes the necessary action for safety reasons,
b) When TNB carries out critical maintenance and repairs on the network components,
c) When matters outside the control of TNB i.e. external influences, are the causes of the supply problem; and

1.3.2.2 d) Other circumstances that cause supply to be interrupted or cause voltage and frequency to fluctuate.

The consumer shall ensure that all equipment to be connected to TNB supply system is compatible with the frequency and voltage to be supplied.

Requirements of Consumer's Equipment

TNB specifies requirement that the consumer's must comply with in order to limit the impact of the potential short duration voltage and frequency fluctuations.

The requirements are:-

Table 1-4: TNB Power Quality Requirements

Type Of Disturbance	Indices	Acceptable permissible values at point of common coupling (PCC)	Reference Document
Voltage Step Change	ΔV %	1% - Frequent starting/switching and/or disconnection of load.	UK's Engineering Recommendation P28
		3 % - Infrequent single starting/ switching or disconnection of Load – once in two hours or more hours.	
		6 % - Starting/switching once or twice a year.	
Voltage Fluctuation and Flicker	Absolute Short Term Flicker Severity (P_{st})	1.0 (at 132kV and below)	UK's Engineering Recommendation P28
		0.8 (Above 132kV)	
	Absolute Long Term Flicker Severity (P_{lt})	0.8 (at 132kV and below)	
		0.6 (Above 132kV)	
Harmonic Distortion[2]	Total Harmonic Distortion Voltage (THDV) %	5 % at ≤ 400 Volt	Engineering Recommendation ER G5/4
		4 % at 11kV to 22kV	
		3% at 33kV	
		3% at 132kV	
Voltage Unbalance	Negative Phase Sequence Voltage %	2% for 1 minute	UK's Engineering Recommendation P29

1.3.1.3

1.3.2.3 It is the responsibility of the consumer to ensure that his/her voltage sensitive equipment is able to function continuously through unanticipated voltage sags, caused when the system is subject to external interference such as lightning, 3rd party cable damage, other consumer's equipment fault, TNB equipment fault etc.

1.3.2.4 The consumer must select modern equipment that is able to ride through many of these voltage sags. Consumers should ask their equipment manufacturers whether their equipment can function properly during the voltage sag conditions illustrated in the **European Standard EN 50160**, **IEC Standard 61000-2-2** and **IEC Standard IEC 61000-2-4**. If the equipment does not have any immunity to voltage sags, then the consumer should request from the manufacturers on measures to immune the equipment against voltage sags.

1.3.2.5 The recommended standards to refer for evaluating equipments' sensitivities and identifying immunity solutions to voltage sags, short interruption and voltage variations are **IEC Standard 61000-4-11** and **IEC Standard 61000-4-34**.

1.3.2.6 Guidelines on some immunity measures against voltage sags can be referred to TNB Power Quality Guidebook at http://www.tnb.com.my/tnb/con_quality.htm

1.3.3 Declaration to Power Quality Requirement

1.3.3.1 The consumer is required to declare his equipment compatibility and compliance with regards to the required power quality standard using the **Power Quality Compliance Declaration Form** in **Appendix 8**.

1.4 SHORT-CIRCUIT LEVELS

TNB network are design and operated in order to remain within the limits of short-circuit levels as in **Item 1.4.5 of Supply Application Section.** TNB equipment design is specified to the same Short Circuit rating. Consumer's equipment at the point of interface or part of the interconnection design shall also comply with the minimum Short Circuit rating. TNB may provide indicative or prospective fault level in terms of X/R at the interface point with consumer, if so required for detailed installation design.

1.5 PROTECTION REQUIREMENTS

1.5.1 Basic Requirements

In all cases, the basic requirement is that the consumer's arrangements for protection at the connection point, including types of equipment and protection settings, shall comply with TNB practices, and be as TNB specifies during the application for supply process. This is especially critical for MV and HV consumers.

1.5.2 Specific Requirements

Consumers shall take into consideration the following specific protection practices of TNB in designing their installation:

(a) Maximum clearance times (from fault current inception to fault clearing) must be within the limits established by TNB in their short circuit rating policy.

(b) Auto-reclosing or sequential switching features may be used on TNB's distribution system. TNB will provide details on the operating sequence utilised for the supplies on the proposed installation so the consumer can plan for this in the design and protection of his facility.

(c) On some of TNB's distribution systems, certain types of faults may cause disconnection of one phase only of a three-phase supply.

(d) The following additional protection features are recommended to consumers with special requirements:

i. For voltage sensitive consumer, it is advisable to install over/under voltage protection scheme.

ii. Consumer intending to have more than 1 incoming feeder shall take into consideration supply option with Automatic Transfer Scheme (ATS). However, all technical requirements shall be discussed and agreed by both TNB and consumer.

All costs and installation work are to be borne by consumer.

1.5.3 Protection System Evaluation Process

Consumer's installation to supplied at 11kV and above shall provide the appropriate and matching protection scheme to support the desired operation of the designed supply scheme. The reliability of the equipment, protective devices and protection systems being deployed at the consumer connection or interface points may effect the reliability of TNB's supply system.

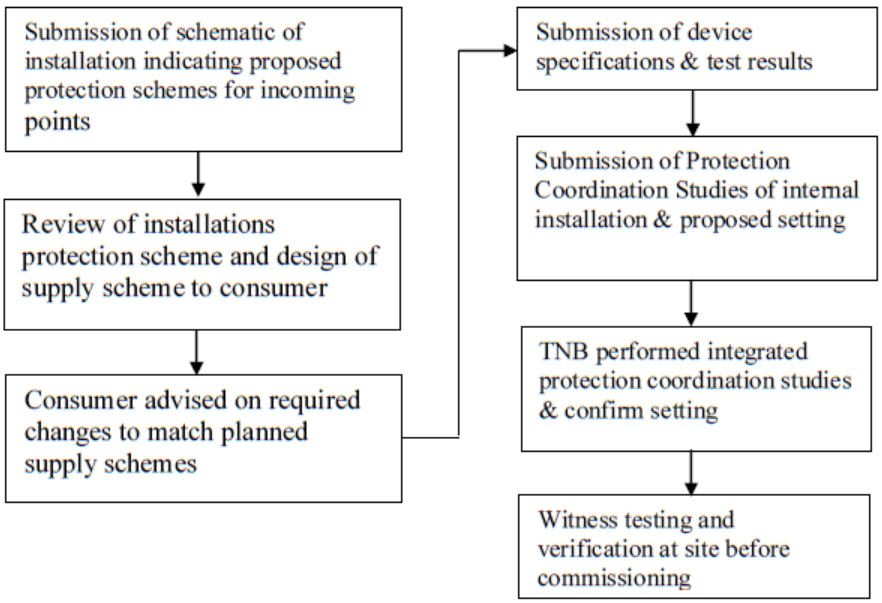

Figure 1-1 above illustrates the steps involved in the evaluation of protection schemes.

3.2 Substation Categories, Type & Design

3.2.1 Sub-Station Categories

a. Transmission Main Intake (Pencawang Masuk Utama-PMU)

Transmission Main Intake is the interconnection point of 132kV or 275kV to the distribution network. The standard voltage transformations provided at the PMU are as follows:-

- 275/132kV
- 132/33kV
- 132/11kV

b. Main Distribution Sub-Station (Pencawang Pembahagian Utama- PPU)

Main Distribution Sub-station is normally applicable to 33kV for interconnecting 33kV networks with 11kV networks. It provides capacity injection into 11kV network through a standardized transformation of 33/11kV.

c. Main Switching Station (Stesyen Suis Utama- SSU)

SSU at 33kV, 22kV and 11kV are established to serve the following function:-

1. To supply a dedicated bulk consumer (33kV, 22kV, 11kV)

2. To provide bulk capacity injection or transfer from a PMU/PPU to a load center for further localized distribution.

d. Distribution Sub-station (Pencawang Elektrik – P/E)

Distribution sub-stations are capacity injection points from 11kV, 22kV and sometimes 33kV systems to the low voltage network (400V, 230V). Typical capacity ratings are 1000kVA, 750kVA, 500kVA and 300kVA.

Note: Service cable from the TNB 33 and 11 kV substation (whereby the metering room is within TNB's control area) to the consumer substation shall be laid and maintain by TNB if the service cable is within 30 metres. For service cable above 30 meters shall be laid and maintain by the consumer.

Conventional Substation

Conventional substation designs are of indoor type (equipment housed in a permanent building) and out-door type (ground-mounted or pole-mounted). Standardized M & E design of SSU 11kV and 11/0. 4kV sub-station is available at TNB offices.

Compact Substation

Compact substation 11/0.4kV of 500kVA capacity is encouraged to be installed for new housing development (**domestic consumers** only) with the following guideline:

- Compact substation 500kVA to be placed close to the load centre.
- Compact substation 500kVA not to be placed at the corners of one development.
- Compact substation 500kVA cannot be placed close to each other to ensure efficient load distribution to the consumers
- Compact substation 500kVA is considered as 'special feature design schemes' in which special features cost is charged to the consumer as per Clause 8.0 of Statement Of Connection Charges 1994/1995.
- Appropriate distribution network design to ensure security & restoration time to consumers will not be affected:
  - ✓ If the housing development is more than 5MVA, 11kV switching station **shall** be provided by the developer within the housing development to support 11kV network connection to respective distribution substation.
  - ✓ For housing development that is < 5MVA, requirement of 11kV switching station depends on the existing network configuration & **constraints**.
  - ✓ A 11kV switching station is able to support a development of maximum 10MVA only.

Compact substation of bigger capacities has limited application and is to be strictly applied in selective situations under the following circumstances:-

- System reinforcement projects for highly built-up areas where substation land is difficult to acquire.
- Any request to use compact substation for dedicated supply to a single or limited group of low voltage consumers is subject to TNB approval in accordance to site constraints situation, and to be considered as 'special feature design schemes'.

3.2.2 Land Or Building Size Requirements For Sub-Stations

Table 3-3 : Land and building size requirements for sub-stations

Substation Category	Type	Land Size (Average Dimensions – NOT inclusive of Land Set-back Requirements)	Building Size (Average Dimensions)
Transmission Main Intake/Pencawang Masuk Utama (PMU): (a)132/33/11kV (b) 132/33/11kV (with capacitor bank)	Gas Insulated Switchgear (GIS) Without outdoor switchyard	(a) 60.0m x 80.0m (b) 140 m x 75m	Customized design to match land size building bylaws

Transmission Main Intake/Pencawang Masuk Utama (PMU): (a) 132/33/11kV (b) 132/33/11kV (with capacitor bank)	Air Insulated Switchgear (AIS) With outdoor switchyard	(a)130.m x 130.0m (b) 160 m x 150 m	Customized design to match land size building bylaws
Main Distribution Substation (PPU) (a) 33/11kV (b) 22/11kV	Indoor type	46.0m x 46.0m	Customized design to match land size building by laws (refer to Buku Panduan Piawai Baru Rekabentuk Pencawang Elektrik (Jenis Bangunan) Di Bahagian Pembahagian, TNB)
Main Switching Substation (SSU) (a) 33kV (b) 22kV(phasing out to 33kV)	Indoor	30.0m x 30.0m	Customized design to match land size building by laws (refer to Buku Panduan Piawai Baru Rekabentuk Pencawang Elektrik (Jenis Bangunan) Di Bahagian Pembahagian, TNB)
Main Switching Station (SSU) 11kV (for LPC)	Conventional – Stand alone	13.0m x 14.2m	Refer to Buku Panduan Piawai Baru Rekabentuk Pencawang Elektrik (Jenis Bangunan) Di Bahagian Pembahagian, TNB **Substation building colour shall be blended with the surrounding environment.**
Main Switching Station (SSU) 11kV (to support 11kV network connection to respective distribution substation (PE).)	Conventional – Stand alone	30.0m x 30.0m	
Distribution Substation (P/E) (a) 11/.415kV (b) 22/.415kV	Conventional – Stand alone (a)Single chamber	13.6m X 14.8m	
	(b) Double chamber	16.6 X 14.8m	
	(c) Compact substation	9.0m x 11.0m	3.0m x 2.0m

Note: Set-back requirement (subject to respective local authority's latest requirement) :

(a) JKR : On all Federal and State Routes: 20.1m (66ft) from center of road + 15.0m (50ft) for service road to substation site.

(b) Local Authority/City Council/Jabatan Perancang Bandar : 6.1m (20ft) for building line + other requirements as requisitioned by Local Authority/City Council/Jabatan Perancang Bandar.

(c) LLM (Malaysian Highway Authority): As requisitioned by LLM.

The establishment of transmission main intake also requires the allocation and acquisition of right of way or wayleaves for the transmission lines. Depending on the specific design of each PMU, the overall right of way or wayleaves requirements may be different.

Developers of large-scale development areas, depending on the estimated demand shall be required to allocate land for any or a combination of sub-stations categories, wayleaves or right of way for 132kV/275kV lines. These requirements will be specified by TNB upon submission of tentative layout plans and load estimates for the whole development area.

3.2.3 Type of fire fighting System for the Substations

Attached substation requires installation of fire fighting system by the consumer. The fire fighting system must be designed to suit the substation and meets the following criteria:

i. Shall be a complete system consists of suppression system and alarm and detection system.
ii. Must be certified and tested by certified test agencies (UL, FM, LPCB or equivalent)
iii. Must be verified by Bomba as a total flooding system.
iv. Must be designed to suit and use in sub station
v. Extinguishing Agent must be clean and residual-free and must not be corrosive on electrical and electronic equipment.
vi. Environmentally friendly as determined by Kyoto Protocol, Montreal Protocol and EPA SNAP List / EPEE
vii. Occupant safe
viii. Must be suitable for extinguishing all Classes of fire (Class A, B, C and E)
ix. Fire fighting system shall be given a warranty of 5 years from date of commissioning by installer that covers all of above and in the event of accidental discharge occurs, warrantee shall cover damages on TNB equipment.

Fire fighting system installed at TNB installation shall be approved according to standards given below :-

1. Suppression system
   a. MS ISO 14520 - Gases Fire Extinguishing System
   b. NFPA 2001 - Clean Agent Fire Extinguishing System
   c. NFPA 2010 - Aerosol System

2. Alarm and detection system
   a. ISO 7240 - Fire Detection and Alarm System
   b. NFPA 72 - Standards for Protective Signalling
   c. EN 54 - Standardization for All Component Parts of a Fire System

All maintenance work shall be conducted by the consumer or owner of building based on standard NFPA: 2001 and ISO14520.

Exhaust fan with thermostat control is required to be installed at all attached substations (SSU 11kV and P/E 11/0.4kV) as well.

3.3 Standard And Special Feature Design Schemes

Standard features of supply schemes are categorized as those typical design schemes for individual or consumer groups or classes. Typical cases are as follows:-

(i) Supply scheme supplying domestic premises is predominantly through overhead systems and conventional sub-station. A fully underground network and any application of compact sub-station shall be considered as special features.

(ii) Bulk supply consumers at 11kV and above, are normally supplied via one or two service cables depending on the MD required. All system will be designed based on Security Level 3 or Security Level 4. If higher security level is required, or another dedicated cable is required by the consumer, then it shall be considered as special features.

(iii) Consumers with MSC status or applying for MSC status requiring higher security level, the installation to meet the higher security level shall be considered as special features.

(iv) For any special features, consumer is required to bear the cost of equipment, installation and any related scope of work.

APPENDIX C: EARTHING SYSTEM STANDARDS

Earthing standards

Installation of a well designed earthing system is a fundamental requirement for all structures and electrical systems (at all voltages).

Effective earthing safeguards people from risk of electric shock, in that *'hazardous-live-parts shall not be accessible and accessible conductive parts shall not be hazardous live'*, and ensures a low impedance route to earth for currents in the electrical system, under both normal and fault conditions.

A number of national and international standards have been published which define earthing system design parameters for structures, electrical equipment and systems, including:

- BS 7430:2011 Code of practice for protective earthing of electrical installations
- BS 7354:1990 Code of practice for design of high voltage open terminal stations
- IEEE Std 80:2000 IEEE Guide for safety in AC substation grounding
- ENA TS 41-24 Guidelines for the design, installation, testing & maintenance of main earthing systems in substations

The design, specification, inspection and periodic testing of earthing systems should follow the guidance and recommendations provided by these standards.

BS 7430:2011 - Protective earthing of electrical installations

British Standard BS 7430 provides guidance on earthing of general land-based electrical installations in and around buildings in the UK, including:

- Low voltage installation earthing and equipotential bonding for general, industrial and commercial buildings, locations with increased risk, rail systems etc
- The interface between low voltage and high voltage substations
- Earthing of generators and Uninterruptible Power Supplies (UPSs) supplying low voltage installations

BS 7430 defines the elements for creating an appropriate earthing arrangement for a low voltage installation, including a main earthing terminal, protective conductors, earthing conductors and circuit protective conductors, and the use of earth electrodes to dissipate currents to the general mass of earth.

Extending the earthing arrangement through the use of equipotential bonding measures to cover exposed and conductive metal parts is further recommended to protect against step and touch voltages, and to remove risk of dangerous sparking.

Five classes of low voltage electrical installation are defined within the standard - TN-S, TN-C, TN-C-S, TT and IT.

Performance requirements for earthing these low voltage installations are defined in the IET Wiring Regulations, BS 7671:2008(+A1:2011).

The earthing arrangement should be sufficiently robust to ensure it lasts the lifetime of the installation, and be protected from mechanical damage and corrosion so that it remains capable of carrying the maximum expected current, under both normal and fault conditions.

BS 7430 therefore defines selection parameters for the earthing arrangement, e.g. the size and material for conductors, earth electrodes etc, and makes clear the need for careful consideration of site conditions (soil composition and resistivity).

Taking actual measurements at the site is important to gauge the expected effectiveness of the earthing arrangement, and guidance is provided for measuring resistance calculations for earth plates, earth rods, ring conductor and foundation earth electrodes.

Where necessary in high resistivity areas or on rocky ground, treatment of the soil through use of an earth electrode backfill is recommended to improve earth contact resistance.

Substation earthing

BS 7354, IEEE std. 80 and ENA TS 41-24 reference the requirements for earthing of substations.

The design and specification of an appropriate earthing arrangement for substations is essential to provide a low impedance path for earth, fault, and lightning currents to earth, and to protect personnel on site from potentially fatal step and touch voltages.

These standards provide guidance on (but not limited to):

- Maximum permitted step and touch voltages
- Methods for calculating earthing system design
- High voltage earth electrode selection, including type, material & size
- Switching and busbar arrangement
- Equipotential bonding
- Insulation co-ordination

Primary to these standards is limiting earth potential rise (EPR) under earth fault conditions so that step and touch potential limits are not exceeded, and earth resistance remains as low as possible.

Essentially, use of an earthing grid consisting of horizontal cross-bonded earthing conductors is recommended, with additional earth rods where the site includes low resistivity layers beneath the surface.

These earth rods mitigate seasonal variations in earth grid resistance at the grid's burial depth.

Furse power earthing solutions have been specified for many installations worldwide. For more information, or to discuss a particular requirement, please contact us.

Furse, Wilford Road, Nottingham, NG2 1EB • Tel: +44 (0)115 964 3700 • Email: enquiry@furse.com • Web: www.furse.com

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Technical reference
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- **BS 7354:** Code of practice for design of high voltage open terminal stations
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BS 7430 therefore defines selection parameters for the earthing arrangement, e.g. the size and material for conductors, earth electrodes etc, and makes clear the need for careful consideration of site conditions (soil composition and resistivity).

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ATTACHMENTS

No	Descriptions	Attachment
1.0	IEC 60076_TRANSFORMER	IEC 60076.pdf
2.0	TNB ELECTRICITY SUPPLY APPLICATION HANDBOOK	TNB ELECTRICITY SUPPLY APPLICATION
3.0	SLD- LEGEND	Legend.pdf
3.1	SLD – MAIN SUBSTATION	Main Substation.pdf
3.2	SLD – SECONDARY SUBSTATION 01	Scondary Substation 01.pdf
3.3	SLD – SECONDARY SUBSTATION 02	Secondary Substation 02.pdf
3.4	SLD – SECONDARY SUBSTATION 03	Secondary Substation 03.pdf
3.5	SLD – SECONDARY SUBSTATION 301	Secondary Substation 301.pdf
3.6	SLD – SECONDARY SUBSTATION 302	Secondary Subdtaion 302.pdf