Load Estimation and Design of Electrical Installation for Hotel in East Jerusalem

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الأهداء:

إلى من رسموا بدمائهم خارطة الوطن وطريق المستقبل وهندسوا .

إلى معلمنا وقائدنا وقدوتنا وحبيبنا وشفيعنا محمد صلى الله عليه وسلم.

بأجسادهم معاقل العزة والكرامة إلى من هم أكرم منا جميعا إلى شهداء الوطن الحبيب.

إلى الذين عشقوا الحرية التي تفوح منها رائحة الياسمين وتوارو خلف القضبان ليفسحوا لنا النور إلى أسرانا الأبطال.

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إلى الزملاء وكوادر جامعه بوليتكنك فلسطين.

Abstract

This project aims at design a complete and stable electrical installation for a 17 floors hotel in East Jerusalem, with capacity of for 324 room 4 stars hotel that contains multi different floors, garage, mezzanine, three floors of parking, restaurant, service floor, praying floor and roof floor. Where the total energy consumption for load demand hours is 11,858 KWh per day.

Due to large consumed energy and variation in energy demand, 3 transformers are installed with total capacity of 1000, 1250 and 1600 KVA. Moreover, 500 KVA backup generator and 60 KVA UPS as a backup power source for critical loads and. In addition, a 400KVA capacitor bank for power factor correction is installed. So, a continuity of service, dependability, and reliability can be achieved.

The total cost of carrying out the electrical works combining hardware installation, engineering design and implementation for this project is estimated to be $6,569,331. Where, the hotel annual demand is about 4,328,038 KWh per year; with cost of energy is $779,046.84 per year.

الملخص:

يهدف هذا المشروع إلى تصميم تركيبات كهربائية كاملة ومستقرة لفندق من 17 طابقًا في القدس الشرقية ، بسعة 324 غرفة ، فندق 4 نجوم يحتوي على عدة طوابق مختلفة ، مرآب ، ميزانين ، ثلاثة طوابق لمواقف السيارات ، مطعم ، طابق خدمة و مصلى. حيث يبلغ إجمالي استهلاك الطاقة لساعات طلب الأحمال 11,858 كيلو وات ساعة في اليوم.

نظرًا لاستهلاك الطاقة الكبيرة والتباين في الطلب على الطاقة ، تم تركيب 3 محولات بسعة إجمالية تبلغ 1000 و 1250 و 1600 كيلو فولت أمبير. علاوة على ذلك ، مولد احتياطي 500 كيلو فولت أمبير و UPS 60 كيلو فولت أمبير كمصدر طاقة احتياطي للأحمال الحرجة و بالإضافة إلى ذلك ، تم تركيب مكثف 400 كيلو فولت امبير لتصحيح معامل القدرة. لذلك ، يمكن تحقيق استمرارية الخدمة والاعتمادية والموثوقية لهذا النظام.

تقدر التكلفة الإجمالية لتنفيذ الأعمال الكهربائية التي تجمع بين تركيب الأجهزة والتصميم الهندسي والتنفيذ لهذا المشروع بمبلغ 6،569،331 دولار. حيث يبلغ الطلب السنوي للفندق حوالي 4،328،038 كيلوواط ساعة في السنة ؛ بتكلفة الطاقة 779،046.84 دولار في السنة.

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List of Abbreviations

ICE	International Electrotechnical Commission
C.S. A	Cross Sectional Area
P. F	Power Factor
CB	Circuit Breaker
DB	Distribution Board
SMDB	sub main distribution board
LV	Low Voltage
MDB	Main Distribution Board
A.C	alternative current
SLD	Single Line Diagram
ATS	Automatic Transfer Switch
BOQ	Bill Of Quantity
R	Resistance
C	Capacitance
A	Ampere
KWh	Kilo Watt Hour
KVA	Kilo Volt Ampere
kA	Kilo Ampere
ms	millisecond
$\boldsymbol{ku}$	Demand Factor
$\boldsymbol{ks}$	Diversity factor
TCC Curve	Time Current Characteristic Curve
NEMA	The National Electrical Manufacturers Association

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1

Chapter One

Introduction to the Project

1.1 Background

In this practical project, the design of power supply at East-Jerusalem supposed to hotel project is investigated. In these kinds of projects, the job is usually done in two main stages; basic design and detail design. In the basic design stage, the location and process of hotel is studied and a rough estimate of load types and demand is expected. While in the next step, different kinds of networks and supplies (based on technical and economic situation) are surveyed and the best choice is selected and basic calculations, drawings and specifications are consequently provided.

Here, it has been tried to have a comprehensive view on the basic design and the detail design. To achieve this, main parameters of an electrical system have been discussed and the methods of design of different parts presented.

1.2 Motivation

Nowadays, electrical energy consumers are considered one of the most challenging tasks around the globe. Among all of the world's electrical energy consumers, hotels which are large consumers of energy and fossil fuels to provide high quality services to guests. Thus, finding the most optimal and efficient ways to effectively use this important resource is an essential. Undoubtedly, electrical engineering does have a big influence on this kind of consumers and many measurements must be taken in order to obtain stable electricity. Thus, working academically on the above subject and achieving a positive result can be considered a breakthrough in energy economy and peoples' lives.

In addition to the above fact, study on this project assists engineers to obtain a profound knowledge in the power system of hotel building that can be counted as a good path for considering the design of power supply in similar energy way.

1.3 Objectives

- To obtain deep understanding of electrical systems in the above-mentioned project.
- To know how to design a stable power system in the different projects by using a relevant software like DiaLux and AutoCAD as example.
- To be able to analyze new power system in case of any possible problems and capability of finding the issues and solving them (trouble shooting).
- To obtain an ability of predicting the possible problems that may happen in power system.

1.4 Scope of the project

Having a stable network in this case is crucially important and power outage during operation could cost lots of money and time. So, an electrical expenditure is considered with little or no value when it comes in comparison to total above mentioned huge costs. Therefore, it is worth it spending time and energy during the design of stable networks to avoid any possible costly failure in the future.

In this project, the electrical system consists of three main transformers as main power supply with three 11kV feeders and one main voltage level of 0.40 kV have been studied. The main purpose of this project is to design a power supply with the right selection of electrical equipment. In addition, other topics such as backup generator, UPS, power factor correction, grounding, and lightning protection have been discussed in details.

1.5 Description of the Project

The supposed project is located in East-Jerusalem, in front of Al-Quds University. The project supposed to consist of high-rise building hotel, for 324 room 4 stars hotel that contains multi different floors, Garage, Mezzanine, three floors of parking, Restaurant, service floor, Praying floor, 17 floors and finally the roof. With total area 21,268 square meters. Figure (1.1) is a picture for supposed project, while Figure (1.2) illustrates the floors of the hotel building.

Figure (1. 1): Picture of the project.

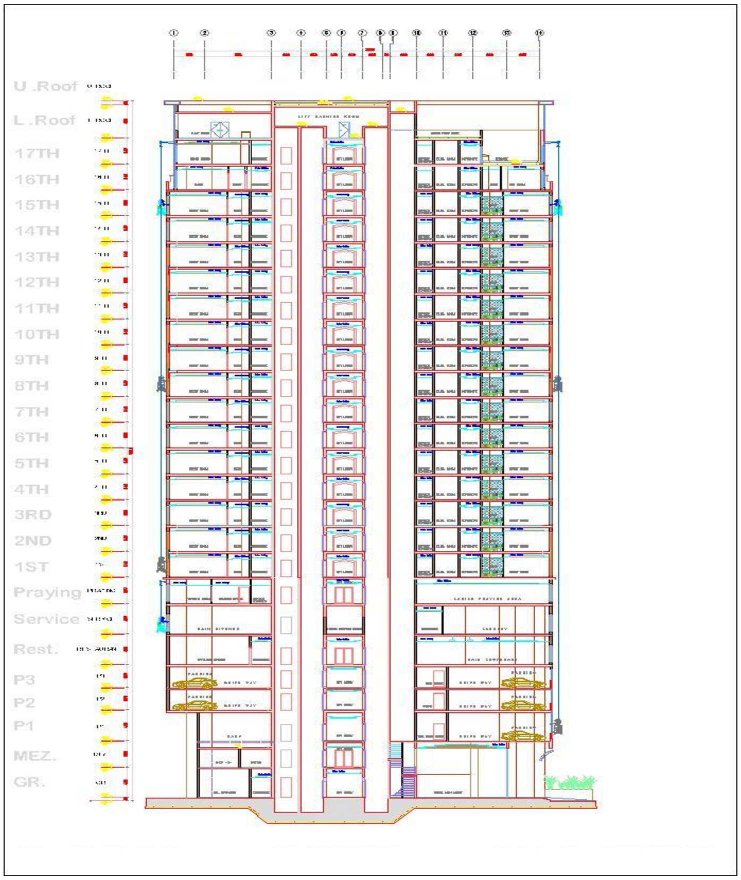

Figure (1. 2): perspective of the project.

In general, the total hotel areas divided into many places as following:

a- Public areas and supporting areas (for guest rooms and guest room's support) with total areas **14,778 sqm.**

b- Public spaces (for restaurants, Waiting Areas, Commercial, Prayer Rooms and Public Circulation) with total areas **2,197 sqm.**

c- Back of the house spaces (for Front office and Security Offices, Part of Administrative Offices, Kitchen / F&B Storage, Employee Facilities, Miscellaneous and IT / Telephone & Systems Rooms) with total areas **4,292 sqm.**

1.6 AutoCAD Project's Floors Layouts

In this section the hotel floors layouts have been shown in appendix A (page 134).

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Chapter Two

Load Estimation & Calculations

2.1 Hotel Electrical Loads Overview

The electrical design professional should determine a building's electrical load characteristics early in the preliminary design stage of the building to select the proper power distribution system and equipment having adequate power capacity with proper voltage levels, and sufficient space and ventilation to maintain proper ambient.

Listed hereafter are typical load groups and examples of classes of electrical equipment that should be considered when estimating initial and future loads.

In the next sections, an overview of the load's types in the project has been provided, as well as the value of each electrical load and whether it was estimated or presented in the information.

2.1.1. Lights Load System

Lighting is provided in industries, commercial buildings, indoor and outdoor for providing comfortable working environment.

In this project, it has many different types of lighting units used to illuminate all hotel different zones and areas. In next Light Design section, it will be explained in details how Dialux Program used in lighting design, and how the equations used to calculate the required dimensions in the distribution of lighting units on the AutoCAD program.

2.1.2. Socket Load System

Sockets are the electrical outlets, which supply the electrical equipment's & instruments by its needed power (current & voltage). Distribution of different types of sockets in a building depends mainly on the type and use of that building.

- **Sockets Design according to (IEC884 / 1987-1989):**

In hotel socket design, the next steps have been followed:

1. Sockets used to supply the electrical equipment's must be corresponding to the specifications of (IEC884 / 1987-1989).
2. Sockets should be fixed at height (35-40 cm), but in kitchen & bathrooms should be fixed at height (135 cm) that's from the final ground datum.
3. Sockets are defined at a certain value of voltage & current, there are sockets may work under different values of voltage, so when the previous two types are used in the same project, they must be of different terminals to avoid overlap of using them.
4. Sockets must have a strong mechanical & electrical contact with its suitable plug.
5. Sockets must have an earthed contact with size differs from the size of the live & neutral contacts (terminals).
6. Sockets copper terminals must be prevented from touching during the operation.

7. The socket box must contain the value of its rated voltage &current.
8. The socket box is made of rigid insulating material & also nonflammable material & has high melting temperature.
9. Sockets are either single or double outlet & either recessed or mounted on wall.
10. Each two successive sockets are placed (2.5-3m) apart according to the location where it is placed.
11. Each circuit contains maximum 8 sockets in order to use cable to the distribution board 2.5 mm2.

In hotel socket design, according to local market experiencer and constancy a 200VA for single outlet socket, 400VA for double outlet socket were estimated.

2.1.3. Elevators Load

In hotel project there are two main types of elevators with total load 73KVA, which are passenger (6 Guests Lift), primarily to serve passengers, and cargo elevators (2 Service Lift) are mainly intended for the transportation of materials, but may sometimes be required for the transportation of passengers, only any of these types will be necessary.

2.1.4. Air-Conditioning System

Air conditioning is defined as a process in which air is heated, cooled, cleaned and circulated and its moisture content is controlled.

Air conditioning consists of three main units- :

a) Indoor unit (fan coil unit), for closed areas such that shops ,hotel rooms, offices, gym...etc. In our project, the FCU loads (in VA) for each room or area have been provided to us, which it changes from 80VA to 600VA depending on the area it is used in.
b) Indoor unit (air handling unit), for open areas such as Reception, halls, coffeehouse, restaurants…etc. This hotel project has six An Air Handling Unit with loads 67.5 KVA.
c) FRESH AIR HANDLING UNIT (FAHU) This hotel project has two FAHU with loads 93 KVA.
d) Outdoor unit (chiller unit). the provided load values (KVA) of hotel chillers are 1029 KVA.
e) Calorifier Unit, there are three Calorifiers in hotel. with provided load values of 862 KVA.

2.1.5. Kitchen Equipment's

The kitchen contains several types of machines used for cooking and food preservation. It contains ovens, refrigerators, dishwashers, kitchen extract fans and other equipment. With total loud 252 KVA.

2.1.6. Motor Control Center (MCC)

A motor control center (MCC) is an assembly to control some or all electric motors in a central location. In this Hotel Project, MCC consist of six pumps, three pumps used as primary and three used as secondary and PRS. the provided MCC parts loads is 76 KVA.

2.1.7. Pumps

The pump is a device, which can be used to raise or transfer fluids. The pumps may be used in different fields not raise & transfer fluids only. Types of pumps used in our hotel projects are:

a) Water Transfer Pump with provided loud 15 KVA.
b) Primary & Secondary Pump, which their loads value was mentioned in MCC.
c) Booster Pumps**,** in hotel projects, there two types were used. As following: Emergency Booster Pump: with load of 0.30KVA, Circulation Booster Pump: with load of 2.10KVA.
d) Fire-Fight Pumps (FF Pumps) The project has one FF pump with provided load 186KVA.

2.1.8. Garbage Compactor Machine

A compactor is a machine or mechanism used to reduce the volume of materials such as waste materials or biomass through compaction. In the project the provided load is 3 KVA.

2.1.9. Hand and Hair Dryer

These two devices are used in each room toilet in the hotel project, and their loads also provided in (VA).

a) Hand Dryer: with load 200VA.
b) Hair Dryer: with load of 1200 VA.

2.1.10. Gate Barrier

A Gate barrier is a rod or pole that pivots to allow a boom to block vehicular or pedestrian access through a controlled point. The provided load of barrier is 3KV.

2.1.11. Access Door Flat

The access door system in the hotel is installed in each flat entry as known, and the provided load in VA for each unit is about 200VA.

2.1.12. Laundry Equipment

Laundry Equipment means washers, washer/extractors, dryers, chest-type ironers, steam boiler, thermal fluid heater for ironer, lint control devices, linen folders, linen carts, dry cleaning equipment (if required), laundry sinks, air compressors, laundry scales and similar items used in the laundry operation of the Project. The total hotel loads of laundry equipment is provided as 488 kVA.

2.2 Lighting Design

Lighting is provided in industries, commercial buildings, indoor and outdoor for providing comfortable working environment. The primary objective is provided that the required lighting effect for the lowest installed load i.e., highest lighting at lowest power consumption.

Lighting layout plan includes lighting, switches and switching layout. There are many kinds of rooms such as reception room, halls, offices living room, bedroom, dining room, kitchen, common area, study room and etc. This kind of rooms are not same necessary lighting lux levels. as shown in table (2.1) recommended light levels indoor in lux (lumens per sqm).

Table (2. 1): recommended light levels indoor in lux (lumens per sqm).

Activity	Illumination *(lux, lumen/m^2)*
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Working areas where visual tasks are only occasionally performed	100 - 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops, Office Landscapes	750
Normal Drawing Work, Detailed Mechanical Workshops, Operation Theatres	1,000
Detailed Drawing Work, Very Detailed Mechanical Works	1500 - 2000
Performance of visual tasks of low contrast and very small size for prolonged periods of time	2000 - 5000
Performance of very prolonged and exacting visual tasks	5000 - 10000
Performance of very special visual tasks of extremely low contrast and small size	10000 - 20000

The sources normally used in public lighting are;

1. Incandescent lamps,
2. Mixed incandescent and high-pressure mercury vapor lamps,
3. High pressure mercury vapor lamps
4. Tubular fluorescent lamps,
5. Mercury-halide lamps and
6. High-pressure sodium vapor lamps [1].

as shown in Figure (2.1) different common types of Light bulbs (Luminaires).

Figure (2. 1): Types light Bulbs.

2.2.1 Emergency lighting:

Emergency lighting is lighting that operates in the event of a power outage, often as a result of a fire or a power outage. Sudden darkness that can occur as a result of a major power outage can cause panic and physical danger to building occupants. Emergency lighting is there to turn on automatically and must give enough light for people to exit the building safely. With such an important role to play in keeping people safe, it is essential that this lighting is regularly inspected and maintained, as shown in Figure (2.2) emergency lighting.

Figure (2. 2): An example for Emergency Light.

2.2.2 Fundamentals of lighting & Definitions

- **Lamp:** Energy conversion device that converts electrical energy into light.
- **Luminous flux (Φ)**: is the amount of light produced by a light source. Unit of measurement $[Lm]$.
- **Lumen**: It is the luminous flux per unit solid angle from a source of candle power

$$\textbf{Lumen} = \textbf{Candle Power} * \textbf{Solid Angle} \tag{2. 1}$$

- **Luminous intensity (I)**: Is the amount of light that a light source emits per unit solid angle (lumen / steradian). Unit of measurement Candela [cd].

$$\mathbf{I} = \frac{\emptyset}{\boldsymbol{\omega}} \tag{2. 2}$$

Where:

I: Light intensity [cd], $\emptyset$: Light Flux $[Lm]$, ω: Spatial Angle Size [rad/sec].

- **Illuminance (E):** Is the amount of light falling per unit surface area. Unit of measurement Lux [lx].

$$\mathbf{E} = \frac{\emptyset}{\mathbf{A}} \tag{2. 3}$$

Where:

E: intensity of illumination, $\emptyset$: Light Flux $[Lm]$, A: area on which the light falls $[m^2]$.

- **Lux:** It is defined as the illumination of the inside of a sphere of radius 1 m at the center of which there is a source of (1) candlepower.
- **Luminance (L):** Known also as (brightness) denotes the intensity of light per square meter of an illuminated surface. Unit of measurement [cd/m^2].
- **Uniformity:** Is the ratio of the minimum to the maximum illuminance.
- **Luminous efficiency:** It indicates the quantity of light a particular light source emits per watt. Unit of measurement Lumen per watt [lm/w]. Symbol (η).
- **Lamp efficacy**: It is defined as the ratio of the luminous flux to the power. It is expressed in lumen per watt.
- **Room index:** Defines the relationship between height, length and width of a room.
- **Maintenance factor (M.F):** Due to accumulation of dust, dirt and smoke on lamps, they emit when they are new ones and similarity that the walls and ceiling 0.9 for indoor application& (0.7 -0.9) for outdoor application.
- **Space high ratio:** It is defined as the ratio of horizontal distance between adjacent lamps and bright of their mountains.

2.2.3 Design Procedure

First, to plan the lighting, we need to choose the body we are going to use and the type of lamp. After that, you need to focus everything the object data such as the length, width and height of the room, the level of illumination should be selected according to the standard or as per the requirements of the scheme, returns from the walls, from the ceilings and the reduction factor as per schedules. It should also be taken Taking into account the length, width and height of the body. Its color as well as the type of lamp.

Next, you need to calculate the Hall coefficient (R_K), so that you can calculate the corresponding luminous flux according to the standard. Considered (R_K) as according to the following formula:

$$\mathbf{H^* = H - H'} \qquad (2.\ 4)$$

$$\mathbf{R_K = \frac{2*W+L}{6H'}} \qquad (2.\ 5)$$

Where:

W: The width of the hall [m].

L: The length of the hall [m].

H^*: The height of the light bulb from the illuminated area [m].

H: Height of the hall[m].

H': lamp height from the illuminated area[m].

- The next step is to calculate the light flux:

$$\mathbf{A = W * L} \qquad (2.\ 6)$$

$$\mathbf{\emptyset_t = \frac{E*A*100}{K*\eta}} \qquad (2.\ 7)$$

Where:

$\emptyset_t$: the flux of light.

K: Reduction factor.

η: Reduction factor.

- After that I will calculate the number of bodies that will give us the desired light flux.

$$\mathbf{n = \frac{\emptyset_t}{\emptyset_L}} \qquad (2.\ 8)$$

Where:

n: number of lamps.

$\emptyset_L$: Light flux of the body.

- After we have calculated the number of bodies that need to be installed on the site, I will define the conditions for their installation:

S - the maximum distance between one lighting fixture and another.

$$\mathbf{S^* = 1.3 * H^*} \qquad (2.\ 9)$$

Finally, we will only have to calculate the distances between the light fixtures and the distances from the walls to the light fixtures.

$$\mathbf{W^* = \frac{W-(W_L*n_W)}{n_W}} \qquad (2.\ 10)$$

Where:

W^*: Distance between one lighting fixture and another in width.

n_W: Quantity of lighting fixtures in width.

W_L: Width of light fixture.

$$\mathbf{L^* = \frac{L-(L_L*n_L)}{n_L}} \qquad (2.\ 11)$$

Where:

l^*: Distance between one lighting fixture and another in length.

n_L: Quantity of lighting fixtures in length.

l_L: length of light fixture.

$$\mathbf{d_L = \frac{L^*}{2}} \qquad (2.\ 12)$$

Where:

d_L: Distance of light fixture to walls in length.

$$\mathbf{d_W = \frac{W^*}{2}} \qquad (2.\ 13)$$

Where:

d_W: Distance of lighting fixture to walls in width.

- Example for calculating interior lighting (calculation for staff canteen in service floor):

Table (2. 2): Account details for staff canteen in service floor:

A description	Abbreviation	Data
Room length	L	9m
Room width	W	13m
Room height	H	4m
Worktop height	H'	0.75m
Required level of illumination	E	500lux
reduction factor	K	0.8
Lighting body length	L_L	60cm
The width of the lighting body	W_L	60cm
Body lamp type	P	63W
Light flux (manufacturer data)	$\emptyset_L$	4800lm

- need to calculate:
  - Quantity and order of lighting fixtures.
  - What is the power and current consumed.

$$H^* = H - H' = 4 - 0.75 = 3.25\text{m}$$

$$R_K = \frac{2*W+L}{6H'} = \frac{2*13+9}{6*0.75} = 7.778$$

$$A = W * L = 13 * 9 = 117$$

$$\emptyset_t = \frac{E * A * 100}{K * \eta} = \frac{500 * 117 * 100}{0.8 * 69.11} = 105809.579 \text{ lm}$$

We assumed that $\eta = 69.11$

Having calculated the general luminous flux required, we calculate the number of objects that will give us this luminous flux:

$$n = \frac{\emptyset_t}{\emptyset_L} = \frac{105809.579}{4800} = 22.04$$

Selected: $n = 22$

Now calculate the energy consumed:

$$p_t = p * n = 63 * 22 = 1386 \text{ W}$$

Current consumption of data sheet page (*37*):

$$U = \frac{E_{max}}{E_{min}} = \frac{1875}{853} = 2.198$$

$$I_T = \frac{P_T}{U * \cos\theta * \sqrt{3}} = \frac{1386}{2.198 * 1 * \sqrt{3}} = 364.06A$$

The distances between the body and between the body and the wall are also taken into account.

$$W^* = \frac{W - (W_L * n_W)}{n_W} = \frac{13 - (60 * 5)}{5} = 57.4m$$

$$L^* = \frac{L - (L_L * n_L)}{n_L} = \frac{9 - (60 * 4)}{4} = 57.7m$$

$$d_L = \frac{L^*}{2} = \frac{57.7}{2} = 28.85 \text{ cm}$$

$$d_W = \frac{W^*}{2} = \frac{57.825}{2} = 28.9 \text{ cm}$$

$$S^* = 1.3 * H^* = 1.3 * 3.25 = 4.22m$$

❖ Arrange the staff canteen lighting fixtures on the service floor

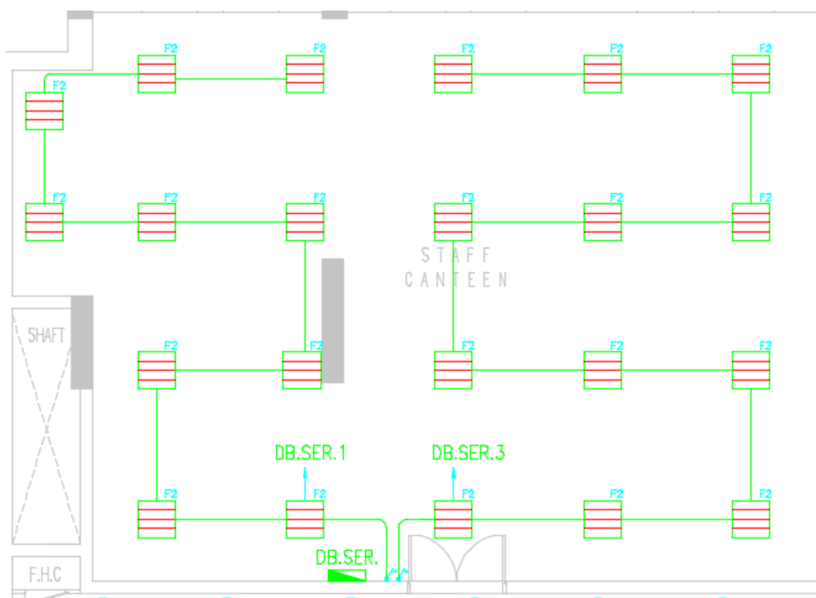
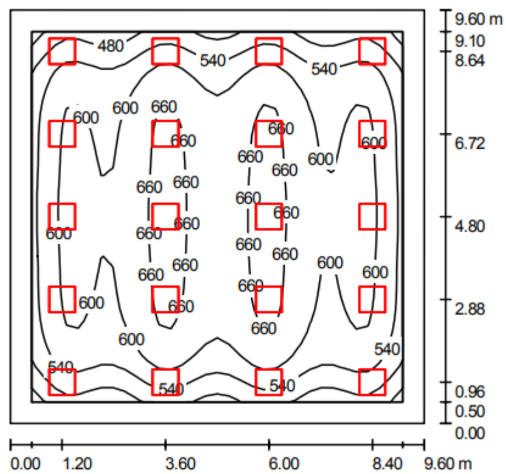


Figure (2. 3): staff canteen on the service floor

Work has been done to distribute lighting in all buildings based on the previous steps that were calculated for the staff canteen on the service floor.

❖ Data Sheet for Luminescent Body:



Height of Room: 2.800 m, Mounting Height: 2.880 m, Maintenance factor: 0.80

Values in Lux, Scale 1:124

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
Workplane	/	593	400	687	0.675
Floor	20	512	278	650	0.542
Ceiling	70	110	82	129	0.745
Walls (4)	50	240	93	409	/

Workplane:

Height:	0.750 m	**UGR**	Lengthways-	Across	to luminaire axis
Grid:	32 x 32 Points	Left Wall	12	18	
Boundary Zone:	0.500 m	Lower Wall	12	18	
		(CIE, SHR = 1.00.)			

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.404, Ceiling / Working Plane: 0.186.

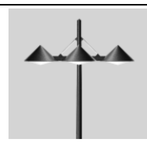
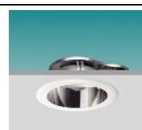
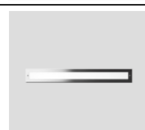
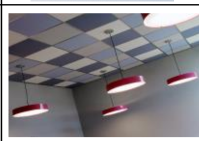
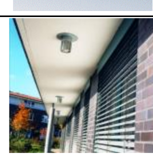
Luminaire Parts List

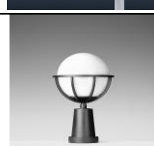
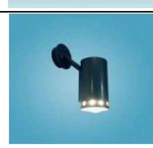
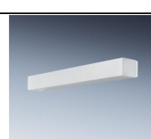
No.	Pieces	Designation (Correction Factor)	Φ [lm]	P [W]
1	20	Philips IMPALA TBS160 4xTL5-14W/840 HF C3 (1.000)	4800	63.0
		Total:	96000	1260.0

Figure (2. 4): Data Sheet for Luminescent Body.

This table (2.3) shows the lighting used in all the buildings, as it was distributed using the Deluxe program. see in Appendix B (page 135).

Table (2. 3): The lighting used:

No.	Luminaire	Item Description	Autocad Symbol	Load (W)
1		Fagerhult 300652_26 Esplanad Bollard 1xTC-TEL	B4	28
2		BEGA 8824 4 HME 80W	B5	356
3		Philips Trilogy 170 FBH170 2xPL-C/2P26W/840 CON	C1	65.6
4		Philips Europa 2 FBS120 2xPL-C/4P18W/840 HF O	C2	38
5		BEGA 2005 1 T16 24W	C3	27
7		TRILUX 1280H/1TCD13+012 80O E Downlights 128...	C5	14
8		CENTRUMVOORLICHTARCHITECTUUR 21000005 Flowerflux 60cm 3x22W - TL5C 22W 2GX13 22 W	C6	78
9		IVALO 777 HF Sol - pendant luminaire 11W FSD 2G7	C7	28
10		TRILUX 7403N/TC11 E Surface-mounted diffuser luminaires 740···	C8	42
11		CENTRUMVOORLICHTARCHITECTUUR 15015050 W-1845.0000 - A60 60W E27 60 W	C9	60

12		Clearvision CR6.414/SP Recessed 4 x 14watt lay - in luminaire	F1	56
13		Philips IMPALA TBS160 4xTL5-14W/840 HF C3	F2	63
14		TRILUX 1330F/158O E Surface-mounted diffuser luminaires 1330···	F3	55
15		TRILUX 1530F/158O E Surface-mounted diffuser luminaires 1530···	F4	110
16		Philips TMX204 2xTL-D58W/840 CON +GMX430	F5	133
17		Clearvision ADR6.240/SP Recessed 2 x 40watt A/H lluminaire	F6	80
18		BEGA 8034 1 TC-TEL 26W	FL	28
19		TRILUX 9901/80-125HME/80W IND Post-top and bracket-mounted luminaires 990···	FS	89
20		BEGA 4236 1 TC-D 18W	L2	24
21		Philips Adante FWG620 2xPL-C/2P26W/840 CON A DG	W1	65.6
22		CENTRUMVOORLICHTARCHITECTUUR 15015333 W-1547.0118 - TC-TE 18W G24 q-2 18 W	W2	19
22		TRILUX 6541/15 E Wall-mounted luminaires for mirror lighting 65···	W3	22

2.3 Hotel Load Estimation Study

In order to design an installation, the actual maximum load demand likely to be imposed on the power-supply system must be assessed. To base the design simply on the arithmetic sum of all the loads existing in the installation would be extravagantly uneconomical, and bad engineering practice.

The installed apparent power is commonly assumed to be the arithmetical sum of the kVA of individual loads. The maximum estimated kVA to be supplied however is *not equal* to the total installed kVA. [1]

2.3.1 Factors to Estimate Actual Maximum Hotel kVA Demand

All individual loads are not necessarily operating at full rated nominal power nor necessarily at the same time. Factors ku and ks allow the determination of the maximum power and apparent-power demands actually required to dimension the installation.

a) Maximum Utilization Factor (or Demand Factor) (ku)

It is defined as the ratio of the maximum coincident demand of a system, or part of a system, to the total connected load of the system.

$$\mathbf{ku} = \frac{\textbf{Maximum Demand}}{\textbf{Total Connected Load}} \qquad (2.\ 14)$$

This factor must be applied to each individual load, with particular attention to electric motors, which are very rarely operated at full load.

The values of ku is as following:[1]

- For motors is 0.75,
- For Lights is 1,
- For Sockets the factors depend entirely on the type of appliances being supplied from the sockets concerned we approximate it is 0.8,
- For Electric Vehicle is 1, and these values will be used in our hotel project.

b) Diversity factor (ks)

It is defined as the ratio of the sum of the individual maximum demands of the various sub circuit of a system to the maximum demand of the whole system.

$$\mathbf{ks} = \frac{\textbf{Sum of Individual Maximum Demands}}{\textbf{Maximum Demand of the System}} \qquad (2.\ 15)$$

The Diversity Factor is applied to each group of loads (e.g., being supplied from a distribution or sub-distribution board).

The following tables (2.4), (2.5), (2.6) shows the different applications of diversity factor in electrical installation system, which we will use in our hotel project design.

Table (2. 4): Example of diversity factors for apartment block:[1]

Number of downstream consumers	Diversity factor (ks)
2 to 4	1
5 to 9	0.78
10 to 14	0.63
15 to 19	0.53
20 to 24	0.49
25 to 29	0.46
30 to 34	0.44
35 to 39	0.42
40 to 49	0.41
50 and more	0.38

Fig. A11 Example of diversity factors for an apartment block as defined in French standard NFC14-100, and applicable for apartments without electrical heating

Table (2. 5): Rated diversity factor for distribution boards:[1]

Type of load	Assumed loading factor
Distribution - 2 and 3 circuits	0.9
Distribution - 4 and 5 circuits	0.8
Distribution - 6 to 9 circuits	0.7
Distribution - 10 or more circuits	0.6
Electric actuator	0.2
Motors ⩽ 100 kW	0.8
Motors > 100 kW	1.0

Fig. A13 Rated diversity factor for distribution boards (cf IEC61439-2 table 101)

Table (2. 6): Diversity factor according to circuit function:[1]

Circuit function		Diversity factor (ks)
Lighting		1
Heating and air conditioning		1
Socket-outlets		0.1 to 0.2 [a]
Lifts and catering hoist [b]	■ For the most powerful motor	1
	■ For the second most powerful motor	0.75
	■ For all motors	0.60

[a] In certain cases, notably in industrial installations, this factor can be higher.
[b] The current to take into consideration is equal to the nominal current of the motor, increased by a third of its starting current.

Fig. A14 Diversity factor according to circuit function (see UTE C 15-105 table AC)

In order to calculate the current in each circuit then select cable sizes for the distribution circuits of an installation, the current *I* (in amps) through a three-phase circuit is determined from the equation (2.9), and for single phase circuit from equation (2.10):

$$\mathbf{I} = \frac{\mathbf{kVA \ x \ 10^3}}{\mathbf{U \ x} \sqrt{\mathbf{3}}} \qquad (2.\ 16)$$

$$\mathbf{I} = \frac{\mathbf{kVA \ x \ 10^3}}{\mathbf{V}} \qquad (2.\ 17)$$

2.3.2 Hotel Floors Loads

In this project, divided the electrical loads has been divided into two main loads, non-essential loads and emergency (essential & critical) loads.

The Non-essential loads include the loads, which withstand to supply Interruption for any period of time without causing series Problems, lighting, small power sockets, air-conditioning.

In other hand, the emergency loads include the loads, which should have a reliable supply and are secure from power failure as fire alarm system, Elevators, ventilation system, stair lighting, Pumps, sockets for CCTV camera system, FCU… etc.

2.3.2.1 Ground Floor Loads Example

The ground floor has been taken as example to show the way used in designing and calculating each floor loads. Also, then drawing the lighting & sockets plan by AutoCAD for each floor. In addition, as mentioned before loads have been divided into non-essential loads and emergency (essential & critical) loads.

Then collecting each kind of loads to one group. As example, group A for normal daily loads, and group B for emergency loads. Then, finally, these groups will finally be considered as Floor Distribution Board (DB).

Each light, sockets and other loads circuit has a number called circuit number (or CT No. in tables). The following figures will show distribution for lights and sockets circuits for ground floor. Figure (2.5) shows the light plan and figure (2.6) also shows the sockets plane drawn by AutoCAD.

In addition, each light circuit may have more than one type of luminaires, figure (2.7) shows two types of lamps, F3 and W3 which mentioned in table (2.2) .in the light circuit 13 in ground floor. Also figure 2.31 shows the design of emergency light circuit.

Figure (2.9) shows an example for non-essential loads and emergency loads design for sockets circuits, DB.GF.EM.30 which is for CCTV, DB.GF.12 for general use of socket, DB.GF.22 for FCU socket outlet.

Figure (2. 5): a plane for light circuits for ground floor by AutoCAD.

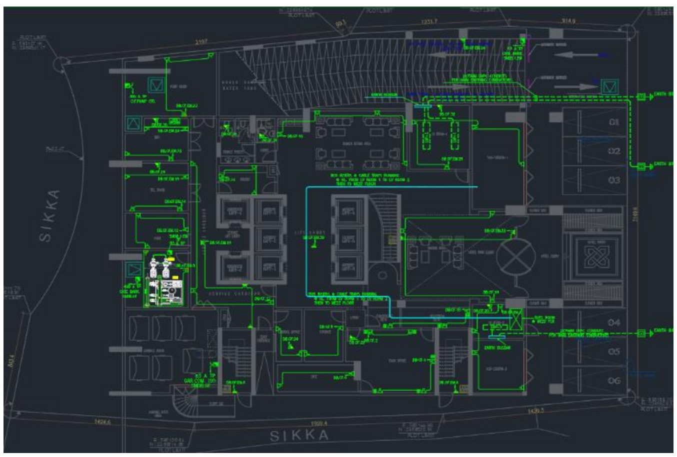


Figure (2. 6): a plane for socket circuits for ground floor by AutoCAD.

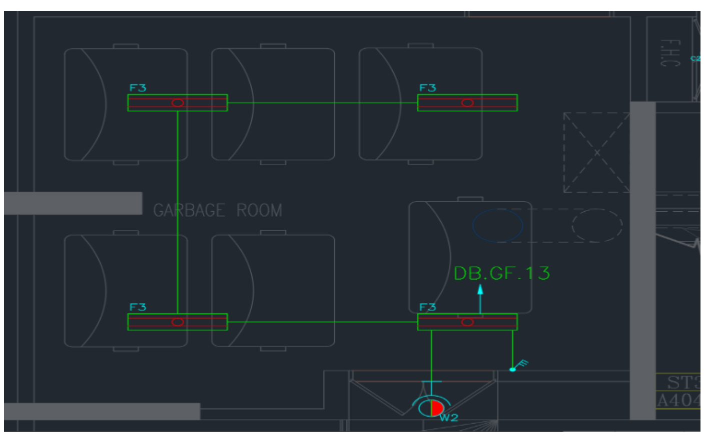


Figure (2. 7): Example for designed light circuit has two types of luminaries.

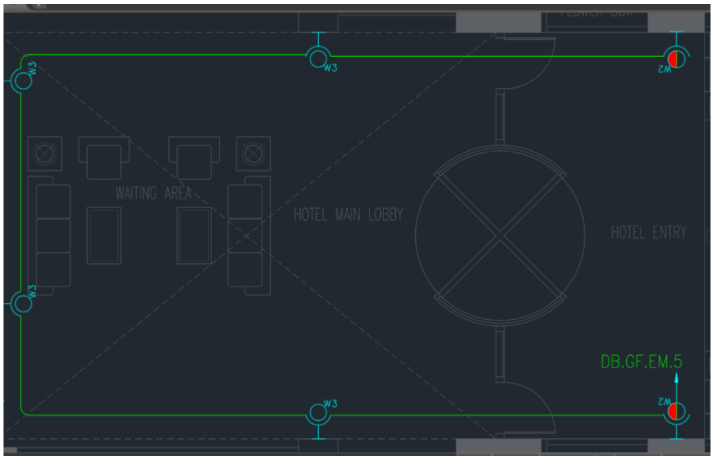


Figure (2. 8): Example for designed emergency light circuit.

Figure (2. 9): Example for designed Non-essential & Emergency socket and FCU circuit.

the methodology used in design was as following, for lights, we calculated each luminaire type load in VA (assuming P.F. 0.8) as Dialux Evo software distributed them in each zone area, then the lights loads have been distributed into circuits, also calculating each socket type (estimated normal socket and provided other loads like FCU), then also divided them into sockets circuits. This way used for non-essential loads and emergency loads.

Table (2.10) shows the design calculations for the non-essential loads type for lights, sockets and FCU loads, then named as DB.GF @ GROUND FLR.

In other hand, table (2.11) shows design calculations for emergency loads type for lights, sockets and FCU loads, then named as DB.GF EM @ GROUND FLR.

Table (2. 7): non-essential loads type ground floor, which named as DB.GF @ GROUND FLR.

CT No.	Description	Luminaire AutoCad Symbol	Total Luminaire	Total Load (W)	Power Factor	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	F2	4	252	0.8	315	2	SOCKET	800
3	LIGHT	C2	12	456	0.8	570	4	SOCKET	1200
5	LIGHT	C5,F2,F3	7	360	0.8	450	6	SOCKET	400
7	LIGHT	C8,W2	6	160	0.8	200	8	SOCKET	800
9	LIGHT	C2	10	380	0.8	475	10	SOCKET	600
11	LIGHT	C2	18	684	0.8	855	12	SOCKET	600
13	LIGHT	F3,W2	5	239	0.8	299	14	SOCKET	600
15	LIGHT	C2	14	532	0.8	665	16	SOCKET	1000
17	LIGHT	C2	19	722	0.8	903	18	SOCKET	1200
19	LIGHT	F1	2	112	0.8	140	20	LV RM-2 FCU	300
21	LIGHT	W3,C5	10	172	0.8	215	22	BACK OFF.FCU	80
23	LIGHT	C2,C5	17	550	0.8	688	24	CONTROL OFF.FCU	80
25	LIGHT	FL	6	168	0.8	210	26	CORRIDOR FCU	80
27	LIGHT	FL	6	168	0.8	210	28	SPACE	-
-	-	-	-	-	-	-	29	TEL.RM FCU	300
-	-	-	-	-	-	-	30	BMS RM.FCU	80
-	-	-	-	-	-	-	31	W.SITTING AREA.FCU	500
-	-	-	-	-	-	-	32	L.V RM-1 FCU	300
TOTAL CONNECTED			**LIGHT LOAD (kVA)**			**6.19**	**POWER LOAD (kVA)**		**8.92**

Table (2. 8): emergency loads type ground floor, which named as DB.GF EM @ GROUND FLR.

CT No.	Description	Luminaire AutoCad Symbol	Total Luminaire	Total Load (W)	Power Factor	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	GF,MEZZ TO 3PARKING	C8	10	420	0.8	525	2	SOCKET	800
3	LIGHT	F3,W2	8	368	0.8	460	4	OUTLET FOR CR.	200
5	LIGHT	W2,W3	6	126	0.8	158	6	OUTLET FOR CR.	200
7	LIGHT	C5	5	70	0.8	88	8	SOCKET	600
9	GF,MEZZ TO 3PARKING	C8	10	420	0.8	525	10	OUTLET FOR CCTV,CR.	600
11	LIGHT	C5	12	168	0.8	210	12	SOCKET	600
13	LIGHT	F3	2	110	0.8	138	14	SOCKET	800
15	LIGHT	F3	4	220	0.8	275	16	SOCKET	800
17	LIGHT	F3	4	220	0.8	275	18	SOCKET	800
19	LIGHT	C5	7	98	0.8	123	20	LV RM-2 FCU	800
21	LIGHT	C5	6	84	0.8	105	22	BACK OFF.FCU	600
23	STAIR LIGHT	C8	2	84	0.8	105	24	OUTLET FOR CCTV	200
25	LIGHT	F3,W2	9	423	0.8	529	26	CORRIDOR FCU	800
27	LIGHT	F4	8	880	0.8	1100	28	OUTLET FOR CCTV,CR.	400
29	LIGHT	F3	10	550	0.8	688	30	OUTLET FOR CCTV	200
-	-	-	-	-	-	-	-	-	-
TOTAL CONNECTED			**LIGHT LOAD (kVA)**			**5.30**	**POWER LOAD (kVA)**		**8.40**

The total load in kVA for each light, sockets outlet and FCU in ground floor was illustrated in table (2.7) & table (2.8), same method is used in the other floors to calculate the loads in kVA. For more details about floors loads, see in Appendix C (page 136).

2.3.2.2 All Hotel Floor loads

In this section, all hotel electrical loads were combined then listed in table (2.9). Moreover, emergency loads were considered and listed in table (2.10).

For making real load estimation, demand factor (ku) and diversity factor (ks) were used in both tables referred to table (2.4), table (2.5) and table (2.6).

Total connected loads (KVA), total demand loads (KVA) and total demand loads current (A) for all hole electrical loads and emergency loads were calculated in both tables.

Table (2. 9): All Hotel Non-Essential Electrical Loads Types.

Floor	Group Load Name (DB)	Feed From SMDB	Phase	Connected Light Load (KVA)	Connected Power Load (KVA)	ku Lights Loads	ku Power Load	ks for DB	Demand Light Load (KVA)	Demand Power Load (KVA)	Total Load Demand (KVA)	Total Demand Ampere (A)
Ground Floor	DB.GF	SMDB Ground Floor	3PH	6.19	8.92	1	0.8	0.9	5.57	6.42	11.99	17.31
	GARBAGE COMPACTOR		3PH	-	3.00	-	0.75	1	-	2.25	2.25	3.25
	FF PUMP		3PH	-	186.00	-	0.75	0.75	-	104.63	104.63	151.01
Mezzanin Floor	DB.MEZ.		3PH	8.10	9.50	1	0.8	0.9	7.29	6.84	14.13	20.39
	DB.SHOP1		3PH	0.60	2.18	1	0.8	0.9	0.54	1.57	2.11	3.04
	DB.SHOP2		3PH	0.60	2.18	1	0.8	0.9	0.54	1.57	2.11	3.04
1st. Parking Floor	DB.1st PAR.	SMDB Parking Floor	3PH	2.80	4.64	1	0.8	0.9	2.52	3.34	5.86	8.46
2nd Parking Floor	DB.2nd PAR.		3PH	3.30	3.16	1	0.8	0.9	2.97	2.28	5.25	7.57
3rd Parking Floor	DB.3rd PAR.		3PH	3.50	4.92	1	0.8	0.9	3.15	3.54	6.69	9.66
	FAHU		3PH	-	30.00	-	0.75	1	-	22.50	22.50	32.48
Restaurant Floor	DB.S.KIT.	SMDB Restaurant Floor	3PH	5.30	4.28	1	0.8	0.9	4.77	3.08	7.85	11.33
	REST. AHU		3PH	-	15.00	-	0.75	1	-	11.25	11.25	16.24
	S.KITCHEN AHU		3PH	-	3.00	-	0.75	1	-	2.25	2.25	3.25
	KITCHEN EQUIPMENT		3PH	-	239.50	-	0.75	0.75	-	134.72	134.72	194.45
	DB.RST.		3PH	14.85	5.30	1	0.8	0.9	13.37	3.82	17.18	24.80
Service Floor	DB.KIT.		3PH	3.00	2.40	1	0.8	0.9	2.70	1.73	4.43	6.39
	DB.SER.	SMDB-1 Service Floor	3PH	10.55	5.40	1	0.8	0.9	9.50	3.89	13.38	19.32
	DB-LOUNDARY		3PH	2.30	1.80	1	0.8	0.9	2.07	1.30	3.37	4.86
	LOUNDARY EQUIPM.		3PH	-	244.00	1	0.75	0.60	-	109.80	109.80	158.48
	MAIN KITCHEN AHU	SMDB-2 Service Floor	3PH	-	15.00	1	0.75	1	-	11.25	11.25	16.24
	LOUNDARY AHU		3PH	-	4.50	1	0.75	1	-	3.38	3.38	4.87
	LOUNDARY EQUIPM.2		3PH	-	244.00	1	0.75	0.60	-	109.80	109.80	158.48
Praying Floor	DB.G.PR	SMDB Prayer Floor	3PH	7.65	3.10	1	0.8	0.9	6.89	2.23	9.12	13.16
	DB.L.PR		3PH	6.70	2.96	1	0.8	0.9	6.03	2.13	8.16	11.78
	DB.IT		3PH	1.90	4.42	1	0.8	0.9	1.71	3.18	4.89	7.06
	G. PRAYER.AHU		3PH	-	15.00	1	0.75	1	-	11.25	11.25	16.24
	F. PRAYER.AHU		3PH	-	15.00	1	0.75	1	-	11.25	11.25	16.24
(1st-15TH) Floors	DB.FLAT 1	SMDB (1st-15TH) Floors	1PH	2.10	5.38	1	0.8	0.46	0.97	1.98	2.95	12.81
	DB.FLAT(2)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(3)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(4)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(5)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(6)		1PH	1.30	3.10	1	0.8	0.46	0.60	1.14	1.74	7.56
	DB.FLAT(7)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(8)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(9)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(10)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(11)		1PH	0.90	2.50	1	0.8	0.46	0.41	0.92	1.33	5.80
	DB.FLAT(12)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(13)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(14)		1PH	0.60	2.20	1	0.8	0.46	0.28	0.81	1.09	4.72
	DB.FLAT(15)		1PH	1.60	3.10	1	0.8	0.46	0.74	1.14	1.88	8.16
	DB.FLAT(16)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(17)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.FLAT(18)		1PH	0.60	2.28	1	0.8	0.46	0.28	0.84	1.12	4.85
	DB.(FF.TO 15F.)		3PH	4.40	1.80	1	0.8	0.46	2.02	0.66	2.69	3.88

16TH Floor	DB.FLAT(01)	SMDB 16TH Floor	1PH	3.40	6.00	1	0.8	0.46	1.56	2.21	3.77	16.40
	DB.FLAT(02)		3PH	5.40	8.90	1	0.8	0.46	2.48	3.28	5.76	8.31
	DB.FLAT(03)		1PH	2.85	5.98	1	0.8	0.46	1.31	2.20	3.51	15.27
	DB.FLAT(04)		3PH	6.15	10.78	1	0.8	0.46	2.83	3.97	6.80	9.81
	DB.16FLR		3PH	4.00	1.80	1	0.8	0.46	1.84	0.66	2.50	3.61
17TH Floor	DB.OFFICE	SMDB 17TH Floor	3PH	4.95	6.68	1	0.8	0.46	2.28	2.46	4.74	6.83
	DB.M.MAJ		3PH	7.00	4.00	1	0.8	0.46	3.22	1.47	4.69	6.77
	DB.W.MAJ		3PH	4.10	2.40	1	0.8	0.46	1.89	0.88	2.77	4.00
	DB.17F.		3PH	4.05	1.80	1	0.8	0.46	1.86	0.66	2.53	3.65
Upper & Lower Roof	GUEST LIFT 2	SMDB-1 Roof Floor	3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	GUEST LIFT 4		3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	GUEST LIFT 6		3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	FAHU		3PH	-	63.00	-	0.75	1	-	47.25	47.25	68.20
	EM. BOOSTER PUMP		1PH	-	0.30	-	0.75	0.75	-	0.17	0.17	0.73
	CIRC. BOOSTER Pump		3PH	-	2.10	-	0.75	0.75	-	1.18	1.18	1.70
	CALORIFIER 1	SMDB-2 Roof Floor	3PH	-	287.00	-	0.75	1.00	-	215.25	215.25	310.69
	CALORIFIER 2		3PH	-	287.00	-	0.75	1.00	-	215.25	215.25	310.69
	CALORIFIER 3		3PH	-	288.00	-	0.75	1.00	-	216.00	216.00	311.77
	MCC-PRIMARY PUMP 1	M.C.C @ Roof Floor	3PH	-	10.00	-	0.75	0.75	-	5.62	5.62	8.12
	MCC-PRIMARY PUMP 2		3PH	-	10.00	-	0.75	0.75	-	5.62	5.62	8.12
	MCC-PRIMARY PUMP 3		3PH	-	10.00	-	0.75	0.75	-	5.62	5.62	8.12
	MCC-SECONDARY PUMP 1		3PH	-	15.00	-	0.75	0.75	-	8.44	8.44	12.18
	MCC-SECONDARY PUMP 2		3PH	-	15.00	-	0.75	0.75	-	8.44	8.44	12.18
	MCC-SECONDARY PUMP 3		3PH	-	15.00	-	0.75	0.75	-	8.44	8.44	12.18
	PRS		1PH	-	1.00	1	0.75	0.75	-	0.56	0.56	2.45
	CHILLER-1 CKT-1	MDB.AC @ Roof Floor	3PH	-	171.00	1	0.7	1	-	119.70	119.70	172.77
	CHILLER-1 CKT-2		3PH	-	172.00	-	0.7	1	-	120.40	120.40	173.78
	CHILLER-2 CKT-1		3PH	-	171.00	-	0.7	1	-	119.70	119.70	172.77
	CHILLER-2 CKT-2		3PH	-	172.00	-	0.7	1	-	120.40	120.40	173.78
	CHILLER-3 CKT-1		3PH	-	171.00	-	0.7	1	-	119.70	119.70	172.77
	CHILLER-3 CKT-2		3PH	-	172.00	-	0.7	1	-	120.40	120.40	173.78
Total Connected Load (KVA)				**3,372.56**		**Total Load Demand (KVA)**					**2,558.75**	-
						Total Load Demand Current (A)					-	**4,739.31**

Table (2. 10): All Hotel Electrical Emergency Loads Types.

Floor	Group Load Name (DB)	Feed From SMDB	Phase	Connected Light Load (KVA)	Connected Power Load (KVA)	ku Lights Loads	ku Power Load	ks for DB	Demand Light Load (KVA)	Demand Power Load (KVA)	Total Load Demand (KVA)	Total Demand Ampere (A)
Ground Floor	DB.GF EM	SMDB-1 EM@ Ground Floor	3PH	5.30	8.40	1	0.8	0.9	4.77	6.05	10.82	15.61
	FRISH AIR TXF.1@2P		3PH	-	6.50	-	1	1	-	6.50	6.50	9.38
	GATE BARRIER		1PH	-	3.00	1	0.8	0.9	-	2.16	2.16	9.39
	WATER TR. PUMP		3PH	-	15.00	-	0.75	0.75	-	8.44	8.44	12.18
Mezzanin Floor	DB.MEZ. EM.		1PH	3.30	0.60	1	0.8	0.9	2.97	0.43	3.40	14.79
1st. Parking Floor	DB.1st PAR.EM		3PH	2.40	3.40	1	0.8	0.9	2.16	2.45	4.61	6.65
2nd Parking Floor	DB.2nd PAR.EM		3PH	2.90	2.80	1	0.8	0.9	2.61	2.02	4.63	6.68
3rd Parking Floor	DB.3rd PAR.EM		3PH	2.50	2.20	1	0.8	0.9	2.25	1.58	3.83	5.53
Resturant Floor	DB.RST.EM		3PH	4.85	0.80	1	0.8	0.9	4.37	0.58	4.94	7.13
Service Floor	DB.SER.EM		1PH	3.10	0.80	1	0.8	0.9	2.79	0.58	3.37	14.63
Praying Floor	DB.IT EM.		1PH	3.00	0.60	1	0.8	0.9	2.70	0.43	3.13	13.62
(1st-15TH) Floors	DB.1.FF.EM	SMDB-2 EM@ 1st Floor	3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.FF.EM		3PH	4.00	3.80	1	0.8	0.44	1.76	1.34	3.10	4.47
	DB.1.2F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.2F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.3F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.3F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.4F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.4F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.5F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.5F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.6F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.6F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.7F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.7F.EM		3PH	4.00	3.80	1	0.8	0.44	1.76	1.34	3.10	4.47
	DB.1.8F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.8F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.9F.EM	SMDB-3 EM@ 9th Floor	3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.9F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.10F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.10F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.11F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.11F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.12F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.12F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.13F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.13F.EM		3PH	4.00	3.80	1	0.8	0.44	1.76	1.34	3.10	4.47
	DB.1.14F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.14F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	DB.1.15F.EM		3PH	1.80	3.60	1	0.8	0.44	0.79	1.27	2.06	2.97
	DB.2.15F.EM		1PH	1.40	2.60	1	0.8	0.44	0.62	0.92	1.53	6.66
	SDB.EM.ROOF		3PH	0.00	0.00	1	0.8	0.44	0.00	0.00	0.00	0.00
16TH Floor	DB.16F.EM.		3PH	3.20	2.00	1	0.8	0.44	1.41	0.70	2.11	3.05
17TH Floor	DB.17F.EM.		3PH	2.90	2.80	1	0.8	0.44	1.28	0.99	2.26	3.26

Upper & Lower Roof	GUEST LIFT 1	SMDB EM @Roof Floor	3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	GUEST LIFT 3		3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	GUEST LIFT 5		3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	SERVICE LIFT 1		3PH	-	9.00	-	0.75	1	-	6.75	6.75	9.74
	SERVICE LIFT 2		3PH	-	10.00	-	0.75	1	-	7.50	7.50	10.83
	CRADLE1		3PH	-	3.00	-	0.8	0.90	-	2.16	2.16	3.12
	CRADLE2		3PH	-	3.00	-	0.8	0.90	-	2.16	2.16	3.12
	BOOSTER PUMP 1		3PH	-	3.00	-	0.75	0.75	-	1.69	1.69	2.44
	BOOSTER PUMP 2		3PH	-	2.10	-	0.75	0.75	-	1.18	1.18	1.70
	KITCHEN EXTR. FAN 1		3PH	-	8.00	-	0.75	0.75	-	4.50	4.50	6.49
	KITCHEN EXTR. FAN 2		3PH	-	4.50	-	0.75	0.75	-	2.53	2.53	3.65
	STAIR PRESS.1		3PH	-	9.00	-	0.75	0.75	-	5.06	5.06	7.31
	STAIR PRESS.2		3PH	-	9.00	-	0.75	0.75	-	5.06	5.06	7.31
	STAIR PRESS.3		3PH	-	9.00	-	0.75	0.75	-	5.06	5.06	7.31
	LOBBY PRESS.		3PH	-	3.00	-	0.75	0.75	-	1.69	1.69	2.44
	SMOKE EXTR. FAN		3PH	-	1.50	-	0.75	0.75	-	0.84	0.84	1.22
	FRISH AIR TXF.1@RF		3PH	-	13.00	-	0.75	1	-	9.75	9.75	14.07
	DB-EM.ROOF		3PH	3.00	4.20	1	0.8	0.9	2.70	3.02	5.72	8.26
Total Connected Load (KVA)				**356.05**		**Total Load Demand (KVA)**					**200.66**	-
						Total Load Demand Current (A)					-	**378.03**

2.4 Summary

An overview electrical load has been shown, then the procedures of lights and sockets outlet design has been discussed, also equations & factors for design and load calculations were used.

Finally, all kinds of electrical hotel loads were listed in tables. So that the result of Total demand loads is 2,759.41 (KVA), and total demand loads current is 4,739.31 (A).

3

Chapter Three

Conductors Sizing & Voltage Drop Testing

3.1 Methodology

3.2 Cable Sizing

3.3 Protective Earthing Conductor (PE)

3.4 Voltage Drop Testing

3.5 Sizing of Busbar Trunking Systems (Busways)

3.6 Summary

3.1 Methodology

The cabling and its protection at each level must satisfy several conditions at the same time, in order to ensure a safe and reliable installation, e.g., it must:

- Carry the permanent full load current, and normal short-time overcurrent,
- Not cause voltage drops likely to result in an inferior performance of certain loads.

Moreover, the protective devices (circuit breakers or fuses) must:

- Protect the cabling and busbars for all levels of overcurrent, up to and including short-circuit currents,
- Ensure protection of persons against indirect contact hazards (fault protection). [1]

The block diagram as shown in the figure (3.1) shows the methodology used for sizing the cables and protective devices in the project.

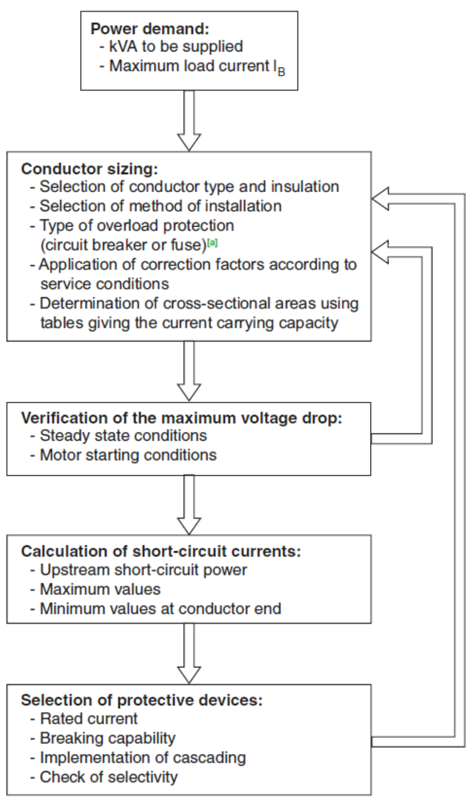


Figure (3. 1): Flow-chart for the selection of cable size and protective device.

In cable sizing and protection, there is definitions must to be known:

- **Maximum load current** ($\mathbf{I_B}$): At the final circuit's level, this current corresponds to the rated kVA of the load.

- **Maximum permissible current** ($\mathbf{I_Z}$)**:** is the maximum permissible that the cabling for the circuit can carry indefinitely, without reducing its normal life expectancy.

The current depends, for a given cross sectional area of conductors, on several parameters:

a) Constitution of the cable and cable-way (Cu or Alu conductors; PVC or XLPE insulation; number of active conductors),
b) Ambient temperature,
c) Method of installation,
d) Influence of neighboring circuits.

- **Overcurrent's:** An overcurrent occurs each time the value of current exceeds the maximum load current $\mathbf{I_B}$ for the load concerned. Two types of overcurrent are distinguished: Overloads and Short-circuit currents $\mathbf{I_{SC}}$.

3.2 Cable sizing

There are factors must to be known before determining the needed cable cross-sectional area.

3.2.1 Methods of Cable installation

It is important to determine the wiring systems and installation methods in any project, to obtain the current carrying capacity of each cable. Figure (3.3) shows the cable installation methods.

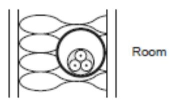
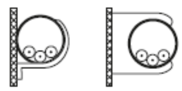
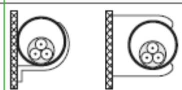
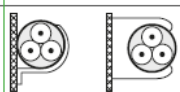
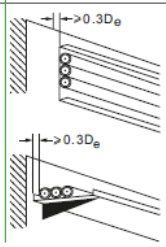
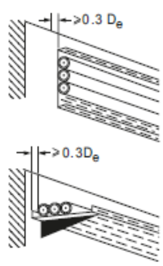
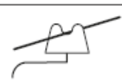
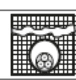
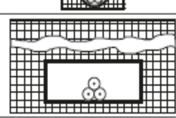
Item No	Method of installation	Description	Reference method of installation to be used to obtain current-carrying capacity
1		Insulated conductors or single-core cables in conduit in a thermally insulated wall	A1
2		Multi-core cables in conduit in a thermally insulated wall	A2
4		Insulated conductors or single-core cables in conduit on a wooden, or masonry wall or spaced less than 0.3 x conduit diameter from it	B1
5		Multi-core cable in conduit on a wooden, or mansonry wall or spaced less than 0.3 x conduit diameter from it	B2
20		Single-core or multi-core cables: - fixed on, or sapoed less than 0.3 x cable diameter from a wooden wall	C
30		Single-core or multi-core cables: on unperforated tray run horizontally or vertically	C
31		Single-core or multi-core cables: on perforated tray run horizontally or vertically	E or F
36		Bare or insulated conductors on insulators	G
70		Multi-core cables in conduit or in cable ducting in the ground	D1
71		Single-core cable in conduit or in cable ducting in the ground	D1

Figure (3. 2): Cable installation methods (part of table A.52.3 of IEC 60364-5-52) [1].

3.2.2 Correction factors

The cross-sectional area of cables is determined using the current-carrying capacity of the cable $\mathbf{I_Z}$, multiplied by correction factors: Data sheet in appendix D (page 137).

$$\mathbf{I'_Z = I_Z * K_1 * K_2 * K_3 * K_4} \qquad (3.1)$$

Where:

$\mathbf{I'_Z}$**:** "corrected" current carrying capacity of the cable in real installation conditions.

$\mathbf{I_Z}$**:** Current carrying capacity of the cable in the reference installation method.

$\mathbf{K_1}$**:** Correction factor, ambient temperature.

$\mathbf{K_2}$**:** Correction factor, Ground temperature.

$\mathbf{K_3}$**:** Correction factor, Soil thermal resistivity.

$\mathbf{K_4}$**:** Correction factor, grouping of conductors or cables, table (3.4) shows the values of correction factor k4 for different configurations of *unburied* cables or conductors, grouping of more than one circuit or multi-core cables.

Table (3. 1): reducing agents (k4) [1]:

Arrangement (cables touching)	Number of circuits or multi-core cables												Reference methods
	1	2	3	4	5	6	7	8	9	12	16	20	
Bunched in air, on a surface, embedded or enclosed	1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.45	0.14	0.38	Methods A to F
Single layer on wall, floor or unperforated tray	1.00	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	No further reduction factor for more than nine circuits or multi-core cables			Method C
Single layer fixed directly under a wooden ceiling	0.95	0.81	0.72	0.68	0.66	0.64	0.63	0.62	0.61				
Single layer on a perforated horizontal or vertical tray	1.00	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72				Methods E and F
Single layer on ladder support or cleats etc.	1.00	0.87	0.82	0.80	0.80	0.79	0.79	0.78	0.78				

3.2.3 Using recommended simplified approach for cables

In order to facilitate the selection of cables, two simplified tables are proposed from IEC 60364-5-52, for unburied and buried cables.

The tables summarize the most frequently used configurations and provide easier access to information. Table (3.2) shows the current ampere in amperes for unburied copper cables, and Table (3.3) shows the current capacity in amperes for buried copper cables.

Table (3. 2): Current-carrying capacity in amperes for copper unburied cables (table C.52.1 of IEC 60364-5-52) [1]:

Reference methods	**Number of loaded conductors and type of insulation**											
A1		2 PVC	3 PVC		3 XLPE	2 XLPE						
A2	3 PVC	2 PVC		3 XLPE	2 XLPE							
B1				3 PVC	2 PVC		3 XLPE		2 XLPE			
B2			3 PVC	2 PVC		3 XLPE	2 XLPE					
C					3 PVC		2 PVC	3 XLPE		2 XLPE		
E						3 PVC		2 PVC	3 XLPE		2 XLPE	
F							3 PVC		2 PVC	3 XLPE		2 XLPE
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Size (mm^2) Cooper												
1.5	13	13.5	14.5	15.5	17	18.5	19.5	22	23	24	26	-
2.5	17.5	18	19.5	21	23	25	27	30	31	33	36	-
4	23	24	26	28	31	34	36	40	42	45	49	-
6	29	31	34	36	40	43	46	51	54	58	63	-
10	39	42	46	50	54	60	63	70	75	80	86	-
16	52	56	61	68	73	80	85	94	100	107	115	-
25	68	73	80	89	95	101	110	119	127	135	149	161
35	-	-	-	110	117	126	137	147	158	169	185	200
50	-	-	-	134	141	153	167	179	192	207	225	242
70	-	-	-	171	179	196	213	229	246	268	289	310
95	-	-	-	207	216	238	258	278	298	328	352	377
120	-	-	-	239	249	276	299	322	346	382	410	437
150	-	-	-	-	285	318	344	371	395	441	473	504
185	-	-	-	-	324	362	392	424	450	506	542	575
240	-	-	-	-	380	424	461	500	538	599	641	679

Table (3. 3) Current-carrying capacity in amperes for copper buried cables (table B.52-1 of IEC 60364-5-52) [1]:

Installation method	**Size mm^2**	**Number of loaded conductors and type of insulation**			
		Two PVC	**Three PVC**	**Two XLPE**	**Three XLPE**
D1/D2	**Copper**				
	1.5	22	18	26	22
	2.5	29	24	34	29
	4	38	31	44	37
	6	47	39	56	46
	10	63	52	73	61
	16	81	67	95	79
	25	104	86	212	101
	35	125	103	146	122
	50	148	122	173	144
	70	183	151	213	178
	95	216	179	252	211
	120	246	203	287	240
	150	278	230	324	271
	185	312	258	363	304
	240	361	297	419	351
	300	408	336	474	396

3.3 Protective Earthing Conductor (PE)

The Protective (PE) conductors provide the bonding connection between all exposed and extraneous conductive parts of an installation, to create the main equipotential bonding system. These conductors conduct fault current due to insulation failure (between a phase conductor and an exposed conductive part) to the earthed neutral of the source. PE conductors are connected to the main earthing terminal of the installation.

3.3.1 Connection of PE

The main earthing terminal is connected to the earthing electrode by the earthing conductors. PE conductors must be:

- Insulated and colored yellow and green (stripes).
- Protected against mechanical and chemical damage.

The connection of PE conductors must be:

- Not include any means of breaking the continuity of the circuit (such as a switch, removable links, etc.)
- Connect exposed conductive parts individually to the main PE conductor, i.e., in parallel, not in series, as shown in figure (3.3).
- Have an individual terminal on common earthing bars in distribution boards.

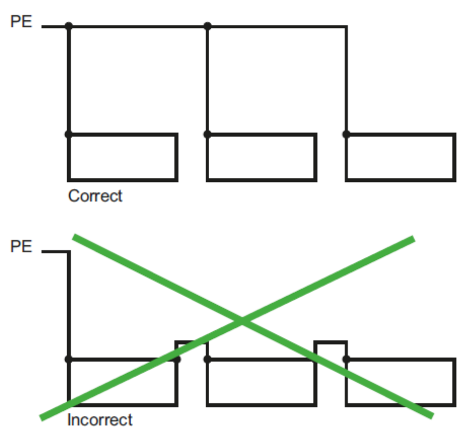


Figure (3. 3): Connection the PE in parallel not in series [1].

3.3.2 PE Conductor Sizing

There are two methods used in PE conductor sizing, adiabatic method and Simplified method. In this project, the simplified method is used, which depends on the C.S.A of phase conductors S_{Ph}. As following formulas:

When,

$$\mathbf{S_{ph} \leq 16\ mm^2, S_{PE} = S_{Ph}} \tag{3. 2}$$

When,

$$\mathbf{16 < S_{ph} \leq 35\ mm^2, S_{PE} = 16\ mm^2} \tag{3. 3}$$

When,

$$\mathbf{S_{ph} > 35\ mm^2, S_{PE} = \frac{S_{Ph}}{2}} \tag{3. 4}$$

3.4 Voltage Drop

The impedance of circuit conductors is low but not negligible: when carrying load current there is a voltage drop between the origin of the circuit and the load terminals [1].

This section deals with methods of determining voltage drops, in order to check that:

- They comply with the particular standards and regulations in force,
- They can be tolerated by the load,
- They satisfy the essential operational requirements.

In this project, cable voltage-drop between the origin of an installation and any load point shall be limited to 5% and 8% values according to (IEC60364-5-52 table G.52.1). Figure (3.4) shows the maximum voltage drop from the source to the load's terminals.

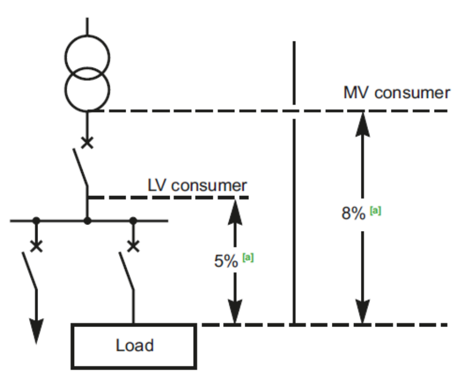


Figure (3. 4): Maximum Voltage Drop [1].

3.4.1 Cables Voltage Drop

Equation (3.5),(3.6) shows the calculation of the voltage drop and the effect on the parameters in a given circle per kilometer of length. Data sheet in appendix D (page 137).

For single-phase system:

$$\Delta \mathbf{v}\% = \frac{\Delta \mathbf{V}}{\mathbf{V_n}} \mathbf{x100}\% = \frac{\mathbf{2\ I_B\ (R\ \cos\emptyset + X\ \sin\emptyset)\ L}}{\mathbf{V_n}} \mathbf{x100}\% \qquad (3.5)$$

For balanced 3-phase system:

$$\Delta \mathbf{v}\% = \frac{\Delta \mathbf{V}}{\mathbf{U_n}} \mathbf{x100}\% = \frac{\mathbf{\sqrt{3}\ I_B\ (R\ \cos\emptyset + X\ \sin\emptyset)\ L}}{\mathbf{U_n}} \mathbf{x100}\% \qquad (3.6)$$

Where:

$\Delta v\%$: Percent voltage drop (%)
ΔV : Absolute value of voltage drops (V)
V_n : Phase-to-neutral voltage
U_n : Phase-to-phase voltage
I_B : The full load current in amps
L : Length of the cable in kilometers
R : Resistance of the cable conductor in Ω/km
X : Inductive reactance of a conductor in Ω/km
$\emptyset$: Phase angle between voltage and current in the circuit considered.

Note: X is negligible for conductors of cables section area. less than 50 mm2. In the absence of any other information, take X as being equal to 0.08 Ω/km.

Note: for Motor: At start-up: cos φ = 0.35, in normal service: cos φ = 0.85

- Example 1: - Cable Sizing & Voltage Drop Testing Calculation Criteria:

This example illustrates using manual calculation, for sizing the cross-sectional cable and testing the voltage drop for the cable at load terminal.

Ground Fire Fighting Pump Tonnage with Detail Table (3.4):

Table (3. 4): Ground fire pump tonnage details:

Cable Details	
System voltage (V)	400
Type of Insulation	N2YX/XLPE
Type of conductor	Copper
Cable Length (meter)	44
Load Example Details	
Power Rating of motor (KW)	161.82
Efficiency (η)	0.95
Power Factor	0.87
Method of installation	F
Correction Factors:	
Ambient air temperature (K1) / @ 30 °C	1
Ground temperature (K2) / @20 °C	1
Soil Thermal Resistivity (K3) / Dry soil	1
Grouping of conductors or cables (K4) / 2 multi core cables	0.87

Using next equation, Full Load Current:

$$\mathbf{I_B} = \frac{\mathbf{P}}{\mathbf{\sqrt{3}\ x\ U_n x\ \eta\ x\ cos\ \varphi}} \qquad (3.\ 7)$$

$$\mathrm{I_B} = \frac{161.82}{\sqrt{3}\ \mathrm{x}\ 0.4\ \mathrm{x}\ 0.95\ \mathrm{x}\ 0.87} = 282.4\ \mathrm{A}$$

From table (3.2) for N2XY/XLPE cable used in the project. The current carrying capacity of the cable $\mathbf{I_Z}$, which is nearest to $\mathbf{I_B}$ is 328A, which referred to cross sectional area of $95mm^2$.

Using Equation (3.1) the "corrected" current carrying capacity and taking K4 from Table (3.1):

$$\mathrm{I'_Z} = \mathrm{I_Z} * \mathrm{K_1} * \mathrm{K_2} * \mathrm{K_3} * \mathrm{K_4}$$

= 328*1*1*1*0.87 = 285.36 A

Note, that $\mathbf{I'_Z}$ is greater than $\mathbf{I_B}$, which is acceptable!

Now, regarding voltage drop testing, at normal service (at running):

R = 0.193 Ω/km   X = 0.08 Ω/km $\emptyset = 29.54^{\circ}$

$\cos\emptyset = 0.87 \qquad \sin\emptyset = 0.49$

From equation (3.6):

$$\Delta v\% = \frac{\Delta V}{U_n} x100\% = \frac{\sqrt{3}\ I_B\,(R\ \cos\emptyset\ +\ X\ \sin\emptyset)\ L}{U_n} x100\%$$

$$= \frac{\sqrt{3}\ x\ 282.4\ x\ (0.193\ x\ 0.87 + 0.08\ x\ 0.49)\ x\ 0.044}{400} x100\% = 1.12\ \%$$

This value is satisfactory value.

Now, testing voltage drop at start-up service, the power factor cos $\emptyset$ will be with low value, and from equation (3.6):

R = 0.193 Ω/km   X = 0.08 Ω/km $\emptyset = 69.51^{\circ}$

$\cos\emptyset = 0.35 \qquad \sin\emptyset = 0.94$

$$= \frac{\sqrt{3}\ x\ 2\ x\ 282.4\ x\ (0.193\ x\ 0.35 + 0.08\ x\ 0.94)\ x\ 0.044}{400} x100\% = 0.77\ \%$$

This value is satisfactory value.

- Example 2: - Cable Sizing & Voltage Drop Testing Calculation Criteria:

Upload the emergency service database on the service floor with details as follows Table (3.5):

Table (3. 5): Details of the emergency service database on the service floor:

Cable Details	
System voltage (V)	230
Type of Insulation	N2YX/XLPE
Type of conductor	Copper
Cable Length (meter)	98
Load Example Details	
Power Rating of DB (KW)	3.198
Efficiency (η)	1
Power Factor	0.82
Method of installation	E or F
Correction Factors:	
Ambient air temperature (K1) / @ 30 °C	1
Ground temperature (K2) / @20 °C	1
Soil Thermal Resistivity (K3) / Dry soil	1
Grouping of conductors or cables (K4) / 7 multi core cables	0.79

Using next equation (3.7), Full Load Current:

$$I_B = \frac{3.198}{230 \text{ x } 1 \text{ x } 0.82} = 16.96 \text{ A}$$

From figure 3.5 for N2XY/XLPE cable used in the project. The current carrying capacity of the cable $\mathbf{I_Z}$, which is nearest to $\mathbf{I_B}$ is 49A, which referred to cross sectional area of $4mm^2$.

Using Equation (3.5) the "corrected" current carrying capacity and taking K4 from Table (3.1):

$$I'_Z = I_Z * K_1 * K_2 * K_3 * K_4$$

$$= 49*1*1*1*0.79 = 38.71 \text{ A}$$

Note, that $\mathbf{I'_Z}$ is greater than $\mathbf{I_B}$, which is acceptable!

Now, regarding voltage drop testing, at normal service (at running):

X = 0.08 Ω/km $\quad \emptyset = 34.91^{\circ} \quad \cos\emptyset = 0.82 \quad \sin\emptyset = 0.57$

From equation (3.5):

$$\Delta v\% = \frac{\Delta V}{V_n} \text{x}100\% = \frac{2\ I_B\ (R\ \cos\emptyset\ +\ X\ \sin\emptyset)\ L}{V_n} \text{x}100\%$$

$$= \frac{2 \text{ x } 16.96 \text{ x } (4.81 \text{ x } 0.82 + 0.08 \text{ x } 0.57) \text{ x } 0.098}{230} \text{x}100\% = 5.77\ \%!$$

This value is not satisfactory value.

So, the C.S.A of cable must be increased to 6 mm^2. With new value of R=3.08 Ω/km.

$$\Delta v\% = \frac{2 \text{ x } 16.96 \text{ x } (3.08 \text{ x } 0.82 + 0.08 \text{ x } 0.57) \text{ x } 0.098}{230} \text{x}100\% = 3.72\ \%!$$

This value is satisfactory value.

Table (3.6) and Table (3.7) show the cross-sectional area measurement results for each load cable and the voltage drop test result for each cable at the load end. Table (3.8) also shows the same results.

Table (3. 6): Sizing the cross-sectional cable and testing the voltage drop for non-essential loads.

Floor	Group Load Name (DB)	Feed From SMDB	Phase	Connected Load (KVA)	Full Load Ib (A)	Install. Method	K4	Corre. I'z (A)	Length of Cable (m)	Cable C.S.A (mm2)	PE C.S.A (mm2)	Cable R (ohms/km)	Cos(Ø)	Sin(Ø)	ΔV%
Ground Floor	DB.GF	SMDB Ground Floor	3PH	15.11	21.81	A2	0.82	34.44	20.50	4	4	4.51	0.8	0.60	0.71%
	GARBAGE COMPACTOR		3PH	3	4.33	A2	0.82	18.86	38.00	1.5	1.5	12.1	0.85	0.53	0.74%
	FF PUMP		3PH	186	282.60	E or F	0.87	285.36	44.00	95	50	0.193	0.87	0.49	1.12%
Mezzanin Floor	DB.MEZ.		3PH	17.6	25.40	E or F	0.82	34.44	71.00	4	4	4.51	0.8	0.60	2.86%
	DB.SHOP1		3PH	2.78	4.01	A2	0.82	34.44	49.00	4	4	4.51	0.8	0.60	0.31%
	DB.SHOP2		3PH	2.78	4.01	A2	0.82	34.44	72.00	4	4	4.51	0.8	0.60	0.46%
1st. Parking Floor	DB.1st PAR.	SMDB Parking Floor	3PH	7.44	10.74	A2	0.75	31.50	19.00	4	4	4.51	0.8	0.60	0.32%
2nd Parking Floor	DB.2nd PAR.		3PH	6.46	9.32	E or F	0.80	33.60	24.00	4	4	4.51	0.8	0.60	0.35%
3rd Parking Floo	DB.3rd PAR.		3PH	8.42	12.15	E or F	0.80	33.60	29.00	4	4	4.51	0.8	0.60	0.56%
	FAHU		3PH	30	43.30	E or F	0.80	60.00	19.00	10	10	1.83	0.88	0.47	0.59%
Restaurant Floor	DB.S.KIT.	SMDB Restaurant Floor	3PH	9.58	13.83	E or F	0.80	33.60	30.70	4	4	4.51	0.8	0.60	0.67%
	REST. AHU		3PH	15	21.65	E or F	0.80	33.60	32.10	4	4	4.51	0.89	0.46	1.22%
	S.KITCHEN AHU		3PH	3	4.33	E or F	0.80	24.80	38.30	2.5	2.5	7.41	0.88	0.47	0.47%
	KITCHEN EQUIPMENT		3PH	239.5	345.69	E or F	0.82	369.00	28.00	185	95	0.0991	0.85	0.53	0.53%
	DB.RST.		3PH	20.15	29.08	A2	0.73	39.42	25.80	6	6	3.08	0.86	0.51	0.87%
Service Floor	DB.KIT.		3PH	5.4	7.79	E or F	0.80	24.80	33.80	4	4	4.51	0.82	0.57	0.43%
	DB.SER.	SMDB-1 Service Floor	3PH	15.95	23.02	A2	0.79	42.66	39.60	6	6	3.08	0.88	0.47	1.08%
	DB-LOUNDARY		3PH	4.1	5.92	A2	0.79	24.49	46.80	4	4	4.81	0.83	0.56	0.48%
	LOUNDARY EQUIPM.		3PH	244	352.18	E or F	0.82	369.00	48.60	185	95	0.0991	0.89	0.46	0.92%
	MAIN KITCHEN AHU	SMDB-2 Service Floor	3PH	15	21.65	E or F	0.82	34.44	21.90	4	4	4.51	0.88	0.47	0.82%
	LOUNDARY AHU		3PH	4.5	6.50	E or F	0.82	25.42	47.20	4	4	4.51	0.89	0.46	0.54%
	LOUNDARY EQUIPM.2		3PH	244	352.18	E or F	0.82	369.00	45.40	185	95	0.0991	0.89	0.46	0.86%
Praying Floor	DB.G.PR	SMDB Prayer Floor	3PH	10.75	15.52	A2	0.73	30.66	25.40	4	4	4.81	0.8	0.60	0.66%
	DB.L.PR		3PH	9.66	13.94	A2	0.73	30.66	42.70	4	4	4.81	0.8	0.60	1.00%
	DB.IT		3PH	6.32	9.12	A2	0.73	30.66	29.40	4	4	4.81	0.8	0.60	0.45%
	G. PRAYER.AHU		3PH	15	21.65	E or F	0.80	33.60	43.50	4	4	4.81	0.89	0.46	1.76%
	F. PRAYER.AHU		3PH	15	21.65	E or F	0.80	33.60	24.50	4	4	4.81	0.89	0.46	0.99%
(1st-15TH) Floors	DB.FLAT 1	SMDB (1st-15TH) Floors	1PH	7.48	32.52	E or F	0.78	49.14	46.50	6	6	3.08	0.8	0.60	3.30%
	DB.FLAT(2)		1PH	2.88	12.52	E or F	0.78	38.22	41.40	4	4	4.81	0.8	0.60	1.76%
	DB.FLAT(3)		1PH	2.88	12.52	E or F	0.78	38.22	36.80	4	4	4.81	0.8	0.60	1.56%
	DB.FLAT(4)		1PH	2.88	12.52	E or F	0.78	38.22	33.50	4	4	4.81	0.8	0.60	1.42%
	DB.FLAT(5)		1PH	2.88	12.52	E or F	0.78	38.22	38.80	4	4	4.81	0.8	0.60	1.65%
	DB.FLAT(6)		1PH	4.4	19.13	E or F	0.78	38.22	39.10	4	4	4.81	0.8	0.60	2.53%
	DB.FLAT(7)		1PH	2.88	12.52	E or F	0.78	38.22	36.20	4	4	4.81	0.8	0.60	1.54%
	DB.FLAT(8)		1PH	2.88	12.52	E or F	0.78	38.22	34.90	4	4	4.81	0.8	0.60	1.48%
	DB.FLAT(9)		1PH	2.88	12.52	E or F	0.78	38.22	31.80	4	4	4.81	0.8	0.60	1.35%
	DB.FLAT(10)		1PH	2.88	12.52	E or F	0.78	38.22	27.10	4	4	4.81	0.8	0.60	1.15%
	DB.FLAT(11)		1PH	3.4	14.78	E or F	0.78	38.22	23.90	4	4	4.81	0.8	0.60	1.20%
	DB.FLAT(12)		1PH	2.88	12.52	E or F	0.78	38.22	24.40	4	4	4.81	0.8	0.60	1.04%
	DB.FLAT(13)		1PH	2.88	12.52	E or F	0.78	38.22	27.50	4	4	4.81	0.8	0.60	1.17%
	DB.FLAT(14)		1PH	2.8	12.17	E or F	0.78	38.22	32.40	4	4	4.81	0.8	0.60	1.34%
	DB.FLAT(15)		1PH	4.7	20.43	E or F	0.78	38.22	34.90	4	4	4.81	0.8	0.60	2.42%
	DB.FLAT(16)		1PH	2.88	12.52	E or F	0.78	38.22	38.60	4	4	4.81	0.8	0.60	1.64%
	DB.FLAT(17)		1PH	2.88	12.52	E or F	0.78	38.22	43.40	4	4	4.81	0.8	0.60	1.84%
	DB.FLAT(18)		1PH	2.88	12.52	E or F	0.78	38.22	46.10	4	4	4.81	0.8	0.60	1.96%
	DB.(FF.TO 15F.)		3PH	6.2	8.95	E or F	0.78	32.76	20.20	4	4	4.81	0.8	0.60	0.30%

16TH Floor	DB.FLAT(01)	SMDB 16TH Floor	1PH	9.4	40.87	E or F	0.78	67.08	40.00	10	10	1.83	0.8	0.60	2.15%
	DB.FLAT(02)		3PH	14.3	20.64	E or F	0.78	32.76	32.90	4	4	4.81	0.8	0.60	1.15%
	DB.FLAT(03)		1PH	8.83	38.39	E or F	0.78	67.08	22.00	10	10	1.83	0.8	0.60	1.11%
	DB.FLAT(04)		3PH	16.93	24.44	E or F	0.78	32.76	44.90	4	4	4.81	0.8	0.60	1.85%
	DB.16FLR		3PH	5.8	8.37	E or F	0.78	32.76	17.50	4	4	4.81	0.86	0.51	0.27%
17TH Floor	DB.OFFICE	SMDB 17TH Floor	3PH	11.63	16.79	E or F	0.78	32.76	34.10	4	4	4.81	0.82	0.57	0.99%
	DB.M.MAJ		3PH	11	15.88	E or F	0.78	32.76	43.10	4	4	4.81	0.81	0.59	1.17%
	DB.W.MAJ		3PH	6.5	9.38	E or F	0.78	32.76	22.10	4	4	4.81	0.82	0.57	0.36%
	DB.17F.		3PH	5.85	8.44	E or F	0.78	32.76	17.30	4	4	4.81	0.86	0.51	0.26%
Upper & Lower Roof	GUEST LIFT 2	SMDB-1 Roof Floor	3PH	9	12.99	E or F	0.79	33.18	28.00	4	4	4.81	0.9	0.44	0.69%
	GUEST LIFT 4		3PH	9	12.99	E or F	0.79	33.18	22.00	4	4	4.81	0.9	0.44	0.54%
	GUEST LIFT 6		3PH	9	12.99	E or F	0.79	33.18	18.00	4	4	4.81	0.9	0.44	0.44%
	FAHU		3PH	63	90.93	E or F	0.79	100.33	32.85	25	16	0.727	0.88	0.47	0.88%
	EM. BOOSTER PUMP		1PH	0.3	1.30	A2	0.79	13.43	25.70	1.5	1.5	12.1	0.9	0.44	0.32%
	CIRC. BOOSTER Pump		3PH	2.1	3.03	A2	0.79	18.17	29.70	1.5	1.5	12.1	0.9	0.44	0.43%
	CALORIFIER 1	SMDB-2 Roof Floor	3PH	287	414.25	E or F	0.82	414.92	30.50	185	95	0.0991	0.92	0.39	0.67%
	CALORIFIER 2		3PH	287	414.25	E or F	0.82	414.92	29.40	185	95	0.0991	0.92	0.39	0.65%
	CALORIFIER 3		3PH	288	415.69	E or F	0.82	414.92	29.90	185	95	0.0991	0.92	0.39	0.66%
	MCC-PRIMARY PUMP 1	M.C.C @ Roof Floor	3PH	10	14.43	E or F	0.79	33.18	32.30	4	4	4.81	0.89	0.46	0.87%
	MCC-PRIMARY PUMP 2		3PH	10	14.43	E or F	0.79	33.18	32.00	4	4	4.81	0.89	0.46	0.86%
	MCC-PRIMARY PUMP 3		3PH	10	14.43	E or F	0.79	33.18	31.80	4	4	4.81	0.89	0.46	0.86%
	MCC-SECONDARY PUMP 1		3PH	15	21.65	E or F	0.79	33.18	32.50	4	4	4.81	0.89	0.46	1.32%
	MCC-SECONDARY PUMP 2		3PH	15	21.65	E or F	0.79	33.18	32.20	4	4	4.81	0.89	0.46	1.30%
	MCC-SECONDARY PUMP 3		3PH	15	21.65	E or F	0.79	33.18	31.90	4	4	4.81	0.89	0.46	1.29%
	PRS		1PH	1	4.35	E or F	0.79	13.43	31.30	1.5	1.5	12.1	0.9	0.44	1.29%
	CHILLER-1 CKT-1	MDB.AC @ Roof Floor	3PH	171	246.82	E or F	0.79	259.12	27.30	95	50	0.193	0.92	0.39	0.61%
	CHILLER-1 CKT-2		3PH	172	248.26	E or F	0.79	259.12	29.65	95	50	0.193	0.92	0.39	0.67%
	CHILLER-2 CKT-1		3PH	171	246.82	E or F	0.79	259.12	17.50	95	50	0.193	0.92	0.39	0.39%
	CHILLER-2 CKT-2		3PH	172	248.26	E or F	0.79	259.12	17.80	95	50	0.193	0.92	0.39	0.40%
	CHILLER-3 CKT-1		3PH	171	246.82	E or F	0.79	259.12	32.80	95	50	0.193	0.92	0.39	0.73%
	CHILLER-3 CKT-2		3PH	172	248.26	E or F	0.79	259.12	27.50	95	50	0.193	0.92	0.39	0.62%

Table (3. 7): Sizing the cross-sectional cable and testing the voltage drop for emergency loads:

Floor	Group Load Name (DB)	Feed From SMDB	Phase	Connected Load (KVA)	Full Load Ib (A)	Install. Method	K4	Corre. I'z (A)	Length of Cable (m)	Cable C.S.A (mm2)	PE C.S.A (mm2)	Cable R (ohms/km)	Cos(Ø)	Sin(Ø)	ΔV%
Ground Floor	DB.GF EM	SMDB-1 EM@ Ground Floor	3PH	13.70	19.77	A2	0.85	23.80	17.50	4	4	4.81	0.8	0.60	0.58%
	FRISH AIR TXF.1@2P		3PH	6.50	9.38	A2	0.85	17.85	52.70	2.5	2.5	7.41	0.88	0.47	1.40%
	GATE BARRIER		1PH	3.00	13.04	E or F	0.87	31.32	38.50	2.5	2.5	7.41	0.89	0.46	2.90%
	WATER TR. PUMP		3PH	15.00	21.65	E or F	0.87	28.71	44.60	2.5	2.5	7.41	0.89	0.46	2.77%
Mezzanin Floor	DB.MEZ. EM.		1PH	3.90	16.96	E or F	0.79	35.55	69.50	4	4	4.81	0.82	0.57	4.09%
1st. Parking Floor	DB.1st PAR.EM		3PH	5.80	8.37	E or F	0.79	35.55	77.00	4	4	4.81	0.82	0.57	1.11%
2nd Parking Floor	DB.2nd PAR.EM		3PH	5.70	8.23	E or F	0.79	35.55	82.00	4	4	4.81	0.82	0.57	1.17%
3rd Parking Floor	DB.3rd PAR.EM		3PH	4.70	6.78	E or F	0.79	35.55	87.00	4	4	4.81	0.82	0.57	1.02%
Resturant Floor	DB.RST.EM		3PH	5.65	8.16	E or F	0.79	35.55	92.00	4	4	4.81	0.82	0.57	1.30%
Service Floor	DB.SER.EM		1PH	3.90	16.96	E or F	0.79	45.82	98.00	6	6	3.08	0.82	0.57	3.72%
Praying Floor	DB.IT EM.		1PH	3.60	15.65	E or F	0.79	45.82	102.00	6	6	3.08	0.82	0.57	3.57%
(1st-15TH) Floors	DB.1.FF.EM	SMDB-2 EM@ 1st Floor	3PH	5.40	7.79	E or F	0.78	35.10	36.50	4	4	4.81	0.8	0.60	0.48%
	DB.2.FF.EM		3PH	7.80	11.26	E or F	0.78	35.10	41.40	4	4	4.81	0.8	0.60	0.79%
	DB.1.2F.EM		3PH	5.40	7.79	E or F	0.78	35.10	36.80	4	4	4.81	0.8	0.60	0.48%
	DB.2.2F.EM		1PH	4.00	17.39	E or F	0.78	38.22	33.50	4	4	4.81	0.8	0.60	1.97%
	DB.1.3F.EM		3PH	5.40	7.79	E or F	0.78	35.10	28.80	4	4	4.81	0.8	0.60	0.38%
	DB.2.3F.EM		1PH	4.00	17.39	E or F	0.78	35.10	29.10	4	4	4.81	0.8	0.60	1.71%
	DB.1.4F.EM		3PH	5.40	7.79	E or F	0.78	35.10	26.20	4	4	4.81	0.8	0.60	0.34%
	DB.2.4F.EM		1PH	4.00	17.39	E or F	0.78	38.22	24.90	4	4	4.81	0.8	0.60	1.47%
	DB.1.5F.EM		3PH	5.40	7.79	E or F	0.78	35.10	21.80	4	4	4.81	0.8	0.60	0.29%
	DB.2.5F.EM		1PH	4.00	17.39	E or F	0.78	38.22	17.10	4	4	4.81	0.8	0.60	1.01%
	DB.1.6F.EM		3PH	5.40	7.79	E or F	0.78	35.10	13.90	4	4	4.81	0.8	0.60	0.18%
	DB.2.6F.EM		1PH	4.00	17.39	E or F	0.78	38.22	14.40	4	4	4.81	0.8	0.60	0.85%
	DB.1.7F.EM		3PH	5.40	7.79	E or F	0.78	35.10	17.50	4	4	4.81	0.8	0.60	0.23%
	DB.2.7F.EM		3PH	7.80	11.26	E or F	0.78	35.10	22.40	4	4	4.81	0.8	0.60	0.43%
	DB.1.8F.EM		3PH	5.40	7.79	E or F	0.78	35.10	24.90	4	4	4.81	0.8	0.60	0.33%
	DB.2.8F.EM		1PH	4.00	17.39	E or F	0.78	38.22	28.60	4	4	4.81	0.8	0.60	1.69%
	DB.1.9F.EM	SMDB-3 EM@ 9th Floor	3PH	5.40	7.79	E or F	0.78	35.10	36.50	4	4	4.81	0.8	0.60	0.48%
	DB.2.9F.EM		1PH	4.00	17.39	E or F	0.78	38.22	41.40	4	4	4.81	0.8	0.60	2.44%
	DB.1.10F.EM		3PH	5.40	7.79	E or F	0.78	35.10	36.80	4	4	4.81	0.8	0.60	0.48%
	DB.2.10F.EM		1PH	4.00	17.39	E or F	0.78	38.22	33.50	4	4	4.81	0.8	0.60	1.97%
	DB.1.11F.EM		3PH	5.40	7.79	E or F	0.78	35.10	28.80	4	4	4.81	0.8	0.60	0.38%
	DB.2.11F.EM		1PH	4.00	17.39	E or F	0.78	38.22	29.10	4	4	4.81	0.8	0.60	1.71%
	DB.1.12F.EM		3PH	5.40	7.79	E or F	0.78	35.10	26.20	4	4	4.81	0.8	0.60	0.34%
	DB.2.12F.EM		1PH	4.00	17.39	E or F	0.78	38.22	24.90	4	4	4.81	0.8	0.60	1.47%
	DB.1.13F.EM		3PH	5.40	7.79	E or F	0.78	35.10	21.80	4	4	4.81	0.8	0.60	0.29%
	DB.2.13F.EM		3PH	7.80	11.26	E or F	0.78	35.10	17.10	4	4	4.81	0.8	0.60	0.32%
	DB.1.14F.EM		3PH	5.40	7.79	E or F	0.78	35.10	13.90	4	4	4.81	0.8	0.60	0.18%
	DB.2.14F.EM		1PH	4.00	17.39	E or F	0.78	38.22	14.40	4	4	4.81	0.8	0.60	0.85%
	DB.1.15F.EM		3PH	5.40	7.79	E or F	0.78	35.10	17.50	4	4	4.81	0.8	0.60	0.23%
	DB.2.15F.EM		1PH	4.00	17.39	E or F	0.78	38.22	22.40	4	4	4.81	0.8	0.60	1.32%
	SDB.EM.ROOF		3PH	121.30	175.08	E or F	0.78	209.04	48.50	70	35	0.268	0.8	0.60	0.96%
16TH Floor	DB.16F.EM.		3PH	5.20	7.51	E or F	0.78	35.10	32.50	4	4	4.81	0.8	0.60	0.41%
17TH Floor	DB.17F.EM.		3PH	5.70	8.23	E or F	0.78	35.10	38.70	4	4	4.81	0.8	0.60	0.54%

Upper & Lower Roof	GUEST LIFT 1	SMDB EM @Roof Floor	3PH	9.00	12.99	E or F	0.78	35.10	27.50	4	4	4.81	0.9	0.44	0.68%
	GUEST LIFT 3		3PH	9.00	12.99	E or F	0.78	35.10	26.70	4	4	4.81	0.9	0.44	0.66%
	GUEST LIFT 5		3PH	9.00	12.99	E or F	0.78	35.10	21.80	4	4	4.81	0.9	0.44	0.54%
	SERVICE LIFT 1		3PH	9.00	12.99	E or F	0.78	35.10	22.30	4	4	4.81	0.9	0.44	0.55%
	SERVICE LIFT 2		3PH	10.00	14.43	E or F	0.78	35.10	24.60	4	4	4.81	0.9	0.44	0.67%
	CRADLE1		3PH	3.00	4.33	E or F	0.78	25.74	33.20	2.5	2.5	7.41	0.86	0.51	0.40%
	CRADLE2		3PH	3.00	4.33	E or F	0.78	25.74	38.40	2.5	2.5	7.41	0.86	0.51	0.46%
	BOOSTER PUMP 1		3PH	3.00	4.33	E or F	0.78	25.74	35.20	2.5	2.5	7.41	0.87	0.49	0.43%
	BOOSTER PUMP 2		3PH	2.10	3.03	E or F	0.78	25.74	34.70	2.5	2.5	7.41	0.87	0.49	0.30%
	KITCHEN EXTR. FAN 1		3PH	8.00	11.55	E or F	0.78	25.74	35.40	2.5	2.5	7.41	0.88	0.47	1.16%
	KITCHEN EXTR. FAN 2		3PH	4.50	6.50	E or F	0.78	25.74	32.10	2.5	2.5	7.41	0.88	0.47	0.59%
	STAIR PRESS.1		3PH	9.00	12.99	E or F	0.78	35.10	16.00	4	4	4.81	0.84	0.54	0.37%
	STAIR PRESS.2		3PH	9.00	12.99	E or F	0.78	35.10	29.80	4	4	4.81	0.85	0.53	0.69%
	STAIR PRESS.3		3PH	9.00	12.99	E or F	0.78	35.10	25.80	4	4	4.81	0.85	0.53	0.60%
	LOBBY PRESS.		3PH	3.00	4.33	E or F	0.78	25.74	37.80	2.5	2.5	7.41	0.86	0.51	0.45%
	SMOKE EXTR. FAN		3PH	1.50	2.17	E or F	0.78	18.72	39.80	1.5	1.5	12.1	0.88	0.47	0.40%
	FRISH AIR TXF.1@RF		3PH	13.00	18.76	E or F	0.78	35.10	33.10	4	4	4.81	0.88	0.47	1.15%
	DB-EM.ROOF		3PH	7.20	10.39	E or F	0.78	35.10	20.00	4	4	4.81	0.82	0.57	0.36%

Table (3. 8): Sizing the cross-sectional cable and testing the voltage drop for hotel SMDB's:

SMDB Name	Phase	Total Connected Load (KVA)	Full Load Ib (A)	Install. Method	K4	Corre. I'z (A)	Length of Cable (m)	Cable C.S.A (mm2)	PE C.S.A (mm2)	Cable R (ohms/km)	Cos(∅)	Sin(∅)	ΔV%
SMDB Ground Floor	3PH	227.27	328.04	E or F	1.00	382.00	15.00	120	70	0.153	0.82	0.57	0.36%
SMDB Parking Floor	3PH	52.32	75.52	E or F	1.00	107.00	20.00	16	16	1.15	0.82	0.57	0.65%
SMDB Restaurant Floor	3PH	292.63	422.38	E or F	1.00	441.00	25.00	150	70	0.124	0.82	0.57	0.67%
SMDB-1 Service Floor	3PH	264.05	381.12	E or F	1.00	441.00	30.00	150	70	0.124	0.82	0.57	0.73%
SMDB-2 Service Floor	3PH	263.5	380.33	E or F	1.00	441.00	32.00	150	70	0.124	0.82	0.57	0.78%
SMDB Prayer Floor	3PH	56.73	81.88	E or F	1.00	107.00	15.00	16	16	1.15	0.82	0.57	0.53%
SMDB (1st-15TH) Floors	3PH	66.42	95.87	E or F	1.00	107.00	15.00	16	16	1.15	0.82	0.57	0.62%
SMDB 16TH Floor	3PH	55.26	79.76	E or F	1.00	107.00	15.00	16	16	1.15	0.82	0.57	0.51%
SMDB 17TH Floor	3PH	34.98	50.49	E or F	1.00	80.00	15.00	10	10	1.83	0.82	0.57	0.51%
SMDB-1 Roof Floor	3PH	92.4	133.37	E or F	1.00	169.00	15.00	35	16	0.524	0.82	0.57	0.41%
SMDB-2 Roof Floor	3PH	862	1244.19	Designed to be connected to Bus Riser Directly									-
M.C.C @ Roof Floor	3PH	76	109.70	E or F	1.00	135.00	15.00	25	16	0.727	0.82	0.57	0.46%
MDB.AC @ Roof Floor	3PH	1029	1485.23	Designed to be connected to Bus Riser Directly									-
SMDB-1 EM@ Ground Floor	3PH	71.45	103.13	E or F	1.00	135.00	17.00	25	16	0.727	0.82	0.57	0.49%
SMDB-2 EM@ 1st Floor	3PH	82.8	119.51	E or F	1.00	135.00	36.00	25	16	0.727	0.82	0.57	1.20%
SMDB-3 EM@ 9th Floor	3PH	201.8	291.27	E or F	1.00	328.00	60.00	95	50	0.193	0.82	0.57	1.54%
SMDB EM @Roof Floor	3PH	121.3	175.08	E or F	1.00	207.00	38.00	50	25	0.387	0.82	0.57	1.05%

3.5 Sizing of busbar Trunking Systems (bus ways)

Busway as defined by NEMA is a prefabricated electrical distribution system consisting of bus bars in a protective enclosure as shown in Figure (3.6), including straight lengths, fixtures, hardware, and accessories. Busway transmits electricity and connects to electrical equipment such as switchgear, panel boards, and transformers.

❖ Busway components include:

- **Bus bars**, or conductors, conduct electricity; they are made from aluminum or copper and vary in size
- **Housing**, an aluminum or steel enclosure to contain the busbars
- **Insulating system** made of a combination of air, epoxy and mylar; it separates the conductors from each other to prevent electrical faults
- **Fittings** such as elbows, offsets and tees help to properly route busway from one electrical connection or termination

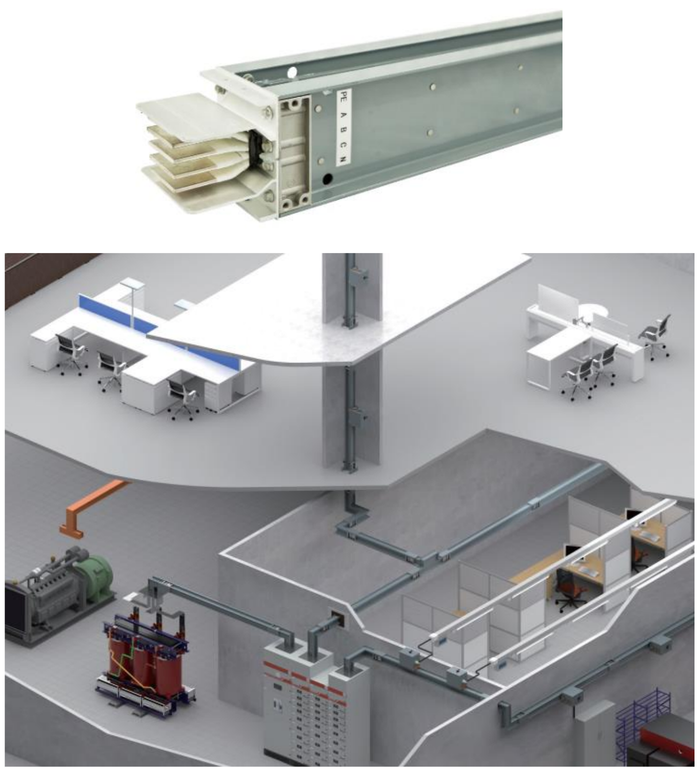


Figure (3. 5): Busbar Trunking Systems (Busways) [2].

Once the trunking system layout is established, it is possible to calculate the absorbed current I_n on the distribution line. I_n is equal to the sum of absorbed currents by the current $I_b$consumers:

$$\mathbf{I_n = \Sigma I_b} \qquad (3.\ 8)$$

The current consumers do not all work at the same time and are not permanently on full load, so we have to use a clustering coefficient K_s which is shown in Table (3.9):

$$\mathbf{I_n = \Sigma(\ I_b\ .\ K_s\ )} \qquad (3.\ 9)$$

Table (3. 9): Diversity factor according to the number of current consumers connected to Busways [1]:

Application	Number of current consumers	Ks Coefficient
Lighting, Heating		1
Distribution (engineering workshop)	2...3	0.9
	4...5	0.8
	6...9	0.7
	10...40	0.6
	40 and over	0.5

The electrical data of ABB's Wave Pro-II bus way, which is used in the project, is shown in Table (3.10). From this figure, the rated drop of riser current and voltage were determined.

Table (3. 10): Electrical Data for Wave Pro-II busway from ABB [2]:

[Data source: calculation]

Rated Current[1]	Rated short-time withstand current (Icw)	Rated peak withstand current (Ipk)	20°C Resistance	100% Rated Load/steady state (50Hz), 20°C Amb. Resistance	Reactance	Impedance	Line-to-line voltage drop (V/m) - Concentrated load, 20°C Amb.[2]				
A	kA/s	kA	($10^{-6}\Omega$/m, phase-to-neutral)				cosϕ=0.6	cosϕ=0.7	cosϕ=0.8	cosϕ=0.9	cosϕ=1.0
400	30	63	101.5	116.0	34.2	120.9	0.067	0.073	0.079	0.083	0.080
630	30	63	88.9	112.1	31.8	116.6	0.101	0.110	0.119	0.125	0.122
800	30	63	71.1	92.6	28.2	96.8	0.108	0.118	0.126	0.133	0.128
1000	50	105	54.7	72.2	24.4	76.2	0.109	0.118	0.125	0.131	0.125
1250	50	105	41.8	57.4	21.0	61.1	0.111	0.119	0.127	0.132	0.124
1600	65	143	29.6	43.5	17.0	46.7	0.110	0.118	0.125	0.129	0.121
2000	65	143	22.2	32.9	14.0	35.8	0.107	0.114	0.120	0.124	0.114
2500	65	143	16.9	27.0	11.3	29.3	0.109	0.117	0.123	0.127	0.117
3200	120	264	14.8	21.9	9.9	24.1	0.117	0.124	0.130	0.133	0.121
4000	120	264	11.1	17.0	7.1	18.4	0.110	0.117	0.124	0.128	0.118
5000	120	264	8.5	13.6	4.4	14.3	0.101	0.109	0.117	0.122	0.117
6300	120	264	5.9	9.6	4.4	10.5	0.101	0.107	0.112	0.115	0.104

The Hotel's SMDB have been divided into 4 main Bus Risers as shown in table (3.11). The absorbed current I_n, bus riser ampere rating and the voltage drop have calculated for each one.

Taking the Bus Riser 1 as example, ks= 0.7, from equation (3.9):

$$I_n = \Sigma(I_b \,.\, K_s)$$

$$= (81.88+95.87+95.87+95.87+95.87+95.87+95.87+95.87+95.87) \text{ x } 0.7$$

$$=597.18 \text{ A}$$

According to table (3.10), the suitable rated current of Bus Riser 1 is 630A.

In addition, according the Wave Pro-II busway manufacturer, to determine the actual voltage drop, at $\cos\emptyset = 0.80$ which occurred at any terminal load is:

$$\textbf{Actual } (\Delta \mathbf{v}) = \textbf{Voltage Drop from Table x} \frac{\textbf{Actaul Load (A)}}{\textbf{Rated Load (A)}} \textbf{ x L} \qquad (3.\ 10)$$

$$= 0.119 \text{ x } \frac{594.18}{848.83} \text{ x } 30 = 2.499 \text{ V}$$

From equation (3.10):

$$\Delta v\% = \frac{\Delta V}{U_n} x100\% = \frac{2.499}{400} x\ 100\% = 0.62475\ \%$$

This value is satisfactory!

Table (3.11) illustrates the calculations result for each bus riser used in the hotel. Also shows the size of the Tap-Off units, which used to connect and protect each SMDB load at each floor. More information about Tap-Off unit will be explained in circuit breaker section.

Table (3. 11): calculations result for Wave Pro-II busway from ABB used in the hotel:

SMDB Name	Bus Riser No.	Total Connected Load (KVA)	Full Load Ib (A)	Tap OFF Unit Size (A)	Bus Full Load In=Σ Ib (A)	Diversity Factor (Ks)	Bus Absorbed Current In (A)	Bus Riser Rating (A)	Length of Bus (meter)	Voltage Drop (V/m) @Cos(Ø)=0.8	ΔV%
SMDB Prayer Floor		56.73	81.88	160A					30.00	0.119	0.62%
SMDB (1ST) Floors		66.42	95.87	160A					33.50	0.119	0.70%
SMDB (2ND) Floors		66.42	95.87	160A					37.00	0.119	0.77%
SMDB (3RD) Floors		66.42	95.87	160A					40.50	0.119	0.84%
SMDB (4TH) Floors	BUS RISER 1	66.42	95.87	160A	848.83	0.70	594.18	630	44.00	0.119	0.92%
SMDB (5TH) Floors		66.42	95.87	160A					47.50	0.119	0.99%
SMDB (6TH) Floors		66.42	95.87	160A					51.00	0.119	1.06%
SMDB (7TH) Floors		66.42	95.87	160A					54.50	0.119	1.13%
SMDB (8TH) Floors		66.42	95.87	160A					58.00	0.119	1.21%
SMDB (9TH) Floors		66.42	95.87	160A					61.50	0.119	1.28%
SMDB (10TH) Floors		66.42	95.87	160A					65.00	0.119	1.35%
SMDB (11TH) Floors		66.42	95.87	160A					68.50	0.119	1.43%
SMDB (12TH) Floors		66.42	95.87	160A					72.00	0.119	1.50%
SMDB (13TH) Floors		66.42	95.87	160A					75.50	0.119	1.57%
SMDB (14TH) Floors	BUS RISER 2	66.42	95.87	160A	934.70	0.60	560.82	630	79.00	0.119	1.65%
SMDB (15TH) Floors		66.42	95.87	160A					82.50	0.119	1.72%
SMDB (16TH) Floor		55.26	79.76	160A					86.00	0.119	1.79%
SMDB (17TH) Floor		34.98	50.49	160A					89.50	0.119	1.86%
SMDB-1 Roof Floor		92.4	133.37	160A					93.00	0.119	1.94%
MDB.AC @ Roof Floor	BUS RISER 3	1105	1594.93	-	1594.93	1.00	1594.93	1600	95.00	0.125	2.97%
SMDB-2 Roof Floor	BUS RISER 4	862	1244.19	-	1244.19	1.00	1244.19	1250	95.00	0.127	3.02%

3.6 Summary

The methodology used in project for cable sizing has been introduced, and factors which must to be known before determining the needed C.S.A. for cables. The simplified method used in PE conductor sizing also determined. Then, voltage drop testing calculation criteria has been shown. Finally, the design of busways system used in project has been shown.

4

Chapter Four

Power Source Sizing & Selection

4.1 Introduction

In this chapter, work was done on selecting the transformers and generators that were considered, and studying the UPS system, and each of them was chosen according to the available data.

4.2 Select the necessary transformers

The hotel has three main panels located on the ground floor, and each panel contains different loads distributed within the hotel. After distributing the loads, the main breaker and the cable sectional area for each panel were calculated, the voltage drop was calculated, and the size of the transformers needed for feeding was chosen.

Each plate was as shown in the following table (4.1) and the transformers were of the oil type immersed as shown in Figure (4.1) and were chosen from Schneider Company from Table (4.2) according to the load of each plate. A data sheet for each of the three adapters is attached in the appendix E (page 138).

Table (4. 1): Transformer capacity per panel:

<table>
<tr><th>MDB / Riser</th><th>Low Voltage Panel Number</th><th>Total Load Demand (KVA)</th><th>Σ Total Load Demand (KVA)</th><th>Future Load Demand with 20 % (KVA)</th><th>Transformer Rating (KVA)</th></tr>
<tr><td>BUS RISER1</td><td rowspan="4">LVP-1</td><td>253.95</td><td rowspan="4">783.94</td><td rowspan="4">940.728</td><td rowspan="4">1000</td></tr>
<tr><td>BUS RISER2</td><td>289.03</td></tr>
<tr><td>MDB-EM</td><td>200.66</td></tr>
<tr><td>SMDB-PARKING</td><td>40.30</td></tr>
<tr><td>BUS RISER3</td><td rowspan="2">LVP-2</td><td>763.05</td><td rowspan="2">900.27</td><td rowspan="2">1080.32</td><td rowspan="2">1250</td></tr>
<tr><td>SMDB GROUND FLOOR</td><td>137.22</td></tr>
<tr><td>BUS RISER 4</td><td rowspan="4">LVP-3</td><td>646.50</td><td rowspan="4">1075.16</td><td rowspan="4">1290.19</td><td rowspan="4">1600</td></tr>
<tr><td>SMDB.1 SERVICE FLOOR</td><td>126.55</td></tr>
<tr><td>SMDB.2 SERVICE FLOOR</td><td>124.43</td></tr>
<tr><td>SMDB RESTAURANT FLOOR</td><td>177.68</td></tr>
</table>

Figure (4. 1): oil type immersed transformer.

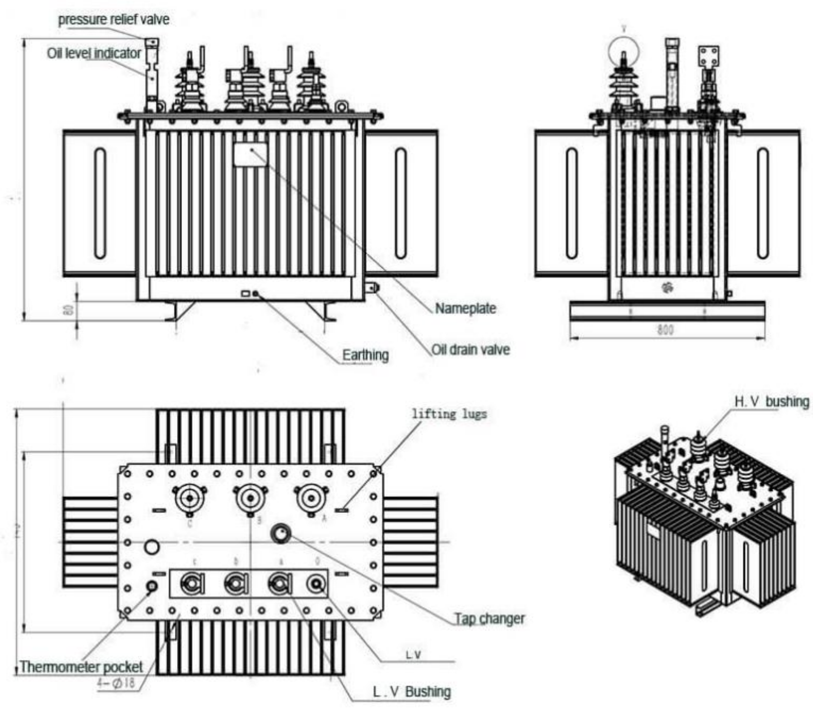


Figure (4. 2): Transformer installation.

Table (4. 2): standard apparent powers for Schneider [1]:

Apparent power kVA	In (A) 237 V [a]	410 V [a]
100	244	141
160	390	225
250	609	352
315	767	444
400	974	563
500	1218	704
630	1535	887
800	1949	1127
1000	2436	1408
1250	3045	1760
1600	3898	2253
2000	4872	2816
2500	6090	3520
3150	7673	4436

4.2.1 Checking the Size Validity of the Transformers

The following example demonstrates Calculate the required tr-r kVA and voltage drop when the load appears on the motors:

- Example: Calculating the voltage drop on the third transformer of 1600 kVA when the motors are working together:

Table (4. 3): contains the motors connected to the third transformer of 1600 kVA:

Name of motor	Power (KW)	Voltage 3ph (V)	Power factor	Code
REST. AHU.	13.35 KW	400 V	0.89	D
REST. SER.	13.2 KW	400 V	0.88	D

- Motors current and starting kVA:

1) Motor Full Load Current of Motor REST. AHU.:

$$\mathbf{I_{flm1}} = \frac{\mathbf{P_{flm1} * 1000}}{\sqrt{\mathbf{3}} * \mathbf{V_{LL}} * \mathbf{PF}} \qquad (4.\ 1)$$

$$= \frac{13.35 \text{ KW} * 1000}{\sqrt{3} * 400 * 0.89} = 13\ A$$

2) Motor Full Load Current of Motor REST. SER.:

$$\mathbf{I_{flm2}} = \frac{\mathbf{P_{flm2} * 1000}}{\sqrt{3} * \mathbf{V_{LL}} * \mathbf{PF}} \qquad (4.\ 2)$$

$$= \frac{13.2\ \text{KW} * 1000}{\sqrt{3} * 400 * 0.88} = 21.6\ A$$

3) Total drawn current:

$$\mathbf{I_{fl-t}} = \mathbf{I_{flm1}} + \mathbf{I_{flm2}} \qquad (4.\ 3)$$

$$= 13 + 21.6 = 34.6$$

4) Where $I_{r_{locked}}$ is locked rotor current and depends on design code according to following table (4.4):

Table (4. 4): design code according:

NEMA Code Letter	kVA/HP with locked rotor	Approximate Mid-Range Value
A	0 - 3.14	1.6
B	3.15 - 3.55	3.3
C	3.55 - 3.99	3.8
→ D	4.0 - 4.49	4.3
E	4.5 - 4.99	4.7
F	5.0 - 5.59	5.3
G	5.6 - 6.29	5.9
H	6.3 - 7.09	6.7
J	7.1 - 7.99	7.5
K	8.0 - 8.99	8.5
L	9.0 - 9.99	9.5
M	10.0 - 11.19	10.6
N	11.2 - 12.49	11.8
P	12.5 - 13.99	13.2
R	14.0 - 15.99	15.0
S	16.0 - 17.99	
T	18.0 - 19.99	
U	20.0 - 22.39	
V	22.4 - and up	

- Design code D has the range of 4 to 4.49 so let D with m=4.5

$$\mathbf{I_{r_{locked\ m1}}} = \mathbf{m} * \mathbf{I_{flm1}} \qquad (4.\ 4)$$

$$= 4.5 * 13 = 58.5\ A$$

$$\mathbf{I_{r_{locked\ m2}}} = \mathbf{m} * \mathbf{I_{flm2}} \qquad (4.\ 5)$$

$$= 4.5 * 21.6 = 97.2\ A$$

5) Motor inrush kVA at Starting (S_{inrush}):

$$\mathbf{S_{inrush\ m1}} = \frac{\mathbf{V_{LL} * I_{r_{locked\_m1}} * \sqrt{3}}}{\mathbf{1000}} \tag{4. 6}$$

$$= \frac{400 * 58.5 * \sqrt{3}}{1000} = 40.5 \text{ KVA}$$

$$\mathbf{S_{inrush\ m2}} = \frac{\mathbf{V_{LL} * I_{r_{locked\_m2}} * \sqrt{3}}}{\mathbf{1000}} \tag{4. 7}$$

$$= \frac{400 * 97.2 * \sqrt{3}}{1000} = 67 \text{ KVA}$$

6) Total Starting (inrush) KVA of both motors:

- ✓ $\mathrm{S_{inrush\ tot}} = (\mathrm{KVA})_{\mathrm{m\_start}}$

$$\mathbf{S_{inrush\ tot}} = \mathbf{S_{inrush\ m1}} + \mathbf{S_{inrush\ m2}} \tag{4. 8}$$

$$= 40.5 + 67 = 107.5 \text{ KVA}$$

- Transformer data:

1) Transformer full load current:

$$\mathbf{I_{T-fl}} = \frac{\mathbf{S_{Tr}}}{\mathbf{\sqrt{3} * V_{LL}}} \tag{4. 9}$$

$$= \frac{1600 \text{ KVA}}{\sqrt{3} * 400} = 2309 \text{ A}$$

2) Short current at secondary coils:

$$\mathbf{I_{T-SC}} = \frac{\mathbf{I_{T-fl}}}{\mathbf{Z\%}} \tag{4. 10}$$

$$= \frac{2309}{0.0625} = 36944\ A$$

Where:

Z%: Short circuit impedance. Data sheet in appendix E (page 138)

3) Max KVA of Tr. at S.C:

$$\mathbf{S_{T-SC}} = \frac{\mathbf{V_{LL} * I_{T-SC} * \sqrt{3}}}{\mathbf{1000}} \tag{4. 11}$$

$$= \frac{400 * 36944 * \sqrt{3}}{1000} = 25595.5 \text{ KVA}$$

4) Voltage drops at Tr.-r secondary due to motor starting:

$$\Delta \mathbf{v_{start}} = \frac{(\mathbf{KVA})_{\mathbf{m-start}}}{(\mathbf{KVA})_{\mathbf{SC}}} * \Delta \mathbf{v_{max}} \quad (4.\ 12)$$

$$= \frac{107.5}{25595.5} * 10\% = 0.42\%$$

➢ Final Check:

1) For safety operation usually the motor current ≤ 65% of Transformer current, therefore:

$$\mathbf{I_{m-allowed}} = \mathbf{0.65} * \mathbf{I_{T-fl}} \quad (4.\ 13)$$

$$= 0.65 * 2309 = 1500.85\ A$$

❖ $I_{fl-t} = 34.6$ A ≤ 1500.85 A OK

2) The voltage drop $\Delta v_{start} \le \Delta v_{max}$:

❖ 0.42% ≤ 10% OK

And therefore, the suitable size of transformers is shown in Table (4.5):

Table (4. 5): Shows the size of the transformer and the voltage drop on each transformer if all the motors were running at the same time:

Transformer	Total Full load Current of motor	Total Starting (inrush) KVA of both motors	Transformer Full load Current	Voltage Drop @ Tr.
1000 KVA	218 A	865.3 KVA	1443 A	4.30%
1250 KVA	825 A	2376 KVA	1804 A	1.10%
1600 KVA	34.6 A	107.5 KVA	2309 A	0.42%

4.3 Backup Generator Sizing

The electric generator works in the event of a power outage, and once the power is restored, it is turned off, and the loads that we need to work in the event of a power outage are connected to it, such as computers at the reception staff, alarms, emergency lighting, surveillance cameras, etc.

Sizing backup generator in this project is based on the value of critical (emergency loads) mentioned in table (2.13), which must be powered with electrical power outage.

In this project, the value of emergency loads was 200.66 KVA and after adding 20% as a future increase percentage. Thus, needed a generator to feed 240.792 KVA.

Therefore, an FG WILSON generator (P500-3) with a capacity of 500 kVA was chosen as shown in Figure (4.3). [3].

Figure (4. 3): generator (P500-3).[3]

4.3.1 Check Sizing of Diesel Generator

To ensure the size of the generator that was previously selected, the starting KVA was checked on the generator for the loads connected to it, and to see if the loads could be operated together.

- Example: KVA calculation starting from the load in the first main panel (SMDB-1 EM@ Ground Floor) connected to the generator shown in Table (4.6) and the load is linear.

Table (4. 6): The first load shown in Table (2.10) connected to the generator:

	Group Loud Name (DB)	Phase	Connected Light Loud (KVA)	Full Loud IB (A)	KS DF	Run-cos(ɵ)	Start-cos(ɵ)	Full Loud Power (KVA)	Full Loud (KVA)	Full Loud Current	Starting (KVA)	Starting Current
1	DB.GF EM	3PH	5.3	-	0.9	0.8	0.8	4.77	5.9625	0.014906	7.453125	18.63281

1) Full load power for the same load category:

$$\mathbf{p_{t\_load}} = \mathbf{P_l} * \mathbf{D_F} \tag{4. 14}$$

$$= 5.3\ (KW) * 0.9 = 4.77\ KW$$

Where:

Pt-Load1: total power of the loads from the same category

PL: power of the individual load in kW or watts

DF: diversity factor

2) Full load KVA for the same load category:

$$\mathbf{S_{T\_load}} = \frac{\mathbf{P_{T\_load}}}{\mathbf{PF_{run}}} \tag{4. 15}$$

$$= \frac{4.77}{0.8} = 5.962\ KVA$$

3) Full load current of Load1 in Amp:

$$\mathbf{I_{load}} = \frac{\mathbf{S_{T\_load}}}{\mathbf{VLL}} \tag{4. 16}$$

$$= \frac{5.962}{400} \quad = 14.9\ A$$

4) Starting KVA of Load:

$$\mathbf{S_{st\_load}} = \frac{\mathbf{K_{st}} * \mathbf{P_{T\_load}}}{\mathbf{PF_{start}}} \tag{4. 17}$$

$$= \frac{1 * 5.962}{0.8} = 7.5\ KVA$$

Note: Since Load 1 is a linear load therefore Kst=100%

5) Starting current:

$$\mathbf{I_{st\_load}} = \frac{\mathbf{K_{st}} * \mathbf{I_{T\_load}}}{\mathbf{PF_{start}}} \tag{4. 18}$$

$$= \frac{1 * 14.9}{0.8} = 18.6\ A$$

Note: All starting KVA loads connected to the generator were calculated using the same method as the previous example, and the result is Total of starting KVA=853 KVA

Hence the result was that the generator could not run the loads together because the starting KVA of the loads was higher than the KVA of the generator as shown in Table (4.7).

Table (4. 7): starting loads:

Name panel		starting KVA	starting current
SMDB-1 EM@ Ground Floor		104 KVA	374.5 A
SMDB-2 EM@ 1st Floor		273 KVA	1743 A
SMDB-3 EM@ 9th Floor		476 KVA	668 A
	Total =	853 KVA	2785.5 A

$$\textbf{Size of Diesel Generator} = \textbf{Total of starting KVA} * \textbf{future expansion} * \textbf{average use of equipment} \quad (4.19)$$

$$= 853 * 1.1 * 0.7 = 656.81\ KVA$$

After making the starting KVA calculations and calculating the future increase in equation (4.19), the generator was selected. But starting KVA for loads that are more than the KVA of the generator, and the solution to this problem was to use the timer control method as shown in Figure (4.4) so that there is a delay of 1 second between the first electrical panel (SMDB -1 EM @ Ground Floor) and the panel second (SMDB-2 (EM @ 1st Floor)) and a one-second delay between the second panel and the third panel (SMDB-3 EM @ 9th Floor), thus reducing generator load when running.

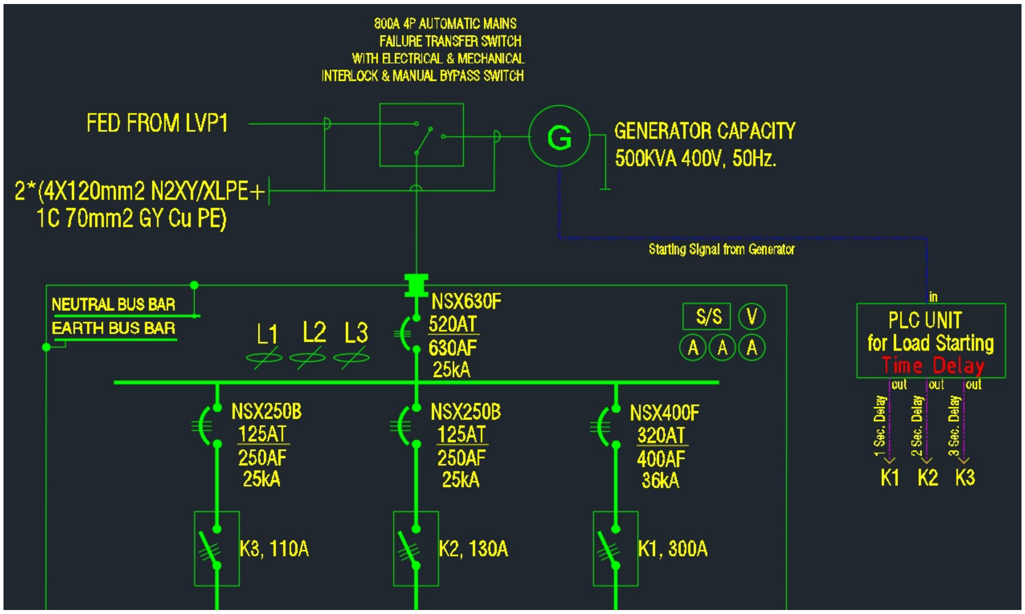


Figure (4. 4): Emergency Panels Control & Backup Generator Wiring Diagram & Hotel ATS.

4.3.2 Automatic Transfer Switch (ATS)

In this project, to guarantee that power is supplied to the loads, a fundamental requirement in an installation is to have a redundancy in supply sources type N+1, usually consisting of a transformer + emergency generator (or, as an alternative, a second transformer). [7]

So, to transfer the electric power from normal supply from transformer to the backup generator, an ATS022 AUTO.TRAN. SWITCH ADVANCED CONTROL with 400A from ABB manufacturer has been used. Figure (4.5) and Figure (4.6) shows the shape and wiring diagram for ATS022.

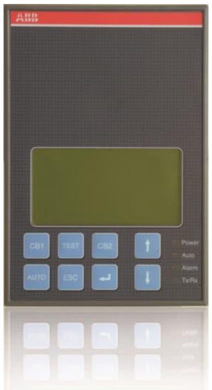


Figure (4. 5): an Automatic Transfer Switch Control Unit.[7]

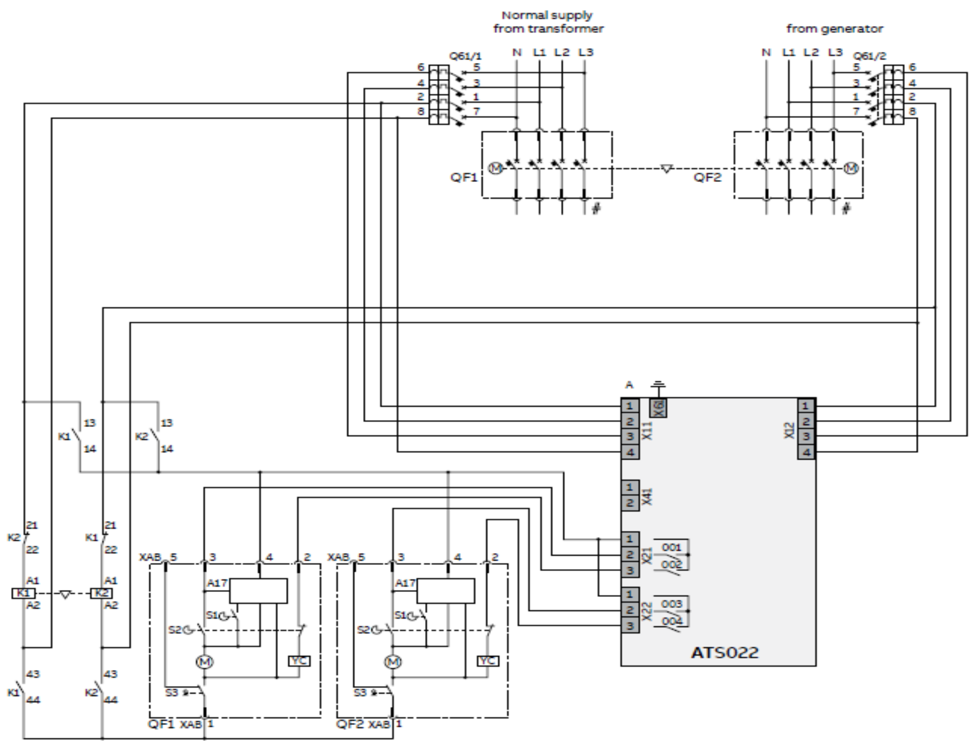


Figure (4. 6): Wiring Diagram of ATS022 Control Unit. [7]

4.4 UPS Sizing

UPS systems depend entirely on thyristors, as it converts DC current into AC current, and this way Learn the Inverter method.

In the case of feeding large loads, the UPS is connected to the electric generator to compensate for the voltage drop.

The loads to be connected to the UPS system shown in Table (4.8). loads were 47kva. When adding 20% for future growth, the total loads became equal to 56.4kva.

Therefore, a UPS was chosen that gives 60 kVA with a current of [8*(20 x 94)] Ah Long life batteries from Legrand, which last up to 15 minutes after a power outage. The company's catalog is attached to the appendix and contains the data sheet, and the shape of the UPS unit as shown in Figure (4.7).[4]

Table (4. 8): UPS loads:

Floor	Group Load Name (DB)	Feed From SMDB	Phase	Connected Light Load (KVA)	Connected Power Load (KVA)	ku Lights Loads	ku Power Load	ks for DB	Demand Light Load (KVA)	Demand Power Load (KVA)	Total Load Demand (KVA)	Total Demand Ampere (A)
Ground Floor	DB.GF EM	SMDB-1 EM@ Ground Floor	3PH	5.30	8.40	1	0.8	0.9	4.77	6.05	10.82	15.61
	FRISH AIR TXF.1@2P		3PH	-	6.50	-	1	1	-	6.50	6.50	9.38
	GATE BARRIER		1PH	-	3.00	1	0.8	0.9	-	2.16	2.16	9.39
	WATER TR. PUMP		3PH	-	15.00	-	0.75	0.75	-	8.44	8.44	12.18
Mezzanin Floor	DB.MEZ. EM.		1PH	3.30	0.60	1	0.8	0.9	2.97	0.43	3.40	14.79
1st. Parkin g Floor	DB.1st PAR.EM		3PH	2.40	3.40	1	0.8	0.9	2.16	2.45	4.61	6.65
2nd Parkin g Floor	DB.2nd PAR.EM		3PH	2.90	2.80	1	0.8	0.9	2.61	2.02	4.63	6.68
3rd Parkin g Floor	DB.3rd PAR.EM		3PH	2.50	2.20	1	0.8	0.9	2.25	1.58	3.83	5.53
Resturant Floor	DB.RST.EM		3PH	4.85	0.80	1	0.8	0.9	4.37	0.58	4.94	7.13
Service Floor	DB.SER.EM		1PH	3.10	0.80	1	0.8	0.9	2.79	0.58	3.37	14.63
Praying Floor	DB.IT EM.		1PH	3.00	0.60	1	0.8	0.9	2.70	0.43	3.13	13.62

Figure (4. 7): Legrand ups unit model number (3 108 11) [4].

At the beginning of the operation of the electric generator, it must be taken into account that the frequency coming out of the generator is set correctly and its vibration is not so great that the so-called synchronization failure does not occur between the equipment, the generator and this UPS. Figure (4.8) shows the UPS diagram.

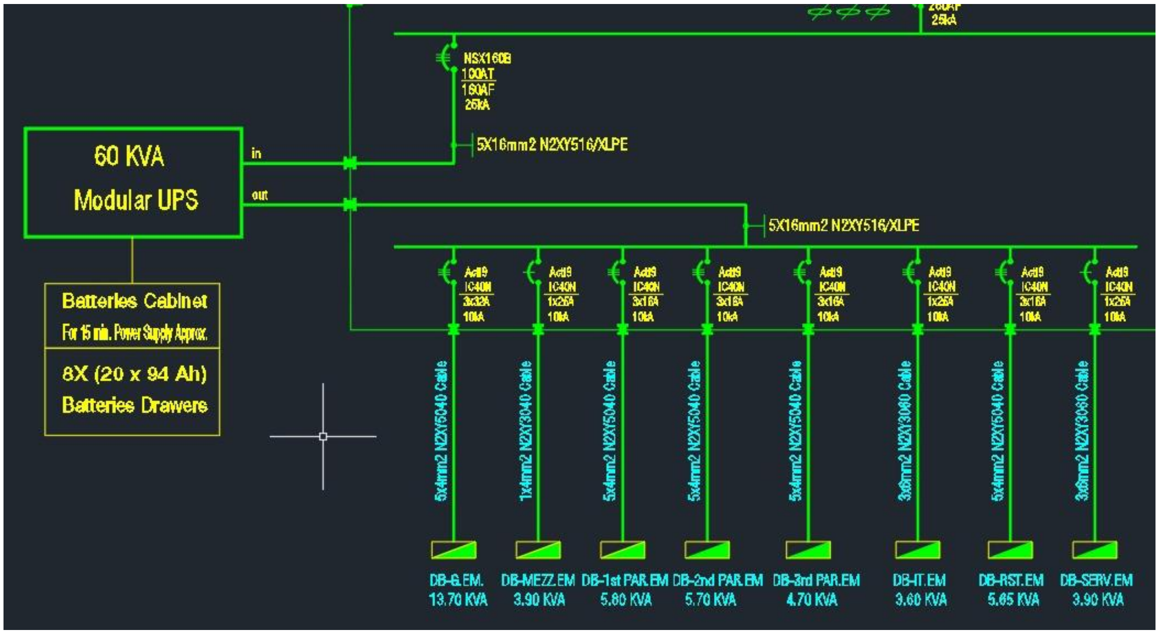


Figure (4. 8): UPS connection diagram.

4.5 Power Sources Cable Sizing

For the MV/LV 1,000 kVA transformer has a rated voltage of 400 V. according table (4.2) the full load current for transformer at secondary side is $I_b = 1{,}443.4\ A\ per\ phase$.

Using recommended simplified approach for cables mentioned in sub-section 3.2.3, and from table (3.3) 4 x multi-core N2XY/XLPE insulated copper cables in parallel will be used. These cables will be buried under the ground according to method D1/D2. Each phase conductor will therefore carry current up to 396 A. table (3.3) indicates that for 3 loaded conductors with XLPE insulation, the required C.S.A. is 300 mm². Table 4.4 shows the C.S.A used for each power source cable and number of multi-core cables in parallel.

Table (4. 9): Cables size for each power source:

Power Source Name	Phase	Power Source Rating (KVA)	Full Load Ib (A) @400V	Install. Method	Cable Corre. I'z (A)	Cable C.S.A (mm2)	PE C.S.A (mm2)	No. of Multi-core Cable in Parallel
Tansformer 1	3PH	1000	1443.38	D1/D2	396.00	300	150	4
Tansformer 2	3PH	1250	1804.22	D1/D2	396.00	300	150	5
Tansformer 3	3PH	1600	2309.40	D1/D2	396.00	300	150	6
Backup Generator	3PH	500	721.69	E or F	346.00	120	70	2
UPS	3PH	60	86.60	E or F	100.00	16	16	1

4.6 Paralleling Connection for Hotel Transformers

For achieving a continuity of service and reliability for the electrical installation of this hotel project, the paralleling connection for three different transformers in kVA will be taken into consideration.

There are various conditions that must be fulfilled for the successful parallel operation of transformers, as following: same voltage and turns ration, same percentage impedance and X/R ration, identical position of tap changer, same phase angle shift, same frequency rating, same Polarity and same phase sequence.

The electrical installation in this project has been designed to operate as Simple Radial System. However, in the cases of a transformer malfunction or any transformer being out of service for the purpose of maintenance, the electrical system will operate as Loop-Primary – Radial Secondary as shown in figure (4.9).

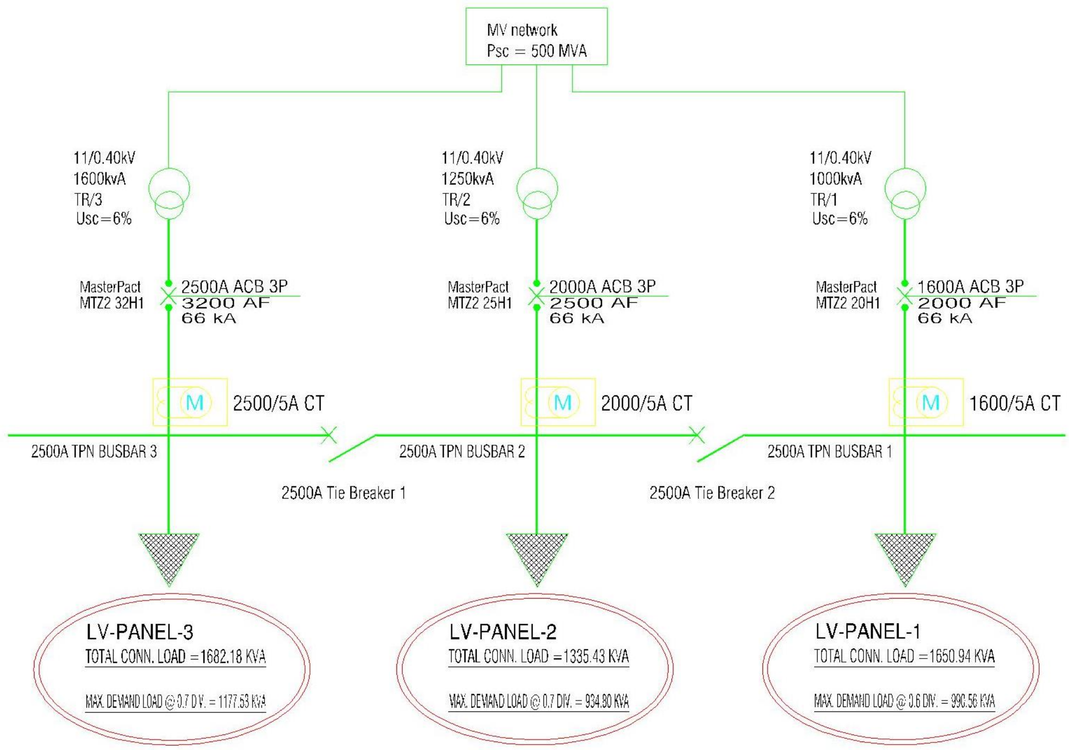


Figure (4. 9): Loop-Primary – Radial

As mentioned before, three possible cases of transformer malfunction or any transformer being out of services, have been considered here in this project, as following:

a) **Case no. 1 for TR/1**: if occurred a malfunction or being out of services for maintenance, TR/2 and TR/3 will be entered to service by closing the tie breakers 1&2. Taking into consideration, to minimize and disconnect some loads as MDB-EM with total loads of 362.95 kVA, then power the MDB-EM by backup generator. This process can be done manually or through a control circuit.

b) **Case no. 2for TR/2**: if occurred a malfunction or being out of services for maintenance, TR/ 1and TR/3 will be entered to service by closing the tie breakers 1&2. Taking into consideration, to minimize and disconnect some loads as CHILLER-1, 2 and 3 of CKT-2 with total loads of 516 kVA. This process also can be done manually or through a control circuit.

c) **Case no. 3 for TR/3**: if occurred a malfunction or being out of services for maintenance, TR/ 1and TR/2 will be entered to service by closing the tie breakers 1&2. Taking into consideration, to minimize and disconnect some loads as

CALORIFIRE-2, 3 and SMDB-2 SERV. with total loads of 838.5 kVA. This process also can be done manually or through a control circuit.

4.7 Summary

In this chapter, each of power source for the hotel project has been sized and determined, and then the automatic transfer switch has been sized. In addition, each cable for power source has been chosen using the recommended simplified approach for cables used in chapter 3. Finally, the paralleling connection for hotel transformers for achieving a reliability and continuity of service has been considered.

5

Chapter Five

Short Circuit Study

5.1 Introduction

5.2 Short-Circuit Current at the Secondary Terminals of a MV/LV Distribution Transformer

5.3 3-phase Short-Circuit Current at Any Point in LV Installation

5.4 Determination of the Impedance of Each Component

5.5 Summary

5.1 Introduction

A knowledge of 3-phase symmetrical short-circuit current values (Isc) at strategic points of an installation is necessary in order to determine switchgear (breaking capacity), cables (thermal withstand rating), protective devices (selective trip settings) and so on...

Power systems with a voltage in excess of 1000 V shall be designed somehow that the RMS value of the A.C. components of the short-circuit breaking current of the circuit breakers shall not exceed 25 KA as per IEC 60056. [5]

For power systems with a voltage less than 1000 volt, the RMS value of the A.C component of the short circuit breaking current of circuit breaker designed shall be as per IEC 60947-2 and shall not exceed 50 KA.[6]

5.2 Short-Circuit Current at the Secondary Terminals of a MV/LV Distribution Transformer.

The project's electrical loads powered by three-separated distribution transformer, as mentioned in chapter 4. For this case of one distribution transformer and in a simplified approach, the impedance of the MV system is assumed to be negligibly small, so that:

$$\mathbf{I_{SC}} = \frac{\mathbf{I_n x100}}{\mathbf{U_{SC}}} \tag{5. 1}$$

$$\mathbf{I_n} = \frac{\mathbf{S\,x1000}}{\mathbf{U_{20} * \sqrt{3}}} \tag{5. 2}$$

Where:

S = kVA rating of the transformer

U_{20} = phase-to-phase secondary no-load voltage

I_n = rated current of the transformer

I_{SC} = short-circuit current in amps

U_{SC} = short-circuit impedance voltage of the transformer in %.

Typical values of U_{SC} for distribution transformers are given in Figure (5.1).

Table (5. 1): Typical values of $\boldsymbol{U_{SC}}$ for kVA ratings of transformers with MV windings ≤ 20 kV: [1]

Transformer rating (kVA)	Usc in %	
	Oil-immersed	Cast-resin dry type
50 to 750	4	6
800 to 3200	6	6

Table (5.2) shows the calculated short circuit current at the secondary terminal for each transformer at no load voltage.

Table (5. 2): Calculated short-circuit current at transformer secondary terminals:

Low Voltage Panel Number	Transformer Rating (KVA)	Usc in %	No-load Voltage U20	Transformer Rated Current In (A)	Short-Circuit Current Isc (kA)
LVP-1	1000	6.0%	420	1374.6	22.9
LVP-2	1250	6.0%	420	1718.3	28.6
LVP-3	1600	6.0%	420	2199.4	36.7

5.3 3-phase Short-Circuit Current at Any Point in LV Installation

The short-circuit current I_{SC} at any point of three phase installation is given by:

$$\mathbf{I_{SC}} = \frac{\mathbf{U_{20}}}{\sqrt{3}\ \mathbf{x}\ \mathbf{Z_T}} \qquad (5.3)$$

Where:

U_{20} = phase-to-phase voltage of the open circuited secondary windings of the power supply transformer(s).
Z_T = total impedance per phase of the installation upstream of the fault location (in Ω).

Each component of an installation (MV network, transformer, cable, busbar, and so on...) is characterized by its impedance Z, comprising an element of resistance (R) and an inductive reactance (X). The parameters R, X and Z are expressed in ohms (Ω).

The method of calculating Z_T consists in dividing the network into convenient sections, and to calculate the R and X values for each. Where sections are connected in series in the network, all the resistive elements in the section are added arithmetically; likewise for the reactance's, to give R_T and X_T.

The impedance (Z_T) for the combined sections concerned is then calculated from:

$$\mathbf{Z_T = \sqrt{R_T^2 + X_T^2}} \qquad (5.\ 4)$$

5.4 Determination of the Impedance of Each Component

The determination of the impedance of each component in LV installation is explained below:

5.4.1 Network upstream of the MV/LV transformer

The 3-phase short-circuit fault level P_{sc}, in kA or in MVA is given by the power supply authority concerned, from which an equivalent impedance can be deduced.

Table (5. 3): the impedance of the MV network referred to the LV side of the MV/LV transformer. [1]

Psc	U_{20} (V)	Ra (mΩ)	Xa (mΩ)
250 MVA	420	0.07	0.7
500 MVA	420	0.035	0.351

A formula, which makes this deduction and at the same time converts the impedance to an equivalent value at LV, is given, as follows:

$$\mathbf{Z_a = \frac{U_{20}^2}{P_{sc}}} \qquad (5.\ 5)$$

Where:

Z_a= impedance of the MV voltage network, expressed in milli-ohms ($m\Omega$).

U_{20}= phase-to-phase no-load LV voltage, expressed in volts (V).

P_{sc}= MV 3-phase short-circuit fault level, expressed in (kVA).

If more accurate calculations are necessary;

$$X_a = 0.995\ Z_a \text{ and } R_a = 0.1\ X_a$$

5.4.2 Distribution Transformer

The impedance Z_{tr} in (mΩ) of a transformer, viewed from the LV terminals, is given by the formula:

$$\mathbf{Z_{tr}} = \frac{U_{20}{}^{2}}{S_n} \times \frac{U_{sc}}{100} \tag{5. 6}$$

Where:

U_{20}= phase-to-phase no-load LV voltage, expressed in volts (V).
S_n= rating of the transformer (in kVA).
U_{SC}= the short-circuit impedance voltage of the transformer expressed in %.

The transformer windings resistance R_{tr} and reactance X_{tr}in (mΩ) can be obtained from following figure (5.2) for typical oil-immersed transformers.

Table (5. 4): Resistance, reactance and impedance values for typical distribution 400V transformers (no-load voltage = 420 V) with MV windings ≤ 20 kV. [1]

Rated Power (kVA)	Oil-immersed			
	Usc (%)	Rtr (mΩ)	Xtr (mΩ)	Ztr (mΩ)
100		37.9	9.5	70.6
160	4	16.2	41.0	44.1
200	4	11.9	33.2	35.3
250	4	9.2	26.7	28.2
315	4	6.2	21.5	22.4
400	4	5.1	16.9	17.6
500	4	3.8	13.6	14.1
630	4	2.9	10.8	11.2
800	6	2.9	12.9	13.2
1000	6	2.3	10.3	10.6
1250	6	1.8	8.3	8.5
1600	6	1.4	6.5	6.6
2000	6	1.1	5.2	5.3

5.4.3 Busbars

The resistance of busbars is generally negligible, so that the impedance is practically all reactive, so the X_{bar} here is provided from ABB manufacture for hotel LV busbars.

5.4.4 Circuit Conductors / Cables

The resistance of a conductor is given by the formula:

$$\mathbf{R_c = \rho \, x \, \frac{L}{S}} \tag{5. 7}$$

Where:

ρ = the resistivity of the conductor material at the normal operating temperature.
L = length of the conductor in meter.
S = C.S.A. of conductor in mm^2

Table (5. 5): Values of ρ as a function of the temperature, cable insulation and cable core material, according to IEC60909-0 and Canelés TR 50480 (in mΩ.mm²/m). [1]

	20 °C	PR/XLPE 90 °C	PVC 70 °C
Copper	18.51	23.69	22.21
Alu	29.41	37.65	35.29

Note, the conductor's reactance here is considered as X_c = 0.08 mΩ/meter.

5.4.5 Example

A three-phase short circuit current occurred on 4 core (3x185mm^2 + 95mm^2) copper cable, at 20 meters away from bus riser 4 which fed by transformer 1 at 20°C .All sections data are given in the following figure (5.1).

So, using the figure data the short circuit value will be calculated.

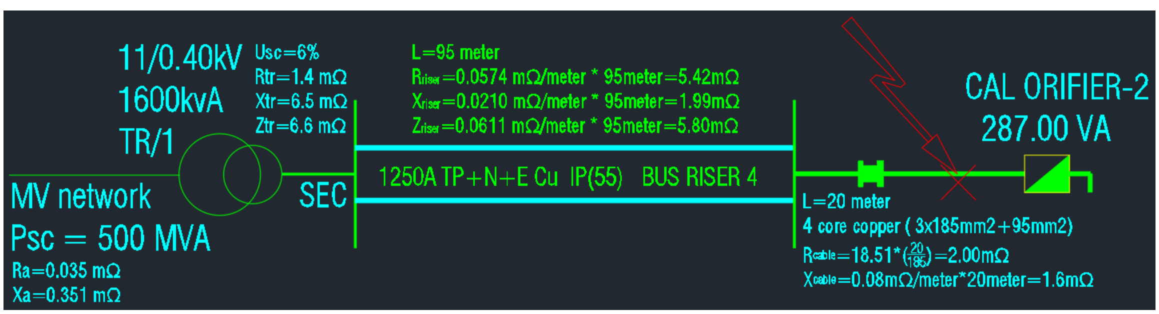


Figure (5. 1): the example data for each installation's section.

As mentioned in section 5.1.2, each component of an installation is connected in series in the network, all the resistive elements in the section are added arithmetically; likewise, for the reactance, to give R_T and X_T. Figure (5.2) shows the equivalent Z_T.

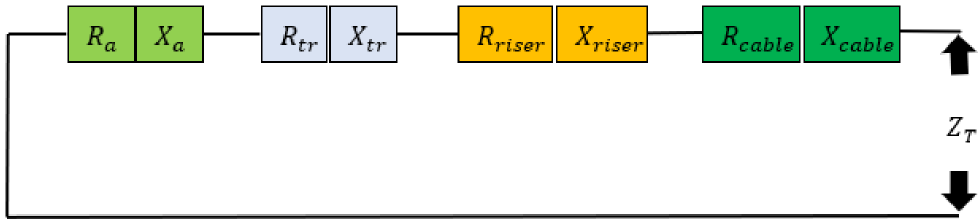


Figure (5. 2): Equivalent impedance seen from fault point.

a) Supply Network:

Z_a Obtained From equation (5.5):

$$Z_a = \frac{U_{20}^2}{P_{sc}} = \frac{420^2}{500} = 0.3528 \text{ m}\Omega$$

$X_a = 0.995\ Z_a = 0.995 * 0.3528 \text{ m}\Omega = 0.351 \text{ m}\Omega$

$R_a = 0.1\ X_a = 0.1 * 0.351 \text{ m}\Omega = 0.0351 \text{ m}\Omega$

b) Distribution Transformer 1:

From figure (5.2), the R_{tr} & X_{tr} for typical distribution 400V transformers:

$R_{tr} = 1.4 \text{ m}\Omega$,

$X_{tr} = 6.5 \text{ m}\Omega$.

c) Bus Riser 4:

From Table (3.10), the R_{riser} & X_{riser} are given per meter by the ABB manufacturer:

$R_{riser} = 0.0574\text{m}\Omega/\text{meter} * 95 \text{ meter} = 5.42 \text{ m}\Omega$

$X_{riser} = 0.0210\text{m}\Omega/\text{meter} * 95 \text{ meter} = 1.99 \text{ m}\Omega$

d) 4 core copper cable:

From Table (5.4),

$$R_{cable} = \rho * \frac{L}{S} = 18.51 * \frac{20}{185} = 2.00 \text{ m}\Omega$$

$X_{cable} = 0.08 \text{ m}\Omega/\text{meter} * 20 \text{ meter} = 1.60 \text{ m}\Omega$

After calculating each section's resistances and reactance, the R_T and X_T will be:

$$R_T = R_a + R_{tr} + R_{riser} + R_{cable} = 0.0351 + 1.4 + 5.42 + 2.00 = 8.8551\ m\Omega$$

$$X_T = X_a + X_{tr} + X_{riser} + X_{cable} = 0.351 + 6.50 + 1.99 + 1.60 = 10.441\ m\Omega$$

So, Z_T obtained from equation (5.4):

$$Z_T = \sqrt{R_T^2 + X_T^2} = \sqrt{8.8551^2 + 10.441^2} = 13.69 m\Omega$$

Finally, the short-circuit current, obtained from equation (5.3):

$$I_{SC} = \frac{U_{20}}{\sqrt{3}\ x\ Z_T} = \frac{420}{\sqrt{3}\ x\ 13.69} = 17.7\ kA$$

Table (5.6) shows the calculated short-circuit current results at each SMDB load point, where the R_T , X_T and Z_T for each section of the LV installation were considered and calculated.

Table (5. 6): the short-circuit value at each SMDB load's Point.

SMDB Name	Bus Riser No.	Transformer No.	Length of Bus Riser (m)	Length of Cable (m)	Cable C.S.A (mm2)	Ra (mΩ)	Xa (mΩ)	Rtr (mΩ)	Xtr (mΩ)	Rriser (mΩ)/ meter	Xriser (mΩ)/ meter	Rriser (mΩ)	Xriser (mΩ)	Rcable (mΩ)	Xcable (mΩ)	RT (mΩ)	XT (mΩ)	ZT (mΩ)	Isc (kA)
SMDB Ground Floor	-	TR/2	-	15.00	120	0.035	0.351	1.8	8.3	-	-	-	-	2.31	1.20	4.15	9.85	10.69	22.69
SMDB Parking Floor		TR/1	-	20.00	16			2.3	10.3					23.14	1.60	25.44	12.25	28.23	8.59
SMDB Restaurant Floor		TR/3	-	25.00	150			1.4	6.5					3.09	2.00	4.49	8.85	9.92	24.44
SMDB-1 Service Floor		TR/3	-	30.00	150									3.70	2.40	5.10	9.25	10.56	22.95
SMDB-2 Service Floor		TR/3	-	32.00	150									3.95	2.56	5.35	9.41	10.82	22.40
SMDB Prayer Floor	BUS RISER 1	TR/1	30.00	15.00	16			2.3	10.3	0.1121	0.0318	3.36	0.95	17.35	1.20	23.05	12.81	26.37	9.20
SMDB (1ST) Floors			33.50	15.00	16							3.76	1.07	17.35	1.20	23.44	12.92	26.77	9.06
SMDB (2ND) Floors			37.00	15.00	16							4.15	1.18	17.35	1.20	23.84	13.03	27.16	8.93
SMDB (3RD) Floors			40.50	15.00	16							4.54	1.29	17.35	1.20	24.23	13.14	27.56	8.80
SMDB (4TH) Floors			44.00	15.00	16							4.93	1.40	17.35	1.20	24.62	13.25	27.96	8.67
SMDB (5TH) Floors			47.50	15.00	16							5.32	1.51	17.35	1.20	25.01	13.36	28.36	8.55
SMDB (6TH) Floors			51.00	15.00	16							5.72	1.62	17.35	1.20	25.41	13.47	28.76	8.43
SMDB (7TH) Floors			54.50	15.00	16							6.11	1.73	17.35	1.20	25.80	13.58	29.16	8.32
SMDB (8TH) Floors			58.00	15.00	16							6.50	1.84	17.35	1.20	26.19	13.70	29.55	8.20
SMDB (9TH) Floors	BUS RISER 2	TR/1	61.50	15.00	16							6.89	1.96	17.35	1.20	26.58	13.81	29.95	8.10
SMDB (10TH) Floors			65.00	15.00	16							7.29	2.07	17.35	1.20	26.97	13.92	30.35	7.99
SMDB (11TH) Floors			68.50	15.00	16							7.68	2.18	17.35	1.20	27.37	14.03	30.75	7.88
SMDB (12TH) Floors			72.00	15.00	16							8.07	2.29	17.35	1.20	27.76	14.14	31.15	7.78
SMDB (13TH) Floors			75.50	15.00	16							8.46	2.40	17.35	1.20	28.15	14.25	31.55	7.68
SMDB (14TH) Floors			79.00	15.00	16							8.86	2.51	17.35	1.20	28.54	14.36	31.95	7.59
SMDB (15TH) Floors			82.50	15.00	16							9.25	2.62	17.35	1.20	28.94	14.47	32.35	7.49
SMDB 16TH Floor			86.00	15.00	16							9.64	2.73	17.35	1.20	29.33	14.59	32.76	7.40
SMDB 17TH Floor			89.50	15.00	10							10.03	2.85	27.77	1.20	40.13	14.70	42.74	5.67
SMDB-1 Roof Floor			93.00	15.00	35							10.43	2.96	7.93	1.20	20.69	14.81	25.45	9.53
SMDB-2 Roof Floor	BUS RISER 4	TR/3	95.00	-	-			1.4	6.5	0.0574	0.021	5.45	2.00	-	-	6.89	8.85	11.21	21.63
MDB.AC @ Roof Floor	BUS RISER 3	TR/2	96.00	-	-			1.8	8.3	0.0435	0.017	4.18	1.63	-	-	6.01	10.28	11.91	20.36
SMDB-1 EM@ Ground Floor	-	TR/1	-	17.00	25			2.3	10.3	-	-	-	-	12.59	1.36	14.92	12.01	19.16	12.66
SMDB-2 EM@ 1st Floor	-	TR/1	-	36.00	25									26.65	2.88	28.99	13.53	31.99	7.58
SMDB-3 EM@ 9th Floor	-	TR/1	-	60.00	95									11.69	4.80	14.03	15.45	20.87	11.62
SMDB EM @Roof Floor	-	TR/1	-	38.00	50									14.07	3.04	16.40	13.69	21.37	11.35

5.5 Summary

A brief introduction for short-circuit has been introduced, then Short-circuit Current at the secondary terminals of the distribution transformer and at any point of the LV installation also have been determined.

Moreover, the method used to determine the impedance for each installation's component has been explained. Finally, an example shows the applied method to determine each component's R_T , X_T and Z_T.

6

Chapter Six

Circuit Breaker

6.1 Definition

An electrical circuit breaker is a switching device that can be operated manually or automatically for controlling and protecting the electrical power system. Without a circuit breaker, there is a high risk of electrical fires, electrocution and electrical shocks.

6.2 Types of Circuit Breakers

There are different types of circuit breakers, which are based on rating current, voltage, installation location, external design and interrupting mechanism. As shown in table (6.1).

Table (6. 1): Rating currents of different low voltage Switchgears:

Item No.	**Switching Device**	**Abbreviation**	**Rated Current (A)**	**Function**	**Photo**
1	Residual-Current Circuit Breaker	RCCB	40, 63A	Protection against electric shocks, also provide sensitive detection (30 mA) of earthleakage current with CB tripping	
2	Miniature Circuit Breaker	MCB	10-125A	Overcurrent protection and circuit isolation features	
3	Moulded-Case Circuit Breakers	MCCB	100-630A	Protect the electrical circuit from excessive current	
4	Air Circuit Breakers	ACB	630-6300A	Protecting low voltage circuit, mainly for energizing and cutting off high current	

6.3 Fundamental Characteristics of a Circuit Breaker

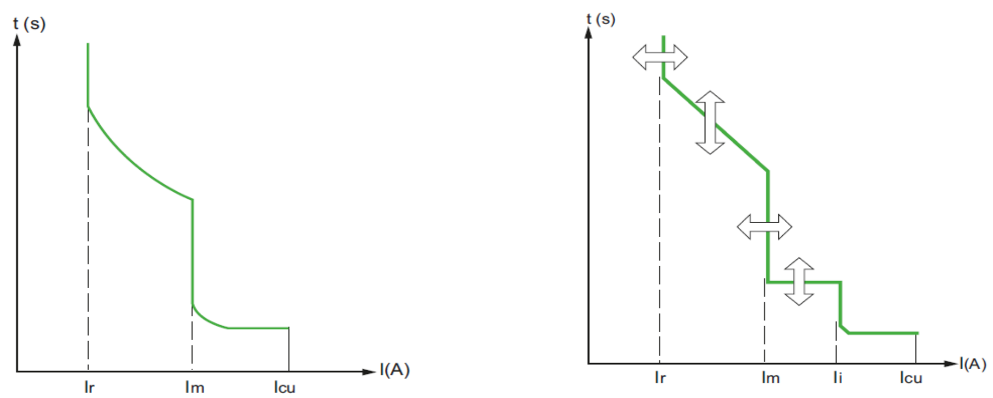
The fundamental characteristics of a circuit breaker are:

- Its rated voltage Ve
- Its rated current In
- Its tripping-current-level adjustment ranges for overload protection (Ir or $Irth$) and for short-circuit protection (Im)
- It short-circuits current breaking rating (Icu for industrial CBs; Icn for domestic-type CBs).

Table (6.2) shows the tripping-current ranges of overload and short-circuit protective devices for LV circuit breakers. Figure (6.1) shows tripping curve of a circuit breaker with advanced electronic trip unit.

Table (6. 2): tripping-current ranges of overload and short-circuit protective devices for LV circuit breakers: [1]

	Type of protective relay	Overload protection	Short-circuit protection		
Domestic breakers IEC 60898	Thermal-magnetic	Ir = In	Low setting type B 3 In ≤ Im ≤ 5 In	Standard setting type C 5 In ≤ Im ≤ 10 In	High setting circuit type D 10 In ≤ Im ≤ 20 In[a]
Modular industrial[b] circuit breakers	Thermal-magnetic	Ir = In fixed	Low setting type B or Z 3.2 In ≤ fixed ≤ 4.8 In	Standard setting type C 7 In ≤ fixed ≤ 10 In	High setting type D or K 10 In ≤ fixed ≤ 14 In
Industrial[b] circuit breakers IEC 60947-2	Thermal-magnetic	Ir = In fixed	Fixed: Im = 7 to 10 In		
		Adjustable: 0.7 In ≤ Ir ≤ In	Adjustable: - Low setting : 2 to 5 In - Standard setting: 5 to 10 In		
	Electronic	Long delay 0.4 In ≤ Ir ≤ In	Short-delay, adjustable 1.5 Ir ≤ Im ≤ 10 Ir Instantaneous (I) fixed I = 12 to 15 In		



a) *b)*

a) Tripping curve of a thermal-magnetic circuit breaker,
b) Tripping curve of a circuit breaker with advanced electronic trip unit.

Figure (6. 1): curve of a circuit breaker. [1]

6.4 Selection of a Circuit Breaker

The choice of a range of circuit breakers is determined by the electrical characteristics of the installation, the environment, the loads and a need for remote control, together with the type of communications system envisaged.

The principle of overcurrent (Overloads and Short-circuit currents $\mathbf{I_{SC}}$) protection device is shown in figure (6.2). Which acting to cut-off the current in a time shorter than that given by the $\mathbf{I^2t}$ Characteristic of the circuit cabling, but allowing the maximum load current $\mathbf{I_B}$ to flow indefinitely.

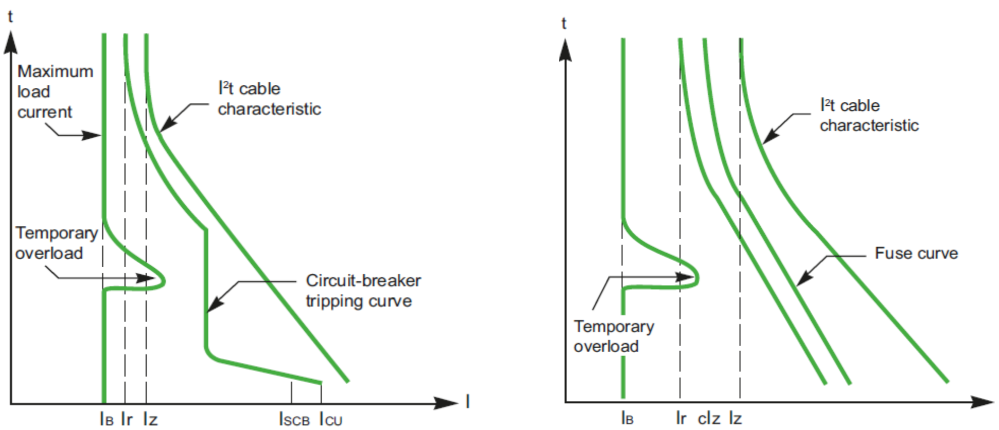


Figure (6. 2): Circuit protection by circuit breaker and fuses. [1]

In project, general rules laid down in the IEC standards, have been considered:

1. The nominal current $\mathbf{I_n}$ for (circuit breaker & fuse) is correctly if:

$$\mathbf{I_B} \leq \mathbf{I_n} \leq \mathbf{I_Z} \qquad (6.\ 1)$$

2. The tripping current **I2** for (circuit breaker & fuse) is:

$$\mathbf{I2} \leq \mathbf{1.45\, I_Z} \qquad (6.\ 2)$$

3. The 3-phase short-circuit fault-current breaking rating $\mathbf{I_{SCB}}$ for (circuit breaker & fuse) is greater than the 3-phase short-circuit current existing at its point of installation:

$$\mathbf{I_{SC}} \leq \mathbf{I_{SCB}} \qquad (6.\ 3)$$

6.4.1 Selection of Circuit Breakers as Main Incomer and Feeders

In the project, according to transformer's rated currents, which mentioned in table (5.2). Also, according to rating currents of different circuit breakers mentioned in table (6.1). Air-circuit breaker (ACB) is suitable for the three main circuit breakers of an installation supplied through the three 3-phase transformers in the hotel substations.

A Master Pact MTZ2 air circuit breakers (ACB) from Schneider with an adjustable tripping-unit range of current, and a short-circuit breaking capacity (Icu) of 66 kA would be a suitable choice for this duty.

Table (6.3) shows the kind of ACB's used in hotel project, with their suitable breaking frame current rating and adjusted breaking trip current.

Table (6. 3): Type of ACB used in hotel project:

Low Voltage Panel Number	Transformer Rating (KVA)	Transformer Rated Current In (A)	Cable Catalog Number	Cable C.S.A (mm2)	Calculated Short-Circuit Current (Isc)	ACB Type	Breaker Frame Current Rating	Breaker Trip Current Rating (In)	Short-Circuit Breaking Capacity (Icu)
LVP-1	1000	1374.6	N2XY4300	4x (4x300+150) mm2	22.9 kA	MasterPact MTZ2 20H1	2000 A	1600	66 kA
LVP-2	1250	1718.3	N2XY4300	5x (4x300+150) mm2	28.6 kA	MasterPact MTZ2 25H1	2500 A	2000	66 kA
LVP-3	1600	2199.4	N2XY4300	6x (4x300+150) mm2	36.7 kA	MasterPact MTZ2 32H1	3200 A	2500	66 kA

6.4.2 Selection of feeder CBs and final-circuit CBs

Using general rules laid down in the IEC standards, which mentioned above, all circuit breaker in hotel project have selected based on this rule. For all hotel SMDB's and DB's.

Taking SMDB of ground floor as example, the NSX400F MCCB used to protect this SMDB using these rules as following:

For nominal current $\mathbf{I_n}$ of NSX400F MCCB:

$$I_B \le I_n \le I_Z \tag{6.1}$$

$$328.04\text{ A} \le 350\text{ A} \le 359\text{ A}$$

For tripping current I2 of NSX400F MCCB:

$$I2 \le 1.45\, I_Z \tag{6.2}$$

$$350\text{ A} \le 1.45\, x\, 359 \rightarrow 350\text{ A} \le 520.55\text{ A}$$

For 3-phase short-circuit fault-current breaking rating $\mathbf{I_{SCB}}$ of NSX400F MCCB:

$$I_{SC} \leq I_{SCB} \tag{6.3}$$

$$22.69 \text{ kA} \leq 36 \text{ kA}$$

After applying all previous rules, we conclude that the NSX400F MCCB is suitable for protection SMDB Ground Floor. Table (6.4) shows all selected circuit breakers for different SMDB's, Table (6.5) shows the result quantities for the circuit breakers used from the transformer secondary side to SMDB panels. Table (6.6) shows all selected circuit breakers for normal DB's Table (6.7) shows all selected circuit breakers for emergency DB's in hotel. in appendix F (page 139)

Table (6. 4): Type of MCCB circuit breaker used to protect SMDB's in hotel:

SMDB Name	Total Connected Load (KVA)	Full Load Ib (A)	Cable Catalog Number	Cable C.S.A (mm2)	Calculated Isc (kA)	Type of Circuit Breaker	Breaker Frame Current Rating	Breaker Trip Current Rating (In)	Short-Circuit Breaking Capacity (Icu)
SMDB Ground Floor	227.27	328.04	N2XY4120	(4x120+70) mm2	22.69	NSX400F	400A	350A	36kA
SMDB Parking Floor	52.32	75.52	N2XY516	5x16 mm2	8.59	NSX160B	160A	100A	25kA
SMDB Restaurant Floor	292.63	422.38	N2XY4150	(4x150+70) mm2	24.44	NSX630F	500A	450A	36kA
SMDB-1 Service Floor	264.05	381.12	N2XY4150	(4x150+70) mm2	22.95	NSX630F	500A	400A	36kA
SMDB-2 Service Floor	263.5	380.33	N2XY4150	(4x150+70) mm2	22.40	NSX630F	500A	400A	36kA
SMDB Prayer Floor	56.73	81.88	N2XY516	5x16 mm2	9.20	NSX160B	160A	100A	25kA
SMDB (1ST) Floors	66.42	95.87	N2XY516	5x16 mm2	9.06	NSX160B	160A	100A	25kA
SMDB (2ND) Floors	66.42	95.87	N2XY516	5x16 mm2	8.93	NSX160B	160A	100A	25kA
SMDB (3RD) Floors	66.42	95.87	N2XY516	5x16 mm2	8.80	NSX160B	160A	100A	25kA
SMDB (4TH) Floors	66.42	95.87	N2XY516	5x16 mm2	8.67	NSX160B	160A	100A	25kA
SMDB (5TH) Floors	66.42	95.87	N2XY516	5x16 mm2	8.55	NSX160B	160A	100A	25kA
SMDB (6TH) Floors	66.42	95.87	N2XY516	5x16 mm2	8.43	NSX160B	160A	100A	25kA
SMDB (7TH) Floors	66.42	95.87	N2XY516	5x16 mm2	8.32	NSX160B	160A	100A	25kA
SMDB (8TH) Floors	66.42	95.87	N2XY516	5x16 mm2	8.20	NSX160B	160A	100A	25kA
SMDB (9TH) Floors	66.42	95.87	N2XY516	5x16 mm2	8.10	NSX160B	160A	100A	25kA
SMDB (10TH) Floors	66.42	95.87	N2XY516	5x16 mm2	7.99	NSX160B	160A	100A	25kA
SMDB (11TH) Floors	66.42	95.87	N2XY516	5x16 mm2	7.88	NSX160B	160A	100A	25kA
SMDB (12TH) Floors	66.42	95.87	N2XY516	5x16 mm2	7.78	NSX160B	160A	100A	25kA
SMDB (13TH) Floors	66.42	95.87	N2XY516	5x16 mm2	7.68	NSX160B	160A	100A	25kA
SMDB (14TH) Floors	66.42	95.87	N2XY516	5x16 mm2	7.59	NSX160B	160A	100A	25kA
SMDB (15TH) Floors	66.42	95.87	N2XY516	5x16 mm2	7.49	NSX160B	160A	100A	25kA
SMDB 16TH Floor	55.26	79.76	N2XY516	5x16 mm2	7.40	NSX160B	160A	100A	25kA
SMDB 17TH Floor	34.98	50.49	N2XY510	5x10 mm2	5.67	NSX100B	100A	63A	25kA
SMDB-1 Roof Floor	92.4	133.37	N2XY435	(4x35+16) mm2	9.53	NSX250B	250A	160A	25kA
SMDB-2 Roof Floor	862	1244.19	1250A TP+N+E Cu IP(55)	-	21.63	MasterPact MTZ2 16N1	1600A	1250A	42kA
MDB.AC @ Roof Floor	1029	1485.23	1600A TP+N+E Cu IP(55)	-	20.36	MasterPact MTZ2 20N1	2000A	1600A	42kA
SMDB-1 EM@ Ground Floor	71.45	103.13	N2XY425	(4x25+16) mm2	12.66	NSX250B	250A	125A	25kA
SMDB-2 EM@ 1st Floor	82.8	119.51	N2XY425	(4x25+16) mm2	7.58	NSX250B	250A	125A	25kA
SMDB-3 EM@ 9th Floor	201.8	291.27	N2XY495	(4x95+50) mm2	11.62	NSX400F	400A	320A	36kA
SMDB EM @Roof Floor	121.3	175.08	N2XY450	(4x50+25) mm2	11.35	NSX250B	250A	200A	25kA

Table (6. 5): the result quantities for the circuit breakers from MDB up to SMDB: Data sheet in appendix G (page 140)

No.	Name Of C.B	Type of C.B	Q'TY
1	MasterPact MTZ2 32H1	ACB	1
2	MasterPact MTZ2 25H1	ACB	1
3	MasterPact MTZ2 20H1	ACB	2
4	MasterPact MTZ2 16N1	ACB	1
5	NSX630F	MCCB	9
6	NSX400F	MCCB	9
7	NSX250B	MCCB	5
8	NSX160B	MCCB	18
9	NSX100B	MCCB	1
10	Acti9 C120H / 3x63A	MCB	3
11	Acti9 iC40N / 3x32A	MCB	15
12	Acti9 iC40N / 3x25A	MCB	1
13	Acti9 iC40N / 3x20A	MCB	25
14	Acti9 iC40N / 3x16A	MCB	35
15	Acti9 iC40N / 3x10A	MCB	9
16	Acti9 iC40N / 1x40A	MCB	1
17	Acti9 iC40N / 1x25A	MCB	16
18	Acti9 iC40N / 1x20A	MCB	17
19	Acti9 iC40N / 1x10A	MCB	2

6.5 Coordination between Circuit Breakers

6.5.1 Principles of Selectivity

Selectivity is achieved by overcurrent and earth fault protective devices if a fault condition, occurring at any point in the installation, is cleared by the protective device located immediately upstream of the fault, while all other protective devices remain unaffected, as shown in figure (6.3).

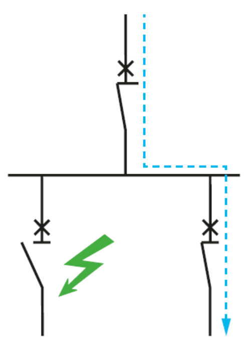


Figure (6. 3): Principle of selectivity. [1]

From installation point of view, Selectivity is achieved when the maximum short-circuit current at a point of installation is below selectivity limit of the circuit breakers supplying this point of installation.

Selectivity shall be checked for all circuits supplied by one source and for all type of fault: Overload, Short-circuit and Earth fault.

Different solution is provided to achieve selectivity based on current, time, energy and logic:

1. **Current based selectivity:** this method is realized by setting successive tripping thresholds at stepped levels, from downstream circuits (lower settings) towards the source (higher settings).
2. **Time based selectivity:** this method is implemented by adjusting the time-delayed tripping units, such that downstream relays have the shortest operating times, with progressively longer delays towards the source. In the two-level arrangement shown, upstream circuit breaker A is delayed sufficiently to ensure total selectivity with B.
3. **Selectivity based on a combination of current & time:** A time-delay added to a current level scheme can improve the overall selectivity performance. The upstream CB has two magnetic tripping thresholds Im: short-delay electronic trip & Ii: instantaneous trip.

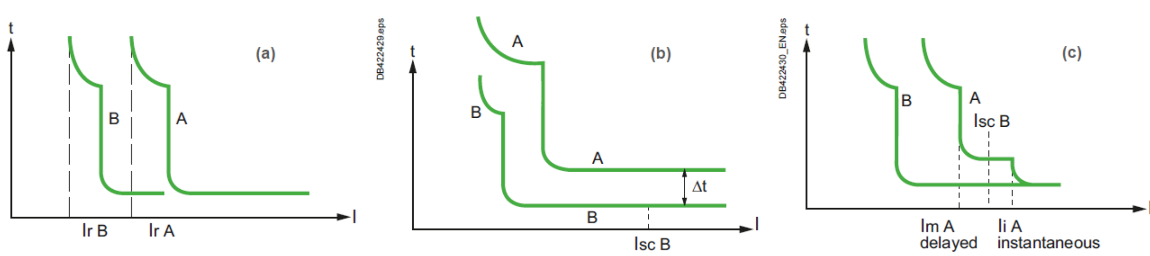


Figure (6. 4): Current based selectivity, Time based selectivity, Combination of both. [1]

6.5.2 Example for coordination between two MCCB's

This example shows how the coordination principle applied in this project. In ground floor, a type of NSX400F MCCB from Schneider used to protect (SMDB Ground Floor) & FF PUMP with breaker frame current rating 400A.

The breaker trip current rating (In) for FF PUMP is set to be 320A, while for (SMDB Ground Floor) is set to be 350A. So here, the current based selectivity has been achieved.

Now, when determining the tripping time of the circuit breaker, you should take into account that:

$$\mathbf{t_{max} > t > 0.1sec} \quad (6.4)$$

Elimination of the minimum short-circuit current possible in the circuit, in a time t_{max} compatible with the thermal constraints of the circuit conductors, where:

$$\mathbf{t_{max} = \frac{k^2 * S^2}{I_{sc}^2}} \text{ (}\mathbf{Valid\ for\ t_{max} < 5\ seconds} \quad (6.5)$$

Where S is the C.S.A of the cable, k is a factor depending of the cable conductor material, the insulation material and initial temperature. For copper XLPE, initial temperature 90 °C, k = 143.

Now, for FF PUMP, S for cable = 95 mm2 and calculated $I_{sc} = 13.14$ kA at its load terminal.

$$\mathbf{t_{max} = \frac{143^2 * 95^2}{13{,}140^2} = 1.07\ sec} \quad (6.6)$$

And, for (SMDB Ground Floor), S for cable = 120 mm2 and calculated $I_{sc} = 22.69\ kA$ at its load terminal.

$$\mathbf{t_{max} = \frac{143^2 * 120^2}{22{,}690^2} = 0.572\ sec} \quad (6.7)$$

Based on formula 6.x, the breaker trip time for (SMDB Ground Floor) NSX400F MCCB is delayed and set to be 500ms. And the breaker trip time for FF PUMP NSX400F MCCB is set to be 300ms. So here, the Time-based selectivity has been achieved.

6.6 Summary

A definition, types and fundamental characteristics for circuit breakers have been introduced. Method of circuit breaker selection and general rules laid down in the IEC standards, also have been considered. The circuit breakers for main incomer feeders and final circuits have determined and selected.

In addition, the principle of selectivity has been introduced. Finally, the coordination between project circuit breakers has been done.

7

Chapter seven

Power Factor Improvement

7.1 Introduction

Power factor is the ratio of active power to apparent power, and is equal to the cosine of the phase angle (cos phi) - which is the difference between the voltage and current angles. Therefore, it is a numerical value that does not have a unit of measurement ranging from zero to one. In power stations, it is preferred and sought to have the power factor as large as possible, as it increases the degree of power factor, the amount of effective capacity increases, and the value of inactive capacity or stored capacity decreases, and the values of power coefficients range in Power stations that adopt AC system electric loads fall into one of the following classifications: [1]

- Resistive
- Inductive
- Capacitive

7.2 Power Factor Correction

Inductive power factor correction uses capacitors connected in parallel to counteract the effects of inductive elements and to reduce the phase shift between voltage and current. Power factor correction is a technique that uses capacitors as shown in Figure (7.1) to reduce the reactive power component of an AC circuit in order to improve its efficiency and reduce current.

Strength factor improvement is of great economic importance. The closer the power factor is to 1, the smaller it is Simulated power transmitted in the electrical system.

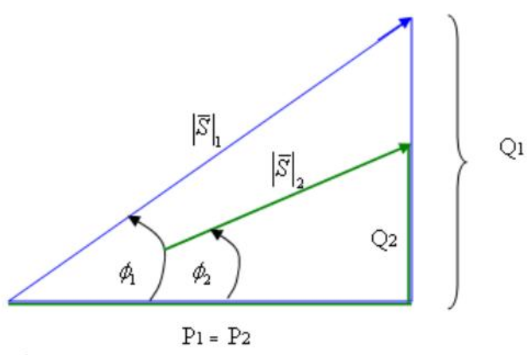


Figure (7.1) Power Factor Correction using Capacitor.

❖ Benefits of power Factor correction.

1. Reduce energy consumption
2. Electricity bills are reduced
3. Improve the efficiency of electrical energy
4. Provides additional kVA of current supply
5. Reduce losses of transformer and distribution equipment
6. Low voltage drops in long cables

❖ Ways to improve power factor:

Reactive power can be reduced in three ways:

1. Add two pure consumers (to increase the active capacity).
2. Add synchronous (capacitive) motors to the system.
3. Connect capacitors (in parallel to consumers).

❖ Capacitor connection options to improve power factor:

1. Single installation - connection of a capacitor in parallel to each nearby consumer or even to connecting clamps.
2. Group installation - connection of a capacitor to groups of consumers that are not all active at the same time (volume of the capacitor) Determined according to the average power factor of the group.
3. Central installation - capacitor connection on the main board. This method improves the power factor of the entire facility, which is the method we will follow to improve the power factor.

- Note: To adjust the capacitor capacity to a variable power factor, it is necessary to install an automatic capacitor regulator.

7.3 Power factor Correction Calculation

It is very important to calculate the P.F for all loads connected at each main feeder, to check that the P.F for all connected loads need an improvement or not. Using following equations, the active Power (P in kW), reactive power (Q in kvar), apparent power (S in KVA), and the angle (in degree) can be calculated for each load:

$$\mathbf{Q = S\ x\ \sin \emptyset} \tag{7. 1}$$

$$\mathbf{P = S\ x\ \cos \emptyset} \tag{7. 2}$$

$$S_{Total} = P_{Total} + j\ Q_{Total} = \sqrt{P_{total}^2 + Q_{total}^2} \tag{7. 3}$$

$$\tan \emptyset = (\frac{P_{Total}}{Q_{Total}}) \tag{7. 4}$$

$$\emptyset = \tan^{-1}(\frac{P_{Total}}{Q_{Total}}) \tag{7. 5}$$

The method used here to calculate the feeder power is:

1- Collecting the given P.F values for each light and power circuits;
2- Collecting the given P.F for each air-conditioning and motor loads;
3- Calculating the P&Q at each distribution board (D.B) load terminal;
4- Then combine the P & Q for each D.B to find total P & Q at SMDB load terminal;
5- Then doing summation for all P & Q of the SMDB's, to find P_{Total} & Q_{Total} absorbed by each transformer feeder
6- Finally, calculate the P.F at the transformer feeder to check if it needs an improvement or not.

To explain how this method used, taking SMDB Ground Floor as example. Using data mentioned in table (3.1). The SMDB Ground Floor feeds four D. B's, Garbage compactor and FF Pump. The S (in KVA) and the P.F for each load type have been given as shown in table (7.1).

Table (7. 1): SMDB Ground Floor example data.

Floor	Group Load Name (DB)	Feed From SMDB	Phase	Connected Load (KVA)	Cos(Ø)	Sin(Ø)
Ground Floor	DB.GF	SMDB Ground Floor	3PH	15.11	0.8	0.60
	GARBAGE COMPACTOR		3PH	3	0.85	0.53
	FF PUMP		3PH	186	0.87	0.49
Mezzanin Floor	DB.MEZ.		3PH	17.6	0.8	0.60
	DB.SHOP1		3PH	2.78	0.8	0.60
	DB.SHOP2		3PH	2.78	0.8	0.60

Now, the P for each load type will be calculated using equation (7.1):

$P_{DB.GF} = S \text{ x } \cos\emptyset = 15.11 \text{ x } 0.80 = 12.088 \text{ kw}$

$P_{Garbage} = S \text{ x } \cos\emptyset = 3 \text{ x } 0.85 = 2.55 \text{ kw}$

$P_{FF\ Pump} = S \text{ x } \cos\emptyset = 186 \text{ x } 0.87 = 161.82 \text{ kw}$

$P_{DB.MEZ.} = S \text{ x } \cos\emptyset = 17.6 \text{ x } 0.80 = 14.08 \text{ kw}$

$P_{Shop\ 1} = S \text{ x } \cos\emptyset = 2.78 \text{ x } 0.80 = 2.224 \text{ kw}$

$P_{Shop\ 2} = S \text{ x } \cos\emptyset = 2.78 \text{ x } 0.80 = 2.224 \text{ kw}$

So, $P_{Total} = P_{DB.GF} + P_{Garbage} + P_{FF\ Pump} + P_{DB.MEZ.} + P_{Shop\ 1} + P_{Shop\ 2}$

$= 12.088 + 2.55 + 161.82 + 14.08 + 2.224 + 2.224 = 194.99 \text{ kw}$

Now, the Q for each load type will be calculated using equation (7.2):

$Q_{DB.GF} = S \text{ x } \sin\emptyset = 15.11 \text{ x } 0.60 = 9.066 \text{ kvar}$

$Q_{Garbage} = S \text{ x } \sin\emptyset = 3 \text{ x } 0.53 = 1.59 \text{ kvar}$

$Q_{FF\ Pump} = S \text{ x } \sin\emptyset = 186 \text{ x } 0.49 = 91.71 \text{ kvar}$

$Q_{DB.MEZ.} = S \text{ x } \sin\emptyset = 17.6 \text{ x } 0.60 = 10.56 \text{ kvar}$

$Q_{Shop\ 1} = S \text{ x } \sin\emptyset = 2.78 \text{ x } 0.60 = 1.668 \text{ kvar}$

$Q_{Shop\ 2} = S \text{ x } \sin\emptyset = 2.78 \text{ x } 0.60 = 1.668 \text{ kvar}$

So, $Q_{Total} = Q_{DB.GF} + Q_{Garbage} + Q_{FF\ Pump} + Q_{DB.MEZ.} + Q_{Shop\ 1} + Q_{Shop\ 2}$

$$= 9.066 + 1.59 + 91.71 + 10.56 + 1.668 + 1.668 = 116.25 \text{ kvar}$$

S_{Total} Can be calculated using equation (7.3):

$$S_{Total} = 194.99 + j\,116.25 = \sqrt{194.99^2 + 116.25^2} = 227.01 \text{ KVA}$$

In addition, the angle $\emptyset$ in degree using equation 7.5:

$$\emptyset = \tan^{-1}\left(\frac{194.99}{116.25}\right) = 30.80^{\circ}$$

Finally, the P.F at SMDB feeder is:

$$\text{P.F} = \text{Cos}(\emptyset) = \text{Cos}(30.80^{\circ}) = 0.859$$

Each SMDB result has been shown in table (7.2), table (7.3), and table (7.4). Moreover, the result value for each SMDB have been collected to find the P_{Total} & Q_{Total} for each transformer feeder.

Table (7. 2): Power Factor Result for total SMDB Connected to Feeder of Transformer 3:

Transformer No.	**SMDB Name**	**Phase**	**Total Connected Load (KVA)**	**Active Power P (in KW)**	**Reactive Power Q (in KVAR)**	**tan (Ø)**	**Ø (in degree)**	**Cos(Ø)**	**Sin(Ø)**
TR/3	SMDB Restaurant Floor	3PH	292.63	248.99	153.55	0.617	31.66	0.851	0.525
	SMDB-1 Service Floor	3PH	264.05	234.60	121.12	0.516	27.31	0.889	0.459
	SMDB-2 Service Floor	3PH	263.5	234.37	120.43	0.514	27.20	0.889	0.457
	SMDB-2 Roof Floor	3PH	862	793.04	337.83	0.426	23.07	0.920	0.392
Final Total Resulet			P total =	1,510.99	Q total =	732.93	S total =	1,679.37	**OK !**
			tan (Ø) =	0.485	Ø =	25.88	Cos(Ø) =	0.900	

Table (7. 3): Power Factor Result for total SMDB Connected to Feeder of Transformer 2:

Transformer No.	**SMDB Name**	**Phase**	**Total Connected Load (KVA)**	**Active Power P (in KW)**	**Reactive Power Q (in KVAR)**	**tan (Ø)**	**Ø (in degree)**	**Cos(Ø)**	**Sin(Ø)**
TR/2	SMDB Ground Floor	3PH	227.27	194.99	116.25	0.596	30.80	0.859	0.512
	MDB.AC @ Roof Floor	3PH	1105	1014.33	437.91	0.432	23.35	0.918	0.396
Final Total Resulet			P total =	1,209.32	Q total =	554.16	S total =	1,330.24	**OK !**
			tan (Ø) =	0.458	Ø =	24.62	Cos(Ø) =	0.909	

Table (7. 4): Power Factor Result for total SMDB Connected to Feeder of Transformer 1:

Transformer No.	SMDB Name	Phase	Total Connected Load (KVA)	Active Power P (in KW)	Reactive Power Q (in KVAR)	tan (Ø)	Ø (in degree)	Cos(Ø)	Sin(Ø)
TR/1	SMDB Parking Floor	3PH	52.32	44.26	27.64	0.625	31.99	0.848	0.530
	SMDB Prayer Floor	3PH	56.73	48.08	29.72	0.618	31.72	0.851	0.526
	SMDB (1ST) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (2ND) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (3RD) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (4TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (5TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (6TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (7TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (8TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (9TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (10TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (11TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (12TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (13TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (14TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB (15TH) Floors	3PH	66.42	53.14	39.85	0.750	36.87	0.800	0.600
	SMDB 16TH Floor	3PH	55.26	44.56	32.64	0.732	36.22	0.807	0.591
	SMDB 17TH Floor	3PH	34.98	28.81	19.81	0.688	34.52	0.824	0.567
	SMDB-1 Roof Floor	3PH	92.4	81.90	42.74	0.522	27.56	0.887	0.463
	SMDB-1 EM@ Ground Floor	3PH	71.45	59.97	38.55	0.643	32.73	0.841	0.541
	SMDB-2 EM@ 1st Floor	3PH	82.8	66.24	49.68	0.750	36.87	0.800	0.600
	SMDB-3 EM@ 9th Floor	3PH	201.8	161.44	121.08	0.750	36.87	0.800	0.600
Final Total Resulet			P total =	1,332.29	Q total =	959.63	S total =	1,641.91	NOT OK !
			tan (Ø) =	0.720	Ø =	35.76	Cos(Ø) =	0.811	

As shown in table (7.4), the P.F at transformer 1 feeder has low value. Therefore, an improvement for this value will be applied, in next section.

7.4 Hotel Power Factor Correction.

Correction factor calculation formula:

$$Q_C = P[\tan(\cos^{-1} PF_{old}) - \tan(\cos^{-1} PF_{new})] \quad (7.6)$$

Where:

Q_C: Reactive power of the required capacitor (KVAR).

P: Total power load (KW).

PF_{old}: power factor before improvement.

PF_{new}: Power factor after optimization.

Current of capacitor (A):

$$I = \frac{Q_C}{\sqrt{3} * V} \quad (7.7)$$

Where:

V: voltage 3ph.

- Calculate the value of the capacitor we need to improve the power factor on the first transformer (single line diagram-6-):

  Power factor old =0.811
  $\cos^{-1}(0.811) = 35.76°$
  $\tan(35.76) = 0.7214$

  Power factor new =0.92
  $\cos^{-1}(0.92) = 23.07°$
  $\tan(23.07) = 0.426$

Power in full load=1,332.29 (KW)

$$Q_C = P[\tan(\cos^{-1} PF_{old}) - \tan(\cos^{-1} PF_{new})]$$

$$= 1{,}332.29 \text{ x } [0.7214 - 0.426] = 393.56\ KVAR$$

So, the 400KVAR capacitor bank will be used.

Now, the rating ampere for the capacitor bank:

$$I = \frac{Q_C}{\sqrt{3} * V}$$

$$= \frac{400 * 10^3}{\sqrt{3} * 400} = 577.35\ A$$

After calculating the needed reactive power to improve P.F, the ratings of capacitor banks have been determined. Moreover, cable for capacitor bank has been determined using simplified methods used in chapter 3. In addition, the size of circuit breaker has been determined. Table (7.5) shows the values of capacitor bank used in project and the C.S.A multi-core cable and the selected circuit breaker.

Table (7. 5): capacitor bank result values, in its cables C.S.A. and circuit breaker:

Low Voltage Panel Number	Total Conncted Load (KW)	P.F. Old	P.F. New	Reactive Power of the Capacitor (KVAR)	Used Capacitor Bank Rating (KVAR)	Current of Capacitor Ic (A)	Install. Method	Cable Corre. I'z (A)	Cable C.S.A (mm2)	PE C.S.A (mm2)	Type of Circuit Breaker	Breaker Frame Current Rating	Breaker Trip Current Rating (In)
LVP-1	1332.29	0.81	0.92	393.5	400.0	577.35	E or F	599.00	240	120	NSX630F	630	580

7.5 Summary

In this chapter, an introduction and benefits of correction P.F have been introduced. Then, the P.F at each D.B, SMDB load terminal has been calculated which resulted to calculate the P_{Total} & Q_{Total} for each transformer feeder. Finally, the needed capacitor bank has been sized; also, the C.S.A of the cable and its protection circuit breaker has been selected.

8

Chapter Eight

Earthing & Lightning Protection

8.1 Introduction

Earthing systems play an essential role in electrical systems in terms of safety for people in the vicinity against the hazard of electric shocks as well as protection and proper operation of equipment during the incidence of faults. Both are achieved by providing a low impedance path that can dissipate fault currents to the conductive mass of Earth [8].

One of the first steps in the design of an earthing system is estimating the total resistance to earth and determining the proper size and basic layout of the earth electrode required. The total resistance of this connection should not be greater than the required resistance value as stipulated in international standards, not be greater than 5 Ω or 10 Ω.

In this hotel project, the maximum permissible resistance value ranges from 1 Ω to 5 Ω for distribution L.V installation depending on the local conditions [9].

8.2 Types of Earthing System

8.2.1 TT System

One point at the supply source is connected directly to earth. All exposed- and extraneous-conductive-parts are connected to a separate earth electrode at the installation point. To prevent a human from electrical shock, a residual current device (RCD) with an operating current of 30 mA. Figure (8.1) shows the arrangement of a TT earthing system.

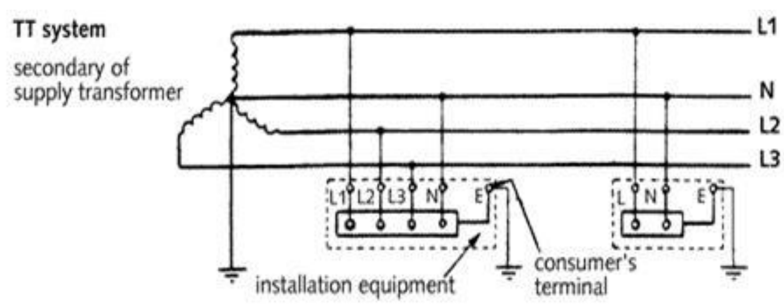


Figure (8. 1): TT earthing system. [10]

8.2.2 TN-S System

In this (five wires system), the electricity supply company providing an earth terminal at the incoming mains position. This earth terminal is connected by the supply protective conductor (PE) back to the star point (neutral) of the secondary winding of the supply transformer, which is also connected at that point to an earth electrode. The system is shown diagrammatically in Figure (8.2).

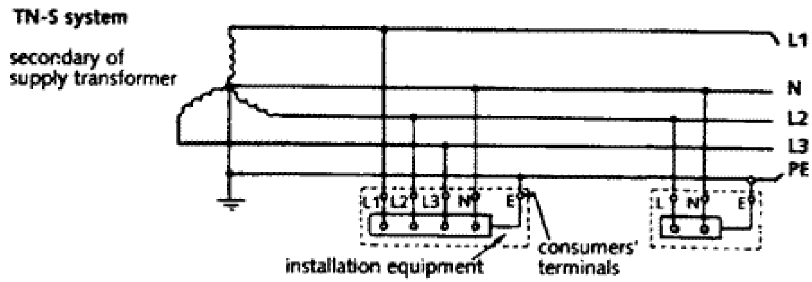


Figure (8. 2): TN-S earthing system. [10]

8.2.3 TN-C-S System

The electricity supply company, uses a common conductor for both the neutral and the earth. This combined and neutral system is sometimes called the 'protective and neutral conductor' (PEN). Figure (8.3) shows the arrangement of a TN-C-S earthing system.

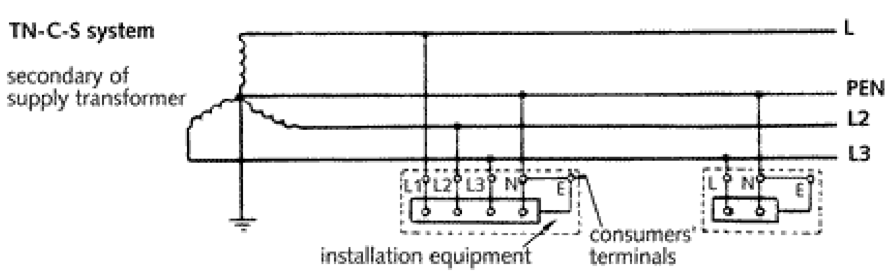


Figure (8. 3): TN-C-S earthing system. [10]

8.2.4 TN-C System

This installation is unusual, because combined neutral and earth wiring is used in both the supply and within the installation itself. Where used, the installation will usually be the earthed concentric system, which can only be installed under the special conditions. Figure (8.4) shows the arrangement of a TN-C earthing system.

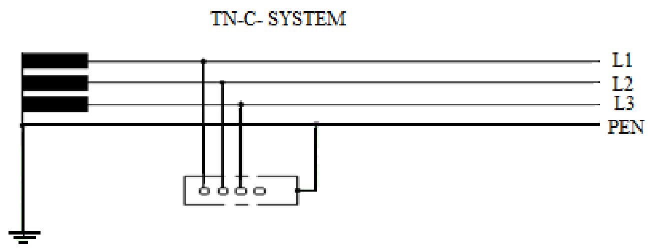


Figure (8. 4): TN-C earthing system. [10]

8.2.5 IT System

The installation arrangements in the IT system are the same for those of the TT system. However, the supply earthing is totally different. The IT system can have an unearthed supply, or one, which is not solidly earthed but is connected to earth through a current limiting impedance. IT system is shown in figure (8.5).

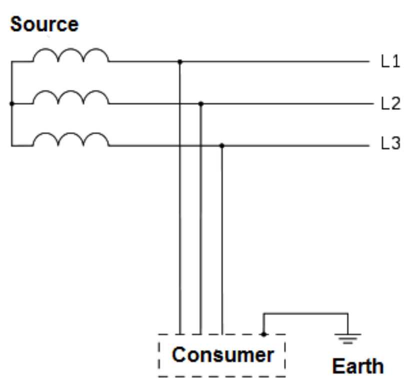


Figure (8. 5): IT earthing system. [10]

8.3 Earthing System Components

Earthing system has three main components:

8.3.1 Earthing Conductors

The earthing conductor is commonly called the earthing lead. It joins the installation earthing terminal to the earth electrode or to the earth terminal provided by the Electricity Supply Company. It is a vital link in the protective system, so care must be taken to see that its integrity will be preserved at all times. [10]

8.3.2 Earth Electrodes

The principle of earthing is to consider the general mass of earth as a reference (zero) potential. Thus, everything connected directly to it will be at these zero potentials. The purpose of the earth electrode is to connect to the general mass of earth, see figure (8.6).

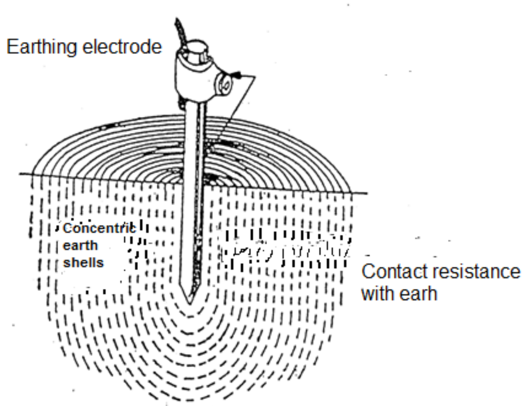


Figure (8. 6): Earth electrode.[10]

8.3.3 Inspection Points (Earth Pits)

For protection of the earthing rod and earthing conductors and for maintenance and inspection purposes an earth well is constructed as shown in figure (8.7).

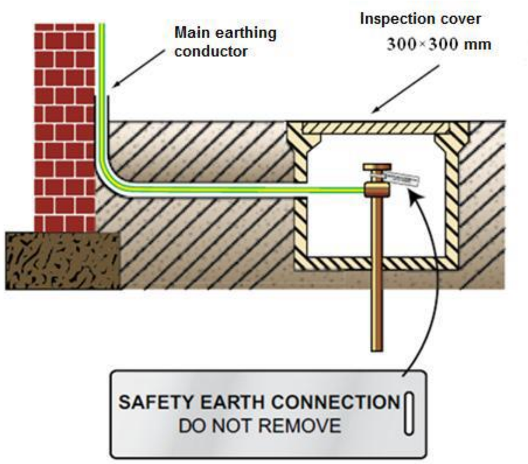


Figure (8. 7): Earth pits.[10]

8.4 Earthing System Calculation

8.4.1 Earthing Resistance Calculation

Calculation The earth resistance (R_g) of a single rod (spike), of diameter (d) and driven length (L) driven vertically into the soil of resistivity (ρ), can be calculated as follows:

$$\mathbf{R_g = \frac{\rho}{2\pi L}\left[\ln\left(\frac{8L}{d}\right) - 1\right]} \qquad (8.\ 1)$$

Where:

ρ= Soil Resistivity in Ωm

L=Buried Length of the electrode in m

d=Diameter of the electrode in m

For any number of rods in parallel, it can calculate the equivalent earthing resistance from the following equation and table (8.1):

$$\mathbf{R_{equ.} = \frac{R_g}{N}\ x\ \lambda} \qquad (8.\ 2)$$

Where;

N: is the number of rods in parallel.

λ: is a multiplying factor that can be taken from the following table8.1. The resistivity (ρ) in ($\Omega.m$) for various types of soils are given table (8.2).

Table (8. 1): Multiplying factor for parallel electrodes in line as per (BS 7430). [11]

Factors for parallel electrodes in line (BS 7430)	
Number of electrodes (n)	Factor (λ)
2	1.0
3	1.66
4	2.15
5	2.54
6	2.87
7	3.15
8	3.39
9	3.61
10	3.8

Table (8. 2): Average resistivity values ($\mathbf{\Omega.m}$) for an approximate sizing of earth electrode.[1]

Type of soil	Mean value of resistivity in Ωm
Fertile soil, compacted damp fill	50
Arid soil, gravel, uncompacted non-uniform fill	500
Stoney soil, bare, dry sand, fissured rocks	3000

Now, for hotel project the earth resistance (R_g) of a 3-meter single rod (spike) with diameter Ø17,28 mm driven in an earth, with soil type (Fertile soil, compacted damp fill) with mean value of 50 Ωm resistivity, is obtained from equation (8.1):

$$R_g = \frac{\rho}{2\pi L}\left[\ln\left(\frac{8L}{d}\right) - 1\right] = \frac{50}{2x\pi x3}\left[\ln\left(\frac{8x3}{0.01782}\right) - 1\right] = 16.54\ \Omega$$

Then, with 3 electrodes in parallel for MDB body the equivalent earthing resistance $R_{equ.}$ from equation (8.2), where λ from table (8.1) 1.66:

$$R_{equ.} = \frac{R_g}{N}\ x\ \lambda = \frac{16.54}{3}\ x\ 1.66 = 9.153\ \Omega$$

The $R_{equ.} = 9.153\ \Omega > 5\ \Omega$, this value is not acceptable!

Therefore, solution could be increasing the number of electrodes in parallel or increasing the lengths of the electrodes. Because the project has three 300x300x300 mm earth pit for inspection purpose, increasing the lengths of the electrodes driven in an earth is better choice. Data sheet in appendix H (page 141)

So, the length of each electrode will be increased to 9 meters for each earth pit:

$$R_g = \frac{\rho}{2\pi L}\left[\ln\left(\frac{8L}{d}\right) - 1\right] = \frac{50}{2x\pi x9}\left[\ln\left(\frac{8x9}{0.01782}\right) - 1\right] = 6.485\ \Omega$$

Finally, the equivalent earthing resistance $R_{equ.}$ is:

$$R_{equ.} = \frac{R_g}{N}\ x\ \lambda = \frac{6.485}{3}\ x\ 1.66 = 3.588\ \Omega$$

The of $R_{equ.} = 3.588\ \Omega < 5\ \Omega$, this value is acceptable.

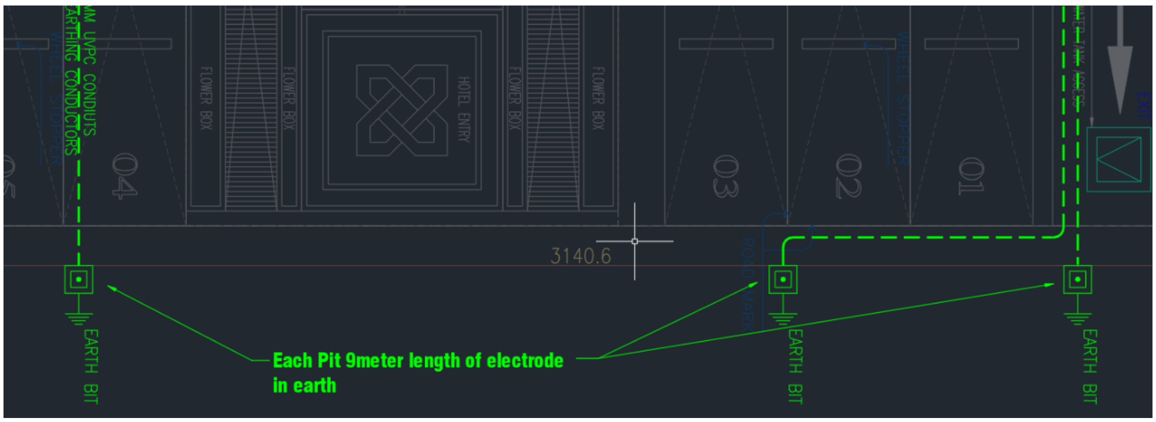


Figure (8. 8): Earth pits location in front of the hotel project

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8.4.2 Earthing Conductors Calculation

In this section, the sized 150 mm^2 of earth conductors, which have been selected in section 4.5, will be checked if it was sized correctly or not.

From the equation 6.5, the earth conductor size PE in mm^2 is:

$$\mathbf{S_{PE}} = \frac{\mathbf{I_{sc} x\sqrt{t}}}{\mathbf{K}} \qquad (8.\ 3)$$

Moreover, in LV installation the maximum time for disconnection or clear fault current is 0.4 sec. so, here the earth conductors will be checked with time of 0.5 sec.

Now, from table (6.3) for LVP-1 (or MDB-1), the earth conductor size PE is:

$S_{PE} = \frac{I_{sc} x\sqrt{t}}{K} = \frac{22{,}900x\sqrt{0.5}}{143} = 113.24\ mm^2 < 150\ mm^2$, so, it is sized correctly.

For LVP-2 (or MDB-2), the earth conductor size PE is:

$S_{PE} = \frac{I_{sc} x\sqrt{t}}{K} = \frac{28{,}600x\sqrt{0.5}}{143} = 141.42\ mm^2 < 150\ mm^2$, so, it is sized correctly.

For LVP-3 (or MDB-3), the earth conductor size PE is:

$S_{PE} = \frac{I_{sc} x \sqrt{t}}{K} = \frac{36,700 x \sqrt{0.5}}{143} = 181.47\ mm^2\ >\ 150\ mm^2$, so, it is sized NOT correctly!

Therefore, the next nearest available conductor size will be 185 mm^2.

Data sheet in appendix I (page 142).

8.5 Lightning Protection System

This project follows BS 6651 code (Protection of structures against lightning), which clearly advises strict adherence to the provision of a conventional Lightning Protection System (LPS) – to the total exclusion of any other device or system for which claims of enhanced protection are made.

Principle components of a conventional structural lightning protection system, in accordance with BS 6651 are:

- Air termination network
- Down conductors
- Earth termination network
- Bonding (to prevent side flashing).

❖ In this project, the Structural Lighting Protection System (LPS) is complying and designed to BS 6651. As following: [12]

1- No part of the roof should be away more than 5m from air termination conductor. This can be achieved by applying mesh of size (10m x 20m).
2- On high-risk structures, the mesh forming the air termination network dimensions to be 5m x 10m so that no part of the roof should be 2.5m away from any air termination conductor.
3- The zone of protection offered by an air termination network for buildings with height less than 20m should not exceed 45°.
4- The zone of protection for higher than 20m buildings must be determined by rolling sphere method.
5- There should be one down conductor for every 20m or part of the building perimeter at roof or ground level whichever is greater for buildings below 20m in heights.
6- If the building is above 20m in height or in abnormal risk, the distance between two down conductors should be reduced to 10m.
7- The length of down conductor forming the loop should not exceed eight times the width of its open side (i.e., the distance between two down conductors).

8- Each down conductor must have a separate earth termination (i.e., earth pit).
9- The resistance to earth of the lighting protection system measured at any point should not exceed 10 ohms.
10- For each down conductor and for disconnection from the earth, test clamp to be provided nearest to the earth pit.
11- The individual resistance of each earth pit constituting apart of the earth termination network should not exceed 10 times the number of down conductors.
12- The combined length of earth rods of LPS should not be less than 9m while each individual earth rod length should not be less than 1.5m in length.
13- In case of using parallel, earth rods to achieve the 10-ohm resistance. The separation distance of earth should be between L to 2L, where L is the length of earth rod.
14- All metal works including water pipes, gas pipes, handrails, air conditioning unit's metal cladding and metal roofs in the vicinity of the LPS must be bonded to it to avoid the danger of side flashing.

So, the previous points were applied in this project, as following:

Due to the nature of the building, approximately mesh of size (10m x 20m) method was selected, and the result number of air termination conductor are 5 conductors.

The hotel building perimeter at roof is about 132 meters. In addition, because the building is higher than 20 meters, the distance between two down conductors is 10 meters. So, a 13 down conductor must be used.

In addition, the building height is about 99.2 meter, same to the lengths of each down conductors forming the loop not exceed eight times the distance between two down conductors.

For example, the distance between two farthest LPE-1 & LPE-2 points are 12.3 meter, multiplying 12.3 meter by 8, which is equal to 98.4 meter, so it less than the length of down conductor, resulting to acceptable value. Moreover, each down conductor has a separate earth pit.

As mentioned in section 8.5.1, the individual resistance of each earth pit constituting apart of the earth termination network with a 3 x 3-meter single rod (spike) with diameter Ø17,28 mm driven in an earth, with soil type (Fertile soil, compacted damp fill) with mean value of 50 $\Omega.m$ resistivity, is obtained from equation (8.1):

$$R_{pit} = \frac{\rho}{2\pi L}\left[\ln\left(\frac{8L}{d}\right) - 1\right] = \frac{50}{2x\pi x9}\left[\ln\left(\frac{8x9}{0.01782}\right) - 1\right] = 6.485\ \Omega$$

This value is less than the number of down conductors multiplied by 10 times; i.e the resistance of each earth; $6.485\ \Omega < 10x13 = 130\ \Omega$.

The equivalent earthing resistance for 13 earth pits obtained from equation (8.2) and table (8.1), the value of λ here is approximated to be with vale of 4:

$$R_{equ.} = \frac{R_{pit}}{N} \text{ x } \lambda = \frac{6.485}{13} \text{ x } 4 = 2\ \Omega$$

The of $R_{equ.} = 2\ \Omega < 5\ \Omega$, this value is acceptable.

In this project, the applied separation distance of earth between L to 2L; i.e the applied separation distance is between 9 to 18 meter.

❖ Addition notes taken into consideration:

- The air termination network conductors consist of 25mm x 3mm tinned copper tape.
- All roof conductors are to be secured at intervals not exceeding 900mm.
- Vertical copper air terminal height (500mm) shall be provided for the termination network.
- A minimum of two air terminals separated by 30m to be provided.
- Down conductor rebar will be bonded to foundation steel network underground stainless-steel tape 25mm x 3mm shall be inter connect all rebar down conductors at the ground level along the perimeter of the building to comply with IE-C 61024-2-2 if rebars used as down conductors.

The figure (8.9) shows the project-designed plan for conventional structural lightning protection system, and figure (8.10) designed components used in project.

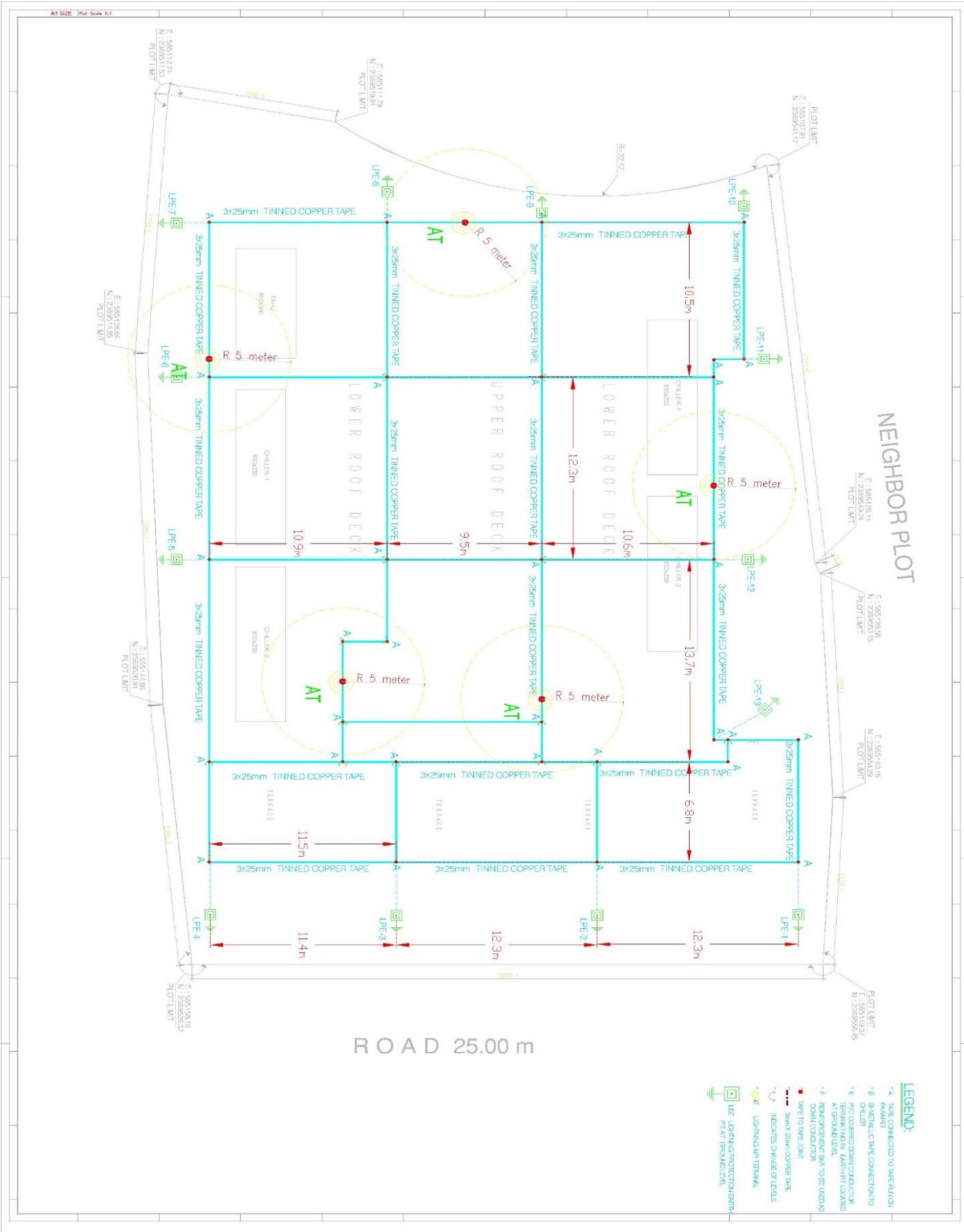


Figure (8. 9): the project-designed plan for conventional structural lightning protection system.

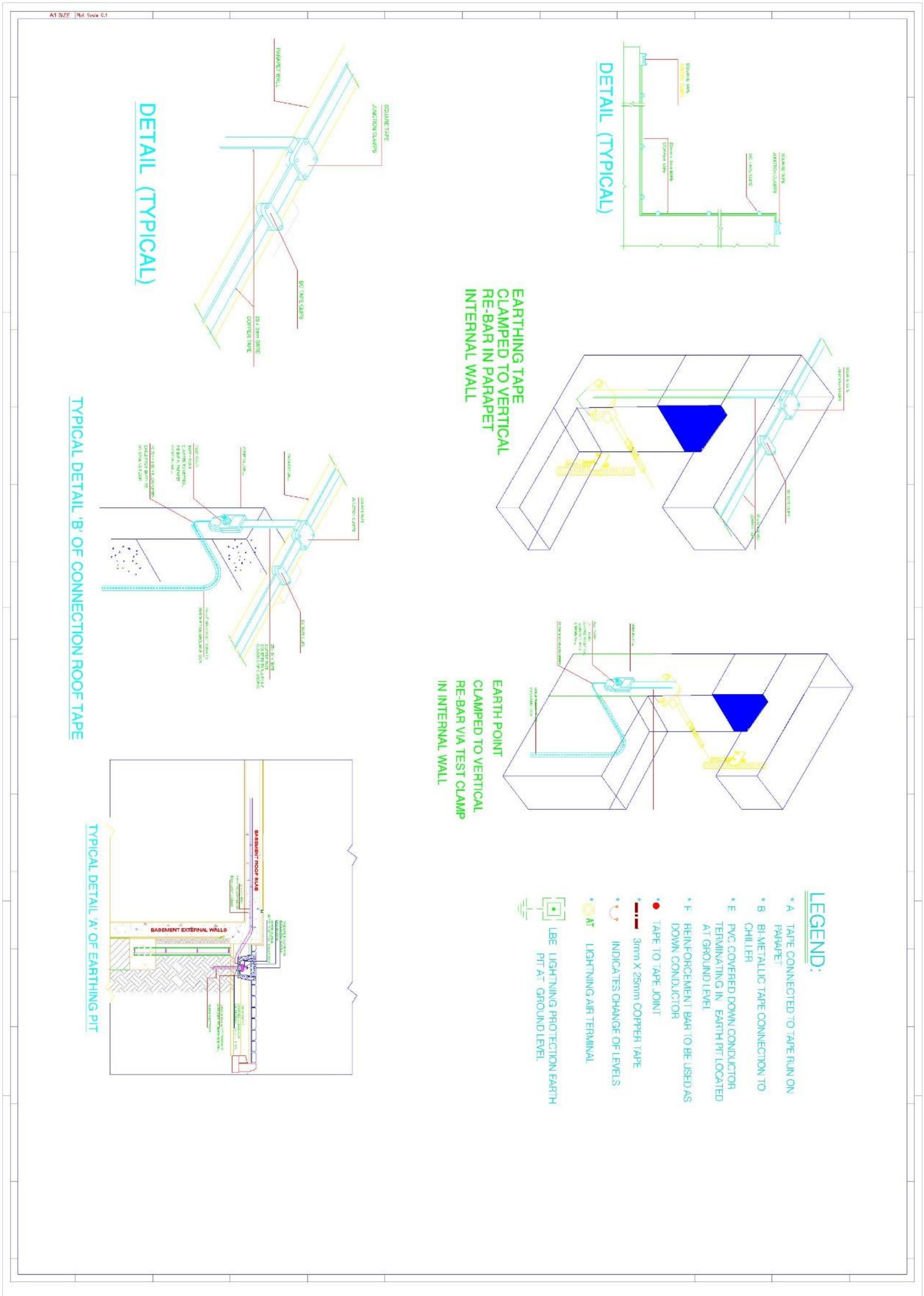


Figure (8. 10): designed components used in project.

8.6 Summary

Introduction about the importance of earthing system & Lightning Protection system have been introduced. Types and components of both systems also are illustrated or displayed. Earthing resistance for determining the proper size and basic layout of the earth electrode has been calculated, and then checked if it was sized correctly or not. The LPS was designed and complied to BS 6651. Finally, a plan for conventional structural lightning protection system and its component has been designed and layer by AutoCAD.

9

Chapter Nine

Project Layout

9.1 Introduction to Hotel Project SLD

9.1 Introduction to Hotel Project SLD

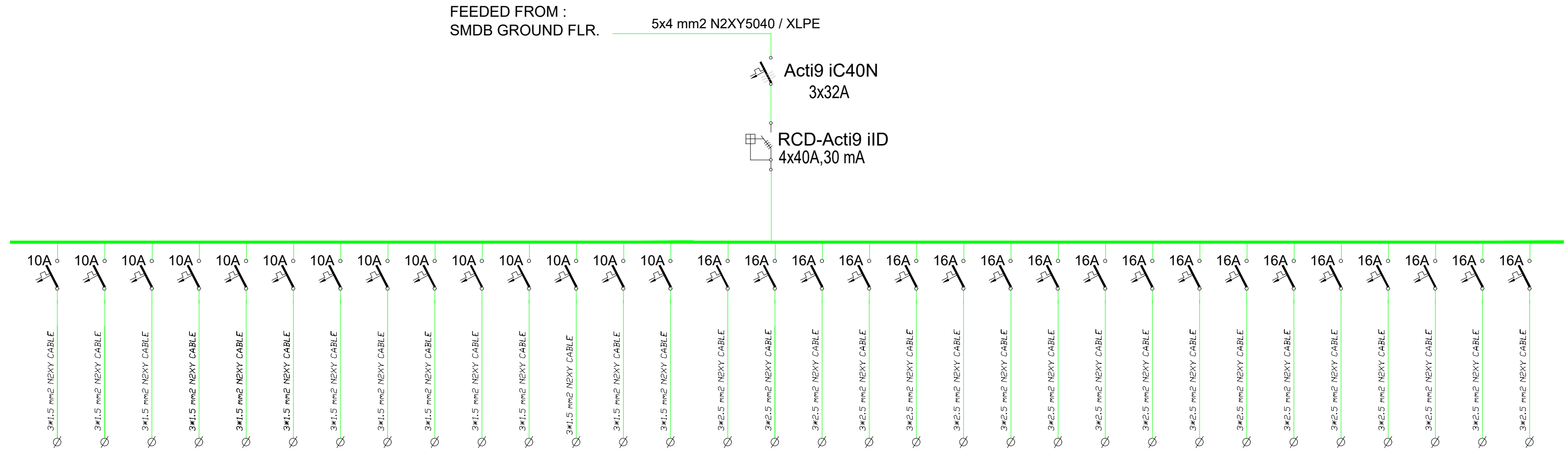
A single-line diagram (also known as an SLD or one-line diagram) is a simplified representation of an electrical system. Symbols and lines are used to represent the nodes and connections in the system, and electrical characteristics may be included as well.

The methods or steps used to build SLD in this Project, is:

1- Represents all types of hotels loads into single phase and three phase circuits; Lights Circuits, Sockets circuits, FCU circuits…etc.
2- Each floor load circuits, represented into distribution Boards (DB).
3- Classification of DB's into Non-essential loads DB's & Emergency loads DB's.
4- Non-essential loads DB's designed to be fed from sub-main distribution board (SMDB); which designed to be fed from main distribution board (MDB), finally supplied from transformer (electric network supplier) only.
5- Emergency loads DB's designed to be fed from emergency SMDB; which designed to be fed from emergency MDB, but these loads have two options to be supplied; from transformer or from standby source as backup generator or UPS in case of power outage.
6- The riser diagram for hotel building floors have been represented also;
7- Connection of power sources for the hotel as distribution transformer, backup generator and UPS has been showed in the SLD.
8- The connection of capacitor bank for PF improvement also has been shown.
9- The protection devices; RCD, CB, MCCB and ACB which used in the project also shown in the SLD.
10- Each electrical element component size in the project, represented with details in SLD with details.

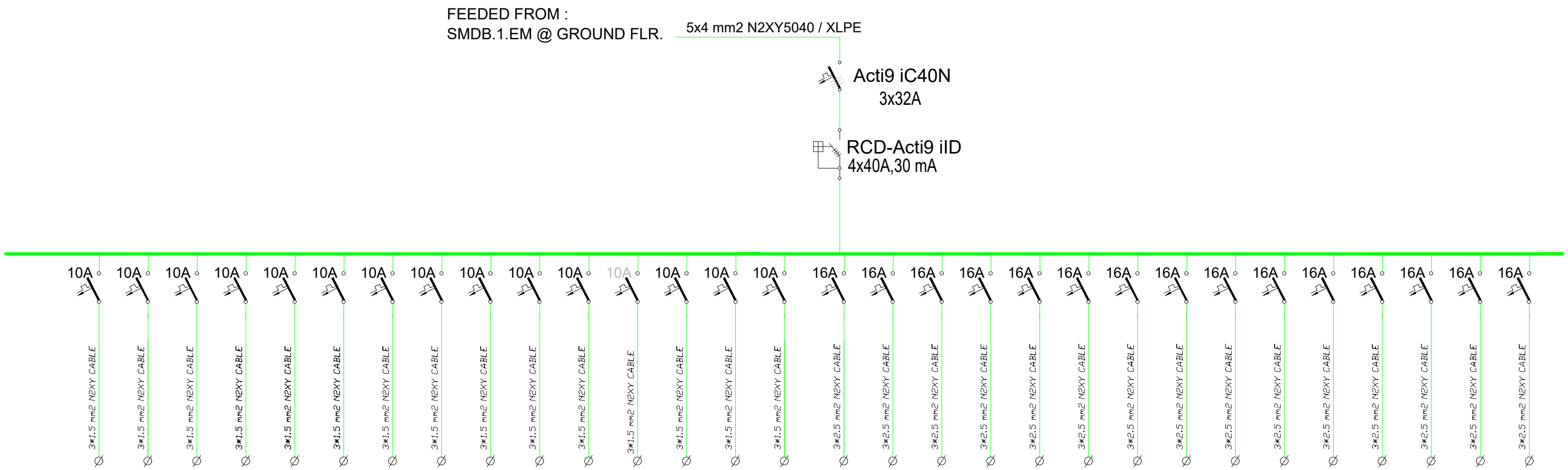
The following figures show the hotel SLD, illustrating all electrical components used in the hotel project in details. An example for DB.GF & DB.GF EM at ground floor as shown in figure (9.1).

Figure 9.1 : SLD for DB.GF &DB.GF EM @ ground floor



CIRCUIT NO.	1	3	5	7	9	11	13	15	17	19	21	23	25	27
TARGET CIRCUIT	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light	Light
Connected Load (VA)	400	650	700	600	500	900	500	700	950	200	1000	1050	600	600
Total Connected Load (kVA)	15.11 kVA													

CIRCUIT NO.	2	4	6	8	10	12	14	16	18	20	22	24	26	28	29	30	31	32
TARGET CIRCUIT	Socket	Socket	Socket	Socket	Socket	Socket	Socket	Socket	Socket	LV RM-2 FCU	BACK OFF.FCU	CONTROL OFF.FCU	CORRIDOR FCU	SPACE	TEL.RM FCU	BMS RM.FCU	W.SITTING AREA.FCU	L.V RM-1 FCU
Connected Load (VA)	800	1200	400	800	600	600	600	1000	1200	300	80	80	80	-	300	80	500	300



CIRCUIT NO.	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
TARGET CIRCUIT	GF,MEZZ TO 3PARKING	Light	Light	Light	GF,MEZZ TO 3PARKING	Light	Light	Light	Light	Light	Light	STAIR LIGHT	SPACE	Light	Light
Connected Load (VA)	1000	800	600	500	1000	1200	200	400	400	700	600	200	-	800	800
Total Connected Load (kVA)	13.70 kVA														

CIRCUIT NO.	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
TARGET CIRCUIT	Socket	OUTLET FOR CR.	OUTLET FOR CR.	Socket	OUTLET FOR CCTV,CR.	Socket	Socket	Socket	LV RM-2 FCU	BACK OFF.FCU	CONTROL OFF.FCU	OUTLET FOR CCTV	Socket	OUTLET FOR CCTV,CR.	OUTLET FOR CCTV
Connected Load (VA)	800	200	200	600	600	600	800	800	800	800	600	200	800	400	200

A4 SIZE | Plot Scale 0.1

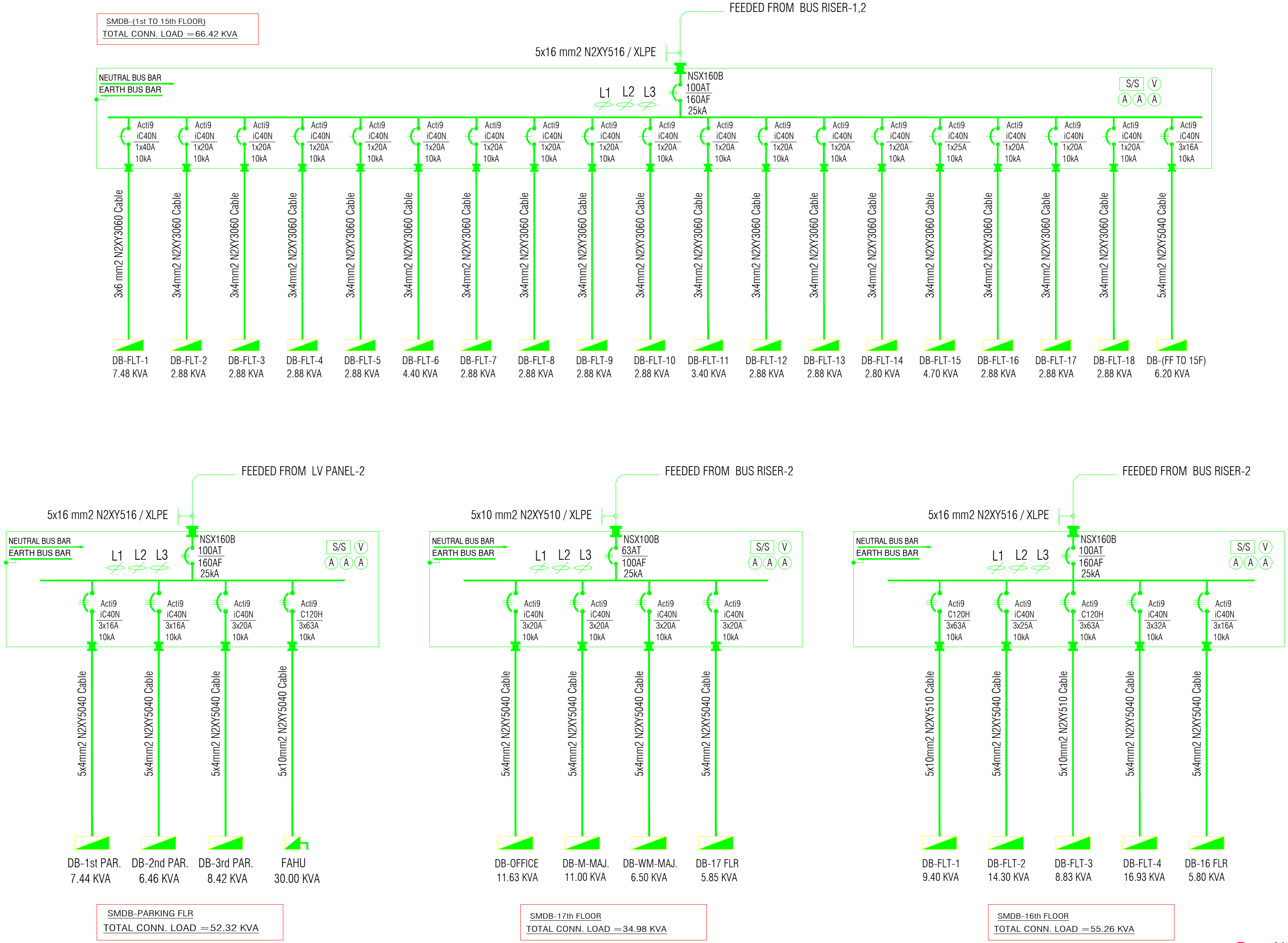


Figure 9.2 : Sing Line Diagrm -1

Eng. Aladdin Sultan

Eng. Laith Abu Joudeh

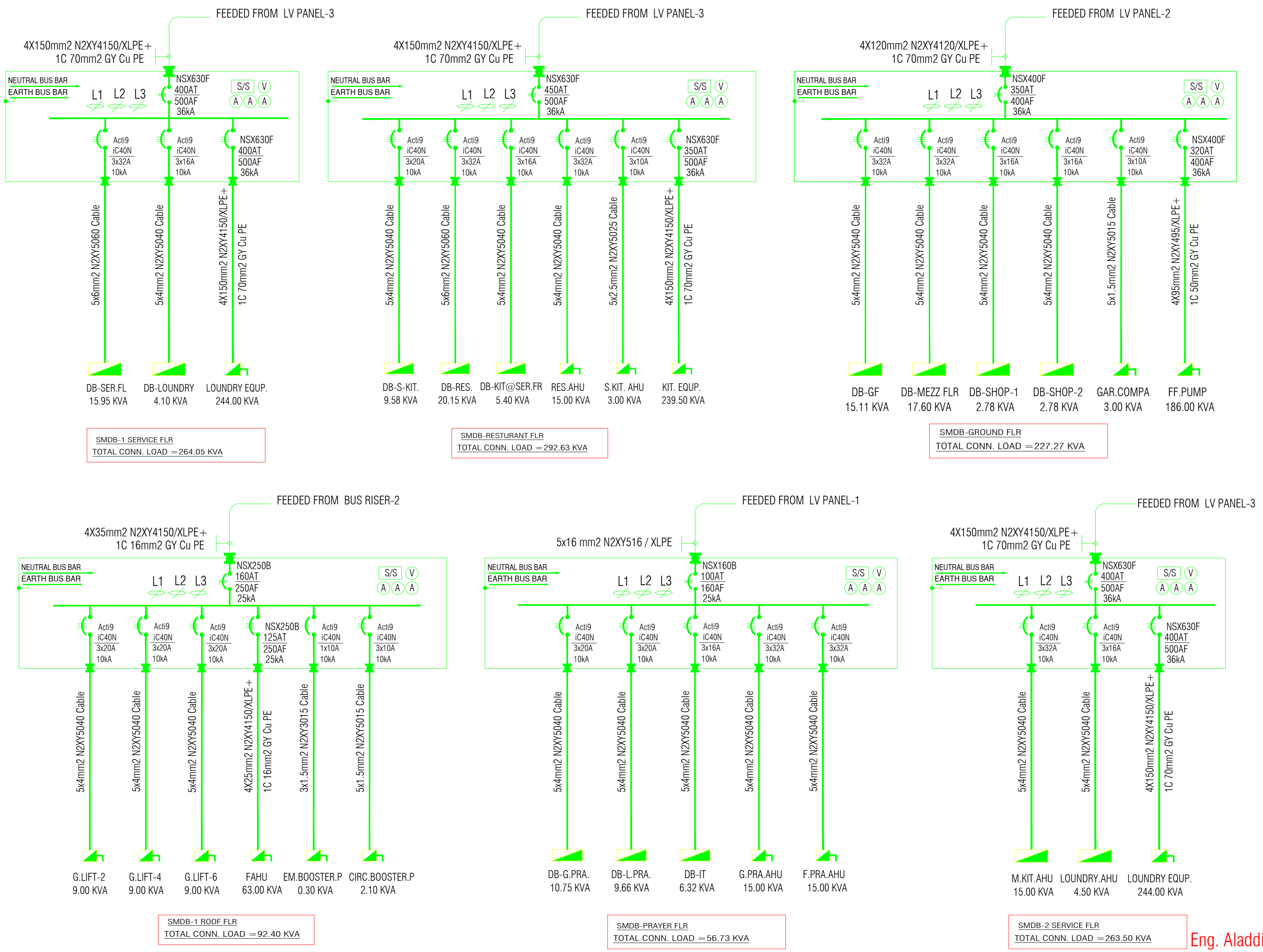


Figure 9.3 : Sing Line Diagrm -2

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Eng. Laith Abu Joudeh

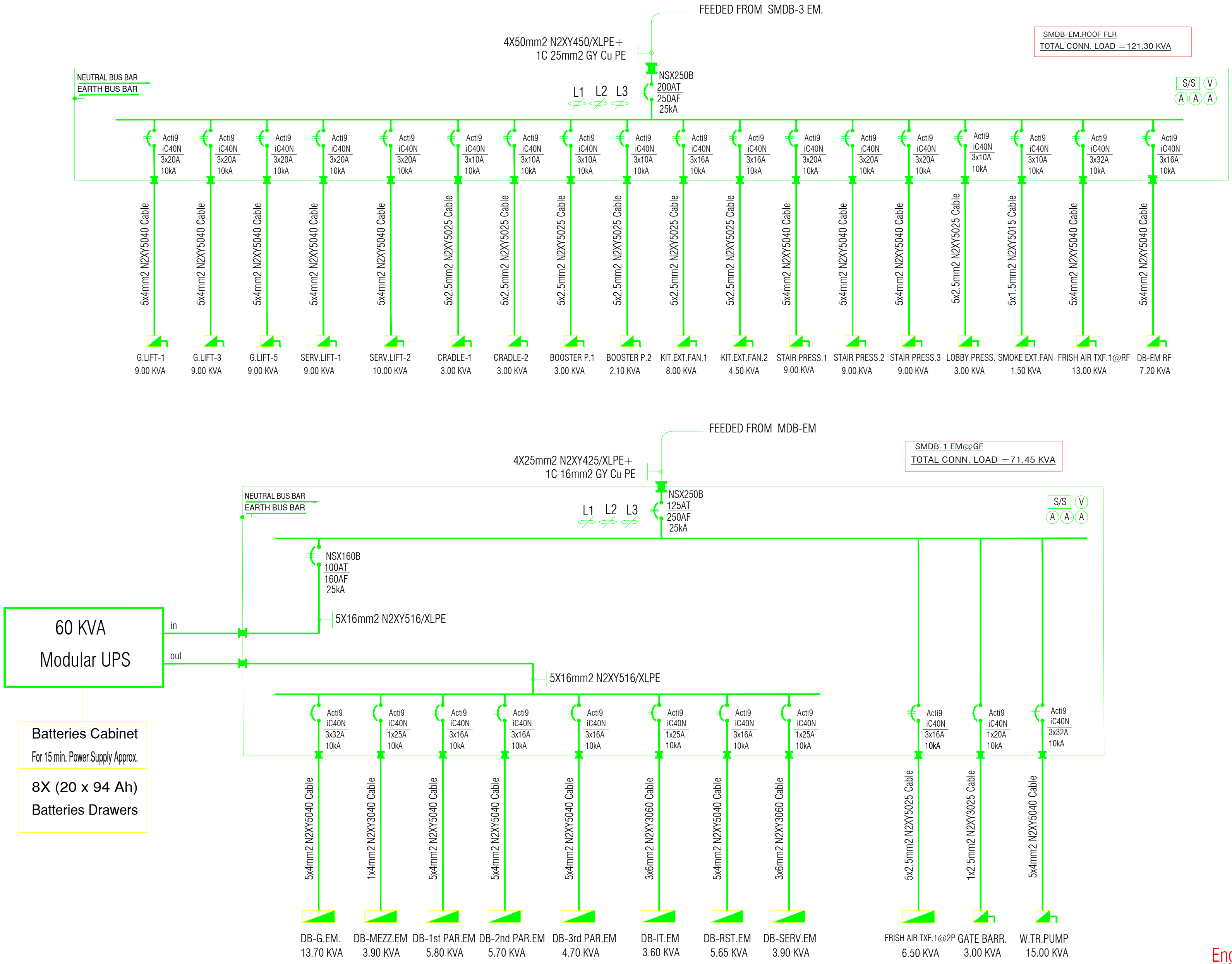

Figure 9.4 : Sing Line Diagrm -3

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Eng. Laith Abu Joudeh

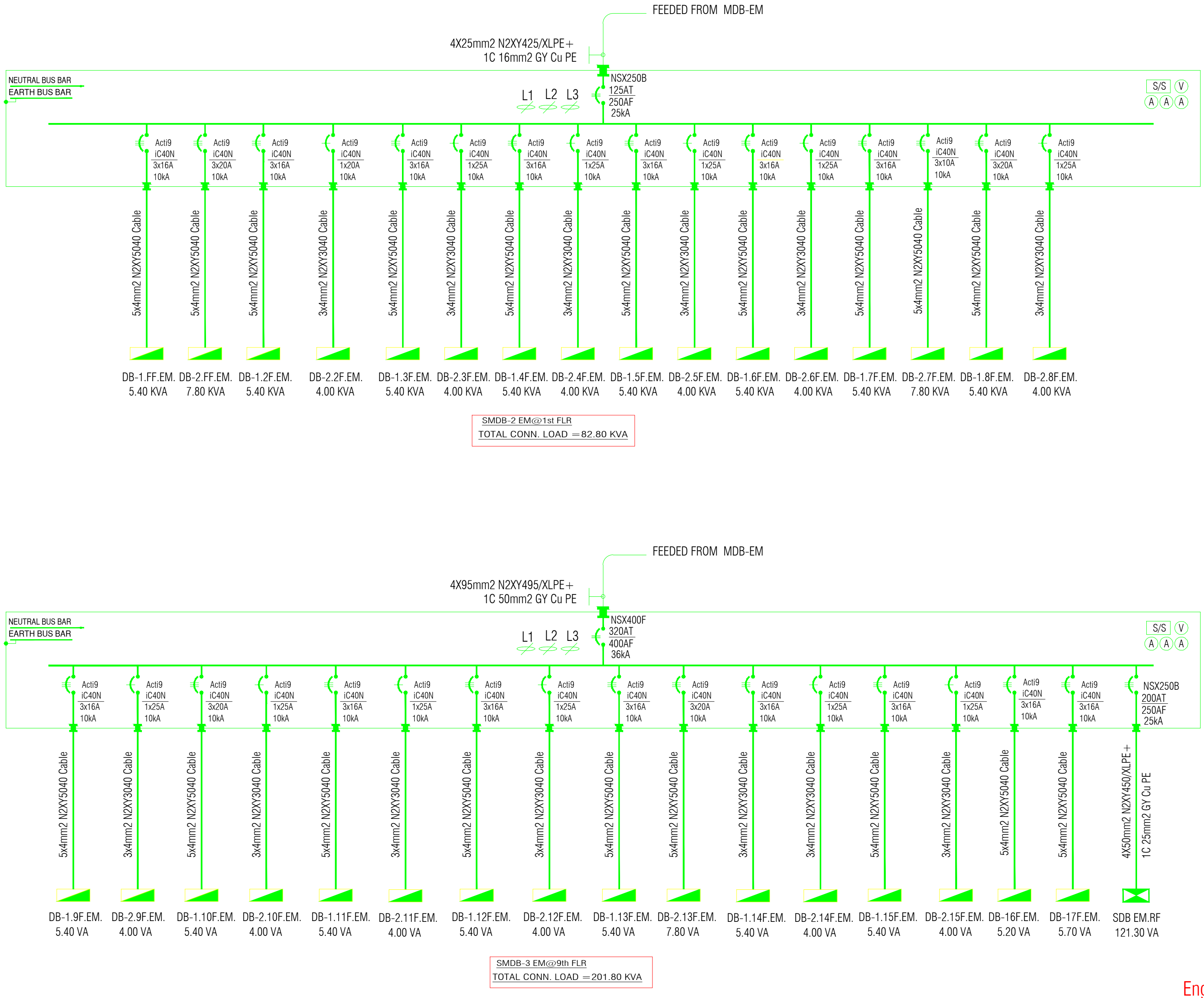

Figure 9.5 : Sing Line Diagrm -4

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Eng. Laith Abu Joudeh

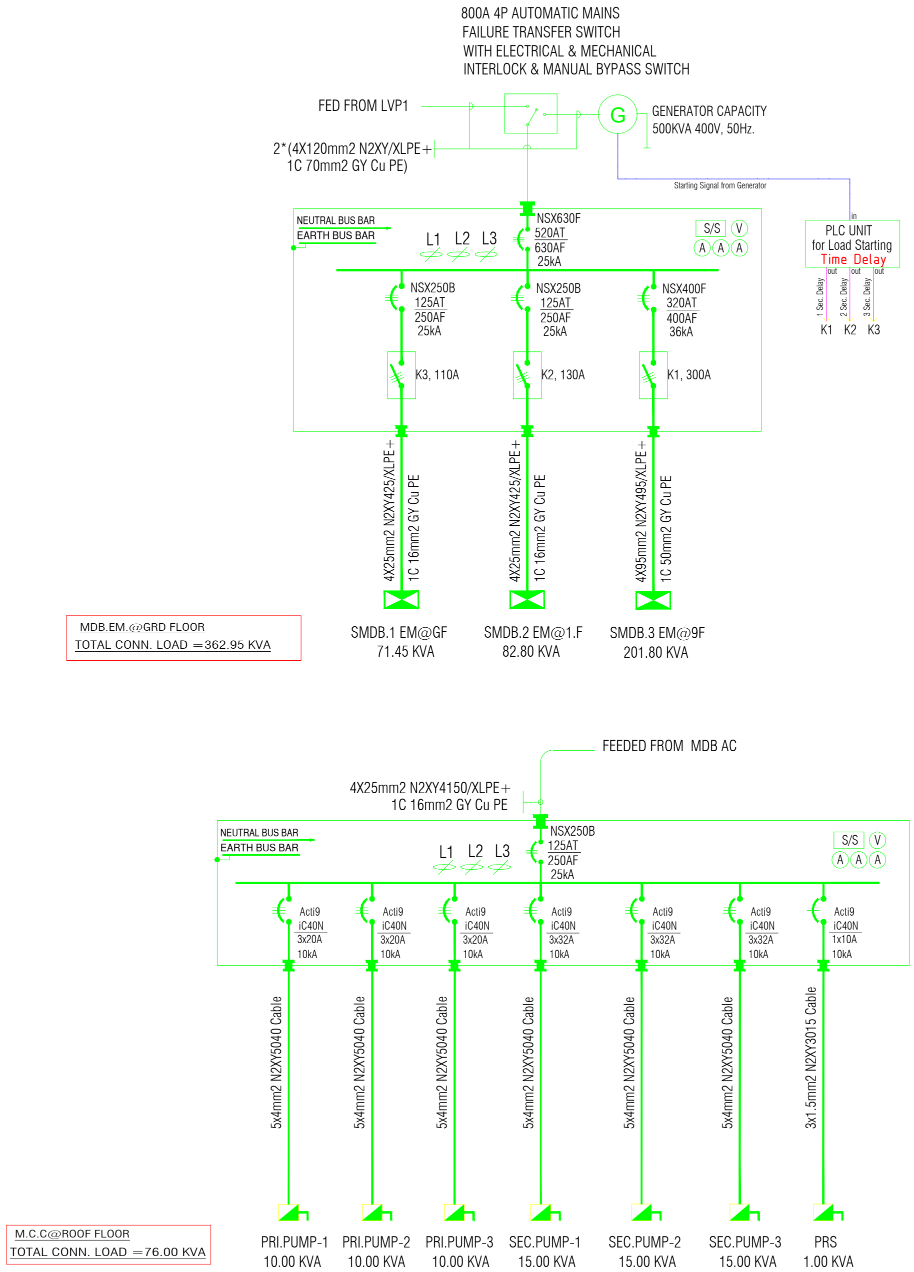

Figure 9.6 : Sing Line Diagrm -5

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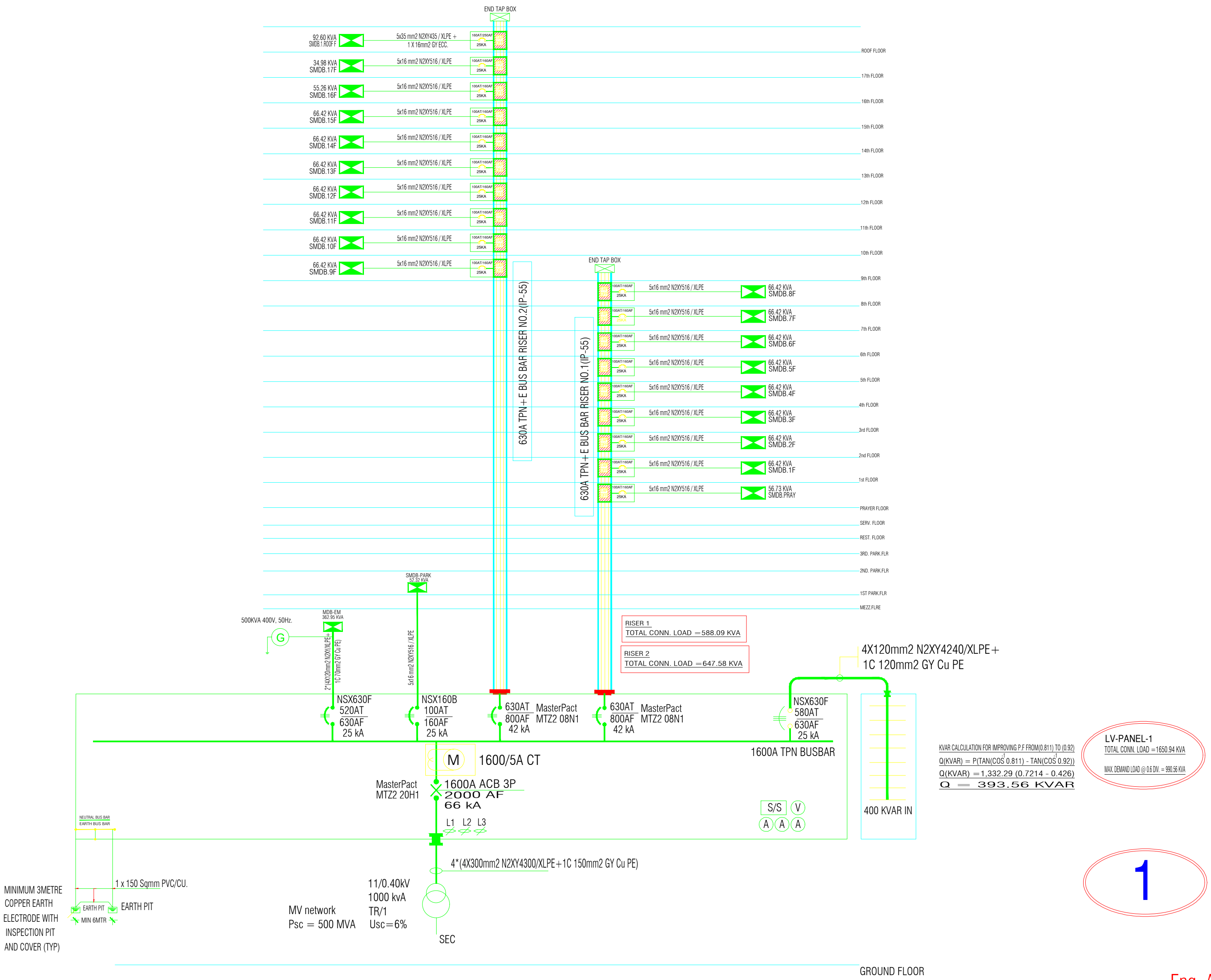

Figure 9.7 : Sing Line Diagrm -6

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Eng. Laith Abu Joudeh

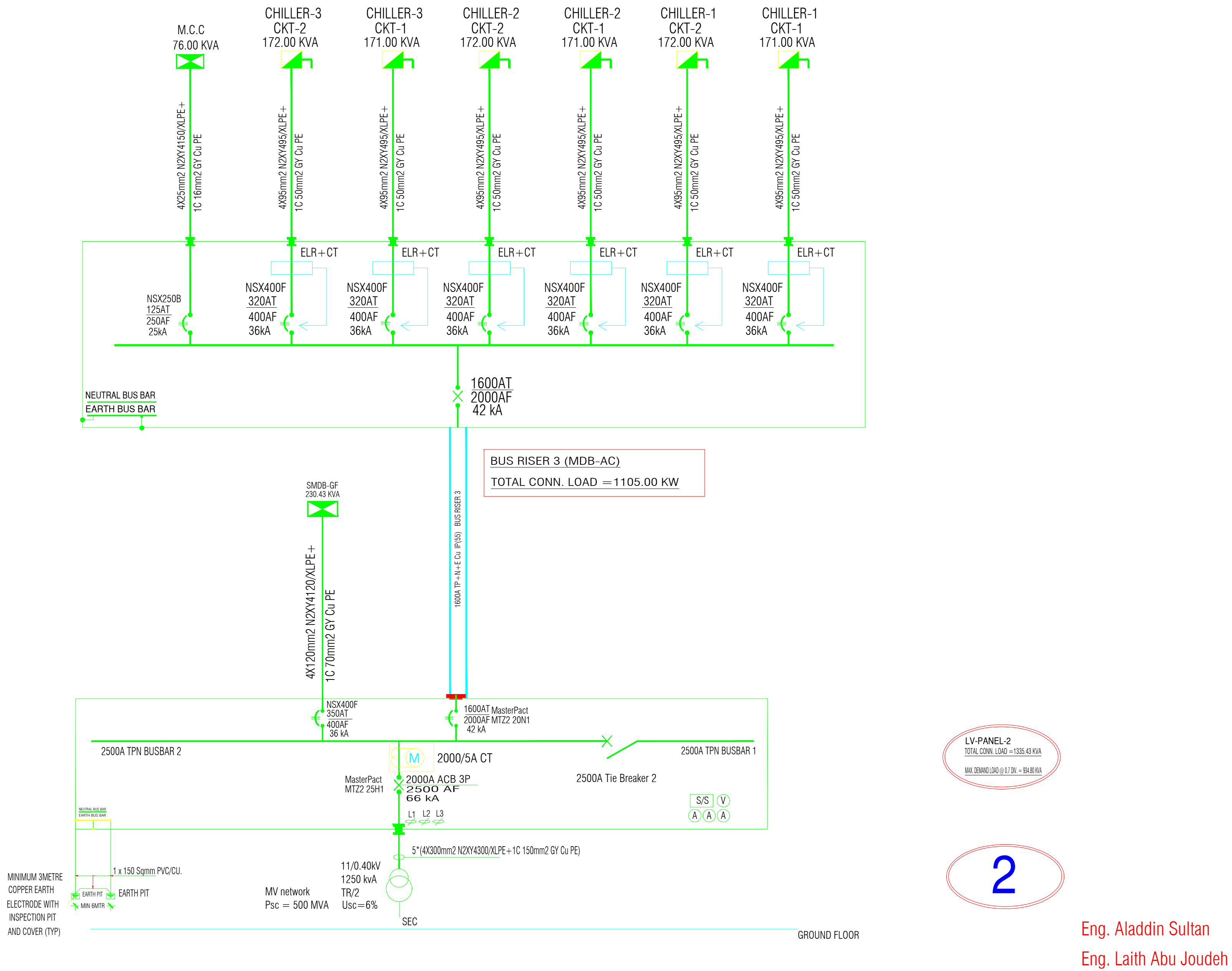
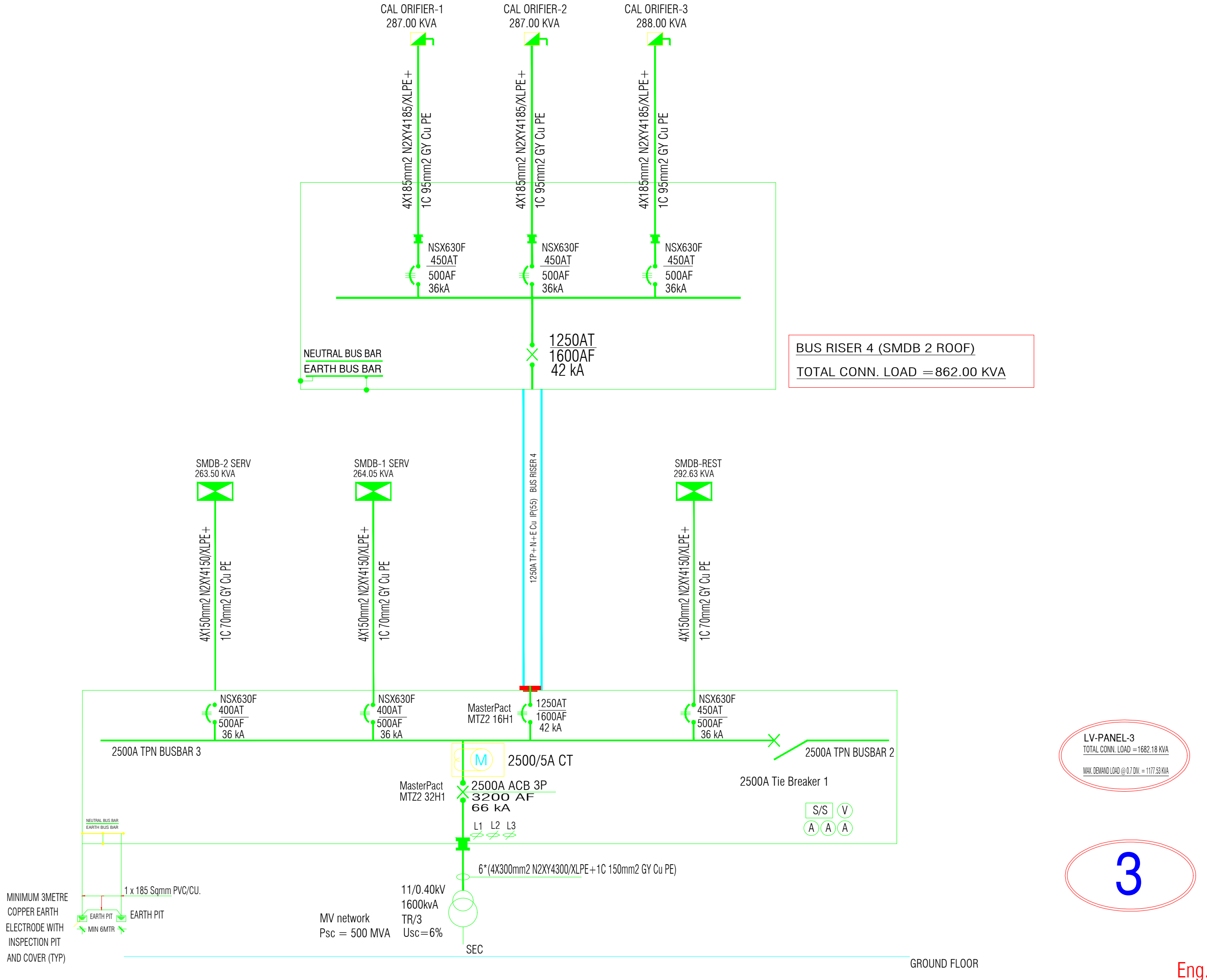


Figure 9.8 : Sing Line Diagrm -7

Figure 9.9 : Sing Line Diagrm -8



Eng. Aladdin Sultan

Eng. Laith Abu Joudeh

10

Chapter Ten

Fire Detection & Alarm System

10.1 Introduction

A fire alarm system warns people when smoke, fire, carbon monoxide or other fire-related or general notification emergency emergencies are detected. These alarms may be activated automatically from smoke detectors and heat detectors or may also be activated via manual fire alarm activation devices such as manual call points or pull stations. Alarms can be either motorized bells or wall mountable sounders or horns. They can also be speaker strobes, which sound an alarm, followed by a voice evacuation message, which warns people inside the building not to use the elevators. [13]

A fire alarm system consists of many different input and output devices, including:

- **Control Panel:** it is the brains of a fire alarm system, which monitors all the system's inputs. It is also responsible for controlling the actions of the system's output actions, and relays information to the notification devices.

- **Power Supply:** fire alarm system requires both a primary and backup power supply.

- **Initiating Devices:** which is responsible for transmitting a signal to the control panel signaling that there is a possible fire. There are two types:

  a) Automatic: consists of detectors that measure or identify the presence of smoke, heat, CO_2, and flames**.**
  b) Manual: these devices need a person to activate them, such as a pull station.

- **Notification Appliances:** notification appliances are made up of visual and audible devices that are used to alert building occupants of a fire.

- **Building Safety Components:** these components manage certain aspects of the building safety infrastructure and are meant to assist people in exiting the building.

- **Others:** there are often other aspects of a fire alarm system including fire doors, sprinklers, elevator recalls, among others. It is also increasingly common to have a building's fire alarm system be integrated with the building's security system or other smart building technologies.

Figure (10.1) shows the different devices connected to fire alarm control panel (FACP).

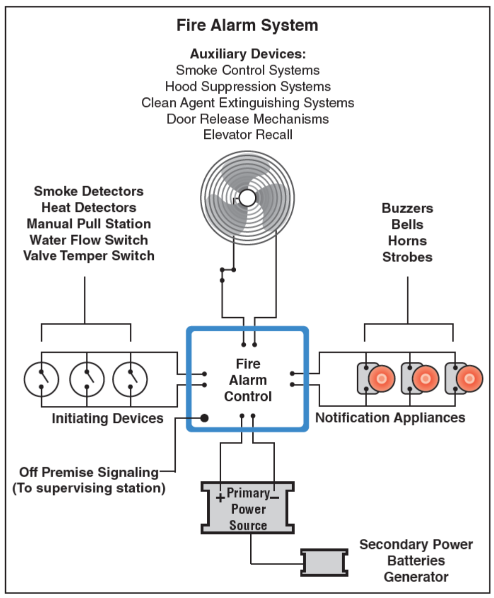


Figure (10. 1): different components of a fire alarm system.[14]

10.2 Hotel Fire Alarm System

The fire alarm system components used in the hotel, are UL 864 & EN-54 approved systems, which function as standard fire detection and alarm systems, including extinguishing release services; fireman's phone; UUKL approved smoke control and addressable voice evacuation. [15]

The type of fire alarm system used in hotel project is an addressable fire alarm system, which gives a unique address to each device that is on the system. The following table (10.1) shows the quantities of fire alarm devices used in the project.

Table (10. 1): Components of hotel addressable Fire Alarm System.

Item Description	Quantity
Addressable Fire Alarm Control Panel (Master)	1
Smoke Detector With Built in Sounder	345
Smoke Detector	425
Heat Detector With Built in Sounder	26
Heat Detector	44
Manual Break glass	67
Weather Proof Manual Break glass	13
Weather Proof Speaker with Built-in Flasher	16
Speaker with Built-in Flasher	75
Celling Speaker	203
Fire man Telephone	74
Voice Evacuation Control Panel	1
Interface unit	30

An example for fire alarm system AutoCAD plan for ground floor as shown in figure (10.2). In addition, the fire alarm riser diagram for the hotel floors from ground to 8^{th} floors as shown in figure (10.3). Moreover, the fire alarm riser diagram for 9^{th} to roof floors as shown in figure (10.4).

10.3 Central Battery System for Emergency Lighting

In short, central battery system for emergency lighting means, that the backup power source for the emergency and exit lights is provided centrally. In other words, each emergency and exit light does not need to have a battery or super capacitor of their own.

In hotel project, a central battery system is designed to supply 565 Emergency light unit and 196 Exit Light. A central battery system riser diagram for the hotel floors from ground to 8^{th} floors as shown in figure (10.5), and the riser diagram for 9^{th} to roof floors as shown in figure (10.6).

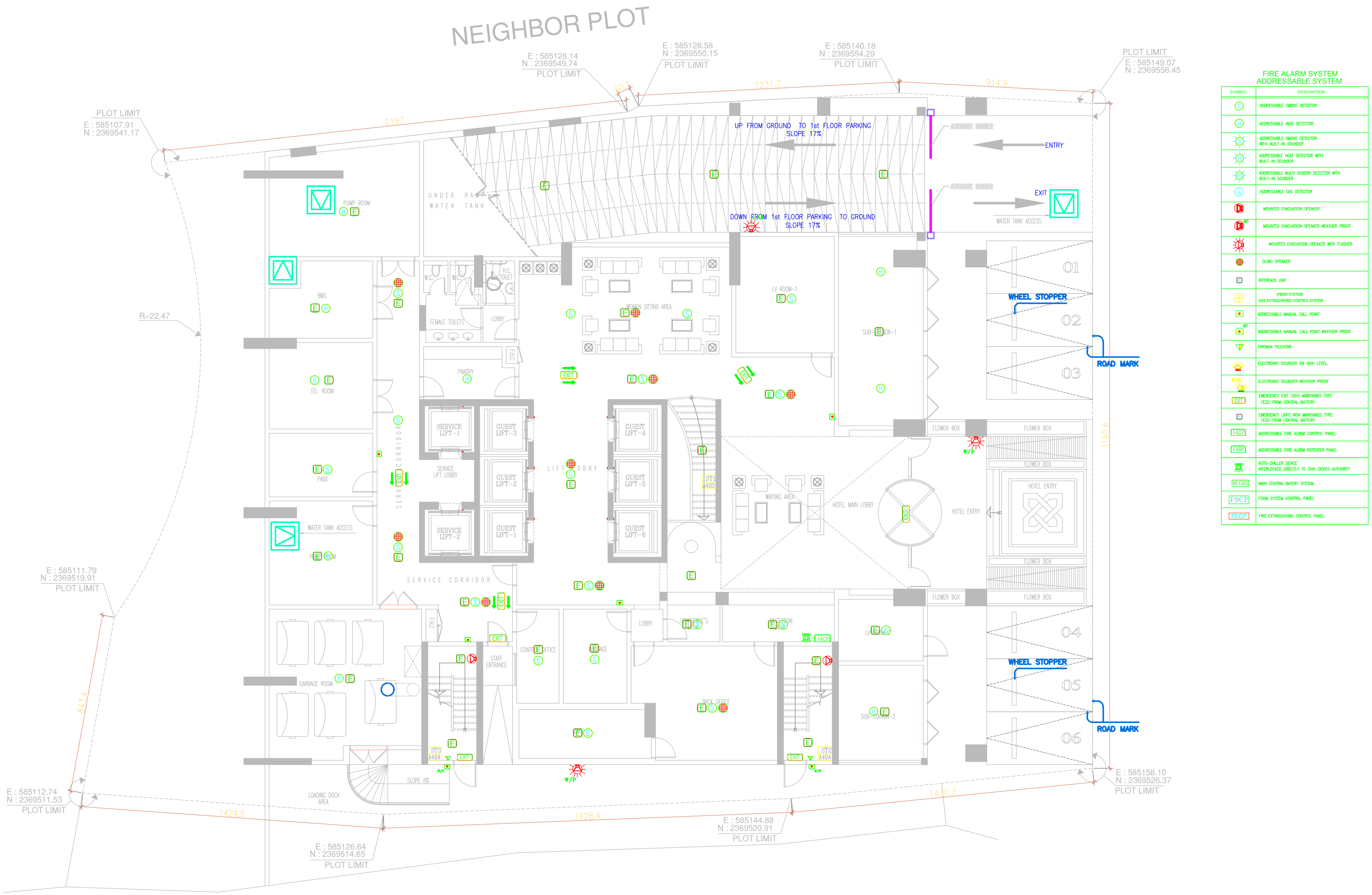


Figure 10.2 : Fire Alarm System for Ground Floor .

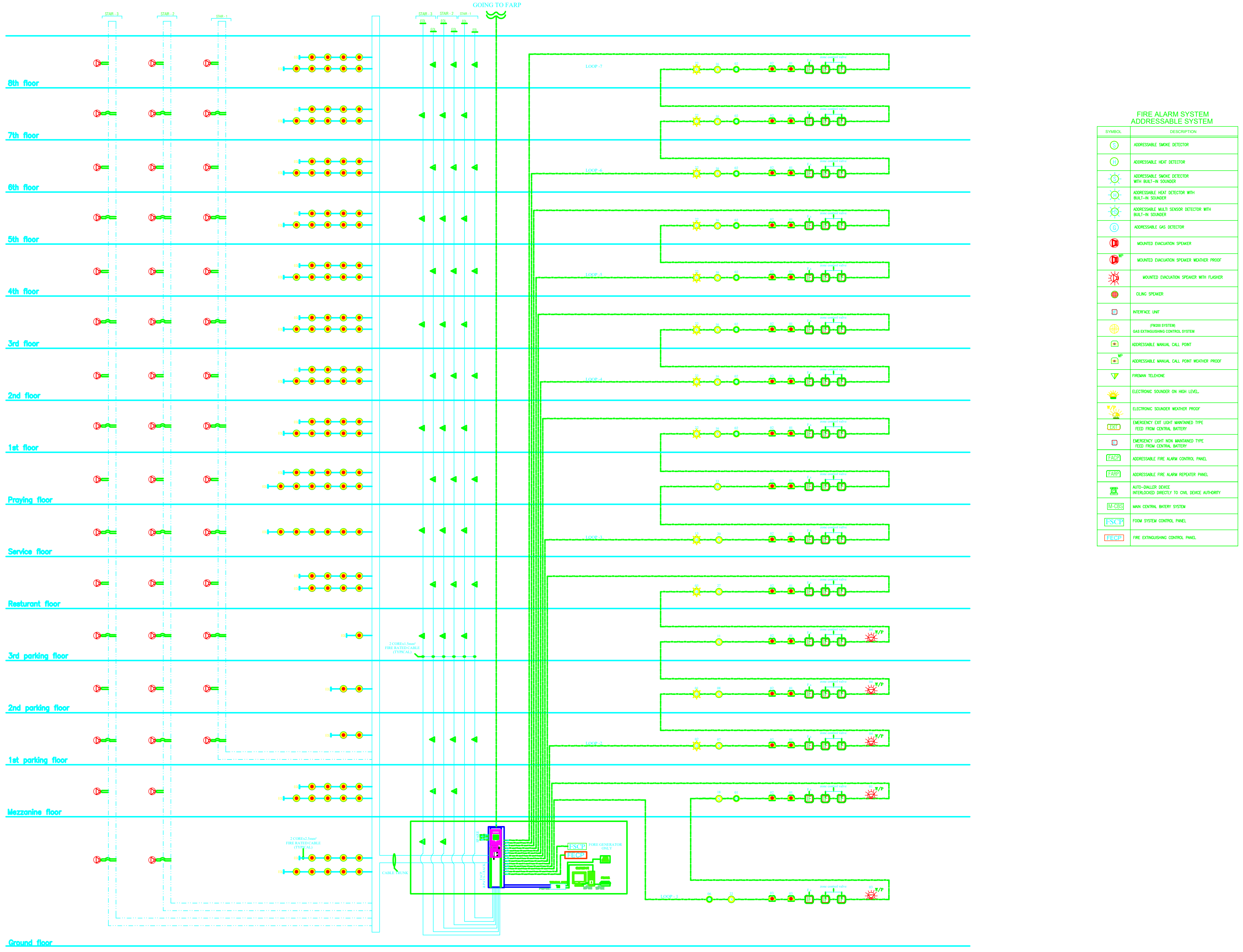


Figure 10.3 : Fire Alarm Riser Diagram for ground to 8th floors .

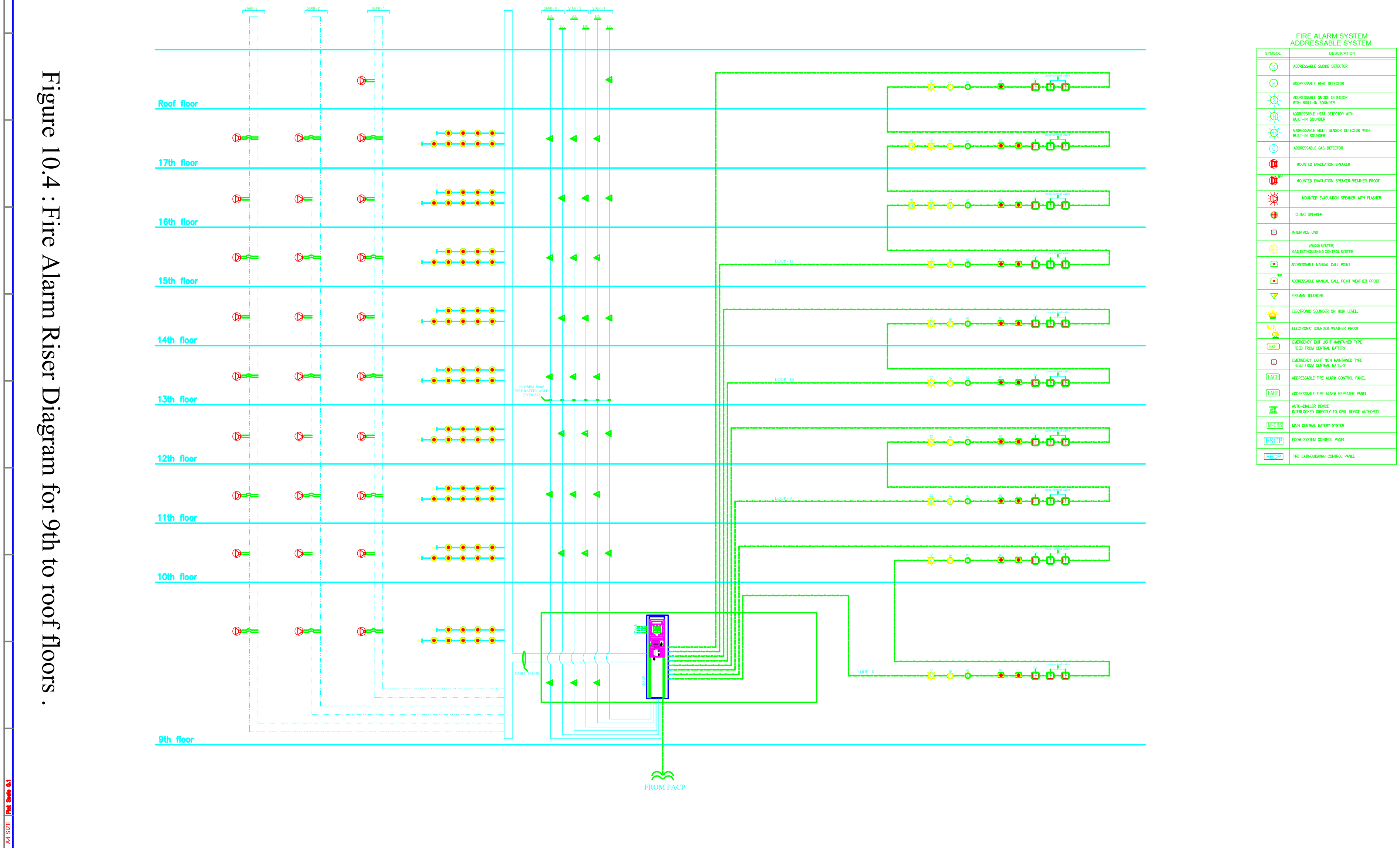
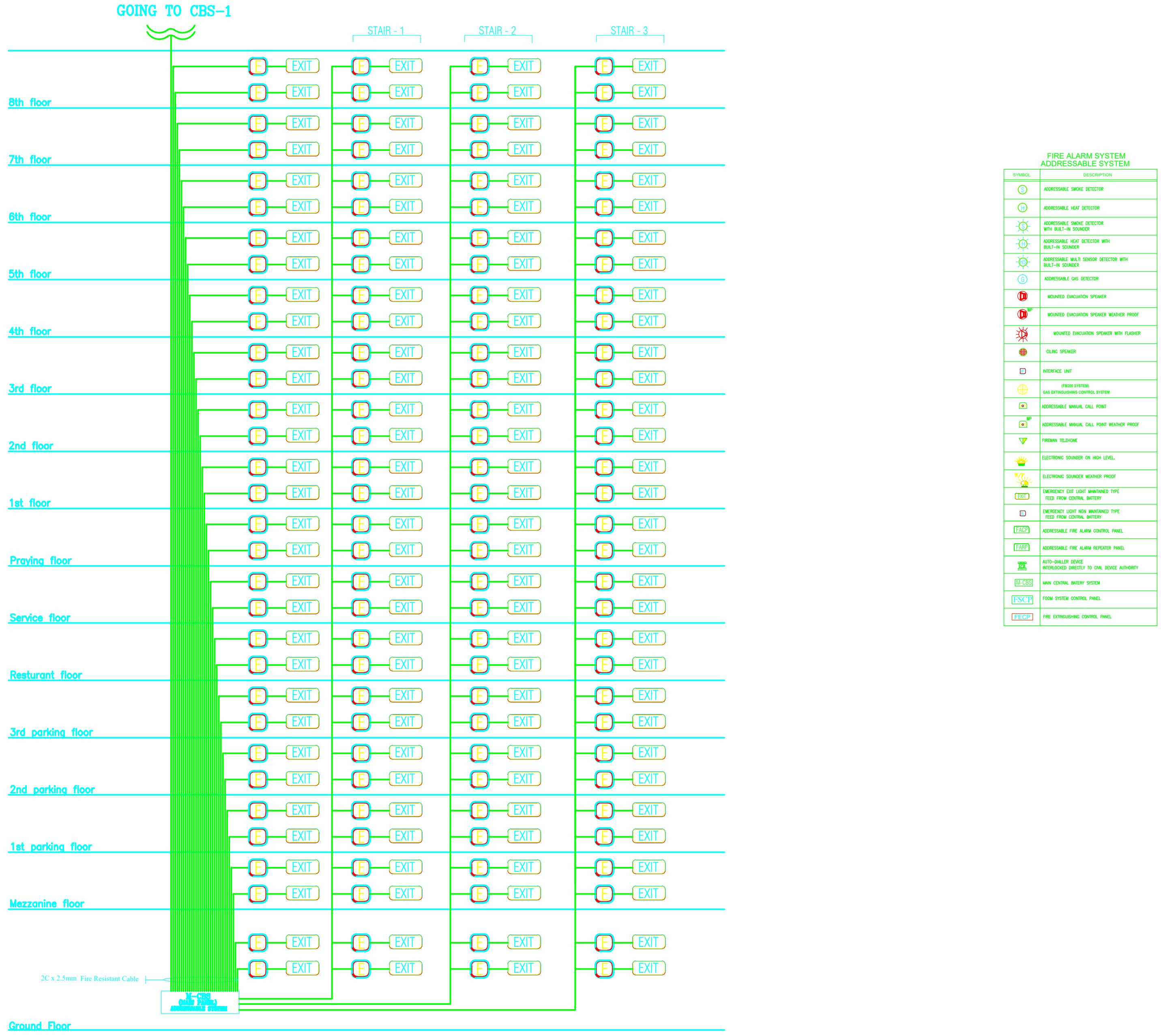


Figure 10.4 : Fire Alarm Riser Diagram for 9th to roof floors .



CENTRAL BATTERY SYSTEM SCHEMATIC RISER DIAGRAM

Figure 10.5 : Central Battery System Riser Diagram for Ground to 8th floors .

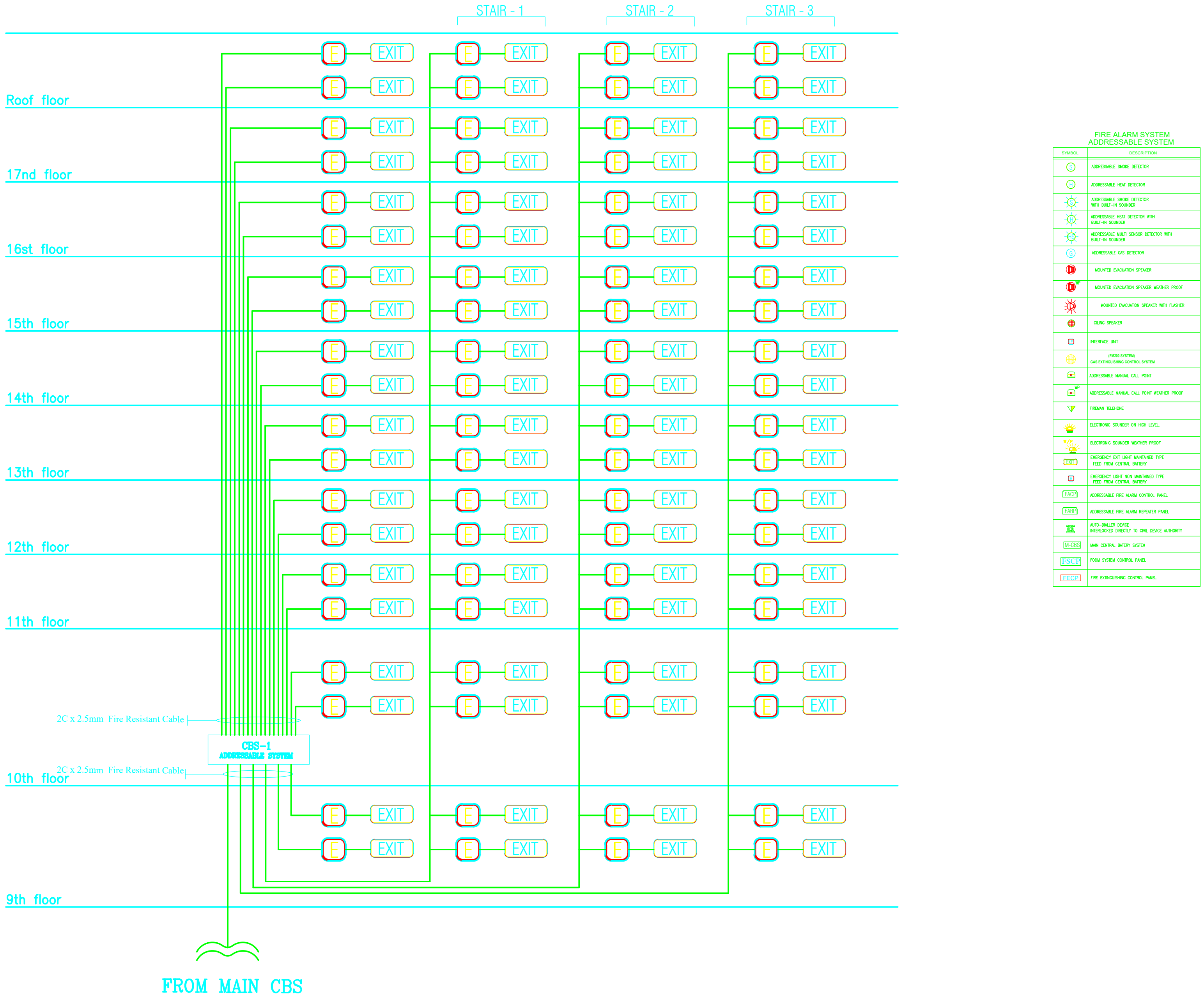


Figure 10.6 : Central Battery System Riser Diagram for 9th to roof floors .

11

Chapter Eleven

Economic Study

11.1 Energy Cost

At the end of the project design, a brief and simple economic cost study has been made. As mentioned in chapter 2 for hotel load estimation study, the total average energy consumption for load demand hours is 2,759.41 KWh, which means the hotel consumes energy of 66,225.84 KWh /day; 24,172,431.60 KWh /year. In other words, this 4-star hotel with 324 rooms and 21,268 m^2, consumes 704,606.3 KWh per room /year or 1,136.56 per m^2/year. Based on many researches these values are unconvincing and unreal.

Hotels in the United States use approximately 185 KWh per m^2/year on average. According to EnergyStar research, on average, America's 47,000 hotels spend $2,196 per available room each year on energy [16]. In addition, to estimate the hotel consumed energy in this report, a large hotel, a 4-star hotel with 311 rooms located near the sea in Greece was chosen, which on average consumes 222 KWh of per m^2/year [17].

Taking into consideration the average of the two pervious values, the 203.5 KWh per m^2/year is used here to estimate the annual hotel consumed energy. Therefore, the result of consumed energy in this project is 11,858 KWh /day; 4,328,038 KWh /year. With cost of $2,134 per day and $779,046.84 per year; respectively. Where the cost of consumed energy for 1KWh is about $0.18/ KWh for commercial as provide from electric supplier company.

11.2 Electrical Works Cost Estimating

The cost estimating of electrical works for any project is very important. which can get an approximation of the material, investment involved and the time to be taken for the completion of electrical project.

It is necessary to know the needed material and the cost to be incurred before starting the project to ensure all the materials required for the execution of the project, to avoid the misuse of money, to save time required for completion of the project and to complete the project un-interruptedly.

For this project, an electrical works cost estimating has been calculated, for all electrical works mentioned and not mentioned in this report with result of $6,569,331. For more details see table the Hotel Project Electrical Works BOQ in appendix J (page 143).

12

Chapter Twelve

Conclusions & Recommendations

12.1 Conclusions

As mentioned in the previous chapters, the purpose of this study is to design the stable electrical system in hotel building. Considering the following items are important key measurements that ascertain a safe, stable and continuous power supply:

1- Precise load list in terms of required power, load factors, load type and relevant feeding type assures a reliable system. Since the main purpose of electrical network is to energize electrical loads, the better understanding of loads, the better design of the network.

2- Taking normal feeding, emergency feeding and vital feeding (for relevant loads) into consideration are crucially important.

3- Reliable protections including relays and circuit breakers to protect equipment and personnel in faulty situation must be paid attention to. In addition, right connection of electrical protection and relays with other instrumentation systems such as fire protection system, distribution control system, and emergency shutdown system will assure safe hotel.

4- Main studies including load estimation, short circuit and voltage drop assist us to confirm stability of system. Furthermore, it should be noted that any modifications to each study will influence on the results of other studies and in the final stages, entire studies' results should be checked in order to approve all desired results.

5- Cable sizing is important in many aspects such as cost, voltage drop and reactive power losses. Wrong cable sizing can adversely effect on the system by leading to faulty conditions as well as huge costs of detecting the fault and replacing the cable, which can be costly, and time consuming.

6- Although in this project the power factor was acceptable in two feeders according to design criteria, but capacitor bank is recommended for improving power factor for the purpose of having lower reactive losses, better control on voltage drops and lower size of cable. Selecting smaller cable cross section can be more economical.

7- By adjusting short circuit impedance of transformer, it is possible to control short circuit current. However, the higher short-circuit impedance, the higher losses. That is why utilizing transformers with higher sizes are sometimes recommended.

8- A well-designed earthing system is a necessity to protect a person, reduction of electromagnetic disturbance and overall network of supply system. So, for enforcement of safety measures, the faults in any supply system are unavoidable. So, each electrical equipment's, system must be earthed to obtain a lower resistance path for dissipation of fault current in to the earth. It is also clear that value of earth resistance is directly related to soil property and earthing electrode. The earthing design for lightning protection system is calculated by considerateness characteristics of the building, its environment and soil resistivity.

9- The single-line diagram or SLD is an electrical diagram or drawing that represents the components of an electrical installation system represented by symbols, which help to describe how the components of the hotel project are related.

10- Early fire detection is crucial and plays a very important role in protecting and saving lives and properties. Having a fire detection system can significantly reduce damages and maximize fire control efforts.

12.2 Recommendations

As result of hotel design, the following recommendations must be taken into consideration:

1- As result of high energy consumption for hotel load demand, a renewable energy source must be taken into consideration, as photovoltaic system or wind turbine to minimize the consumed energy cost.

2- Due to the increasing use of electric vehicles in the market, installing a charge unit in parking floors for electric vehicles as future work is recommended.

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[15] https://telefire.com/wp-content/uploads/2022/07/7000.pdf

[16]https://www.energystar.gov/sites/default/files/buildings/tools/SPP%20Sales%20Flyer%20for%20Hospitality%20and%20Hotels.pdf

[17]https://www.researchgate.net/publication/230817809_A_Statistical_Approach_to_the_Prediction_of_the_Energy_Performance_of_Hotel_Stock

Appendix A:

AutoCAD Project's Floors Layouts

A) GROUND FLOOR Layout:

Which consists of hotel entry, hotel main lobby, waiting area, reception desk, control office, luggage, lifts lobby …etc. as shown in figure (1.3).

Figure (1.3) Hotel Ground Floor Layout.

B) MEZZANINE FLOOR Layout:

Which consists of administration, sitting area, shop 1, shop 2, pantry, electric room, toilets, lifts lobby…etc. as shown in figure (1.4).

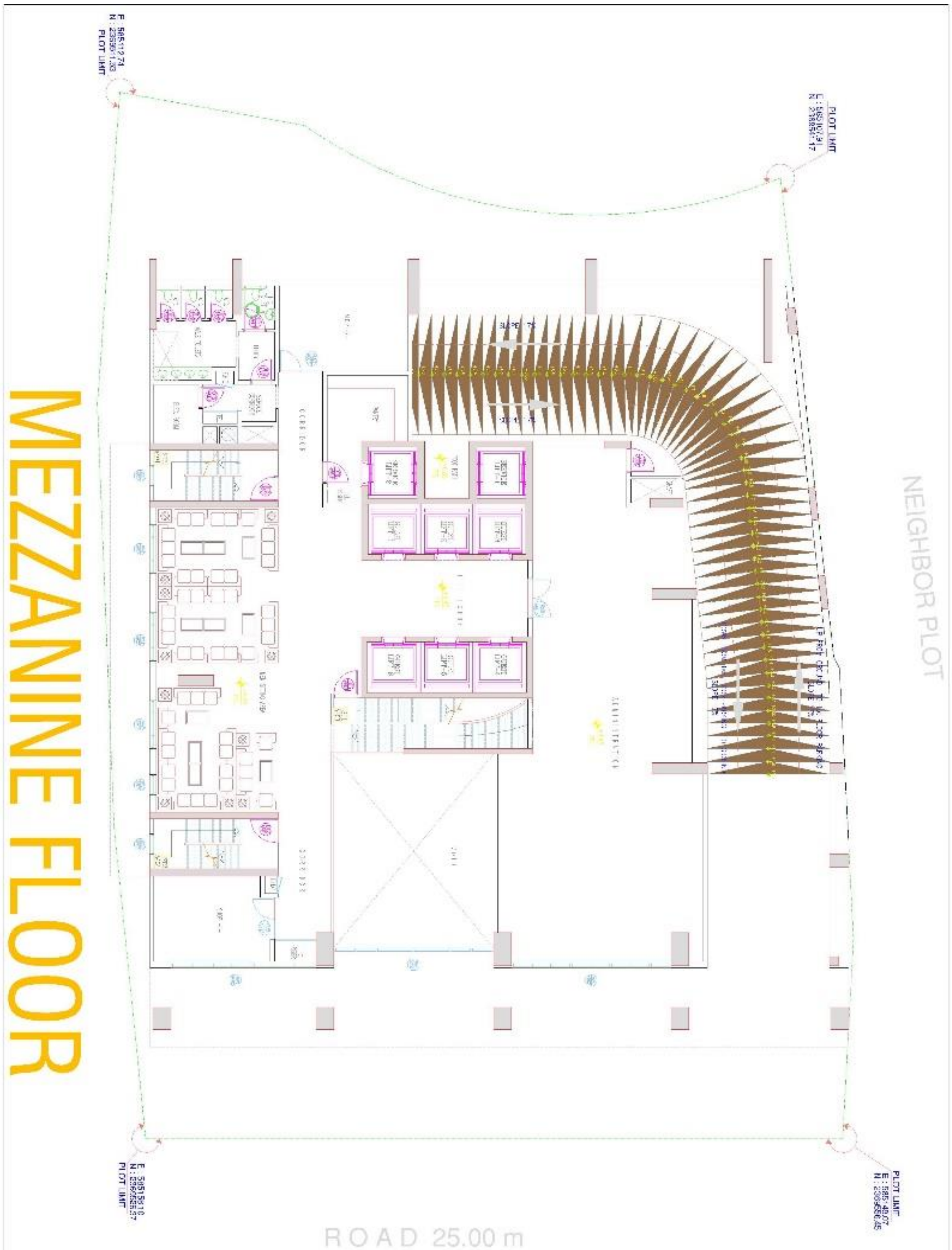


Figure (1.4) Mezzanine Floor Layout.

C) 1st PARKING FLOOR Layout:

Which consists of car parking, cargo lift, receiving room, stores…etc. as shown in figure (1.5).

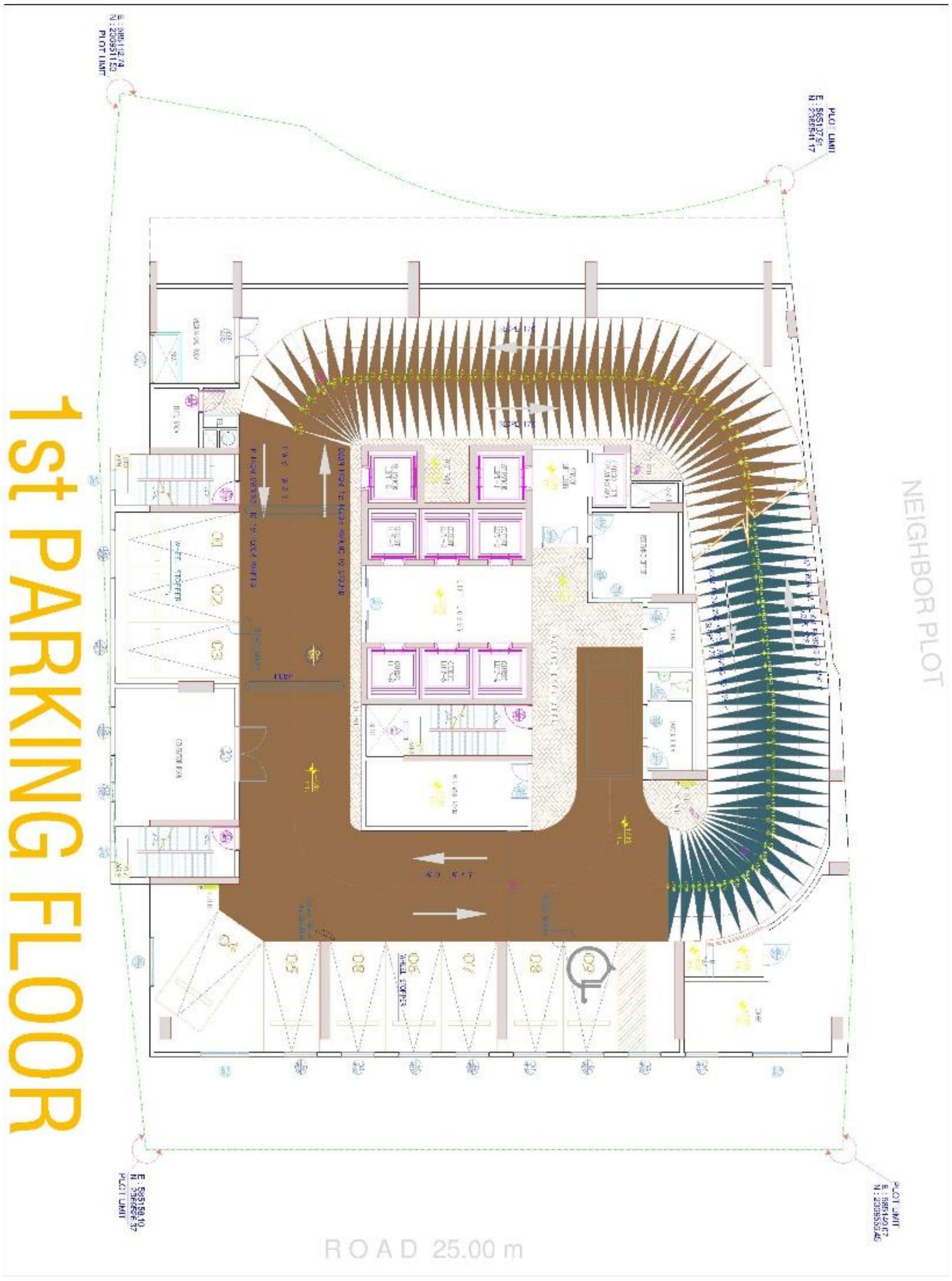


Figure (1.5) 1st Parking Floor Layout.

D) 2nd PARKING FLOOR Layout:

Which consists of car parking, cargo lift, kitchen store, mechanical room …etc. as shown in figure (1.6).

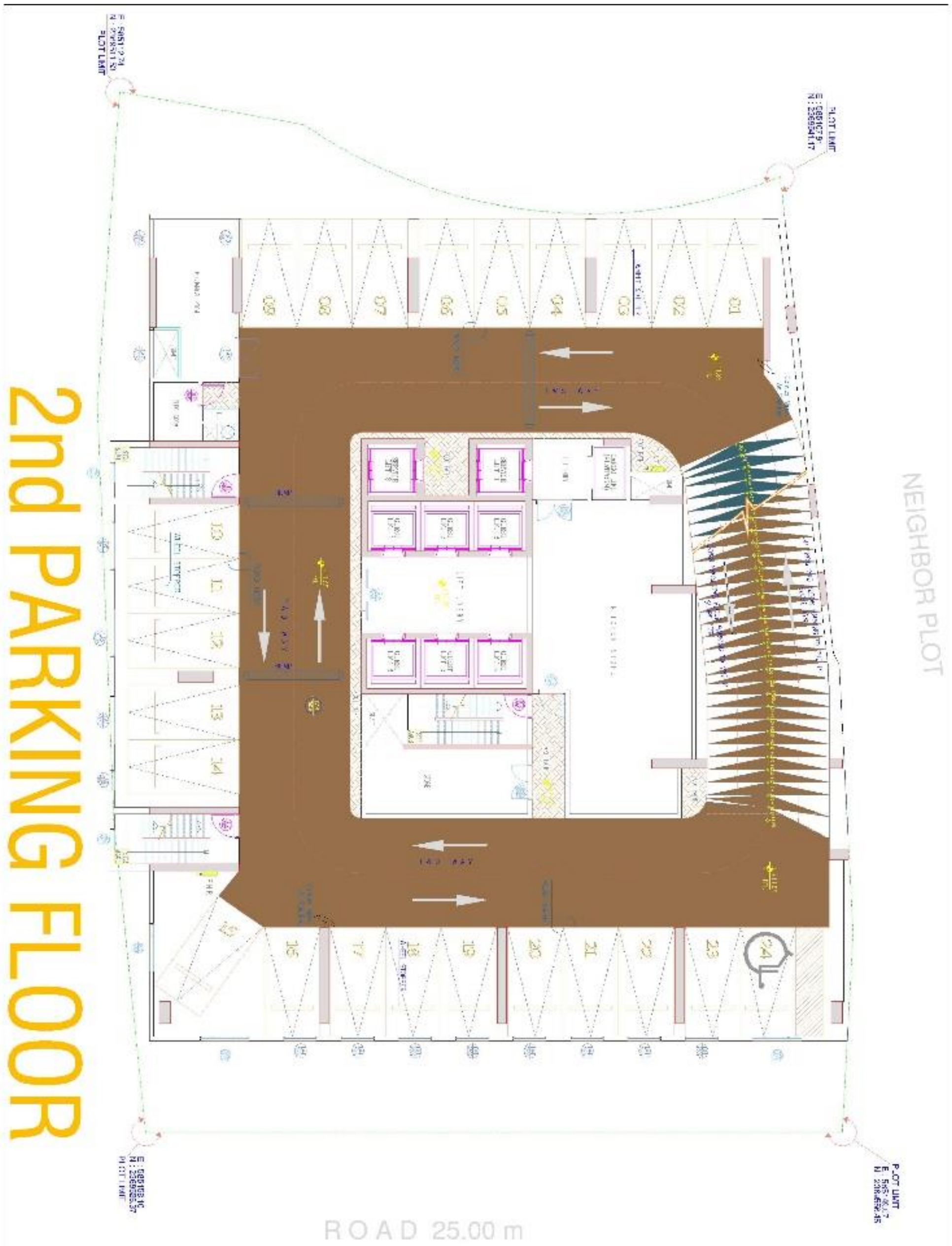


Figure 1.6 2nd Parking Floor Layout.

E) **3rd PARKING FLOOR Layout:**

Which consists of car parking, chief engineer office, mechanical, electrical, carpentry and paint workshops…etc. as shown in figure (1.7).

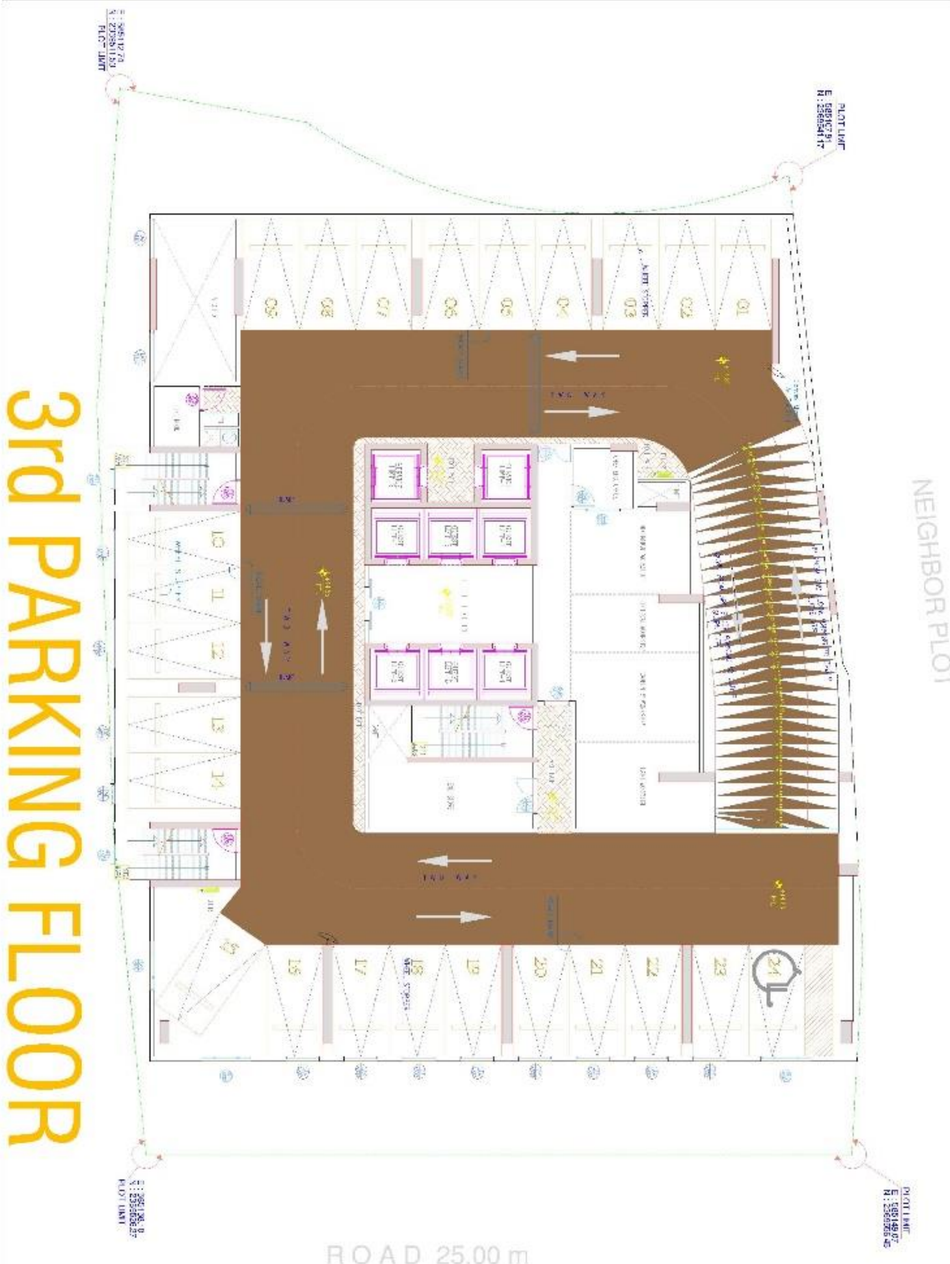


Figure (1.7) 3rd Parking Floor Layout.

F) RESTURANT FLOOR Layout:

Which consists of main restaurant, satellite kitchen, toilets, storage room…etc. as shown in figure (1.8).

Figure 1.8 Restaurant Floor Layout.

G) SERVICES FLOOR Layout:

Which consists of main kitchen, staff canteen, laundry, housekeeping, toilets…etc. as shown in figure (1.9).

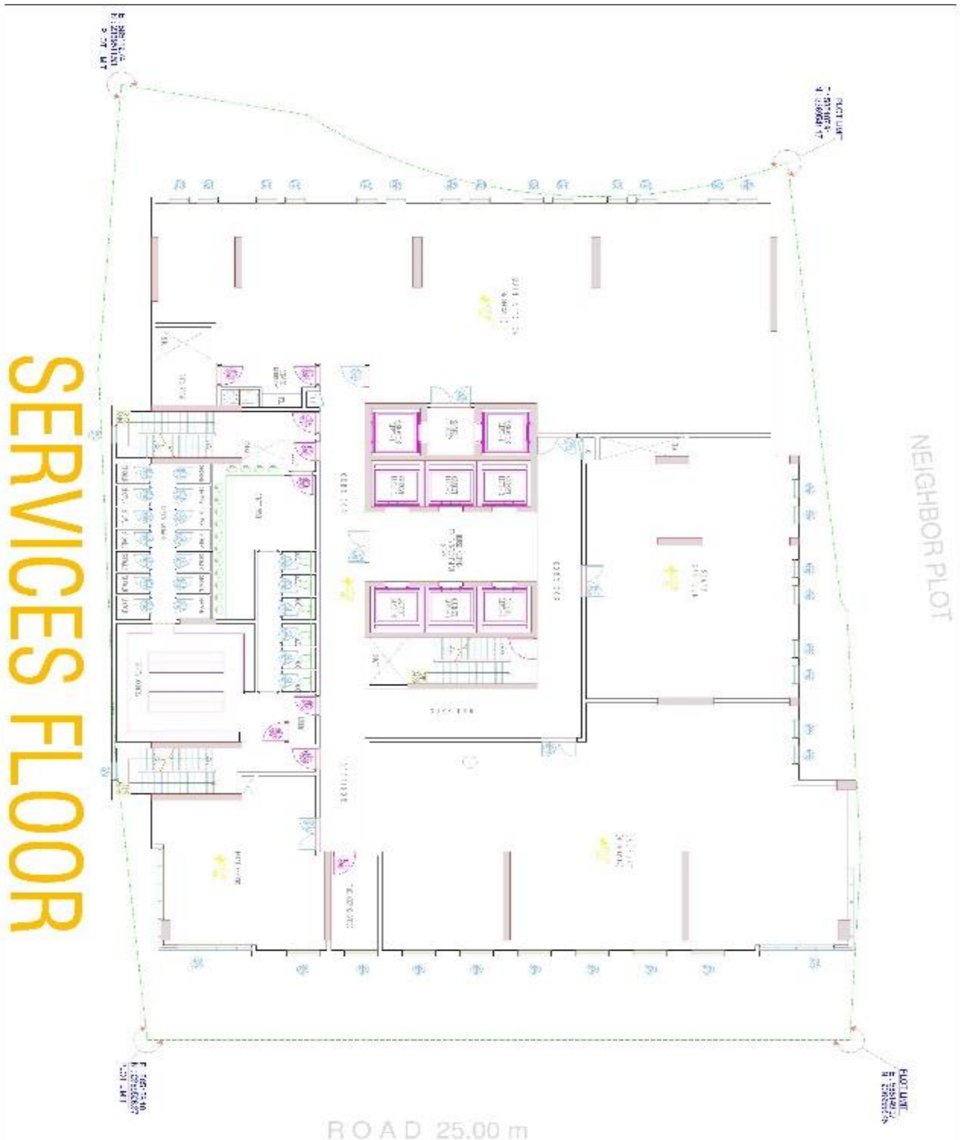


Figure 1.9 Services Floor Layout.

H) PRAYING FLOOR Layout:

Which consists of main gents and ladies praying, toilets, services room…etc. as shown in figure (1.10).

Figure (1.10) Praying Floor Layout.

I) TYPICAL (1ST to 15TH FLOORS) Layout:

The floors from 1st floor to 15th floor are typical, so one layout for all of them is considered, which consists of 19 guest rooms for each floor i.e. 285 guest rooms, with their services …etc. as shown in figure (1.11).

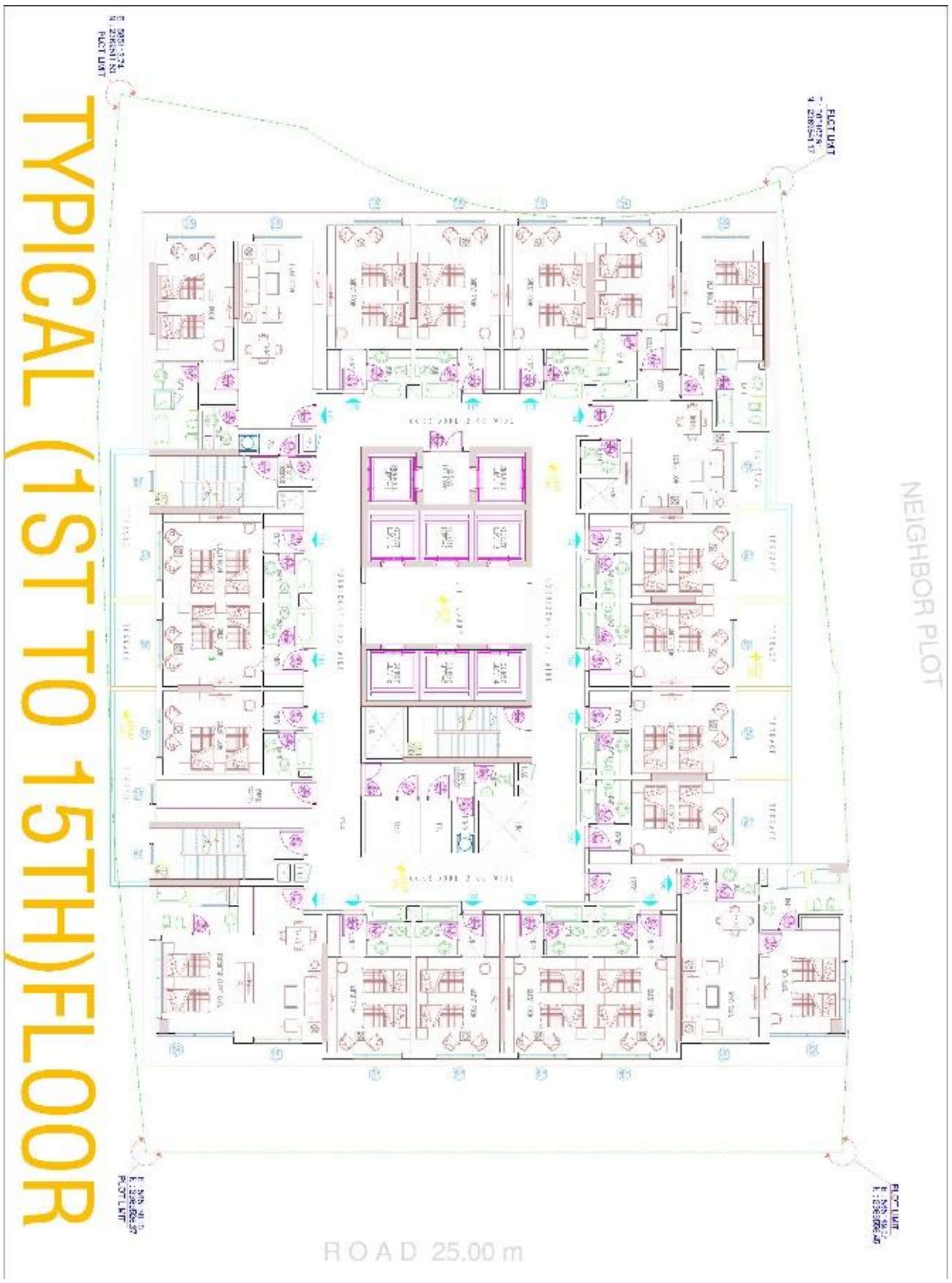


Figure (1.11) Typical (1ST to 15TH FLOORS) Layout.

J) 16TH FLOOR Layout:

Which consists of 9 guest rooms, dining and living rooms, etc. as shown in figure (1.12).

Figure (1.12) 16TH Floors Layout.

K) 17TH FLOOR Layout:

Which consists of reception, men and women majlis, dining rooms, dining and living rooms, bedrooms…etc. as shown in figure (1.13).

Figure (1.13) 17TH Floor Layout.

L) LOWER ROOF Layout:

This floor has been prepared to have heavy electrical, mechanical, HVAC loads as chillers, FAHU, pumps; lift lobby …etc. as shown in figure (1.14).

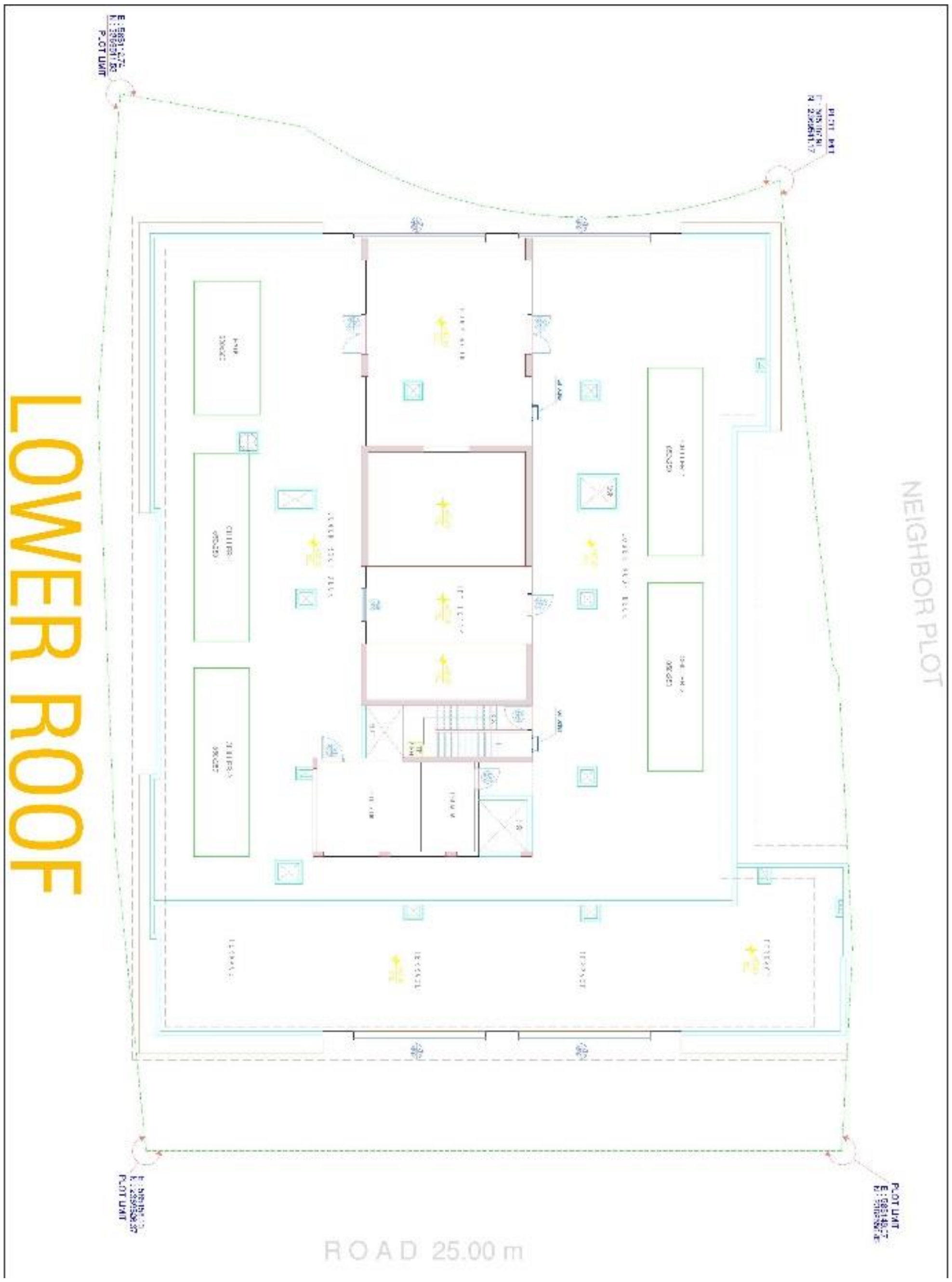


Figure (1.14) Lower Roof Layout.

M) UPPER ROOF Layout:

Same to lower roof, this floor has been prepared to have heavy electrical, mechanical, HVAC loads as chillers, FAHU, pumps; lift lobby …etc. as shown in figure (1.15).

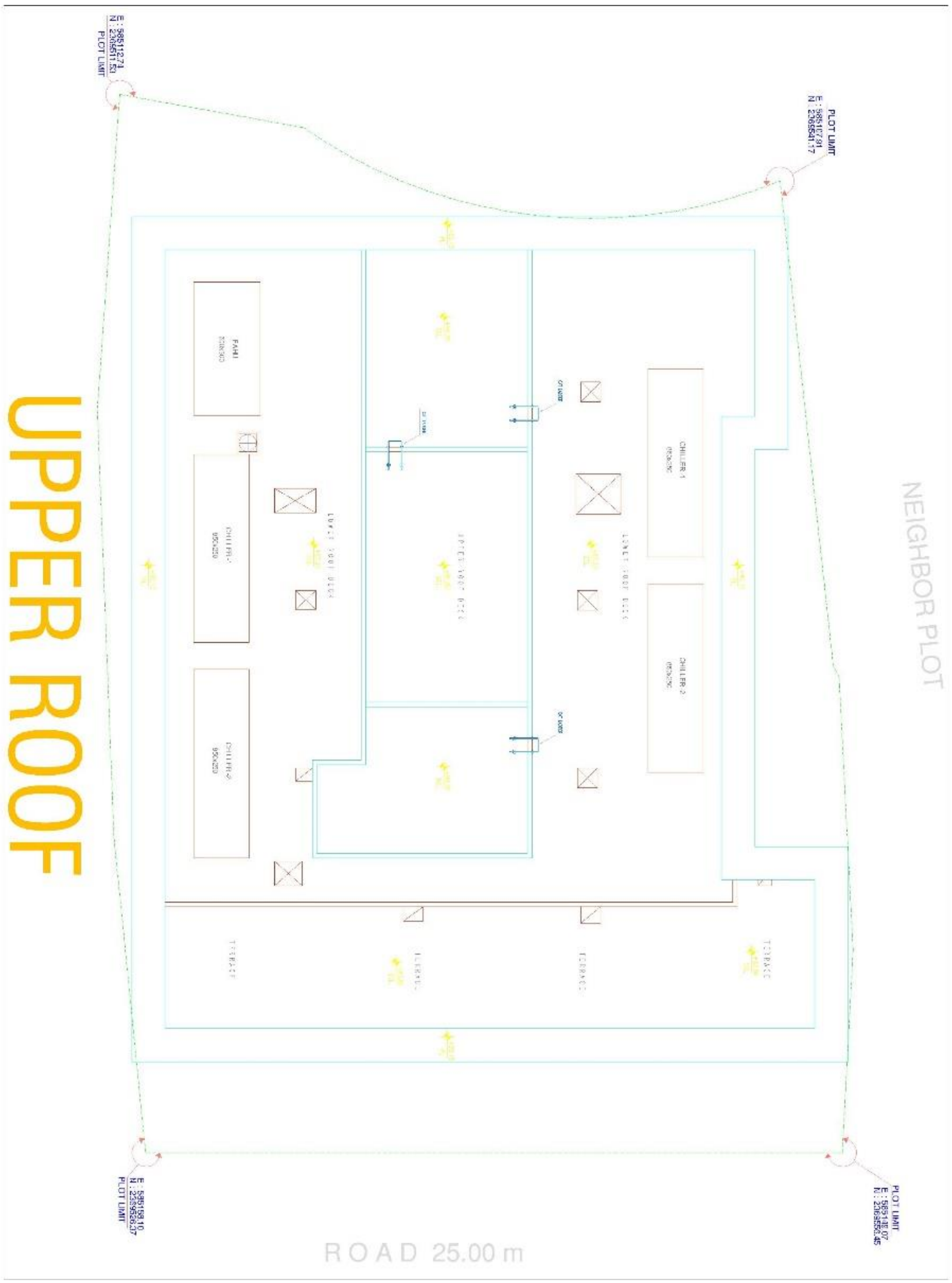


Figure (1.15) Upper Roof Layout.

Appendix B:

Lighting used in the project

Operator
Telephone
Fax
e-Mail

Fagerhult 300652_26 Esplanad Bollard 1xTC-TEL 26W / Luminaire Data Sheet

Luminaire classification according to CIE: 76
CIE flux code: 17 48 80 76 37

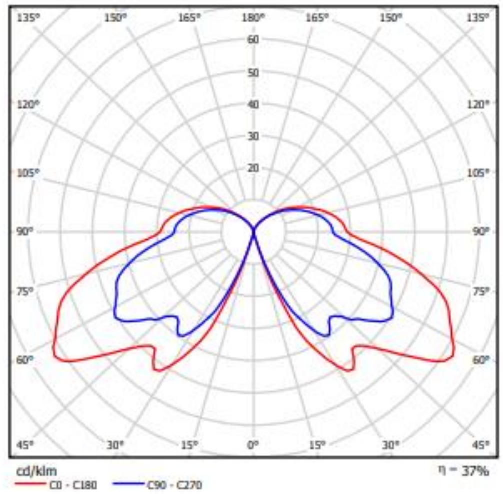
Installation
Luminaire for assembly on 76-foundation. Can also be mounted on an in-situ cast foundation or on a mounting plate. Supplement with accessories.

Connection
Terminal block 4x10 mm².

Design
Black enamelled (RAL9005) body of cast aluminium with stainless steel bolted joints. White finish inside. Shade of UV-stabilized, clear polycarbonate. Ballast integrated in the body.

Accessories
Base plate or hot-dip galvanized ground bracket ordered separately.

Luminous emittance 1:



Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	17.6	18.9	18.2	19.6	20.3	18.1	19.4	18.7	20.1	20.8
	3H	20.9	22.1	21.6	22.8	23.6	20.6	21.9	21.3	22.5	23.3
	4H	22.4	23.6	23.1	24.2	25.0	21.8	22.9	22.4	23.6	24.4
	6H	23.8	24.8	24.4	25.5	26.4	22.9	23.9	23.5	24.6	25.5
	8H	24.4	25.5	25.1	26.2	27.0	23.4	24.4	24.1	25.2	26.0
	12H	25.1	26.1	25.8	26.8	27.7	24.0	25.0	24.7	25.7	26.6
4H	2H	18.5	19.6	19.2	20.3	21.1	18.8	20.0	19.5	20.7	21.5
	3H	21.6	22.6	22.3	23.3	24.1	21.8	22.8	22.5	23.5	24.4
	4H	23.2	24.1	23.9	24.8	25.7	23.2	24.1	23.9	24.8	25.7
	6H	24.8	25.6	25.6	26.4	27.3	24.5	25.3	25.3	26.1	27.0
	8H	25.6	26.4	26.4	27.1	28.1	25.2	25.9	25.9	26.7	27.6
	12H	26.5	27.2	27.2	27.9	28.9	25.9	26.6	26.6	27.3	28.3
8H	4H	23.7	24.5	24.5	25.3	26.2	23.7	24.5	24.5	25.3	26.2
	6H	25.5	26.1	26.3	26.9	27.8	25.4	26.1	26.2	26.8	27.8
	8H	26.4	27.0	27.2	27.8	28.7	26.3	26.9	27.1	27.7	28.6
	12H	27.5	28.0	28.3	28.8	29.8	27.2	27.7	28.0	28.5	29.5
12H	4H	23.9	24.6	24.6	25.3	26.3	23.8	24.5	24.6	25.3	26.2
	6H	25.7	26.3	26.5	27.1	28.0	25.6	26.2	26.4	27.0	27.9
	8H	26.7	27.2	27.5	28.0	29.0	26.6	27.1	27.4	27.9	28.9
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.3 / -0.3				
S = 2.0H		+0.3 / -0.3					+0.5 / -0.6				
Standard table		BK12					BK12				
Correction Summand		6.3					5.9				
Corrected Glare Indices referring to 1800lm Total Luminous Flux											

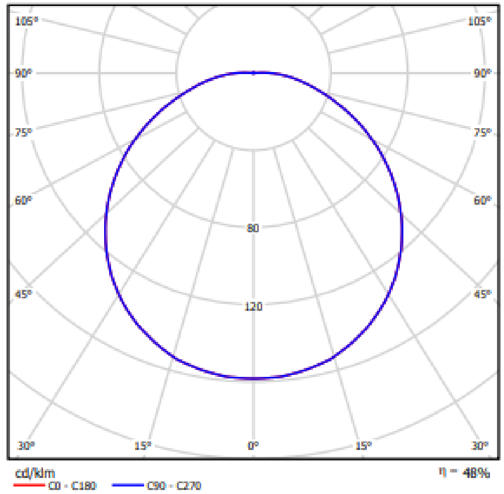
Operator
Telephone
Fax
e-Mail

BEGA 8824 4 HME 80W / Luminaire Data Sheet

Luminaire classification according to CIE: 99
CIE flux code: 45 76 93 99 48

BEGA-Aufsatzleuchte Nr. 8824

Luminous emittance 1:



Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	17.8	19.2	18.1	19.4	19.7	17.8	19.2	18.1	19.4	19.7
	3H	19.7	20.9	20.0	21.2	21.5	19.7	20.9	20.0	21.2	21.5
	4H	20.5	21.6	20.8	21.9	22.2	20.5	21.6	20.8	21.9	22.2
	6H	21.2	22.3	21.5	22.6	22.9	21.2	22.3	21.5	22.6	22.9
	8H	21.5	22.6	21.9	22.9	23.2	21.5	22.6	21.9	22.9	23.2
	12H	21.8	22.8	22.2	23.2	23.5	21.8	22.8	22.2	23.2	23.5
4H	2H	18.4	19.6	18.8	19.9	20.2	18.4	19.6	18.8	19.9	20.2
	3H	20.5	21.5	20.9	21.8	22.2	20.5	21.5	20.9	21.8	22.2
	4H	21.4	22.3	21.9	22.7	23.1	21.4	22.3	21.9	22.7	23.1
	6H	22.3	23.1	22.8	23.5	23.9	22.3	23.1	22.8	23.5	23.9
	8H	22.8	23.5	23.2	23.9	24.3	22.8	23.5	23.2	23.9	24.3
	12H	23.2	23.9	23.7	24.3	24.7	23.2	23.9	23.7	24.3	24.7
8H	4H	21.8	22.5	22.3	23.0	23.4	21.8	22.5	22.3	23.0	23.4
	6H	22.9	23.5	23.4	24.0	24.4	22.9	23.5	23.4	24.0	24.4
	8H	23.5	24.0	24.0	24.5	25.0	23.5	24.0	24.0	24.5	25.0
	12H	24.1	24.6	24.6	25.0	25.6	24.1	24.6	24.6	25.0	25.6
12H	4H	21.9	22.5	22.3	23.0	23.4	21.9	22.5	22.3	23.0	23.4
	6H	23.1	23.6	23.5	24.1	24.5	23.1	23.6	23.5	24.1	24.5
	8H	23.7	24.2	24.2	24.6	25.2	23.7	24.2	24.2	24.6	25.2

Variation of the observer position for the luminaire distances S

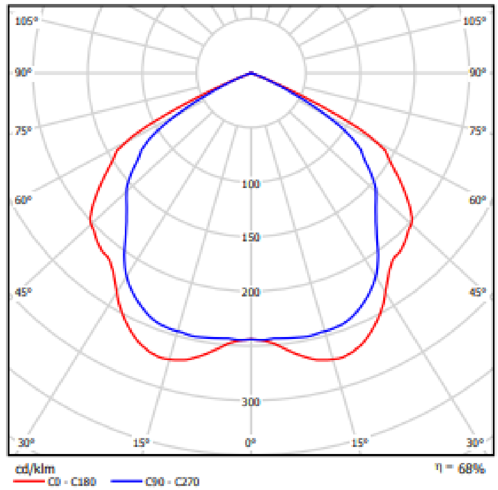
	Viewing direction at right angles to lamp axis	Viewing direction parallel to lamp axis
S = 1.0H	+0.1 / -0.1	+0.1 / -0.1
S = 1.5H	+0.2 / -0.3	+0.2 / -0.3
S = 2.0H	+0.3 / -0.6	+0.3 / -0.6
Standard table	BK07	BK07
Correction Summand	-0.8	-0.8

Corrected Glare Indices referring to 4000lm Total Luminous Flux

Operator
Telephone
Fax
e-Mail

Philips Trilogy 170 FBH170 2xPL-C/2P26W/840 CON / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 55 92 100 100 68

Luminous emittance 1:

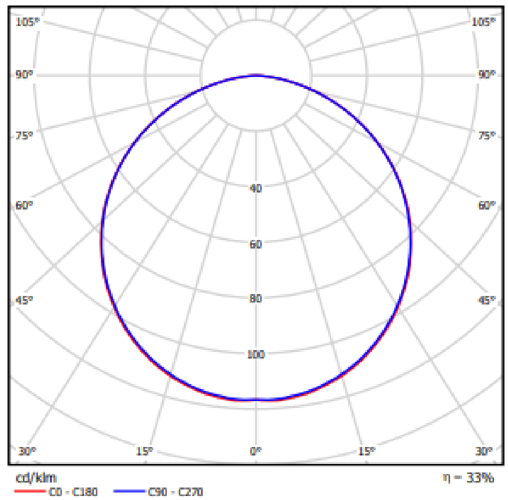
Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	26.5	27.7	26.8	27.9	28.2	24.4	25.6	24.7	25.9	26.1
	3H	26.4	27.5	26.8	27.8	28.0	24.4	25.5	24.7	25.7	26.0
	4H	26.4	27.4	26.7	27.6	27.9	24.3	25.3	24.7	25.6	25.9
	6H	26.3	27.2	26.6	27.5	27.8	24.3	25.2	24.6	25.5	25.8
	8H	26.3	27.1	26.6	27.4	27.8	24.2	25.1	24.6	25.4	25.7
	12H	26.2	27.0	26.6	27.4	27.7	24.2	25.0	24.5	25.3	25.7
4H	2H	26.6	27.6	26.9	27.8	28.1	24.7	25.7	25.0	26.0	26.3
	3H	26.5	27.3	26.9	27.6	28.0	24.7	25.5	25.0	25.8	26.2
	4H	26.4	27.2	26.8	27.5	27.9	24.6	25.3	25.0	25.7	26.0
	6H	26.4	27.0	26.8	27.4	27.8	24.5	25.2	25.0	25.5	25.9
	8H	26.3	26.9	26.8	27.3	27.7	24.5	25.1	24.9	25.5	25.9
	12H	26.3	26.8	26.7	27.2	27.6	24.5	25.0	24.9	25.4	25.8
8H	4H	26.3	26.9	26.8	27.3	27.7	24.5	25.1	24.9	25.5	25.9
	6H	26.3	26.7	26.7	27.1	27.6	24.4	24.9	24.9	25.3	25.8
	8H	26.2	26.6	26.7	27.1	27.5	24.4	24.8	24.9	25.2	25.7
	12H	26.2	26.5	26.7	27.0	27.5	24.4	24.7	24.9	25.2	25.7
12H	4H	26.3	26.8	26.7	27.2	27.6	24.5	25.0	24.9	25.4	25.8
	6H	26.2	26.6	26.7	27.1	27.5	24.4	24.8	24.9	25.2	25.7
	8H	26.2	26.5	26.7	27.0	27.5	24.4	24.7	24.8	25.2	25.7
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.5 / -0.4					+0.4 / -0.3				
S = 1.5H		+1.2 / -1.5					+1.2 / -2.5				
S = 2.0H		+2.3 / -9.4					+2.1 / -8.3				
Standard table		BK01					BK01				
Correction Summand		3.0					1.4				
Corrected Glare Indices referring to 3600lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

Philips Europa 2 FBS120 2xPL-C/4P18W/840 HF O / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 47 79 96 100 33

Luminous emittance 1:

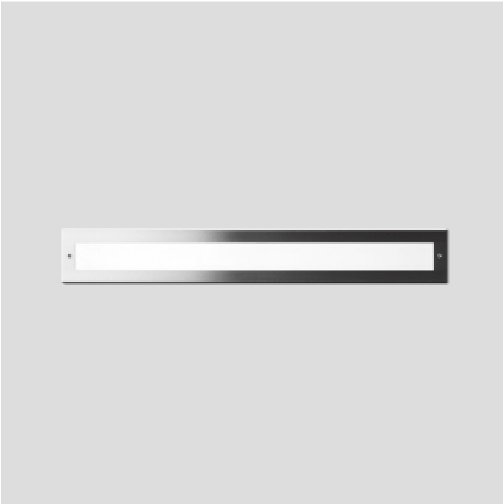
Glare Evaluation According to UGR

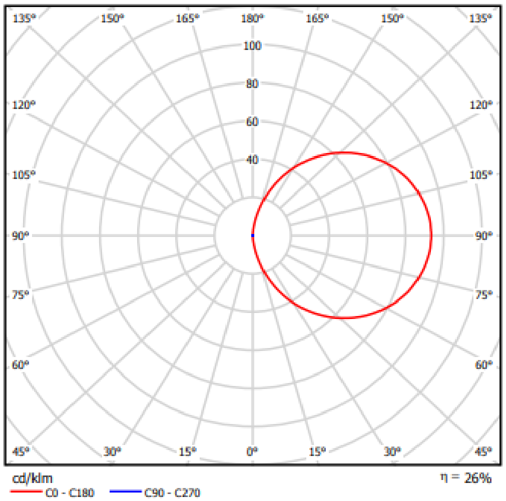
ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	19.9	21.2	20.1	21.4	21.6	19.9	21.2	20.1	21.4	21.6
	3H	21.6	22.8	21.9	23.0	23.3	21.6	22.8	21.9	23.0	23.3
	4H	22.2	23.3	22.5	23.6	23.9	22.2	23.3	22.5	23.6	23.9
	6H	22.6	23.6	23.0	24.0	24.3	22.6	23.6	23.0	23.9	24.3
	8H	22.7	23.7	23.1	24.0	24.3	22.7	23.7	23.1	24.0	24.3
	12H	22.7	23.7	23.1	24.0	24.4	22.7	23.7	23.1	24.0	24.4
4H	2H	20.4	21.5	20.8	21.8	22.1	20.4	21.5	20.8	21.8	22.1
	3H	22.4	23.3	22.7	23.7	24.0	22.4	23.3	22.7	23.7	24.0
	4H	23.1	24.0	23.5	24.3	24.7	23.1	24.0	23.5	24.3	24.7
	6H	23.6	24.4	24.1	24.8	25.1	23.6	24.4	24.1	24.8	25.1
	8H	23.8	24.5	24.2	24.9	25.3	23.8	24.5	24.2	24.9	25.3
	12H	23.9	24.5	24.3	24.9	25.3	23.9	24.5	24.3	24.9	25.3
8H	4H	23.4	24.1	23.8	24.5	24.9	23.4	24.1	23.8	24.5	24.9
	6H	24.0	24.6	24.5	25.0	25.5	24.0	24.6	24.5	25.0	25.5
	8H	24.2	24.7	24.7	25.2	25.6	24.2	24.7	24.7	25.2	25.6
	12H	24.3	24.8	24.8	25.2	25.7	24.3	24.8	24.8	25.2	25.7
12H	4H	23.4	24.0	23.9	24.4	24.9	23.4	24.0	23.9	24.4	24.9
	6H	24.1	24.6	24.5	25.0	25.5	24.1	24.6	24.5	25.0	25.5
	8H	24.3	24.7	24.8	25.2	25.7	24.3	24.7	24.8	25.2	25.7
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.3					+0.2 / -0.3				
S = 2.0H		+0.4 / -0.7					+0.4 / -0.7				
Standard table		BK05					BK05				
Correction Summand		-0.1					-0.1				
Corrected Glare Indices referring to 2400lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

BEGA 2005 1 T16 24W / Luminaire Data Sheet

Luminous emittance 1:





Luminaire classification according to CIE: 50
CIE flux code: 12 36 67 50 26

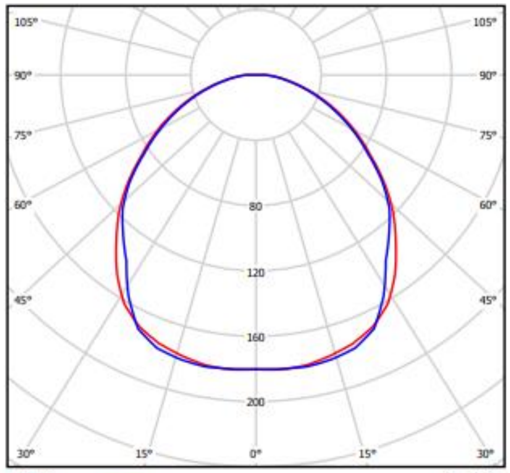
Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

BEGA-2005 Recessed wall luminaire with unshielded light source. For 1 fluorescent lamp T 16 14/24 W.
With electronic ballast. 1.200/1.750 lumen.
Protection class IP 65.
Luminaire made of aluminium, front panel made of stainless steel. White safety glass. Luminaires can be installed horizontally or vertically.
Including recess housing.
Dimensions: 645 x 125 x 125 mm.
Recessed opening: 635 x 115 x 125 mm.

Operator
Telephone
Fax
e-Mail

TRILUX 1280H/1TCD13+01280O E Downlights 128··· / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 50 80 95 100 51

Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

Application
Entrance areas, corridors, conference rooms, cafeterias, lounges, hotels, restaurants and residential areas.

Optical system
Reflector made of UV-stabilised polycarbonate. Aluminised, highly-specular, for narrow/wide-angle light distribution. With perfectly integrated highly-specular bezel ring.

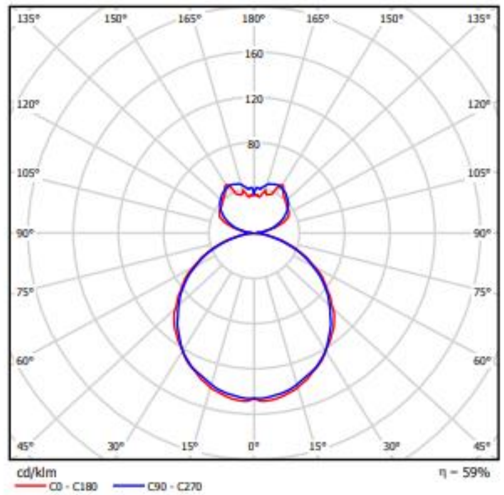
Luminaire body
Sheet steel, galvanised. Ceiling recess mounting by means of integrated spring brackets, does not require tools.

Control gear option
[VG].
Covers
Plastic, with concentric detail. Tool-free installation in downlight. Safe retention by means of bayonet system. IP 44 from underside. Opal.

Operator
Telephone
Fax
e-Mail

CENTRUMVOORLICHTARCHITECTUUR 21000005 Flowerflux 60cm 3x22W - TL5C 22W 2GX13 22 W / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 69
CIE flux code: 49 81 97 69 59

Pendant metal lighting fittings for direct and indirect lighting. (standard color alu gray RAL 9006). Suitable for T5 fluorescent tubes.
Cover opal white acrilyc.

Luminous emittance 1:

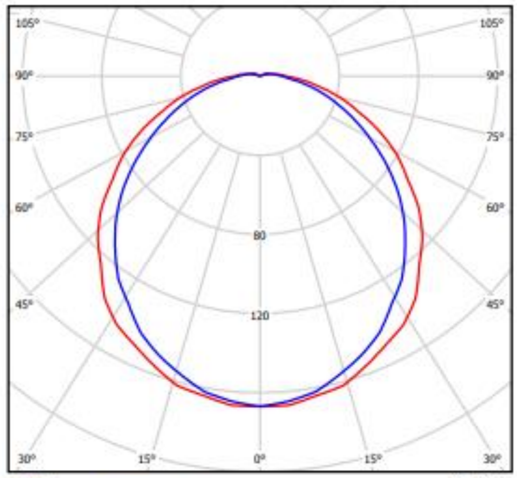
Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	13.6	14.5	14.3	15.2	16.0	13.6	14.6	14.3	15.3	16.1
	3H	15.1	16.0	15.8	16.7	17.5	15.1	15.9	15.8	16.6	17.5
	4H	15.6	16.4	16.3	17.1	18.0	15.6	16.3	16.3	17.1	17.9
	6H	15.8	16.6	16.6	17.3	18.2	15.8	16.5	16.5	17.2	18.1
	8H	15.9	16.6	16.6	17.3	18.2	15.8	16.5	16.6	17.3	18.2
	12H	15.9	16.5	16.6	17.3	18.2	15.8	16.5	16.6	17.2	18.2
4H	2H	14.0	14.8	14.7	15.5	16.4	14.0	14.8	14.8	15.5	16.4
	3H	15.7	16.4	16.5	17.1	18.0	15.7	16.3	16.5	17.1	18.0
	4H	16.3	16.9	17.1	17.6	18.6	16.3	16.8	17.1	17.6	18.6
	6H	16.6	17.1	17.4	17.9	18.9	16.5	17.0	17.4	17.9	18.8
	8H	16.7	17.1	17.5	17.9	18.9	16.6	17.1	17.4	17.9	18.9
	12H	16.7	17.1	17.5	17.9	18.9	16.6	17.1	17.5	17.9	18.9
8H	4H	16.4	16.9	17.2	17.7	18.7	16.4	16.8	17.2	17.7	18.7
	6H	16.8	17.2	17.7	18.0	19.1	16.8	17.1	17.6	18.0	19.0
	8H	16.9	17.2	17.8	18.1	19.2	16.9	17.2	17.7	18.0	19.1
	12H	17.0	17.2	17.8	18.1	19.2	16.9	17.2	17.8	18.1	19.1
12H	4H	16.4	16.8	17.2	17.6	18.6	16.4	16.8	17.2	17.6	18.6
	6H	16.8	17.1	17.7	18.0	19.0	16.8	17.1	17.6	17.9	19.0
	8H	16.9	17.2	17.8	18.1	19.1	16.9	17.1	17.8	18.0	19.1
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.2					+0.1 / -0.1				
S = 1.5H		+0.3 / -0.4					+0.3 / -0.4				
S = 2.0H		+0.5 / -0.8					+0.5 / -0.8				
Standard table		BK05					BK05				
Correction Summand		-6.9					-6.9				
Corrected Glare Indices referring to 5400lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

IVALO 777 HF Sol - pendant luminaire 11W FSD 2G7 / Luminaire Data Sheet

Luminous emittance 1:



cd/klm
C0 - C180   C90 - C270
η = 49%

Luminaire classification according to CIE: 97
CIE flux code: 46 77 93 97 49

SOL –Pendant Luminaire SSTL No.
777.001 HF 42 009 11
777.501 HF 42 009 15

IP20 Protection class 2 ta 25°C 2 x TC-E 11 W / 2G7 1,7 kg

Mounting
- To ceiling with suspension hook.

Connection
- 3 x 0,75 mm2, with a surface cup
- Ceiling flush mounting with suspension cover, to socket outlet

Construction
- Diameter Ø 390 mm, height h 115 mm.
- Housing of impact-resistant white or coated white polycarbonate.
- Upper cover of impact-resistant white polycarbonate.
- Lower cover of impact-resistant opal polycarbonate.
- Hinged intermediate cover of white polycarbonate.
- Frame painted aluminium
- Two electronic ballast
- Suspension cable 3 m, white MSK 3 x 0,75 mm2 + suspension hook
- Surface cup of white plastic

Louvre
- Impact-resistant opal polycarbonate.

Colours
- Frame colours:
- .000 white, RAL 9016
- .500 grain surface aluminium grey, RAL 9006

Accessories
- Luminaire will be delivered with lamp. (830)
- Plug is not included.

Luminous emittance 1:

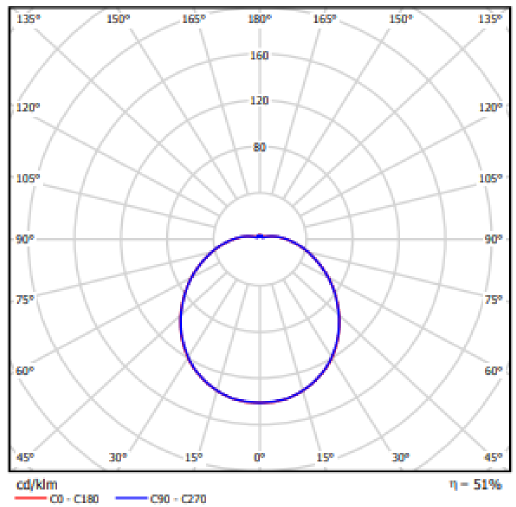
Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	17.2	18.5	17.5	18.7	19.0	16.4	17.7	16.7	18.0	18.3
	3H	19.2	20.4	19.6	20.7	21.0	18.2	19.4	18.6	19.7	20.0
	4H	20.1	21.2	20.5	21.5	21.9	19.0	20.1	19.4	20.4	20.8
	6H	20.9	21.9	21.3	22.3	22.7	19.7	20.7	20.1	21.1	21.5
	8H	21.3	22.3	21.7	22.7	23.1	20.0	21.0	20.4	21.4	21.8
	12H	21.7	22.7	22.1	23.0	23.4	20.3	21.3	20.8	21.7	22.1
4H	2H	17.6	18.7	17.9	19.0	19.4	16.9	18.0	17.3	18.4	18.7
	3H	19.8	20.8	20.3	21.2	21.6	19.0	20.0	19.4	20.4	20.8
	4H	20.9	21.8	21.4	22.2	22.6	20.0	20.8	20.4	21.2	21.7
	6H	21.9	22.7	22.4	23.1	23.6	20.9	21.6	21.3	22.0	22.5
	8H	22.4	23.1	22.9	23.6	24.1	21.3	22.0	21.8	22.4	22.9
	12H	22.9	23.6	23.4	24.0	24.5	21.7	22.3	22.2	22.8	23.3
8H	4H	21.2	21.9	21.7	22.3	22.8	20.4	21.1	20.9	21.5	22.0
	6H	22.4	23.0	22.9	23.5	24.0	21.5	22.1	22.0	22.5	23.1
	8H	23.1	23.6	23.6	24.1	24.6	22.0	22.5	22.6	23.0	23.6
	12H	23.7	24.2	24.3	24.7	25.3	22.6	23.0	23.1	23.6	24.1
12H	4H	21.2	21.9	21.7	22.3	22.8	20.5	21.1	20.9	21.5	22.1
	6H	22.5	23.0	23.1	23.5	24.1	21.6	22.1	22.2	22.6	23.2
	8H	23.2	23.7	23.8	24.2	24.8	22.3	22.7	22.8	23.2	23.8
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.2 / -0.3				
S = 2.0H		+0.3 / -0.4					+0.3 / -0.6				
Standard table		BK08					BK07				
Correction Summand		2.1					0.6				
Corrected Glare Indices referring to 1800lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

TRILUX 7403N/TC11 E Surface-mounted diffuser luminaires 740··· / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 91
CIE flux code: 42 71 89 91 51

Circular surface-mounted luminaire with opal diffuser, for 2 compact fluorescent lamps 24W, socket 2G10. Luminaire body in sheet steel, white. Degree of protection IP40. With electronic control gear units (E).

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	12.2	13.5	12.6	13.9	14.3	12.2	13.5	12.6	13.9	14.3
	3H	14.1	15.3	14.6	15.7	16.2	14.1	15.3	14.6	15.7	16.2
	4H	15.0	16.1	15.4	16.5	17.0	15.0	16.1	15.4	16.5	17.0
	6H	15.8	16.8	16.2	17.3	17.8	15.8	16.8	16.3	17.3	17.8
	8H	16.1	17.1	16.6	17.6	18.1	16.1	17.1	16.6	17.6	18.1
	12H	16.4	17.4	16.9	17.9	18.4	16.5	17.4	17.0	17.9	18.4
4H	2H	12.8	13.9	13.2	14.3	14.8	12.7	13.9	13.2	14.3	14.8
	3H	14.9	15.9	15.4	16.4	16.9	14.9	15.9	15.4	16.4	16.9
	4H	16.0	16.8	16.5	17.3	17.9	16.0	16.8	16.5	17.3	17.9
	6H	16.9	17.7	17.5	18.2	18.8	16.9	17.7	17.5	18.2	18.8
	8H	17.4	18.1	17.9	18.6	19.2	17.4	18.1	17.9	18.6	19.2
	12H	17.8	18.4	18.4	19.0	19.6	17.8	18.5	18.4	19.0	19.6
8H	4H	16.3	17.1	16.9	17.6	18.2	16.4	17.1	16.9	17.6	18.2
	6H	17.5	18.1	18.1	18.7	19.3	17.5	18.1	18.1	18.7	19.3
	8H	18.1	18.6	18.7	19.2	19.9	18.1	18.6	18.7	19.2	19.9
	12H	18.7	19.1	19.3	19.7	20.4	18.7	19.2	19.3	19.8	20.5
12H	4H	16.4	17.1	17.0	17.6	18.2	16.4	17.1	17.0	17.6	18.2
	6H	17.7	18.2	18.3	18.8	19.4	17.7	18.2	18.3	18.8	19.4
	8H	18.3	18.8	18.9	19.4	20.1	18.3	18.8	18.9	19.4	20.1

Variation of the observer position for the luminaire distances S

S = 1.0H	+0.1 / -0.1	+0.1 / -0.1
S = 1.5H	+0.2 / -0.3	+0.2 / -0.3
S = 2.0H	+0.3 / -0.5	+0.3 / -0.5
Standard table	BK08	BK08
Correction Summand	-3.8	-3.8

Corrected Glare Indices referring to 2550lm Total Luminous Flux

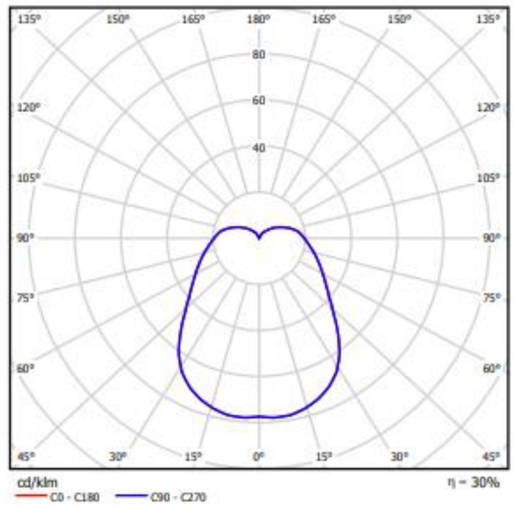
Operator
Telephone
Fax
e-Mail

CENTRUMVOORLICHTARCHITECTUUR 15015050 W-1845.0000 - A60 60W E27 60 W / Luminaire Data Sheet

Luminaire classification according to CIE: 80
CIE flux code: 43 68 86 80 30

Made from 5mm thick galvanised steel, suitable for compact fluorescent lamps and incandescent lamps.
Can also be supplied in colours, on request.

Luminous emittance 1:



Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	11.6	12.7	12.2	13.3	13.9	11.6	12.7	12.2	13.3	13.9
	3H	13.6	14.6	14.2	15.2	15.9	13.6	14.6	14.2	15.2	15.9
	4H	14.5	15.5	15.1	16.1	16.8	14.5	15.5	15.1	16.1	16.8
	6H	15.4	16.4	16.1	17.0	17.7	15.4	16.4	16.1	17.0	17.7
	8H	15.9	16.7	16.5	17.4	18.1	15.9	16.7	16.5	17.4	18.1
	12H	16.3	17.1	16.9	17.8	18.5	16.3	17.1	16.9	17.8	18.5
4H	2H	12.1	13.1	12.7	13.7	14.4	12.1	13.1	12.7	13.7	14.4
	3H	14.4	15.3	15.0	15.9	16.6	14.4	15.3	15.0	15.9	16.6
	4H	15.5	16.3	16.2	16.9	17.7	15.5	16.3	16.2	16.9	17.7
	6H	16.6	17.3	17.3	18.0	18.8	16.6	17.3	17.3	18.0	18.8
	8H	17.1	17.7	17.8	18.4	19.3	17.1	17.7	17.8	18.4	19.3
	12H	17.6	18.2	18.3	18.9	19.7	17.6	18.2	18.3	18.9	19.7
8H	4H	15.9	16.5	16.6	17.2	18.1	15.9	16.5	16.6	17.2	18.1
	6H	17.2	17.7	17.9	18.5	19.3	17.2	17.7	17.9	18.5	19.3
	8H	17.9	18.4	18.6	19.1	20.0	17.9	18.4	18.6	19.1	20.0
	12H	18.6	19.0	19.3	19.7	20.6	18.6	19.0	19.3	19.7	20.6
12H	4H	16.0	16.6	16.7	17.3	18.1	16.0	16.6	16.7	17.3	18.1
	6H	17.4	17.8	18.1	18.6	19.4	17.4	17.8	18.1	18.6	19.4
	8H	18.1	18.5	18.9	19.3	20.2	18.1	18.5	18.9	19.3	20.2

Variation of the observer position for the luminaire distances S		
S = 1.0H	+0.1 / -0.1	+0.1 / -0.1
S = 1.5H	+0.2 / -0.3	+0.2 / -0.3
S = 2.0H	+0.2 / -0.5	+0.2 / -0.5
Standard table	BK08	BK08
Correction Summand	-1.2	-1.2

Corrected Glare Indices referring to 730lm Total Luminous Flux

Operator
Telephone
Fax
e-Mail

Clearvision CR6.414/SP Recessed 4 x 14watt lay - in luminaire / Luminaire Data Sheet

Luminaire classification according to CIE: 100
CIE flux code: 57 88 98 100 56

Recessed 4 x 14w T5 module with polarising panel for Tgrid ceilings.

Lamp format: 4 x 14w T5

Gear: High frequency electronic

Optics: VDT Optika polarising lens.

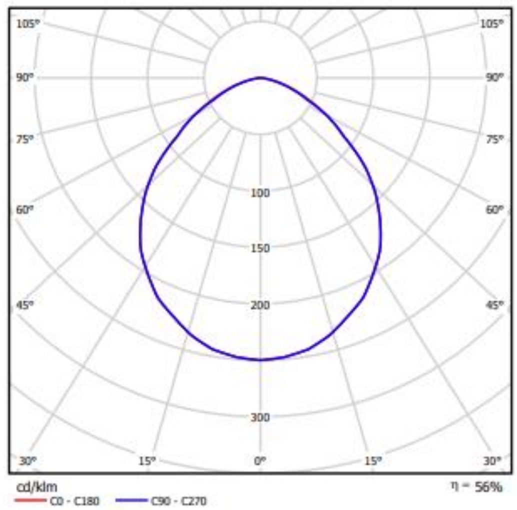
Construction: White powder coated mild steel.

Options: Emergency dimming or both

Ceiling void required: 300mm

Ceiling fix: Lay-in on T-grid

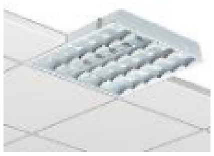
Luminous emittance 1:



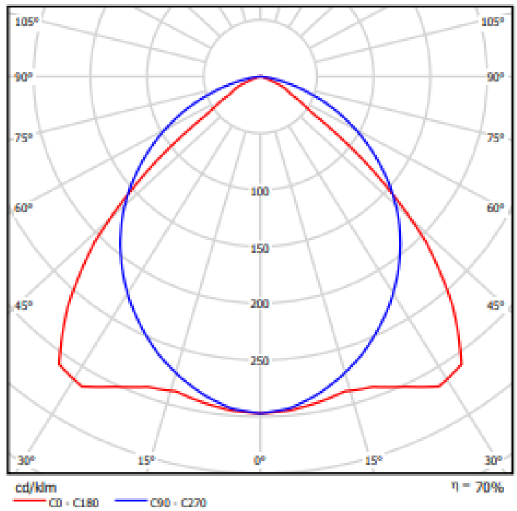
Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

Operator
Telephone
Fax
e-Mail

Philips IMPALA TBS160 4xTL5-14W/840 HF C3 / Luminaire Data Sheet



Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 59 92 99 100 70

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	10.8	11.9	11.1	12.1	12.4	16.8	18.0	17.1	18.2	18.4
	3H	11.1	12.1	11.4	12.4	12.6	17.9	19.0	18.2	19.2	19.5
	4H	11.0	12.0	11.4	12.3	12.5	18.2	19.1	18.5	19.4	19.7
	6H	11.0	11.8	11.3	12.1	12.4	18.3	19.2	18.6	19.5	19.8
	8H	10.9	11.8	11.3	12.1	12.4	18.3	19.1	18.6	19.4	19.7
	12H	10.9	11.7	11.3	12.0	12.3	18.3	19.1	18.6	19.4	19.7
4H	2H	11.2	12.2	11.6	12.5	12.8	16.7	17.7	17.0	17.9	18.2
	3H	11.6	12.4	12.0	12.8	13.1	17.9	18.7	18.3	19.0	19.4
	4H	11.6	12.3	12.0	12.6	13.0	18.2	18.9	18.6	19.3	19.6
	6H	11.5	12.1	12.0	12.5	12.9	18.4	19.0	18.8	19.4	19.8
	8H	11.5	12.1	11.9	12.4	12.8	18.4	19.0	18.8	19.4	19.8
	12H	11.5	12.0	11.9	12.4	12.8	18.4	18.9	18.9	19.3	19.7
8H	4H	11.7	12.3	12.2	12.7	13.1	18.2	18.7	18.6	19.1	19.5
	6H	11.7	12.1	12.1	12.6	13.0	18.3	18.8	18.8	19.2	19.6
	8H	11.6	12.0	12.1	12.5	13.0	18.4	18.7	18.8	19.2	19.7
	12H	11.6	11.9	12.1	12.4	12.9	18.4	18.7	18.8	19.2	19.7
12H	4H	11.7	12.2	12.2	12.6	13.1	18.1	18.6	18.6	19.0	19.5
	6H	11.7	12.1	12.2	12.5	13.0	18.3	18.7	18.8	19.1	19.6
	8H	11.6	12.0	12.1	12.4	12.9	18.3	18.6	18.8	19.1	19.6

Variation of the observer position for the luminaire distances S

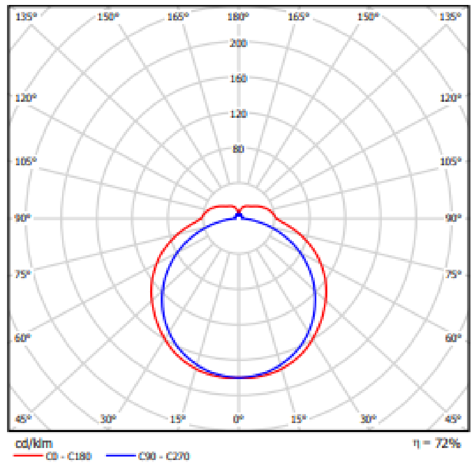
S = 1.0H	+1.3 / -2.6	+0.3 / -0.4
S = 1.5H	+2.5 / -5.5	+1.0 / -1.1
S = 2.0H	+4.0 / -7.1	+1.1 / -1.9
Standard table	BK01	BK03
Correction Summand	-9.2	-5.4

Corrected Glare Indices referring to 4800lm Total Luminous Flux

Operator
Telephone
Fax
e-Mail

TRILUX 1330F/158O E Surface-mounted diffuser luminaires 1330··· / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 85
CIE flux code: 41 71 90 85 72

Application
Offices, sales areas, showrooms, lounges and corridors.

Optical system
PLEXIGLAS trapezium-shaped diffuser, made in one piece, stable and torsionally rigid. Safe retention of the diffuser by means of internal spring clips. Opal diffuser with fine-grained matt surface.

Luminaire body
Powder-coated sheet steel, white, slim profile. End caps made of impact-resistant ABS.

Control gear option
With electronic control gear (E).

Luminous emittance 1:

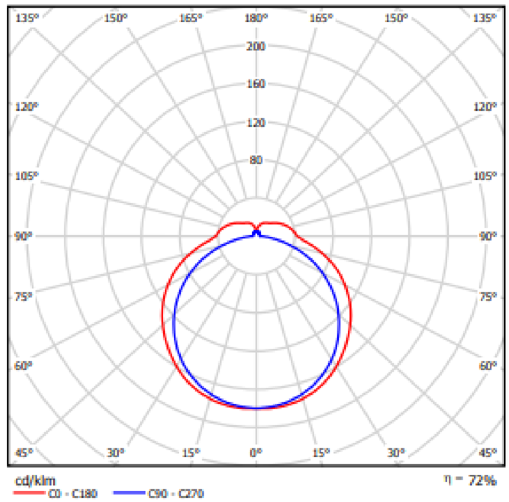
Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	15.2	16.4	15.7	16.9	17.4	14.5	15.7	15.0	16.2	16.7
	3H	17.4	18.5	17.9	19.0	19.6	16.3	17.4	16.8	17.9	18.5
	4H	18.4	19.4	18.9	19.9	20.5	16.9	18.0	17.5	18.5	19.1
	6H	19.3	20.2	19.8	20.8	21.4	17.4	18.4	18.0	18.9	19.5
	8H	19.7	20.6	20.2	21.2	21.8	17.6	18.5	18.1	19.1	19.7
	12H	20.0	20.9	20.6	21.5	22.2	17.7	18.6	18.3	19.1	19.8
4H	2H	15.7	16.8	16.3	17.3	17.9	15.2	16.2	15.7	16.8	17.4
	3H	18.2	19.0	18.7	19.6	20.3	17.2	18.1	17.8	18.7	19.3
	4H	19.3	20.1	19.9	20.7	21.4	18.0	18.8	18.6	19.4	20.1
	6H	20.4	21.1	21.0	21.7	22.4	18.6	19.3	19.3	19.9	20.7
	8H	20.9	21.5	21.5	22.2	22.9	18.8	19.5	19.5	20.1	20.9
	12H	21.4	21.9	22.0	22.6	23.3	19.0	19.6	19.7	20.2	21.0
8H	4H	19.6	20.2	20.2	20.9	21.6	18.5	19.2	19.2	19.8	20.5
	6H	20.9	21.4	21.6	22.1	22.8	19.3	19.9	20.0	20.5	21.3
	8H	21.5	22.0	22.2	22.7	23.5	19.7	20.2	20.4	20.8	21.6
	12H	22.2	22.6	22.9	23.3	24.1	19.9	20.3	20.6	21.0	21.9
12H	4H	19.6	20.2	20.3	20.9	21.6	18.6	19.2	19.3	19.8	20.6
	6H	21.0	21.4	21.7	22.1	22.9	19.5	20.0	20.2	20.7	21.5
	8H	21.7	22.1	22.4	22.8	23.6	19.9	20.4	20.7	21.1	21.9
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.2 / -0.3				
S = 2.0H		+0.3 / -0.4					+0.3 / -0.6				
Standard table		BK09					BK07				
Correction Summand		-1.0					-3.4				
Corrected Glare Indices referring to 5000lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

TRILUX 1330F/158O E Surface-mounted diffuser luminaires 1330··· / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 85
CIE flux code: 41 71 90 85 72

Application
Offices, sales areas, showrooms, lounges and corridors.

Optical system
PLEXIGLAS trapezium-shaped diffuser, made in one piece, stable and torsionally rigid. Safe retention of the diffuser by means of internal spring clips. Opal diffuser with fine-grained matt surface.

Luminaire body
Powder-coated sheet steel, white, slim profile. End caps made of impact-resistant ABS.

Control gear option
With electronic control gear (E).

Luminous emittance 1:

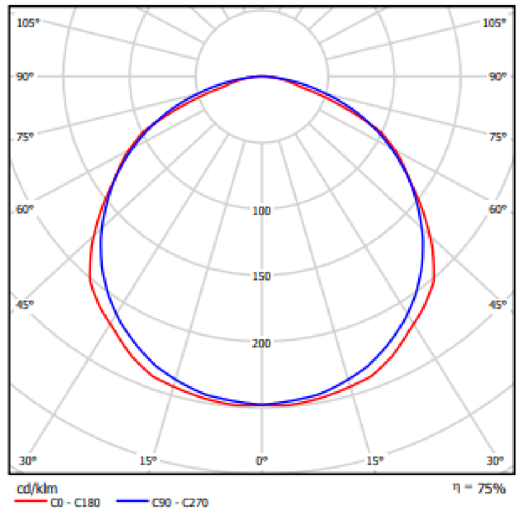
Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	15.2	16.4	15.7	16.9	17.4	14.5	15.7	15.0	16.2	16.7
	3H	17.4	18.5	17.9	19.0	19.6	16.3	17.4	16.8	17.9	18.5
	4H	18.4	19.4	18.9	19.9	20.5	16.9	18.0	17.5	18.5	19.1
	6H	19.3	20.2	19.8	20.8	21.4	17.4	18.4	18.0	18.9	19.5
	8H	19.7	20.6	20.2	21.2	21.8	17.6	18.5	18.1	19.1	19.7
	12H	20.0	20.9	20.6	21.5	22.2	17.7	18.6	18.3	19.1	19.8
4H	2H	15.7	16.8	16.3	17.3	17.9	15.2	16.2	15.7	16.8	17.4
	3H	18.2	19.0	18.7	19.6	20.3	17.2	18.1	17.8	18.7	19.3
	4H	19.3	20.1	19.9	20.7	21.4	18.0	18.8	18.6	19.4	20.1
	6H	20.4	21.1	21.0	21.7	22.4	18.6	19.3	19.3	19.9	20.7
	8H	20.9	21.5	21.5	22.2	22.9	18.8	19.5	19.5	20.1	20.9
	12H	21.4	21.9	22.0	22.6	23.3	19.0	19.6	19.7	20.2	21.0
8H	4H	19.6	20.2	20.2	20.9	21.6	18.5	19.2	19.2	19.8	20.5
	6H	20.9	21.4	21.6	22.1	22.8	19.3	19.9	20.0	20.5	21.3
	8H	21.5	22.0	22.2	22.7	23.5	19.7	20.2	20.4	20.8	21.6
	12H	22.2	22.6	22.9	23.3	24.1	19.9	20.3	20.6	21.0	21.9
12H	4H	19.6	20.2	20.3	20.9	21.6	18.6	19.2	19.3	19.8	20.6
	6H	21.0	21.4	21.7	22.1	22.9	19.5	20.0	20.2	20.7	21.5
	8H	21.7	22.1	22.4	22.8	23.6	19.9	20.4	20.7	21.1	21.9
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.2 / -0.3				
S = 2.0H		+0.3 / -0.4					+0.3 / -0.6				
Standard table		BK09					BK07				
Correction Summand		-1.0					-3.4				
Corrected Glare Indices referring to 5000lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

Philips TMX204 2xTL-D58W/840 CON +GMX430 / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 46 79 96 100 75

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	19.5	20.9	19.8	21.1	21.3	19.7	21.1	20.0	21.3	21.5
	3H	21.1	22.3	21.5	22.6	22.9	21.5	22.7	21.9	23.0	23.3
	4H	21.4	22.5	21.7	22.8	23.1	22.2	23.3	22.5	23.6	23.9
	6H	21.6	22.6	21.9	22.9	23.2	22.7	23.7	23.0	24.0	24.3
	8H	21.6	22.6	22.0	23.0	23.3	22.8	23.8	23.1	24.1	24.4
	12H	21.7	22.6	22.0	23.0	23.3	22.8	23.8	23.2	24.1	24.5
4H	2H	20.1	21.3	20.5	21.5	21.8	20.3	21.4	20.6	21.7	22.0
	3H	22.0	22.9	22.3	23.2	23.6	22.3	23.3	22.7	23.6	24.0
	4H	22.3	23.2	22.7	23.5	23.9	23.2	24.0	23.6	24.4	24.7
	6H	22.6	23.3	23.0	23.7	24.1	23.8	24.5	24.2	24.9	25.3
	8H	22.7	23.3	23.1	23.7	24.1	23.9	24.6	24.4	25.0	25.4
	12H	22.7	23.3	23.2	23.8	24.2	24.0	24.7	24.5	25.1	25.5
8H	4H	22.6	23.3	23.0	23.7	24.1	23.4	24.1	23.8	24.5	24.9
	6H	22.9	23.5	23.4	23.9	24.4	24.1	24.6	24.5	25.1	25.5
	8H	23.1	23.6	23.5	24.0	24.5	24.3	24.8	24.8	25.3	25.7
	12H	23.2	23.6	23.7	24.1	24.6	24.5	24.9	25.0	25.4	25.9
12H	4H	22.6	23.2	23.1	23.6	24.1	23.4	24.0	23.8	24.4	24.8
	6H	23.0	23.5	23.4	23.9	24.4	24.1	24.6	24.6	25.0	25.5
	8H	23.1	23.6	23.6	24.0	24.5	24.4	24.8	24.9	25.3	25.8

Variation of the observer position for the luminaire distances S

	Viewing direction at right angles to lamp axis	Viewing direction parallel to lamp axis
S = 1.0H	+0.2 / -0.2	+0.1 / -0.1
S = 1.5H	+0.3 / -0.4	+0.3 / -0.4
S = 2.0H	+0.4 / -0.7	+0.4 / -0.8
Standard table	BK04	BK06
Correction Summand	-3.5	-1.9

Corrected Glare Indices referring to 10400lm Total Luminous Flux

Operator
Telephone
Fax
e-Mail

Clearvision ADR6.240/SP Recessed 2 x 40watt A/H Iluminaire / Luminaire Data Sheet

Luminaire classification according to CIE: 100
CIE flux code: 58 87 98 100 55

Recessed modular 2 x 40w PLL module with polarising panel.

Lamp format: 2 x 40w PLL

Gear: High frequency electronic

Optics: VDT Optika polarising lens.

Construction: Powder coated white mild steel

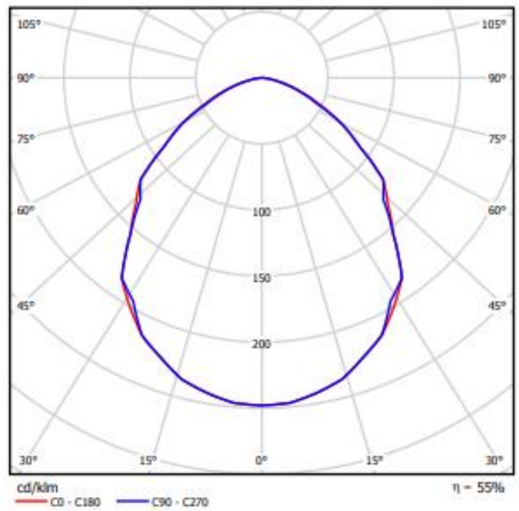
Options: Emergency, dimming or both

Return air handling: 40 l/s

Ceiling void required: 90mm

Ceiling fix: Side brackets above T- grid

Luminous emittance 1:



Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

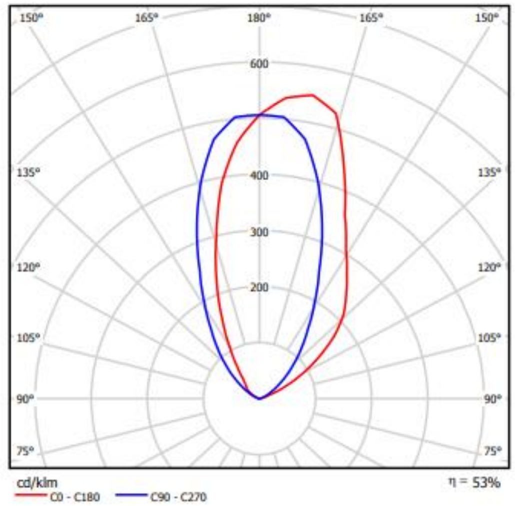
Operator
Telephone
Fax
e-Mail

BEGA 8034 1 TC-TEL 26W / Luminaire Data Sheet

Luminaire classification according to CIE: 0
CIE flux code: 00 00 00 00 53

BEGA-8034 In-ground luminaire. Walk-over and drive-over luminaire for pressure load up to 2.000 kg. With asymmetrical light distribution. For 1 fluorescent lamp TC-TEL 26 W, with electronic ballast, 1.800 lumen. Protection class IP 68, 10 m. Luminaire made of stainless steel. Safety glass. Reflector of anodized pure aluminium. 2 screw cable glands for connecting cable ø 9-15 mm. The glass surface of the luminaire attains in its optical centre a temperature of 55ºC according to EN 60598 measured at an ambient temperature of ta 15ºC. This luminaire can also be supplied with a special skid-blocking glass. If required you may denote the article number with additional letter "R".

Luminous emittance 1:

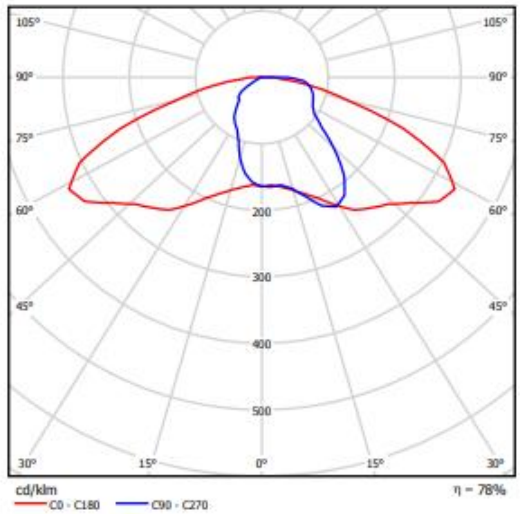


Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

Operator
Telephone
Fax
e-Mail

TRILUX 9901/80-125HME/80W IND Post-top and bracket-mounted luminaires 990··· / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 36 71 93 100 78

Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

Luminaire family
Post-top and bracket-mounted luminaires 990···

Mounting type
Post-top mounting, bracket mounting pole and wall fixing, wall mounting

Light guidance
Specular reflector, multi-functional mirror optics, aluminium, PMMA diffuser, transparent, PMMA-diffuser, transparent

Equipment
1 high-pressure mercury vapour lamp HME 80 W or HME 125 W

With inductive ballast

Application recommendation
Streets, inner-city motorways, motorways, main streets and local streets, collector roads, subsidiary roads, traffic-reduced streets, squares, traffic areas and traffic circles, parking areas, outdoor working facilities, factory streets, port facilities and shipyards, storage facilities and container parks, power plant sites

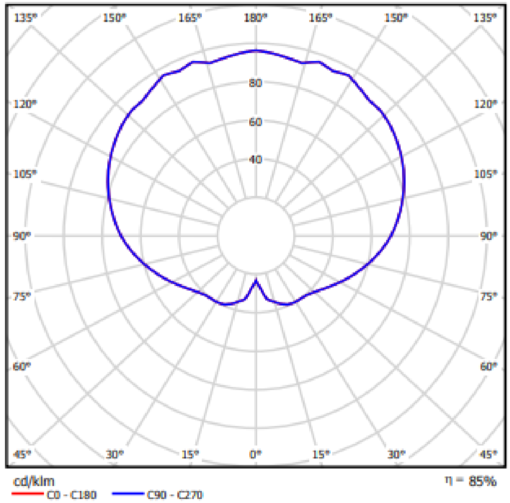
Operator
Telephone
Fax
e-Mail

BEGA 4236 1 TC-D 18W / Luminaire Data Sheet

Luminaire classification according to CIE: 37
CIE flux code: 19 41 68 37 85

BEGA-4236 Pillar luminaire (equivalent to BEGA 7280).
The sphere. For 1 fluorescent lamp TC-D 18 W,
1.200 lumen. Protection class IP 44.
Aluminium alloy and stainless steel.
Three-ply opal glass - diam. 300 mm.
Height of the luminaire: 590 mm.
Colour: graphite - article number
white - article number + W

Luminous emittance 1:



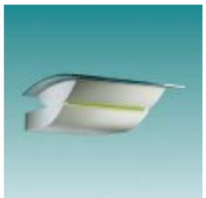
Luminous emittance 1:

Glare Evaluation According to UGR

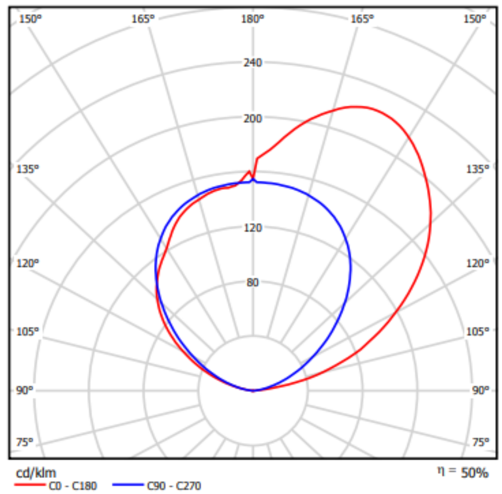
ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	6.7	7.5	7.7	8.6	9.9	6.7	7.5	7.7	8.6	9.9
	3H	9.9	10.6	10.9	11.7	13.1	9.9	10.6	10.9	11.7	13.1
	4H	11.4	12.1	12.4	13.2	14.6	11.4	12.1	12.4	13.2	14.6
	6H	13.0	13.6	14.0	14.7	16.1	13.0	13.6	14.0	14.7	16.1
	8H	13.7	14.3	14.7	15.4	16.8	13.7	14.3	14.7	15.4	16.8
	12H	14.4	15.0	15.5	16.1	17.5	14.4	15.0	15.5	16.1	17.5
4H	2H	7.5	8.2	8.5	9.3	10.7	7.5	8.2	8.5	9.3	10.7
	3H	10.8	11.5	11.9	12.5	14.0	10.8	11.5	11.9	12.5	14.0
	4H	12.6	13.1	13.6	14.2	15.7	12.6	13.1	13.6	14.2	15.7
	6H	14.2	14.7	15.3	15.8	17.3	14.2	14.7	15.3	15.8	17.3
	8H	15.1	15.5	16.2	16.6	18.1	15.1	15.5	16.2	16.6	18.1
	12H	15.9	16.3	17.0	17.4	18.9	15.9	16.3	17.0	17.4	18.9
8H	4H	13.1	13.6	14.2	14.7	16.2	13.1	13.6	14.2	14.7	16.2
	6H	15.1	15.4	16.2	16.6	18.1	15.1	15.4	16.2	16.6	18.1
	8H	16.0	16.4	17.1	17.5	19.0	16.0	16.4	17.1	17.5	19.0
	12H	17.0	17.3	18.1	18.5	20.0	17.0	17.3	18.1	18.5	20.0
12H	4H	13.2	13.7	14.3	14.8	16.3	13.2	13.7	14.3	14.8	16.3
	6H	15.3	15.6	16.4	16.7	18.2	15.3	15.6	16.4	16.7	18.2
	8H	16.3	16.6	17.5	17.8	19.3	16.3	16.6	17.5	17.8	19.3
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.2 / -0.2				
S = 2.0H		+0.4 / -0.4					+0.4 / -0.4				
Standard table		BK12					BK12				
Correction Summand		0.8					0.8				
Corrected Glare Indices referring to 1200lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

Philips Adante FWG620 2xPL-C/2P26W/840 CON A DG / Luminaire Data Sheet



Luminous emittance 1:



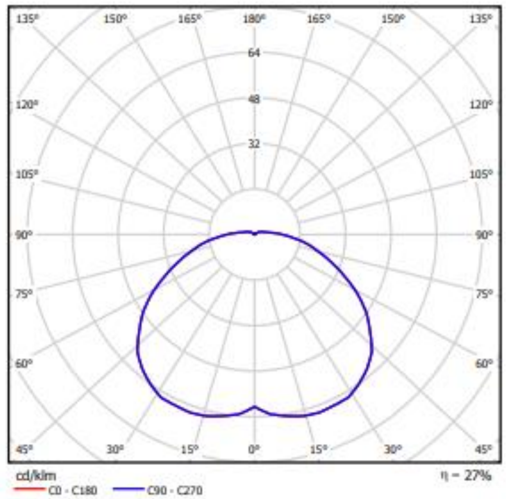
Luminaire classification according to CIE: 0
CIE flux code: 12 34 64 00 50

Due to missing symmetry properties, no UGR table can be displayed for this luminaire.

Operator
Telephone
Fax
e-Mail

CENTRUMVOORLICHTARCHITECTUUR 15015333 W-1547.0118 - TC-TE 18W G24 q-2 18 W / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 95
CIE flux code: 39 71 90 95 27

Made from 5mm thick galvanised steel, suitable for compact fluorescent lamps and incandescent lamps.
Can also be supplied in colours, on request.

Luminous emittance 1:

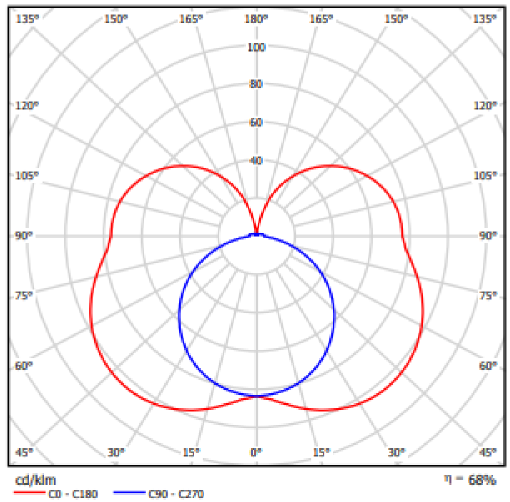
Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	17.2	18.6	17.6	18.9	19.2	17.2	18.6	17.6	18.9	19.2
	3H	18.9	20.2	19.3	20.5	20.9	18.9	20.2	19.3	20.5	20.9
	4H	19.6	20.8	20.0	21.2	21.6	19.6	20.8	20.0	21.2	21.6
	6H	20.2	21.3	20.7	21.7	22.2	20.2	21.3	20.7	21.7	22.2
	8H	20.5	21.6	21.0	22.0	22.4	20.5	21.6	21.0	22.0	22.4
	12H	20.7	21.7	21.2	22.2	22.6	20.7	21.7	21.2	22.2	22.6
4H	2H	17.7	18.9	18.1	19.3	19.7	17.7	18.9	18.1	19.3	19.7
	3H	19.7	20.7	20.1	21.1	21.5	19.7	20.7	20.1	21.1	21.5
	4H	20.5	21.4	21.0	21.9	22.4	20.5	21.4	21.0	21.9	22.4
	6H	21.3	22.1	21.8	22.6	23.1	21.3	22.1	21.8	22.6	23.1
	8H	21.7	22.4	22.2	22.9	23.4	21.7	22.4	22.2	22.9	23.4
	12H	22.0	22.7	22.5	23.2	23.7	22.0	22.7	22.5	23.2	23.7
8H	4H	20.9	21.6	21.4	22.1	22.6	20.9	21.6	21.4	22.1	22.6
	6H	21.9	22.5	22.4	23.0	23.6	21.9	22.5	22.4	23.0	23.6
	8H	22.3	22.9	22.9	23.4	24.0	22.3	22.9	22.9	23.4	24.0
	12H	22.8	23.2	23.3	23.8	24.4	22.8	23.2	23.3	23.8	24.4
12H	4H	20.9	21.6	21.4	22.1	22.6	20.9	21.6	21.4	22.1	22.6
	6H	22.0	22.5	22.5	23.1	23.6	22.0	22.5	22.5	23.1	23.6
	8H	22.5	23.0	23.1	23.5	24.1	22.5	23.0	23.1	23.5	24.1
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.3					+0.2 / -0.3				
S = 2.0H		+0.4 / -0.6					+0.4 / -0.6				
Standard table		BK07					BK07				
Correction Summand		0.5					0.5				
Corrected Glare Indices referring to 1200lm Total Luminous Flux											

Operator
Telephone
Fax
e-Mail

TRILUX 6541/15 E Wall-mounted luminaires for mirror lighting 65··· / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 67
CIE flux code: 31 59 82 67 68

Luminaire family
Wall-mounted luminaires for mirror lighting 65···

Mounting type
Surface mounting to walls

Light guidance
PLEXIGLAS diffuser, opal

Equipment
1 fluorescent lamp 15 W

With electronic control gear (E)

Application recommendation
Restaurants, hotels, sanitary areas, residential areas

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	10.1	11.1	10.8	11.9	12.8	6.2	7.3	6.9	8.0	8.9
	3H	13.0	13.9	13.7	14.7	15.6	7.8	8.8	8.5	9.5	10.4
	4H	14.4	15.3	15.1	16.1	17.0	8.3	9.3	9.1	10.0	11.0
	6H	15.8	16.7	16.6	17.5	18.4	8.7	9.6	9.5	10.4	11.3
	8H	16.5	17.3	17.3	18.1	19.1	8.8	9.7	9.6	10.5	11.4
	12H	17.2	18.0	18.0	18.8	19.8	8.9	9.7	9.7	10.5	11.5
4H	2H	10.5	11.4	11.2	12.2	13.1	7.8	8.7	8.6	9.5	10.5
	3H	13.7	14.5	14.4	15.3	16.3	9.8	10.6	10.6	11.4	12.4
	4H	15.3	16.0	16.1	16.8	17.8	10.6	11.3	11.4	12.1	13.1
	6H	16.9	17.6	17.8	18.4	19.5	11.1	11.7	11.9	12.6	13.6
	8H	17.8	18.4	18.6	19.2	20.3	11.3	11.9	12.1	12.7	13.8
	12H	18.6	19.2	19.5	20.0	21.1	11.4	11.9	12.2	12.8	13.9
8H	4H	15.5	16.1	16.4	17.0	18.1	11.9	12.5	12.8	13.4	14.4
	6H	17.5	18.0	18.4	18.9	19.9	12.9	13.4	13.7	14.2	15.3
	8H	18.5	19.0	19.4	19.8	21.0	13.2	13.7	14.1	14.6	15.7
	12H	19.6	20.0	20.5	20.9	22.0	13.5	13.9	14.4	14.8	15.9
12H	4H	15.6	16.1	16.4	17.0	18.0	12.3	12.9	13.2	13.7	14.8
	6H	17.6	18.0	18.4	18.9	20.0	13.5	13.9	14.4	14.8	15.9
	8H	18.7	19.1	19.6	20.0	21.1	14.0	14.4	14.9	15.3	16.4

Variation of the observer position for the luminaire distances S

S = 1.0H	+0.1 / -0.1	+0.1 / -0.1
S = 1.5H	+0.2 / -0.3	+0.2 / -0.3
S = 2.0H	+0.4 / -0.4	+0.4 / -0.6
Standard table	BK12	BK13
Correction Summand	2.5	-4.1

Corrected Glare Indices referring to 1050lm Total Luminous Flux

Appendix C:

Details about floors loads

A) Mezzanine Floor Loads

The listed tables below show the loads divided into DB's for mezzanine floor.

Table (2.11): normal loads type mezzanine floor, which named as DB.MEZ. @ MEZZANIN FLR:

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	800	2	SOCKET	1200
3	LIGHT	1000	4	SOCKET	1200
5	LIGHT	700	6	SOCKET	1200
7	LIGHT	200	8	SOCKET	800
9	LIGHT	500	10	SOCKET	800
11	LIGHT	500	12	SOCKET	600
13	LIGHT	700	14	SOCKET	600
15	LIGHT	650	16	SOCKET	600
17	LIGHT	1200	18	SOCKET	400
19	LIGHT	750	21	ADM.FCU	700
20	LIGHT	1100	22	SETTING FCU	600
-	-	-	23	GF WAITING AREA FCU	600
-	-	-	24	HAND DRAYER	200
LIGHT LOAD (kVA)		**8.10**	**POWER LOAD (kVA)**		**9.50**

Table (2.12) emergency loads type mezzanine floor, which named as DB.MEZ. EM. @ MEZZANIN FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1200	2	SOCKET	200
3	LIGHT	600	4	SOCKET	200
5	LIGHT	700	6	SOCKET	200
7	LIGHT (STAIR UP TO 3 PARK)	800	8	SPACE	-
LIGHT LOAD (kVA)		**3.30**	**POWER LOAD (kVA)**		**0.60**

Table (2.13): Shop1 and Shop 2 in mezzanine floor, which named as DB. SHOP1, 2 @ MEZZANIN FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	400
-	-	-	3	SHOP FCU	80
-	-	-	4	SOCKET	600
-	-	-	5	SPAR LOAD	500
-	-	-	6	SPAR LOAD	600
LIGHT LOAD (kVA)		**0.60**	**POWER LOAD (kVA)**		**2.18**

B) 1st Parking Floor Loads

The listed tables below show the loads divided into DB's for 1st parking floor.

Table (2.14): normal loads type 1st parking floor, which named as DB.1st PAR. @ 1st PARKING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	500	2	SOCKET	400
3	LIGHT	400	4	SOCKET	400
5	LIGHT	400	6	SOCKET	400
7	LIGHT	400	8	SOCKET	600
9	LIGHT	300	10	SOCKET	600
11	LIGHT	200	12	SOCKET	400
13	LIGHT	600	14	SOCKET	1200
-	-	-	15	DRIVER RM.FCU	80
-	-	-	16	SOCKET	400
-	-	-	17	RECIVING FLR.FCU	80
-	-	-	18	PAR.LOBBY FCU	80
LIGHT LOAD (kVA)		**2.80**	**POWER LOAD (kVA)**		**4.64**

Table (2.15): emergency loads type 1st parking floor, which named as DB.1st PAR.EM @ 1st PARKING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	300	2	OUTLET FOR CCTV.CR	400
3	LIGHT	400	4	OUTLET FOR CCTV.CR	400
5	LIGHT	400	6	OUTLET FOR CCTV.CR	600
7	LIGHT	700	8	OUTLET FOR CCTV.CR	600
9	LIGHT	400	10	SOCKET	800
11	LIGHT	200	12	SOCKET	600
LIGHT LOAD (kVA)		**2.40**	**POWER LOAD (kVA)**		**3.40**

C) 2nd Parking Floor Loads

The listed tables below show the loads divided into DB's for 2nd parking floor.

Table (2.16): normal loads type 2nd parking floor, which named as DB.2nd PAR. @ 2nd PARKING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	900	2	SOCKET	600
3	LIGHT	500	4	SOCKET	400
5	LIGHT	400	6	SOCKET	400
7	LIGHT	600	8	SOCKET	400
9	LIGHT	600	10	SOCKET	400
11	LIGHT	300	12	SOCKET	400
-	-	-	13	KIT.STORE FCU	80
-	-	-	14	SOCKET	400
-	-	-	15	SPACE	-
-	-	-	16	PAR.LOBBY FCU	80
LIGHT LOAD (kVA)		**3.30**	**POWER LOAD (kVA)**		**3.16**

Table (2.17): emergency loads type 2nd parking floor, which named as DB.2nd PAR.EM@ 2nd PARKING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	300	2	OUTLET FOR CCTV&CR	400
3	LIGHT	600	4	OUTLET FOR CCTV&CR	400
5	LIGHT	700	6	OUTLET FOR CCTV&CR	600
7	LIGHT	600	8	SOCKET	1000
9	LIGHT	500	10	OUTLET FOR CCTV&CR	200
11	LIGHT	200	12	OUTLET FOR CCTV&CR	200
LIGHT LOAD (kVA)		**2.90**	**POWER LOAD (kVA)**		**2.80**

D) 3rd Parking Floor Loads

The listed tables below show the loads divided into DB's for 3rd parking floor.

Table (2.18): normal loads type 3rd parking floor, which named as DB.3rd PAR. @ 3rd PARKING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	400	2	SOCKET	800
3	LIGHT	500	4	SOCKET	1000
5	LIGHT	400	6	SOCKET	800
7	LIGHT	300	8	SOCKET	400
9	LIGHT	600	10	SOCKET	400
11	LIGHT	300	12	SOCKET	400
13	LIGHT	600	14	SOCKET	400
15	LIGHT	400	16	SOCKET	400
-	-	-	17	PAR. LOBBY FCU	80
-	-	-	18	STORE FCU	80
-	-	-	19	PAR. CHIEF OFF.FCU	80
-	-	-	20	PAR.W/SHOP FCU	80
LIGHT LOAD (kVA)		**3.50**	**POWER LOAD (kVA)**		**4.92**

Table (2.19): emergency loads type 3rd parking floor, which named as DB.3rd PAR.EM@ 2nd PARKING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	300	2	OUTLET FOR CCTV.	200
3	LIGHT	200	4	OUTLET FOR CCTV&CR	400
5	LIGHT	800	6	OUTLET FOR CCTV&CR	400
7	LIGHT	600	8	OUTLET FOR CCTV&CR	600
9	LIGHT	600	10	OUTLET FOR CR.	200
-	-	-	11	SOCKET	400
LIGHT LOAD (kVA)		**2.50**	**POWER LOAD (kVA)**		**2.20**

E) Restaurant Floor Loads

The listed tables below show the loads divided into DB's for Restaurant floor.

Table (2.20): normal loads type restaurant floor, which named as DB.S.KIT. @ RESTURANT FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1300	2	SOCKET	400
3	LIGHT	1100	4	OUTLET FOR HAND DR.	200
5	LIGHT	800	6	OUTLET FOR HAND DR.	200
7	LIGHT	900	8	SOCKET	600
9	LIGHT	600	10	SOCKET	800
11	LIGHT	600	12	SOCKET	400
-	-	-	13	STORE FCU	80
-	-	-	14	SOCKET	800
-	-	-	15	SPACE	-
-	-	-	16	SOCKET	800
LIGHT LOAD (kVA)		**5.30**	**POWER LOAD (kVA)**		**4.28**

Table (2.21): normal loads type restaurant floor, which named as DB.RST. @ RESTURANT FLR

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	800
3	LIGHT	900	4	SOCKET	600
5	LIGHT	1150	6	SOCKET	800
7	LIGHT	600	8	SOCKET	600
9	LIGHT	1000	10	SOCKET	800
11	LIGHT	900	12	SOCKET	1000
13	LIGHT	600	26	RST.LOBBY FCU	700
14	LIGHT	900	-	-	-
15	LIGHT	600	-	-	-
16	LIGHT	900	-	-	-
17	LIGHT	600	-	-	-
18	LIGHT	900	-	-	-
19	LIGHT	600	-	-	-
20	LIGHT	900	-	-	-
21	LIGHT	1200	-	-	-
22	LIGHT	500	-	-	-
23	LIGHT	1200	-	-	-
24	LIGHT	800	-	-	-
LIGHT LOAD (kVA)		**14.85**	**POWER LOAD (kVA)**		**5.30**

Table (2.22): emergency loads type restaurant floor, which named DB.RST.EM @ RESTURANT FLR..

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	700	2	OUTLET FOR CCTV.	400
3	LIGHT	1050	4	SOCKET	400
5	LIGHT	300	-	-	-
6	LIGHT(STR UP TO PRY FLR)	900	-	-	-
7	LIGHT	600	-	-	-
8	LIGHT(STR UP TO PRY FLR)	600	-	-	-
9	LIGHT	700	-	-	-
LIGHT LOAD (kVA)		**4.85**	**POWER LOAD (kVA)**		**0.80**

F) Service Floor Loads

The listed tables below show the loads divided into DB's for service floor.

Table (2.23): normal loads type service floor, which named as DB.SER. @ SERVICE FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1000	2	SOCKET	800
3	LIGHT	1200	4	SOCKET	800
5	LIGHT	1150	6	SOCKET	200
7	LIGHT	1300	8	SOCKET	400
9	LIGHT	600	10	SOCKET	800
11	LIGHT	1100	12	SOCKET	800
13	LIGHT	900	14	SOCKET	200
15	LIGHT	700	16	SOCKET	400
17	LIGHT	900	18	OUTLET FOR HAND DR.	200
19	LIGHT	700	20	HSE KPG FCU	100
21	LIGHT	1000	22	CORRIDOR FCU	600
23	SPACE	-	24	STAFF CAND.FCU	100
LIGHT LOAD (kVA)		**10.55**	**POWER LOAD (kVA)**		**5.40**

Table (2.24): emergency loads type service floor, which named DB.SER.EM @ SERVICE FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1000	2	OUTLET FOR CCTV.	200
3	LIGHT	1000	4	OUTLET FOR CCTV.	200
5	LIGHT	300	6	SOCKET	400
7	LIGHT	800	8	SPACE	-
LIGHT LOAD (kVA)		**3.10**	**POWER LOAD (kVA)**		**0.80**

Table (2.25): normal loads type service floor, which named as DB.LAU. @ SERVICE FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	600
3	LIGHT	800	4	SOCKET	600
5	LIGHT	900	6	SOCKET	600
LIGHT LOAD (kVA)		**2.30**	**POWER LOAD (kVA)**		**1.80**

Table (2.26): normal loads type service floor, which named as DB.KIT. @ SERVICE FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1200	2	SOCKET	800
3	LIGHT	1000	4	SOCKET	600
5	LIGHT	800	6	SOCKET	600
-	-	-	8	SOCKET	400
LIGHT LOAD (kVA)		**3.00**	**POWER LOAD (kVA)**		**2.40**

G) Praying Floor Loads

The listed tables below show the loads divided into DB's for praying floor.

Table (2.27): emergency loads type praying floor, which named DB.IT EM.@ PRAYING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	200	2	SOCKET	200
3	LIGHT	300	4	SOCKET	200
5	LIGHT	800	6	SOCKET	200
7	LIGHT	700	8	SPACE	-
9	LIGHT	1000	10	SPACE	-
LIGHT LOAD (kVA)		**3.00**	**POWER LOAD (kVA)**		**0.60**

Table (2.28): normal loads type praying floor, which named as DB.IT @ PRAYING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	900	2	SOCKET	600
3	LIGHT	300	4	SOCKET	600
5	LIGHT	400	6	SOCKET	400
7	LIGHT	300	8	SOCKET	600
-	-	-	9	IT STAFF FCU	80
-	-	-	10	SOCKET	600
-	-	-	11	IT ROOM FCU	80
-	-	-	12	SOCKET	600
-	-	-	13	FIRE OFF.FCU	80
-	-	-	14	SOCKET	600
-	-	-	15	TRAINIG RM.FCU	100
-	-	-	16	TRAINING OFF.FCU	80
LIGHT LOAD (kVA)		**1.90**	**POWER LOAD (kVA)**		**4.42**

Table (2.29): normal loads type praying floor, which named as DB.G.PR @ PRAYING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1000	2	SOCKET	800
3	LIGHT	600	4	SOCKET	800
5	LIGHT	1200	6	SOCKET	400
7	LIGHT	900	8	SOCKET	400
9	LIGHT	800	10	OUTLET FOR HAND DR.	200
11	LIGHT	800	12	OUTLET FOR HAND DR.	200
13	LIGHT	900	14	GENT ABLUTION FCU	300
15	LIGHT	650	16	SPACE	-
17	LIGHT	800	18	SPACE	-
LIGHT LOAD (kVA)		**7.65**	**POWER LOAD (kVA)**		**3.10**

Table (2.30): normal loads type praying floor, which named as DB.L.PR @ PRAYING FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	800
3	LIGHT	800	4	SOCKET	800
5	LIGHT	1000	6	SOCKET	400
7	LIGHT	700	8	OUTLET FOR HAND DR.	200
9	LIGHT	1000	10	OUTLET FOR HAND DR.	200
11	LIGHT	800	12	SOCKET	400
13	LIGHT	1000	14	LADIES ABLUTION FCU	80
15	LIGHT	800	16	CORR,LOBBY FCU	80
LIGHT LOAD (kVA)		**6.70**	**POWER LOAD (kVA)**		**2.96**

H) (1ST TO 15TH) Floors Loads

The listed tables below show the loads divided into DB's for (1st-15th) floors.

Table (2.31): flat (1) loads in (1st-15th) floors, which named as DB. FLAT (1) @ (1ST TO 15TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	800
3	LIGHT	800	4	SOCKET	800
5	LIGHT	700	6	SOCKET	800
-	-	-	7	OUTLET FORE SHAVOR	200
			8	OUTLET FORE SHAVOR	200
			9	BED ROOMS FCU	100
			10	OUTLET FOR HAIR DR.	1200
			11	LIVING FCU	80
			12	OUTLET FOR HAIR DR.	1200
LIGHT LOAD (kVA)		**2.10**	**POWER LOAD (kVA)**		**5.38**

Table (2.32): flat (2-5,7-10,12-14,16-18) loads in (1st-15th) floors, which named as DB. FLAT (2-5,7-10,12-14,16-18) @ (1ST TO 15TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	800
-	-	-	3	FLAT FCU	80
-	-	-	4	OUTLET FORE SHAVOR	200
-	-	-	5	OUTLET FOR HAIR DR.	1200
LIGHT LOAD (kVA)		**0.60**	**POWER LOAD (kVA)**		**2.28**

Table (2.33): flat (6) loads in (1st-15th) floors, which named as DB. FLAT (6) @ (1ST TO 15TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	600	2	SOCKET	800
-	LIGHT	700	4	SOCKET	800
-	-	-	5	FLAT FCU	100
-	-	-	6	OUTLET FORE SHAVOR	200
-	-	-	7	SPACE	-
-	-	-	8	OUTLET FOR HAIR DR.	1200
LIGHT LOAD (kVA)		**1.30**	**POWER LOAD (kVA)**		**3.10**

Table (2.34): flat (11) loads in (1st-15th) floors, which named as DB. FLAT (11) @ (1ST TO 15TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	500	2	SOCKET	600
-	LIGHT	400	4	SOCKET	400
-	-	-	5	FLAT FCU	100
-	-	-	6	OUTLET FORE SHAVOR	200
-	-	-	7	SPACE	-
-	-	-	8	OUTLET FOR HAIR DR.	1200
LIGHT LOAD (kVA)		**0.90**	**POWER LOAD (kVA)**		**2.50**

Table (2.35): flat (15) loads in (1st-15th) floors, which named as DB. FLAT (15) @ (1ST TO 15TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	800	2	SOCKET	800
-	LIGHT	800	4	SOCKET	800
-	-	-	5	FLAT FCU	100
-	-	-	6	OUTLET FORE SHAVOR	200
-	-	-	7	SPACE	-
-	-	-	8	OUTLET FOR HAIR DR.	1200
LIGHT LOAD (kVA)		**1.60**	**POWER LOAD (kVA)**		**3.10**

Table (2.36): emergency loads type 1st floor, which named as DB.2.FF.EM@ 1st FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (ELC. TEL,ROOM)	400	2	SOCKET (ELC. TEL,ROOM)	400
3	LIGHT (CORRIDOR)	300	4	OUTLET FOR CCTV	400
5	LIGHT (LIFT LOBBY)	300	6	OUTLET FOR CCTV	400
7	LIGHT (CORRIDOR)	400	-	-	-
8	LIGHT (STAIR 2. FF TO 6F)	1200	-	-	-
9	LIGHT (STAIR 1. FF TO 6F)	1200	-	-	-
10	LIGHT (CORRIDOR)	700	-	-	-
11	LIGHT (STAIR 3. FF TO 6F)	1200	-	-	-
12	LIGHT (CORRIDOR)	700	-	-	-
13	LIGHT (FLAT LOBBY)	200	-	-	-
LIGHT LOAD (kVA)		**6.60**	**POWER LOAD (kVA)**		**1.20**

Table (2.37): emergency flats load, which named as DB.1 (FF.EM. TO 15F.EM.) @ TYP FLR. (1st TO 15th).

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT ENT. FLAT 1	100	2	ACCESS DOOR FLAT 1	200
3	LIGHT ENT. FLAT 2	100	4	ACCESS DOOR FLAT 2	200
5	LIGHT ENT. FLAT 3	100	6	ACCESS DOOR FLAT 3	200
7	LIGHT ENT. FLAT 4	100	8	ACCESS DOOR FLAT 4	200
9	LIGHT ENT. FLAT 5	100	10	ACCESS DOOR FLAT 5	200
11	LIGHT ENT. FLAT 6	100	12	ACCESS DOOR FLAT 6	200
13	LIGHT ENT. FLAT 7	100	14	ACCESS DOOR FLAT 7	200
15	LIGHT ENT. FLAT 8	100	16	ACCESS DOOR FLAT 8	200
17	LIGHT ENT. FLAT 9	100	18	ACCESS DOOR FLAT 9	200
19	LIGHT ENT. FLAT 10	100	20	ACCESS DOOR FLAT 10	200
21	LIGHT ENT. FLAT 11	100	22	ACCESS DOOR FLAT 11	200
23	LIGHT ENT. FLAT 12	100	24	ACCESS DOOR FLAT 12	200
25	LIGHT ENT. FLAT 13	100	26	ACCESS DOOR FLAT 13	200
27	LIGHT ENT. FLAT 14	100	28	ACCESS DOOR FLAT 14	200
29	LIGHT ENT. FLAT 15	100	30	ACCESS DOOR FLAT 15	200
31	LIGHT ENT. FLAT 16	100	32	ACCESS DOOR FLAT 16	200
33	LIGHT ENT. FLAT 17	100	34	ACCESS DOOR FLAT 17	200
35	LIGHT ENT. FLAT 18	100	36	ACCESS DOOR FLAT 18	200
LIGHT LOAD (kVA)		**1.80**	**POWER LOAD (kVA)**		**3.60**

Table (2.38): emergency flats load, which named as DB.2.FF.EM@ 1st FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (ELC. TEL,ROOM)	400	2	SOCKET (ELC. TEL,ROOM)	400
3	LIGHT (CORRIDOR)	300	4	OUTLET FOR CCTV	400
5	LIGHT (LIFT LOBBY)	300	6	OUTLET FOR CCTV	400
7	LIGHT (CORRIDOR)	400	-	-	-
8	LIGHT (CORRIDOR)	700	-	-	-
9	SPACE	-	-	-	-
10	LIGHT (CORRIDOR)	700	-	-	-
LIGHT LOAD (kVA)		**2.80**	**POWER LOAD (kVA)**		**1.20**

Table (2.39): normal flats load, which named as DB. (FF.TO 15F.) @ TYP FLR. (1st TO 15th)

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (HOUSE KEEPING)	300	2	SOCKET (HOUSE KEEPING)	400
3	LIGHT (TOILET)	300	4	SOCKET (CORRIDOR)	400
5	LIGHT (LIFT LOBBY)	400	6	SOCKET (CORRIDOR)	400
7	LIGHT (CORRIDOR)	500	8	FCU (CORRIDOR)	300
9	LIGHT (CORRIDOR)	1150	10	FCU (CORRIDOR)	300
11	LIGHT (CORRIDOR)	1150	-	-	-
12	LIGHT (CORRIDOR)	400	-	-	-
13	LIGHT (SERV. CORRIDOR)	200	-	-	-
LIGHT LOAD (kVA)		**4.40**	**POWER LOAD (kVA)**		**1.80**

I) 7TH Floor Loads

The listed table below show the loads divided into DB for 7th floor.

Table (2.40): normal 7th flat loads, which named as DB.2.7F.EM@ 7th FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (ELC. TEL,ROOM)	400	2	SOCKET (ELC. TEL,ROOM)	400
3	LIGHT (CORRIDOR)	300	4	OUTLET FOR CCTV	400
5	LIGHT (LIFT LOBBY)	300	6	OUTLET FOR CCTV	400
7	LIGHT (CORRIDOR)	400	-	-	-
8	LIGHT (STAIR 2. 7F TO 12F)	1200	-	-	-
9	LIGHT (STAIR 1. 7F TO 12F)	1200	-	-	-
10	LIGHT (CORRIDOR)	700	-	-	-
11	LIGHT (STAIR 3. 7F TO 12F)	1200	-	-	-
12	LIGHT (CORRIDOR)	700	-	-	-
13	LIGHT (FLAT LOBBY)	200	-	-	-
LIGHT LOAD (kVA)		**6.60**	**POWER LOAD (kVA)**		**1.20**

J) 13TH Floors Loads

The listed table below show the loads divided into DB for 13th floor.

Table (2.41): emergency flats load, which named as DB.2.13F.EM@ 13th FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (ELC. TEL,ROOM)	400	2	SOCKET (ELC. TEL,ROOM)	400
3	LIGHT (CORRIDOR)	300	4	OUTLET FOR CCTV	400
5	LIGHT (LIFT LOBBY)	300	6	OUTLET FOR CCTV	400
7	LIGHT (CORRIDOR)	400	-	-	-
8	LIGHT (STAIR 2. 13F TO RF)	1200	-	-	-
9	LIGHT (STAIR 1. 13F TO RF)	1200	-	-	-
10	LIGHT (CORRIDOR)	700	-	-	-
11	LIGHT (STAIR 3. 13F TO RF)	1200	-	-	-
12	LIGHT (CORRIDOR)	700	-	-	-
13	LIGHT (FLAT LOBBY)	200	-	-	-
LIGHT LOAD (kVA)		**6.60**	**POWER LOAD (kVA)**		**1.20**

K) 16TH Floors Loads

The listed tables below show the loads divided into DB's for 16th floor.

Table (2.42): flat (1) loads in 16th floor, which named as DB. FLAT (01) @ (16TH) FLR

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	750	2	SOCKET	600
3	LIGHT	800	4	SOCKET	800
5	LIGHT	200	6	SOCKET	600
7	LIGHT	800	8	SOCKET	800
9	LIGHT	850	10	OUTLET FOR HAND DR.	200
-	-	-	11	OUTLET FORE SHAVOR	200
-	-	-	12	OUTLET FOR HAIR DR.	1200
-	-	-	13	OUTLET FORE SHAVOR	200
-	-	-	14	OUTLET FOR HAIR DR.	1200
-	-	-	15	BED ROOMS FCU	100
-	-	-	16	LIVING FCU	100
LIGHT LOAD (kVA)		**3.40**	**POWER LOAD (kVA)**		**6.00**

Table (2.43): flat (2) loads in 16th floor, which named as DB. FLAT (02) @ (16TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	500	2	SOCKET	600
3	LIGHT	200	4	SOCKET	600
5	LIGHT	700	6	SOCKET	600
7	LIGHT	200	8	SOCKET	600
9	LIGHT	1000	10	SOCKET	400
11	LIGHT	100	12	SOCKET	400
13	LIGHT	900	14	SOCKET	600
15	LIGHT	800	16	SOCKET	600
17	LIGHT	1000	18	SOCKET	800
-	-	-	19	OUTLET FOR HAIR DR.	1200
-	-	-	20	OUTLET FOR HAND DR.	200
-	-	-	21	OUTLET FORE SHAVOR	200
-	-	-	22	OUTLET FOR HAND DR.	200
-	-	-	23	DINING FCU	500
-	-	-	24	OUTLET FOR HAIR DR.	1200
-	-	-	25	BED ROOM FCU	100
-	-	-	26	LIVING FCU	100
LIGHT LOAD (kVA)		**5.40**	**POWER LOAD (kVA)**		**8.90**

Table (2.44): flat (3) loads in 16th floor, which named as DB. FLAT (03) @ (16TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1000	2	SOCKET	600
3	LIGHT	200	4	SOCKET	800
5	LIGHT	800	6	SOCKET	600
7	LIGHT	850	8	SOCKET	800
-	-	-	9	OUTLET FORE SHAVOR	200
-	-	-	10	OUTLET FOR HAIR DR.	1200
-	-	-	11	OUTLET FOR HAND DR.	200
-	-	-	12	OUTLET FOR HAIR DR.	1200
-	-	-	13	OUTLET FORE SHAVOR	200
-	-	-	14	LIV.&DINING FCU	80
-	-	-	15	BED ROOMS FCU	100
LIGHT LOAD (kVA)		**2.85**	**POWER LOAD (kVA)**		**5.98**

Table (2.45): flat (4) loads in 16th floor, which named as DB. FLAT (04) @ (16TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	400	2	SOCKET	600
3	LIGHT	100	4	SOCKET	600
5	LIGHT	200	6	SOCKET	200
7	LIGHT	1000	8	SOCKET	600
9	LIGHT	750	10	SOCKET	800
11	LIGHT	850	12	SOCKET	800
13	LIGHT	900	14	SOCKET	600
15	LIGHT	950	16	SOCKET	400
17	LIGHT	800	18	SOCKET	600
19	LIGHT	200	20	SOCKET	400
-	-	-	21	OUTLET FORE SHAVOR	200
-	-	-	22	OUTLET FOR HAIR DR.	1200
-	-	-	23	OUTLET FOR HAND DR.	200
-	-	-	24	OUTLET FORE SHAVOR	200
-	-	-	25	OUTLET FOR HAND DR.	200
-	-	-	26	OUTLET FOR HAIR DR.	1200
-	-	-	27	OUTLET FORE SHAVOR	200
-	-	-	28	OUTLET FOR HAIR DR.	1200
-	-	-	29	DIN,KIT,BREAK RM FCU	100
-	-	-	30	BED . FCU	80
-	-	-	31	BED RM1,2 FCU	100
-	-	-	32	LIVING FCU	300
LIGHT LOAD (kVA)		**6.15**	**POWER LOAD (kVA)**		**10.78**

Table (2.46): emergency flats load, which named as DB.16F.EM. @ 16th FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT ENT. FLAT 1	100	2	ACCESS DOOR FLAT 1	200
3	LIGHT ENT. FLAT 2	100	4	ACCESS DOOR FLAT 2	200
5	LIGHT ENT. FLAT 3	100	6	ACCESS DOOR FLAT 3	200
7	LIGHT ENT. FLAT 4	100	8	ACCESS DOOR FLAT 4	200
9	LIGHT (ELC. TEL,ROOM)	400	10	SOCKET (ELC. TEL,ROOM)	400
11	LIGHT (CORRIDOR)	300	12	OUTLET FOR CCTV	400
13	LIGHT (LIFT LOBBY)	300	14	OUTLET FOR CCTV	400
15	LIGHT (CORRIDOR)	700	-	-	-
16	LIGHT (CORRIDOR)	400	-	-	-
17	LIGHT (CORRIDOR)	700	-	-	-
LIGHT LOAD (kVA)		**3.20**	**POWER LOAD (kVA)**		**2.00**

Table (2.47): flat 16 loads in 16th floor, which named as DB.16F. @ 16th FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (HOUSE KEEPING)	200	2	SOCKET (HOUSE KEEPING)	400
3	LIGHT (CORRIDOR)	400	4	SOCKET (CORRIDOR)	400
5	LIGHT (LIFT LOBBY)	400	6	SOCKET (CORRIDOR)	400
7	LIGHT (CORRIDOR)	1150	8	FCU (CORRIDOR)	300
9	LIGHT (CORRIDOR)	500	10	FCU (CORRIDOR)	300
11	LIGHT (CORRIDOR)	1150	-	-	-
12	LIGHT (CORRIDOR)	200	-	-	-
LIGHT LOAD (kVA)		**4.00**	**POWER LOAD (kVA)**		**1.80**

L) 17TH Floors Loads

The listed tables below show the loads divided into DB's for 17h floor.

Table (2.48): office loads in 17th floor, which named as DB. OFFICE @ (17TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1500	2	SOCKET	800
3	LIGHT	300	4	SOCKET	800
5	LIGHT	1200	6	SOCKET	1200
7	LIGHT	1000	8	SOCKET	800
9	LIGHT	750	10	SOCKET	600
11	LIGHT	200	12	SOCKET	400
-	-	-	13	OUTLET FOR HAND DR.	200
-	-	-	14	OUTLET FOR HAIR DR.	1200
-	-	-	15	OUTLET FORE SHAVOR	200
-	-	-	16	OUTLET FOR HAND DR.	200
-	-	-	17	BED RM.FCU	100
-	-	-	18	OFFICE FCU	100
-	-	-	19	RECEPTION FCU	80
LIGHT LOAD (kVA)		**4.95**	**POWER LOAD (kVA)**		**6.68**

Table (2.49): men majlis loads in 17th floor, which named as DB.M.MAJ @ (17TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1200	2	SOCKET	600
3	LIGHT	500	4	SOCKET	600
5	LIGHT	200	6	SOCKET	600
7	LIGHT	200	8	SOCKET	800
9	LIGHT	1500	10	SOCKET	600
11	LIGHT	1200	12	OUTLET FOR HAND DR.	200
13	LIGHT	600	14	MENS DINING FCU	600
15	LIGHT	200	-	-	-
17	LIGHT	1400	-	-	-
LIGHT LOAD (kVA)		**7.00**	**POWER LOAD (kVA)**		**4.00**

Table (2.50): women majlis loads in 17th floor, which named as DB.W.MAJ @ (17TH) FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	1000	2	SOCKET	600
3	LIGHT	200	4	SOCKET	600
5	LIGHT	1000	6	SOCKET	600
7	LIGHT	200	8	OUTLET FOR HAND DR.	200
9	LIGHT	1200	10	WOMEN MAJLIS FCU	300
11	LIGHT	500	12	MAEN DINING FCU	100
LIGHT LOAD (kVA)		**4.10**	**POWER LOAD (kVA)**		**2.40**

Table (2.51): emergency flats load, which named as DB.17F.EM.@ 17th FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (RECEPTION)	100	2	ACCESS DOOR (RECEPTION)	200
3	LIGHT (SH.SOLIMAN OFF.)	200	4	ACCESS DR. (SH.SOL. OFF.)	200
5	LIGHT (MEN MAJLES)	200	6	ACCESS DR. (MEN MAJLES)	200
7	LIGHT (MEN DINIG)	200	8	ACCESS DR. (MEN DINIG)	200
9	LIGHT (WOMEN MAJLES)	200	10	ACCESS DR. (WOM. MAJLES)	400
11	LIGHT (WMEN DINIG)	200	12	ACCESS DR. (WMEN DINIG)	400
13	LIGHT (ELC. TEL,ROOM)	400	14	SOCKET (ELC. TEL,ROOM)	400
15	LIGHT (LIFT LOBBY)	300	16	SPUR OUTLET FOR CCTV	400
17	LIGHT (CORRIDOR)	700	18	SPUR OUTLET FOR CCTV	400
19	LIGHT (LIFT LOBBY)	400	20	SPACE	-
LIGHT LOAD (kVA)		**2.90**	**POWER LOAD (kVA)**		**2.80**

Table (2.52): flat 17 loads in 17th floor, which named as DB.17F. @ 17th FLR.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT (HOUSE KEEPING)	200	2	SOCKET (HOUSE KEEPING)	400
3	LIGHT (CORRIDOR)	400	4	SOCKET (CORRIDOR)	400
5	LIGHT (LIFT LOBBY)	400	6	SOCKET (CORRIDOR)	400
7	LIGHT (CORRIDOR)	1150	8	FCU (CORRIDOR)	300
9	LIGHT (CORRIDOR)	500	10	FCU (CORRIDOR)	300
11	LIGHT (CORRIDOR)	1200	-	-	-
12	LIGHT (CORRIDOR)	200	-	-	-
LIGHT LOAD (kVA)		**4.05**	**POWER LOAD (kVA)**		**1.80**

M) Lower Roof Floor Loads

The listed table below show the loads divided into DB for lower roof floor.

Table (2.53): lower roof floor.

CT No.	Description	Total Circuit Load (VA)	CT No.	Description	Total Circuit Load (VA)
1	LIGHT	400	2	SOCKET	800
3	LIGHT	400	4	SOCKET	400
5	LIGHT	600	6	SOCKET	400
7	LIGHT	600	8	SOCKET	400
9	LIGHT	500	10	SOCKET	600
11	LIGHT(UPPER ROOF)	500	12	ELE.RM.FCU	300
13	-	-	13	GSM RM.FCU	300
15	-	-	14	MACH.RM FCU	500
13	-	-	15	PUMP RM.FCU	500
LIGHT LOAD (kVA)		**3.00**	**POWER LOAD (kVA)**		**4.20**

Appendix D:

Data sheet of Cable

Click here for more information:
elandcables.com | N2XY IEC 60502-1 XLPE PVC 0.6/1kV Cable

ELAND CABLES

N2XY IEC 60502-1 XLPE PVC 0.6/1kV Cable

Eland Product Group: **A2N**

APPLICATION

These power and fixed wiring cables are used for electricity supply in low voltage installation systems. They are well adapted to underground use in industrial applications with an additional mechanical protection. These cables can be fixed on cable trays, within conduits or fixed to walls.

CHARACTERISTICS

Voltage Rating Uo/U
0.6/1kV

Temperature Rating
During installation -5°C to +50°C
Fixed Installation: -20°C to +90°C

Minimum Bending Radius
Fixed: 12 x overall diameter

CONSTRUCTION

Conductor
RE: Class 1 solid copper conductor
RM: Class 2 stranded circular or circular compacted
SM: Class 2 stranded sectoral shaped

Insulation
XLPE (Cross-Linked Polyethylene)

Bedding
PVC (Polyvinyl Chloride)

Sheath
PVC (Polyvinyl Chloride)

Core Identification
3 core: Green/Yellow ● Blue ● Brown
4 core: Green/Yellow ● Brown ● Black ● Grey
5 core: Green/Yellow ● Blue ● Brown ● Black ● Grey
7 cores and above: ● Black cores and ○ White numbers

Sheath Colour
● Black

STANDARDS

IEC 60502-1, VDE 0276-603, IEC/EN 60228

Flame retardant according to IEC/EN 60332-1-2

ISO/IEC 17025 LABORATORY TESTED

This product is subject to the Quality Assurance protocols of The Cable Lab®, an ISO/IEC 17025 accredited cable testing laboratory. Testing includes vertical flame, conductor resistance, tensile & elongation, and dimensional consistency, verified to published standards and approved product drawings.

REGULATORY COMPLIANCE

This cable is compliant with European Regulation EN 50575, the Construction Products Regulation.

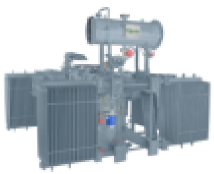
This cable meets the requirements of the Low Voltage Directive 2014/35/EU and the RoHS Directive 2011/65/EU. RoHS compliance has been tested and confirmed by The Cable Lab® as meeting the requirements of the BSI RoHS Trusted Kitemark™.

Appendix E:

Data sheet of Transformer

Product data sheet

Specifications



Transformer, Minera, IEC, oil type, 1000kVA, 11kV, on load, cable box MV connection bus duct LV connection, convertional tank, loss level2

MIN100011559700001

Main

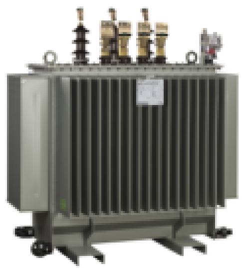
Product range	Minera
Product or component type	Transformer
Transformer type	Oil type transformer
Dielectric liquid	Mineral oil
Network type	AC
Standards	IS 1180
Type of installation	Indoor/outdoor
Maximum altitude	< 1000 m
Cooling mode	ONAN (oil natural air natural)
Winding material	Copper
Degree of protection	IP00 conventional IS 2099 IP00 conventional IS 3347 IP55 low voltage cable box
Mounting mode	Ground mounted

Complementary

Directives	2015/2014/548/EC- ecodesign
Phase	3 phases
Rated power	1000 kVA
Rated frequency	50 Hz
Rated primary voltage	11 kV
Secondary voltage (at no-load)	Operation/loading as per IS standard: 433 V
Insulation voltage to industrial frequency (50 Hz 1 mn)	28 kV primary 3 kV secondary
Rated insulation level	Primary circuit: 12 kV Secondary circuit: 1.1 kV
Lighting impulse whistand voltage (BIL) , 1.2/50 µs	75 kV
Vector group	Dyn11
HV tappings (off circuit)	- 15...5 x 2.5 %
Short circuit impedance	5 %

Product data sheet

Specifications



Discontinued

MINERA TRANSFORMER 1250 kVA- 15-20kV/410V AoBk

MIN125015201133

Discontinued on: 31 March 2022

Main

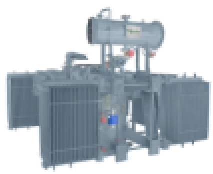
Product range	Minera
Product or component type	Oil type transformer
Dielectric liquid	Mineral oil
Network type	AC
Standards	NF EN EN 50588-1
Type of installation	Indoor
Maximum altitude	< 1000 m
Cooling mode	ONAN (oil natural air natural)
Winding material	Aluminium
Degree of protection	IP00 IP21 low voltage cable box
Mounting mode	Ground mounted

Complementary

Directives	2015/2014/548/EC- ecodesign
Phase	3 phases
Rated power	1250 kVA
Rated frequency	50 Hz
Rated primary voltage	15/20 kV
Secondary voltage (at no-load)	No load: 410 V
Insulation voltage to industrial frequency (50 Hz 1 mn)	50 kV primary 3 kV secondary
Rated insulation level	Primary circuit: 24 kV Secondary circuit: 1.1 kV
Lighting impulse whistand voltage (BIL) , 1.2/50 µs	125 kV
Vector group	Dyn11
HV tappings (off circuit)	+/- 2 x 2.5 %
Short circuit impedance	6 %
No-load losses	1092.5 W

Product data sheet

Specifications



Transformer, Minera, IEC, oil type, 1600kVA, 11kV, off circuit, cable box MV connection bus duct LV connection, convertional tank, loss level2

MIN160011559700001

Main

Product range	Minera
Product or component type	Transformer
Transformer type	Oil type transformer
Dielectric liquid	Mineral oil
Network type	AC
Standards	IS 1180
Type of installation	Indoor/outdoor
Maximum altitude	< 1000 m
Cooling mode	ONAN (oil natural air natural)
Winding material	Copper
Degree of protection	IP00 conventional IS 2099 IP00 conventional IS 3347 IP55 low voltage cable box
Mounting mode	Ground mounted

Complementary

Directives	2015/2014/548/EC- ecodesign
Phase	3 phases
Rated power	1600 kVA
Rated frequency	50 Hz
Rated primary voltage	11 kV
Secondary voltage (at no-load)	Operation/loading as per IS standard: 433 V
Insulation voltage to industrial frequency (50 Hz 1 mn)	28 kV primary 3 kV secondary
Rated insulation level	Primary circuit: 12 kV Secondary circuit: 1.1 kV
Lighting impulse whistand voltage (BIL) , 1.2/50 µs	75 kV
Vector group	Dyn11
HV tappings (off circuit)	- 10...5 x 2.5 %
Short circuit impedance	6.25 %

Appendix F:

Table (6.6) selected circuit breakers for normal DB's
Table (6.7) selected circuit breakers for emergency DB's in hotel.

Table (6. **6**): Type of MCB &MCCB circuit breaker used to protect normal DB's in hotel:

Floor	Distribution Board	Feed From SMDB	Connected Load (KVA)	Full Load Ib (A)	Cable Catalog Number	Cable C.S.A (mm2)	Type of Circuit Breaker	Breaker Frame Current Rating	Breaker Trip Current Rating (In)	Short-Circuit Breaking Capacity (Icu)
Ground Floor	DB.GF	SMDB Ground Floor	15.11	21.81	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	GARBAGE COMPACTOR		3	4.33	N2XY5015	5x1.5 mm2	Acti9 iC40N / 3x10A	-	10A	10kA
	FF PUMP		186	282.60	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA
Mezzanin Floor	DB.MEZ.		17.6	25.40	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	DB.SHOP1		2.78	4.01	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
	DB.SHOP2		2.78	4.01	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
1st. Parking Floor	DB.1st PAR.	SMDB Parking Floor	7.44	10.74	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
2nd Parking Floor	DB.2nd PAR.		6.46	9.32	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
3rd Parking Floor	DB.3rd PAR.		8.42	12.15	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	FAHU		30	43.30	N2XY510	5x10 mm2	Acti9 C120H / 3x63A	-	63A	10kA
Restaurant Floor	DB.S.KIT.	SMDB Restaurant Floor	9.58	13.83	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	REST. AHU		15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	S.KITCHEN AHU		3	4.33	N2XY5025	5x2.5 mm2	Acti9 iC40N / 3x10A	-	10A	10kA
	KITCHEN EQUIPMENT		239.5	345.69	N2XY4150	(4x150+70) mm2	NSX630F	500A	350A	36kA
	DB.RST.		20.15	29.08	N2XY5060	5x6 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
Service Floor	DB.KIT.		5.4	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
	DB.SER.	SMDB-1 Service Floor	15.95	23.02	N2XY5060	5x6 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	DB-LOUNDARY		4.1	5.92	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
	LOUNDARY EQUIPM.		244	352.18	N2XY4150	(4x150+70) mm2	NSX630F	500A	400A	36kA
	MAIN KITCHEN AHU	SMDB-2 Service Floor	15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	LOUNDARY AHU		4.5	6.50	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
	LOUNDARY EQUIPM.2		244	352.18	N2XY4150	(4x150+70) mm2	NSX630F	500A	400A	36kA
Praying Floor	DB.G.PR	SMDB Prayer Floor	10.75	15.52	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	DB.L.PR		9.66	13.94	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	DB.IT		6.32	9.12	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
	G. PRAYER.AHU		15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	F. PRAYER.AHU		15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
(1st-15TH) Floors	DB.FLAT 1	SMDB (1st-15TH) Floors	7.48	32.52	N2XY3060	3x6 mm2	Acti9 iC40N / 1x40A	-	40A	10kA
	DB.FLAT(2)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(3)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(4)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(5)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(6)		4.4	19.13	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(7)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(8)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(9)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(10)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(11)		3.4	14.78	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(12)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(13)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(14)		2.8	12.17	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(15)		4.7	20.43	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	-	25A	10kA
	DB.FLAT(16)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(17)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.FLAT(18)		2.88	12.52	N2XY3040	3x4 mm2	Acti9 iC40N / 1x20A	-	20A	10kA
	DB.(FF.TO 15F.)		6.2	8.95	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA

16TH Floor	DB.FLAT(01)	SMDB 16TH Floor	9.4	40.87	N2XY510	5x10 mm2	Acti9 C120H / 3x63A	-	63A	10kA
	DB.FLAT(02)		14.3	20.64	N2XY5040	5x4 mm2	Acti9 iC40N / 3x25A	-	25A	10kA
	DB.FLAT(03)		8.83	38.39	N2XY510	5x10 mm2	Acti9 C120H / 3x63A	-	63A	10kA
	DB.FLAT(04)		16.93	24.44	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	DB.16FLR		5.8	8.37	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	-	16A	10kA
17TH Floor	DB.OFFICE	SMDB 17TH Floor	11.63	16.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	DB.M.MAJ		11	15.88	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	DB.W.MAJ		6.5	9.38	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	DB.17F.		5.85	8.44	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
Upper & Lower Roof	GUEST LIFT 2	SMDB-1 Roof Floor	9	12.99	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	GUEST LIFT 4		9	12.99	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	GUEST LIFT 6		9	12.99	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	FAHU		63	90.93	N2XY425	(4x25+16) mm2	NSX250B	250A	125A	25kA
	EM. BOOSTER PUMP		0.3	1.30	N2XY3015	3x1.5 mm2	Acti9 iC40N / 1x10A	-	10A	10kA
	CIRC. BOOSTER Pump		2.1	3.03	N2XY5015	5x1.5 mm2	Acti9 iC40N / 3x10A	-	10A	10kA
	CALORIFIER 1	SMDB-2 Roof Floor	287	414.25	N2XY4185	(4x185+95) mm2	NSX630F	500A	450A	36kA
	CALORIFIER 2		287	414.25	N2XY4185	(4x185+95) mm2	NSX630F	500A	450A	36kA
	CALORIFIER 3		288	415.69	N2XY4185	(4x185+95) mm2	NSX630F	500A	450A	36kA
	MCC-PRIMARY PUMP 1	M.C.C @ Roof Floor	10	14.43	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	MCC-PRIMARY PUMP 2		10	14.43	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	MCC-PRIMARY PUMP 3		10	14.43	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	-	20A	10kA
	MCC-SECONDARY PUMP 1		15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	MCC-SECONDARY PUMP 2		15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	MCC-SECONDARY PUMP 3		15	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	-	32A	10kA
	PRS		1	4.35	N2XY3015	3x1.5 mm2	Acti9 iC40N / 1x10A	-	10A	10kA
	CHILLER-1 CKT-1	MDB.AC @ Roof Floor	171	246.82	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA
	CHILLER-1 CKT-2		172	248.26	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA
	CHILLER-2 CKT-1		171	246.82	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA
	CHILLER-2 CKT-2		172	248.26	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA
	CHILLER-3 CKT-1		171	246.82	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA
	CHILLER-3 CKT-2		172	248.26	N2XY495	(4x95+50) mm2	NSX400F	400A	320A	36kA

Table (6.7): Type of MCB &MCCB circuit breaker used to protect emergency DB's in hotel.

Floor	Group Load Name (DB)	Feed From SMDB	Connected Load (KVA)	Full Load Ib (A)	Cable Catalog Number	Cable No. * C.S.A (No.* mm2)	Type of Circuit Breaker	Breaker Trip Current Rating (In)	Short-Circuit Breaking Capacity (Icu)
Ground Floor	DB.GF EM	SMDB-1 EM@ Ground Floor	13.70	19.77	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	32A	10kA
	FRISH AIR TXF.1@2P		6.50	9.38	N2XY5025	5x2.5 mm2	Acti9 iC40N / 3x16A	16A	10kA
	GATE BARRIER		3.00	13.04	N2XY3025	1x2.5 mm2	Acti9 iC40N / 1x20A	20A	10kA
	WATER TR. PUMP		15.00	21.65	N2XY5040	5x4 mm2	Acti9 iC40N / 3x32A	32A	10kA
Mezzanin Floor	DB.MEZ. EM.		3.90	16.96	N2XY3040	1x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
1st. Parking Floor	DB.1st PAR.EM		5.80	8.37	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
2nd Parking Floor	DB.2nd PAR.EM		5.70	8.23	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
3rd Parking Floor	DB.3rd PAR.EM		4.70	6.78	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
Resturant Floor	DB.RST.EM		5.65	8.16	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
Service Floor	DB.SER.EM		3.90	16.96	N2XY3060	3x6 mm2	Acti9 iC40N / 1x25A	25A	10kA
Praying Floor	DB.IT EM.		3.60	15.65	N2XY3060	3x6 mm2	Acti9 iC40N / 1x25A	25A	10kA
(1st-15TH) Floors	DB.1.FF.EM	SMDB-2 EM@ 1st Floor	5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.FF.EM		7.80	11.26	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	20A	10kA
	DB.1.2F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.2F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.3F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.3F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.4F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.4F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.5F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.5F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.6F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.6F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.7F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.7F.EM		7.80	11.26	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	20A	10kA
	DB.1.8F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.8F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.9F.EM	SMDB-3 EM@ 9th Floor	5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.9F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.10F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.10F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.11F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.11F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.12F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.12F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.13F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.13F.EM		7.80	11.26	N2XY5040	5x4 mm2	Acti9 iC40N / 3x20A	20A	10kA
	DB.1.14F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.14F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
	DB.1.15F.EM		5.40	7.79	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
	DB.2.15F.EM		4.00	17.39	N2XY3040	3x4 mm2	Acti9 iC40N / 1x25A	25A	10kA
16TH Floor	DB.16F.EM.		5.20	7.51	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA
17TH Floor	DB.17F.EM.		5.70	8.23	N2XY5040	5x4 mm2	Acti9 iC40N / 3x16A	16A	10kA

Appendix G:

Data sheet of Cricket Bricker

Product data sheet

Specifications

Circuit breaker, ComPacT NSX100B, 25kA/415VAC, 3 poles, MicroLogic 2.2 trip unit 100A

C10B32D100

Main

Range	ComPacT new generation
Product name	ComPacT NSX new generation
Device short name	NSX100B
Product or component type	Circuit breaker
Device application	Distribution
Poles description	3P
Protected poles description	3D
[In] rated current	100 A at 40 °C
[Ue] rated operational voltage	690 V AC 50/60 Hz
Network type	AC
Network frequency	50/60 Hz
Suitability for isolation	Yes conforming to EN/IEC 60947-2
Utilisation category	Category A
[Icu] rated ultimate short-circuit breaking capacity	40 kA Icu at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 25 kA Icu at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 20 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 15 kA Icu at 500 V AC 50/60 Hz conforming to IEC 60947-2
Performance level	B 25 kA 415 V AC
Trip unit name	Micrologic 2.2
Trip unit technology	Electronic
Trip unit protection functions	LSoI
Control type	Toggle
Circuit breaker mounting mode	Fixed

Complementary

[Ui] rated insulation voltage	800 V AC 50/60 Hz
[Uimp] rated impulse withstand voltage	8 kV
[Ics] rated service short-circuit breaking capacity	40 kA at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 25 kA at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 20 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 7 kA at 500 V AC 50/60 Hz conforming to IEC 60947-2
Mechanical durability	50000 cycles

Product data sheet

Specifications

Circuit breaker, ComPacT NSX160B, 25kA/415VAC, 3 poles, MicroLogic 2.2 trip unit 160A

C16B32D160

Main

Range	ComPacT new generation
Product name	ComPacT NSX new generation
Device short name	NSX160B
Product or component type	Circuit breaker
Device application	Distribution
Poles description	3P
Protected poles description	3D
[In] rated current	160 A at 40 °C
[Ue] rated operational voltage	690 V AC 50/60 Hz
Network type	AC
Network frequency	50/60 Hz
Suitability for isolation	Yes conforming to EN/IEC 60947-2
Utilisation category	Category A
[Icu] rated ultimate short-circuit breaking capacity	40 kA Icu at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 25 kA Icu at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 20 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 15 kA Icu at 500 V AC 50/60 Hz conforming to IEC 60947-2
Performance level	B 25 kA 415 V AC
Trip unit name	Micrologic 2.2
Trip unit technology	Electronic
Trip unit protection functions	LSoI
Control type	Toggle
Circuit breaker mounting mode	Fixed

Complementary

[Ui] rated insulation voltage	800 V AC 50/60 Hz
[Uimp] rated impulse withstand voltage	8 kV
[Ics] rated service short-circuit breaking capacity	40 kA at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 25 kA at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 20 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 15 kA at 500 V AC 50/60 Hz conforming to IEC 60947-2
Mechanical durability	40000 cycles

Product data sheet

Specifications

Circuit breaker, ComPacT NSX250B, 25kA/415VAC, 3 poles, MicroLogic 2.2 trip unit 250A

C25B32D250

Main

Range	ComPacT new generation
Product name	ComPacT NSX new generation
Device short name	NSX250B
Product or component type	Circuit breaker
Device application	Distribution
Poles description	3P
Protected poles description	3D
[In] rated current	250 A at 40 °C
[Ue] rated operational voltage	690 V AC 50/60 Hz
Network type	AC
Network frequency	50/60 Hz
Suitability for isolation	Yes conforming to EN/IEC 60947-2
Utilisation category	Category A
[Icu] rated ultimate short-circuit breaking capacity	40 kA Icu at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 25 kA Icu at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 20 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 15 kA Icu at 500 V AC 50/60 Hz conforming to IEC 60947-2
Performance level	B 25 kA 415 V AC
Trip unit name	Micrologic 2.2
Trip unit technology	Electronic
Trip unit protection functions	LSoI
Control type	Toggle
Circuit breaker mounting mode	Fixed

Complementary

[Ui] rated insulation voltage	800 V AC 50/60 Hz
[Uimp] rated impulse withstand voltage	8 kV
[Ics] rated service short-circuit breaking capacity	40 kA at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 25 kA at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 20 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 15 kA at 500 V AC 50/60 Hz conforming to IEC 60947-2
Mechanical durability	20000 cycles

Product data sheet

Specifications

Circuit breaker, ComPacT NSX400F, 36kA/415VAC, 3 poles, MicroLogic 2.3 trip unit 400A

C40F32D400

Main

Range	ComPacT new generation
Product name	ComPacT NSX new generation
Device short name	NSX400F
Product or component type	Circuit breaker
Device application	Distribution
Poles description	3P
Protected poles description	3D
[In] rated current	400 A at 40 °C
[Ue] rated operational voltage	690 V AC 50/60 Hz
Network type	AC
Network frequency	50/60 Hz
Suitability for isolation	Yes conforming to EN/IEC 60947-2
Utilisation category	Category A
[Icu] rated ultimate short-circuit breaking capacity	40 kA Icu at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 36 kA Icu at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 30 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 25 kA Icu at 500 V AC 50/60 Hz conforming to IEC 60947-2 20 kA Icu at 525 V AC 50/60 Hz conforming to IEC 60947-2 10 kA Icu at 660/690 V AC 50/60 Hz conforming to IEC 60947-2 20 kA at 600 V AC 50/60 Hz conforming to UL 508
Performance level	F 36 kA 415 V AC
Trip unit name	Micrologic 2.3
Trip unit technology	Electronic
Trip unit protection functions	LSoI
Control type	Toggle
Circuit breaker mounting mode	Fixed

Complementary

[Ui] rated insulation voltage	800 V AC 50/60 Hz
[Uimp] rated impulse withstand voltage	8 kV
[Ics] rated service short-circuit breaking capacity	40 kA at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 36 kA at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 30 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 25 kA at 500 V AC 50/60 Hz conforming to IEC 60947-2

Product data sheet

Specifications

Circuit breaker, ComPacT NSX630F, 36kA/415VAC, 3 poles, MicroLogic 2.3M trip unit 500A

C63F32M500

Main

Range	ComPacT new generation
Product name	ComPacT NSX new generation
Device short name	NSX630F
Product or component type	Circuit breaker
Device application	Motor protection
Poles description	3P
Protected poles description	3D
[In] rated current	500 A at 65 °C
[Ue] rated operational voltage	690 V AC 50/60 Hz
Network type	AC
Network frequency	50/60 Hz
Suitability for isolation	Yes conforming to EN/IEC 60947-2
Utilisation category	Category A
[Icu] rated ultimate short-circuit breaking capacity	40 kA Icu at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 36 kA Icu at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 30 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 25 kA Icu at 500 V AC 50/60 Hz conforming to IEC 60947-2 20 kA Icu at 525 V AC 50/60 Hz conforming to IEC 60947-2 10 kA Icu at 660/690 V AC 50/60 Hz conforming to IEC 60947-2 20 kA at 600 V AC 50/60 Hz conforming to UL 508
Performance level	F 36 kA 415 V AC
Trip unit name	Micrologic 2.3 M
Trip unit technology	Electronic
Trip unit protection functions	LSoI
Control type	Toggle
Circuit breaker mounting mode	Fixed

Complementary

[Ui] rated insulation voltage	800 V AC 50/60 Hz
[Uimp] rated impulse withstand voltage	8 kV
[Ics] rated service short-circuit breaking capacity	40 kA at 220/240 V AC 50/60 Hz conforming to IEC 60947-2 36 kA at 380/415 V AC 50/60 Hz conforming to IEC 60947-2 30 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 25 kA at 500 V AC 50/60 Hz conforming to IEC 60947-2

Product data sheet

Specifications

Circuit breaker frame, MasterPact MTZ2 16N1, 1600A, 42kA/440VAC 50/60Hz (Icu), 3P, drawout, without control unit

LV848272

Main

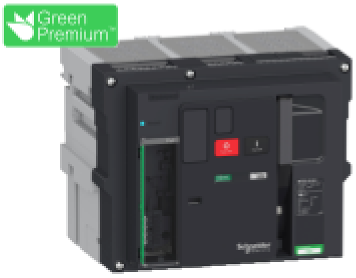
Range	Masterpact
Product name	MasterPact MTZ2
Device short name	MTZ2 16 N1
Product or component type	Circuit breaker
Device application	Protection
Poles description	3P
Network type	AC
Network frequency	50/60 Hz
Breaking capacity code	N1
Suitability for isolation	Yes conforming to IEC 60947-2
Selectivity category	Category B

Complementary

Control type	Push-button
Mounting mode	Drawout
Mounting support	Base plate Rails
[In] rated current	1600 A at 40 °C
[Ui] rated insulation voltage	1000 V AC 50/60 Hz conforming to IEC 60947-2
[Uimp] rated impulse withstand voltage	12 kV conforming to IEC 60947-2
[Icm] rated short-circuit making capacity	88 kA 220/415 V AC at 50/60 Hz 88 kA 440 V AC at 50/60 Hz 88 kA 500/525 V AC at 50/60 Hz 88 kA 660/690 V AC at 50/60 Hz
[Ue] rated operational voltage	690 V AC 50/60 Hz conforming to IEC 60947-2
Circuit breaker CT rating	1600 A
Performance level	42 kA Icu at 220/415 V AC 50/60 Hz conforming to IEC 60947-2 42 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 42 kA Icu at 500/525 V AC 50/60 Hz conforming to IEC 60947-2 42 kA Icu at 660/690 V AC 50/60 Hz conforming to IEC 60947-2
[Ics] rated service breaking capacity	42 kA at 220/415 V AC 50/60 Hz conforming to IEC 60947-2 42 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 42 kA at 500/525 V AC 50/60 Hz conforming to IEC 60947-2 42 kA at 660/690 V AC 50/60 Hz conforming to IEC 60947-2

Product data sheet

Specifications



Circuit breaker frame, MasterPact MTZ2 20N1, 2000A, 42kA/440VAC 50/60Hz (Icu), 3P, drawout, without control unit

LV848286

Main

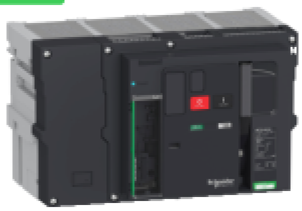
Range	Masterpact
Product name	MasterPact MTZ2
Device short name	MTZ2 20 N1
Product or component type	Circuit breaker
Device application	Protection
Poles description	3P
Network type	AC
Network frequency	50/60 Hz
Breaking capacity code	N1
Suitability for isolation	Yes conforming to IEC 60947-2
Selectivity category	Category B

Complementary

Control type	Push-button
Mounting mode	Drawout
Mounting support	Rails Base plate
[In] rated current	2000 A at 40 °C
[Ui] rated insulation voltage	1000 V AC 50/60 Hz conforming to IEC 60947-2
[Uimp] rated impulse withstand voltage	12 kV conforming to IEC 60947-2
[Icm] rated short-circuit making capacity	88 kA 220/415 V AC at 50/60 Hz 88 kA 440 V AC at 50/60 Hz 88 kA 500/525 V AC at 50/60 Hz 88 kA 660/690 V AC at 50/60 Hz
[Ue] rated operational voltage	690 V AC 50/60 Hz conforming to IEC 60947-2
Circuit breaker CT rating	2000 A
Performance level	42 kA Icu at 220/415 V AC 50/60 Hz conforming to IEC 60947-2 42 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 42 kA Icu at 500/525 V AC 50/60 Hz conforming to IEC 60947-2 42 kA Icu at 660/690 V AC 50/60 Hz conforming to IEC 60947-2
[Ics] rated service breaking capacity	42 kA at 220/415 V AC 50/60 Hz conforming to IEC 60947-2 42 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 42 kA at 500/525 V AC 50/60 Hz conforming to IEC 60947-2 42 kA at 660/690 V AC 50/60 Hz conforming to IEC 60947-2

Product data sheet

Specifications



Circuit breaker frame, MasterPact MTZ2 32H1, 3200A, 66kA/440VAC (Icu), 4P, drawout, right Neutral, without control unit

LV848437

Main

Range	Masterpact
Product name	MasterPact MTZ2
Device short name	MTZ2 32 H1
Product or component type	Circuit breaker
Device application	Protection
Poles description	4P
Neutral position	Right
Network type	AC
Network frequency	50/60 Hz
Breaking capacity code	H1
Suitability for isolation	Yes conforming to IEC 60947-2
Selectivity category	Category B

Complementary

Control type	Push-button
Mounting mode	Drawout
Mounting support	Base plate Rails
[In] rated current	3200 A at 40 °C
[Ui] rated insulation voltage	1000 V AC 50/60 Hz conforming to IEC 60947-2
[Uimp] rated impulse withstand voltage	12 kV conforming to IEC 60947-2
[Icm] rated short-circuit making capacity	145 kA 220/415 V AC at 50/60 Hz 145 kA 440 V AC at 50/60 Hz 145 kA 500/525 V AC at 50/60 Hz 145 kA 660/690 V AC at 50/60 Hz
[Ue] rated operational voltage	690 V AC 50/60 Hz conforming to IEC 60947-2
Circuit breaker CT rating	3200 A
Performance level	66 kA Icu at 220/415 V AC 50/60 Hz conforming to IEC 60947-2 66 kA Icu at 440 V AC 50/60 Hz conforming to IEC 60947-2 66 kA Icu at 500/525 V AC 50/60 Hz conforming to IEC 60947-2 66 kA Icu at 660/690 V AC 50/60 Hz conforming to IEC 60947-2
[Ics] rated service breaking capacity	66 kA at 220/415 V AC 50/60 Hz conforming to IEC 60947-2 66 kA at 440 V AC 50/60 Hz conforming to IEC 60947-2 66 kA at 500/525 V AC 50/60 Hz conforming to IEC 60947-2

Appendix H:

Data sheet of Earth Cable

Click here for more information:
elandcables.com | UX 0.6/1kV Earth Cable

ELAND® CABLES

UX 0.6/1kV Earth Cable

Eland Product Group: ASH

APPLICATION

Insulated conductor for earthing and bonding services. MUD resistant in accordance with NEK TS 606.

CHARACTERISTICS

Voltage Rating Uo/U
0.6/1kV

Temperature Rating
+90°C

CONSTRUCTION

Conductor
Class 2 stranded tinned copper conductor

Insulation
SHF2 compound

Insulation Colour
Green/Yellow

STANDARDS

NEK 606

ISO/IEC 17025 LABORATORY TESTED

This product is subject to the Quality Assurance protocols of The Cable Lab®, an ISO/IEC 17025 accredited cable testing laboratory. Testing includes vertical flame, conductor resistance, tensile & elongation, and dimensional consistency, verified to published standards and approved product drawings.

REGULATORY COMPLIANCE

This cable meets the requirements of the RoHS Directive 2011/65/EU. RoHS compliance has been tested and confirmed by The Cable Lab® as meeting the requirements of the BSI RoHS Trusted Kitemark™.

Appendix I:

Data sheet of EARTH ELECTRODES

> EARTH ELECTRODES, GROUND ENHANCING PRODUCTS AND EARTH PITS

> 254 µm COPPERBOND EARTH RODS

Aplicaciones Tecnológicas, S.A. uses copperbond earth rods of a high quality which comply with even the most demanding regulations in order to achieve long-lasting earthing. All these earth rods are electrolytically coated with copper which is 254 µm thick and 99.9% pure, with a proven resistance to corrosion. This type of electrolytic coating prevents cracks or fissures, which may be caused in the outer layer of the earth rods with mechanical coating.

Numerous regulations specify that the copper coating on the copperbond earth electrodes should be at least 250 µm:

- BS 7430: Implementation guide for earthing systems (Great Britain)
- UL 467: Grounding and bonding equipment (United States)
- Section 250 of National Electrical Code (NEC) (United States)
- Technical Guide for implementing no. 18 of the Spanish Low Voltage Electrotechnical Regulations
- IEC 62305-3 (international lightning protection standard)
- EN 50164 (IEC 62561-2 (international standard on components of lightning protection systems)

Using the appropriate accessories, threaded copperbond earth rods enable the electrode to extend in order to obtain better earth resistances.

INSTALLATION

The electrodes should be placed at a depth of at least 50 cm.
It is preferable to use several conductors conveniently spread out rather than one very long conductor.
In the case of an earthing system made up of various interconnected electrodes, it is recommended that:

> The buried earth rods must be placed in a triangle or line and spaced out at a distance of at least that of their buried depth.

> The buried earth rods are connected by an identical or compatible conductor to the one used for the down-conductor.

> The conductor joining the earth rod should be buried at a depth of at least 50 cm.

> Apply the ground enhancing product CONDUCTIVER PLUS (AT-010L) to the buried electrodes in order to obtain a lower earth resistance.

Reference	Dimensions (mm)	Ø minimum (mm)	Shape	Weight (kg)
AT-076H	Ø16 x 1200	14.23	Two 5/8" threads	1.50
AT-077H	Ø16 x 1500	14.23	Two 5/8" threads	1.90
AT-078H	Ø16 x 1800	14.23	Two 5/8" threads	2.28
AT-041H	Ø16 x 2000	14.23	Two 5/8" threads	2.53
AT-016H	Ø16 x 2400	14.23	Two 5/8" threads	3.00
AT-098H	Ø16 x 3000	14.23	Two 5/8" threads	3.80
AT-069H	Ø14,23 x 1200	14.23	No thread	1.50
AT-071H	Ø14,23 x 1500	14.23	No thread	1.90
AT-053H	Ø14,23 x 1800	14.23	No thread	2.28
AT-072H	Ø14,23 x 2000	14.23	No thread	2.53
AT-026H	Ø14,23 x 2400	14.23	No thread	3.00
AT-043H	Ø14,23 x 3000	14.23	No thread	3.80
AT-086H	Ø19 x 1200	17.28	Two 3/4" threads	2.15
AT-087H	Ø19 x 1500	17.28	Two 3/4" threads	2.75
AT-017H	Ø19 x 1800	17.28	Two 3/4" threads	3.27
AT-042H	Ø19 x 2000	17.28	Two 3/4" threads	3.62
AT-018H	Ø19 x 2400	17.28	Two 3/4" threads	4.35
AT-019H	Ø19 x 3000	17.28	Two 3/4" threads	5.44
AT-079H	Ø17,28 x 1200	17.28	No thread	2.15
AT-081H	Ø17,28 x 1500	17.28	No thread	2.75
AT-027H	Ø17,28 x 1800	17.28	No thread	3.27
AT-082H	Ø17,28 x 2000	17.28	No thread	3.62
AT-028H	Ø17,28 x 2400	17.28	No thread	4.35
AT-029H	Ø17,28 x 3000	17.28	No thread	5.44
Complies with BS 7430, UL 467, IEC 62305, EN 50164 (IEC 62561), NFPA 780, UNE 21186, NF C 17-102				

Other copper thickness also available. Please contact us.

APPLICATION AT-041H

> ACCESSORIES FOR COPPERBOND EARTH RODS

Reference	Denomination	Dim. (mm)	Material	Weight(g)
AT-002K	5/8" threaded coupling (Ø16 mm)	Ø19 x 70	Gunmetal	124
AT-003K	5/8" threaded driving stud (Ø16 mm)	54 x 22	Stainless steel	60
AT-004K	Threaded clamp 3/4" (Ø19 mm)	Ø24 x 70	Gunmetal	192
AT-005K	Threaded driving stud 3/4" (Ø19 mm)	54 x 25	Stainless steel	130
Complies with EN 50164 (IEC 62562), BS EN 1982				

Appendix J:

BOQ-Hotel

Item	Item Description	Quantity	Unit	Rate: USD($)	Amount: USD($)
	<u>ELECTRICAL WORKS</u>				
	Supply and install the complete Electrical Installation as indicated on drawings, strictly in accordance with general and particular specification, including but not limited to the following items:				
	Incoming supply in accordance with specifications and Authority requirements :				
A	HT & LT cables by supplying and installing UPVC sleeves, and cable trays in a complete route from entry point up to RMU, Transformers and to MDB's	1	L.S.	$285,714	$285,714
	Main Low Voltage Distribution Boards				
A	LVP - 1.	1	No	$42,857	$42,857
B	LVP - 2.	1	No	$42,857	$42,857
C	LVP - 3.	1	No	$42,857	$42,857
D	MDB-AC	1	No	$22,857	$22,857
E	MDB-EM	1	No	$18,571	$18,571
	Power Factor Capacitor Bank				
A	Capacitor Bank 400 kVAr.	1	No	$25,714	$25,714
	Automatic Change Over Switch				
A	800A 4P ATS.	1	No	$10,000	$10,000
	<u>Sub-Main Distribution Boards (SMDB)</u>				
A	SMDB-1 SER.	1	No	$6,857	$6,857
B	SMDB-2 SER.	1	No	$5,143	$5,143
C	SMDB-REST	1	No	$9,429	$9,429
D	SMDB-GF	1	No	$6,000	$6,000
E	SMDB-PARK.	1	No	$4,286	$4,286
F	SMDB-PRAY	1	No	$5,143	$5,143
G	SMDB-(1ST to 15TH) FLR	15	No	$6,857	$102,857
H	SMDB-16TH FLR	1	No	$5,143	$5,143
I	SMDB-17TH FLR	1	No	$5,143	$5,143
J	SMDB1-ROOF FLR	1	No	$5,143	$5,143
K	SMDB2-ROOF FLR	1	No	$7,714	$7,714
L	SMDB-1.EM	1	No	$7,714	$7,714
M	SMDB-2.EM	1	No	$6,000	$6,000
N	SMDB-3.EM	1	No	$6,857	$6,857
O	MCC	1	No	$6,000	$6,000

	Distribution Boards (SMDB)				
A	DB-GF.	1	No	$686	$686
B	DB-MEZZ.	1	No	$686	$686
C	DB-SHOP-1	1	No	$686	$686
D	DB-SHOP-2	1	No	$686	$686
E	DB-G.PRAYER	1	No	$686	$686
F	DB-L.PRAYER	1	No	$686	$686
G	DB-IT	1	No	$686	$686
H	DB-SERV.	1	No	$686	$686
I	DB-LAUNDRY	1	No	$686	$686
J	DB-S-KIT.	1	No	$686	$686
K	DB-REST.	1	No	$686	$686
L	DB-KIT. At SER. FR	1	No	$686	$686
M	DB-OFFICE	1	No	$686	$686
N	DB-M.MAJ	1	No	$686	$686
O	DB-WM.MAJ	1	No	$686	$686
P	DB-1st PAR.	1	No	$686	$686
Q	DB-2nd PAR.	1	Nos	$686	$686
R	DB-3rd PAR.	1	Nos	$686	$686
S	DB-FLT.1 (1st TO 16th) FLR	16	Nos	$686	$10,971
T	DB-FLT.2 (1st TO 16th) FLR	16	Nos	$686	$10,971
U	DB-FLT.3 (1st TO 16th) FLR	16	Nos	$686	$10,971
V	DB-FLT.4 (1st TO 16th) FLR	16	Nos	$686	$10,971
W	DB-FLT.5 (1st TO 15th) FLR	15	Nos	$686	$10,286
X	DB-FLT.6 (1st TO 15th) FLR	15	Nos	$686	$10,286
Y	DB-FLT.7 (1st TO 15th) FLR	15	Nos	$686	$10,286
Z	DB-FLT.8 (1st TO 15th) FLR	15	Nos	$686	$10,286
AA	DB-FLT.9 (1st TO 15th) FLR	15	Nos	$686	$10,286
AB	DB-FLT.10 (1st TO 15th) FLR	15	Nos	$686	$10,286
AC	DB-FLT.11 (1st TO 15th) FLR	15	Nos	$686	$10,286
AD	DB-FLT.12 (1st TO 15th) FLR	15	Nos	$686	$10,286
AE	DB-FLT.13 (1st TO 15th) FLR	15	Nos	$686	$10,286
AF	DB-FLT.14 (1st TO 15th) FLR	15	Nos	$686	$10,286
AG	DB-FLT.15 (1st TO 15th) FLR	15	Nos	$686	$10,286
AH	DB-FLT.16 (1st TO 15th) FLR	15	Nos	$686	$10,286
AI	DB-FLT.17 (1st TO 15th) FLR	15	Nos	$686	$10,286
AJ	DB-FLT.18 (1st TO 15th) FLR	15	Nos	$686	$10,286
AK	DB-(1F TO 17F)	17	No	$686	$11,657
AL	DB-G.EM	1	No	$686	$686
AM	DB-(1F TO 17F)	17	No	$686	$11,657
AN	DB-G.EM	1	No	$686	$686
AO	DB-MEZZ.EM	1	No	$686	$686
AP	DB-1st PAR.EM	1	No	$686	$686
AQ	DB-2nd PAR.EM	1	No	$686	$686
AR	DB-3rd PAR.EM	1	No	$686	$686
AS	DB-REST.EM	1	No	$686	$686
AT	DB-SER. EM.	1	No	$686	$686
AV	DB-IT.EM.	1	No	$686	$686
AW	DB-1.FF EM. (1st TO 15th) FLR	15	Nos	$686	$10,286
AX	DB-2.FF EM. (1st TO 15th) FLR	15	Nos	$686	$10,286
AY	DB-16F EM.	1	No	$686	$686
AZ	DB-17F EM.	1	No	$686	$686
BB	DB-ROOF	1	No	$686	$686

	Busbar Trunking Systems (BusWays)				
A	1600 A BUS BAR.	1	Set	$250,000	$250,000
B	1250 A BUS BAR.	1	Set	$250,000	$250,000
B	630 A BUS BAR.	2	Set	$230,000	$460,000
C	100 A TAP OFF UNIT	19	Nos	$10,000	$190,000
	Feeding Cables				
A	3X1.5mm2 N2XY/XLPE Cable	2,450	m	$10	$24,304
B	3X2.5mm2 N2XY/XLPE Cable	2,000	m	$11	$22,080
C	3X4mm2 N2XY/XLPE Cable	480	m	$20	$9,600
D	3X6mm2 N2XY/XLPE Cable	370	m	$24	$9,058
E	5X1.5mm2 N2XY/XLPE Cable	900	m	$20	$18,000
F	5X2.5mm2 N2XY/XLPE Cable	350	m	$25	$8,736
G	5X4mm2 N2XY/XLPE Cable	932	m	$30	$27,587
H	5X6mm2 N2XY/XLPE Cable	630	m	$34	$21,571
I	5X10mm2 N2XY/XLPE Cable	450	m	$44	$19,800
J	5X16mm2 N2XY/XLPE Cable	420	m	$53	$22,176
K	4X25mm2 N2XY/XLPE+1C 16mm2 GY Cu PE Cable	150	m	$63	$9,456
L	4X35mm2 N2XY/XLPE+1C 16mm2 GY Cu PE Cable	86	m	$72	$6,192
M	4X50mm2 N2XY/XLPE+1C 25mm2 GY Cu PE Cable	50	m	$78	$3,912
N	4X95mm2 N2XY/XLPE+1C 50mm2 GY Cu PE Cable	80	m	$87	$6,976
O	4X120mm2 N2XY/XLPE+1C 70mm2 GY Cu PE Cable	75	m	$97	$7,272
P	4X150mm2 N2XY/XLPE+1C 70mm2 GY Cu PE Cable	95	m	$111	$10,564
Q	4X185mm2 N2XY/XLPE+1C 95mm2 GY Cu PE Cable	90	m	$125	$11,290
R	4X300mm2 N2XY/XLPE+1C 150mm2 GY Cu PE Cable	50	m	$140	$6,976
	ISOLATOR				
A	2500 AT/3200AF, ACB	1	Nos	$3,000	$3,000
B	2000 AT/2500AF, ACB	1	Nos	$3,000	$3,000
C	1600 AT/2000AF, ACB	2	Nos	$3,000	$6,000
D	1250 AT/1600AF, ACB	1	Nos	$3,000	$3,000
E	450 AT/500AF, MCCB	9	Nos	$2,500	$22,500
F	350 AT/400AF, MCCB	9	Nos	$2,400	$21,600
G	160 AT/250AF, MCCB	5	Nos	$2,300	$11,500
H	100 AT/160AF, MCCB	18	Nos	$2,200	$39,600
I	63 AT/100AF, MCCB	1	Nos	$2,000	$2,000
	Small Power Points				
A	points such as radial/ring ckt for 16 amps 3pin socket outlet & DP Switches for water heater wired	3,720	Nos	$75	$279,000
	Wiring Accessories				
A	16A Single, switched socket outlet.	1,800	Nos	$49	$87,429
B	16A Double switched socket outlet.	115	Nos	$50	$5,750
C	16A Single switched Socket Outlet, Weather Proof.	50	Nos	$86	$4,286
D	16A Universal socket outlet.	394	Nos	$57	$22,514
E	16A Data Point.	35	Nos	$114	$4,000
F	Flex outlet for Hair Dryer.	295	Nos	$114	$33,714
G	Flex outlet for Hand Dryer.	18	Nos	$86	$1,543
H	Flex outlet for FCU.	375	Nos	$86	$32,143
I	Shaver socket outlet.	295	Nos	$86	$25,286
J	TV. Outlet	370	Nos	$86	$31,714

	Light Points				
A	Points including conduit , PVC boxes , G.I boxes and single core wires and all associated work to complete the job as per specifications and drawings.	6,270	Nos	$57	$358,286
B	One Gang One Way, Light Switch, 10A.	655	Nos	$30	$19,650
C	Two Gang One Way, Light Switch, 10A.	660	Nos	$30	$19,800
D	Three Gang One Way, Light Switch, 10A.	60	Nos	$30	$1,800
E	One Gang Two Way, Light Switch, 10A.	15	Nos	$30	$450
F	Multi Gang Switch panel.	17	Nos	$86	$1,457
G	Motion Detector.	200	Nos	$86	$17,143
H	Light push button switches for stair cases, 10A.	80	Nos	$171	$13,714
I	Light Control Panel	25	Nos	$86	$2,143
	Light Fittings:				
	Fix only of the following light fixtures				
A	Type (F1)	55	Nos	$186	$10,214
B	Type (F2)	195	Nos	$171	$33,429
C	Type (F3)	175	Nos	$129	$22,500
D	Type (F4)	70	Nos	$129	$9,000
E	Type (C2)	2,320	Nos	$143	$331,429
F	Type (C5)	1,395	Nos	$143	$199,286
G	Type (C6)	25	Nos	$200	$5,000
H	Type (C7)	20	Nos	$286	$5,714
I	Type (C8)	195	Nos	$171	$33,429
J	Type (W1)	5	Nos	$171	$857
K	Type (W2)	35	Nos	$286	$10,000
L	Type (W3)	430	Nos	$229	$98,286
M	Type (B1)	1,335	Nos	$714	$953,571
N	Type (FL)	15	Nos	$571	$8,571
	Telephone System:				
	Maintain a complete Telephone System as per Bezeq regulation including all necessary cabling and terminations				
A	MTR	1	No	$42,857	$42,857
B	IDF	25	No	$4,286	$107,143
C	Telephone Outlet (Voice), RJ-45	626	No	$100	$62,600
D	Dual Outlet (Data & Voice), RJ-45	555	No	$100	$55,500
E	ONU	282	No	$114	$32,229
F	60 x 60 x 80 Manhole with grade "A" cover	1	No	$286	$286
	Cable Tray Risers:				
A	Cable Tray size 450 x 50 mm	2,845	m	$29	$81,286
B	Cable Ladder size 300 x 50 mm	100	m	$23	$2,286
C	Cable Ladder size 200 x 50 mm	100	m	$21	$2,143
D	1C x 16 mm^2 , PVC / Copper Cable.	80	m	$3	$274
E	Earth Pit	2	No	$2,857	$5,714
F	Earth Bar 50 x 2.5 x 1 cm	1	No	$143	$143

	Fire Alarm System:				
A	Addressable Fire Alarm Control Panel (Master)	1	No	$10,857	$10,857
B	Smoke Detector With Built in Sounder	345	No	$129	$44,357
C	Smoke Detector	425	No	$114	$48,571
D	Heat Detector With Built in Sounder	26	No	$129	$3,343
E	Heat Detector	44	No	$114	$5,029
F	Manual Break glass	67	No	$129	$8,614
G	Weather Proof Manual Break glass	13	No	$200	$2,600
H	Weather Proof Speaker with Built-in Flasher	16	No	$200	$3,200
I	Speaker with Built-in Flasher	75	No	$200	$15,000
J	Celling Speaker	203	No	$86	$17,400
K	Fire mnn Telephone	74	No	$114	$8,457
L	Voice Evacuation Control Panel	1	No	$857	$857
M	Interface unit	30	No	$571	$17,143
N	Emergency Light	565	No	$29	$16,143
O	Exit Light	196	No	$171	$33,600
	Standby Diesel Generator Set:				
A	500KVA stand by generator with complete installation including all necessary pipes and insulation …etc	1	Set	$175,000	$175,000
	Earthing System:				
A	earth point for MDB body with at least 3 meters long copper rod in 300x300x300 mm earth pit with inspection cover complete in all aspects.	3	No	$5,714	$17,143
B	2X150 mm2 copper conductor in 32 mm diameter UPVC pipe as earth leads between MDB body and earth pit complete with clamps and accessories.	50	m	$50	$2,500
	Miscellaneous:				
A	Car Gate Barrier System.	1	item	$30,000	$30,000
B	Access Control System.	1	item	$35,000	$35,000
C	CCTV System.	1	item	$45,000	$45,000
D	BMS System.	1	item	$300,000	$300,000
E	Central Battery Emergency Lighting System including wiring & CBU-Monitor and investors (including Emergency & exit lights as per Civil Defense Approval)	1	item	$90,000	$90,000
F	Lightning Protection System for the building structure complete with Air Terminal Networks, Earth Termination Networks, Down Conductors, Air Rods, Tapes and all necessary accessories inclusive of bonds, brackets, cable clips, saddles, clamps, couplings, waterproof earth pits, etc.	1	item	$85,000	$85,000
G	INTERCOM system.	1	item	$38,000	$38,000
Total Estimated Cost for Hotel Electrical Works ($)					**$6,569,331**