Design and Analysis of Electrical System for Orient Hotel (Myanmar)

PWINT PHYU THAE[1], SOE SOE THAN[2], AYE MAR OO[3], AYE AYE THAET[4]
[1, 2, 3, 4] *Department of Electrical Power Engineering, Technological University (Sagaing)*

Abstract- Lighting design is fundamental to the success of any building. This paper is about the design and analysis of electrical system for a hotel. This paper aims to know electrical system for all rooms, common areas and other places of hotel which are important to require light, socket outlets and other electrical equipments for the safety. The paper describes the basic lighting theory and illumination system, design and calculation, choice of the cable size, circuit breaker size and selection of light source fitting, earthing system and lightning protection system for a hotel. In this paper, selection of light sources and switch socket outlets, design calculations of illuminance levels and numbers of fittings to know modern wiring installation for Orient Hotel are described.

Indexed Terms- Room Index, Utilization Factor, Lighting Layout Design, Power Layout Design, Total Power

I. INTRODUCTION

Electrical system is fundamental for the success of any building. For all building construction or remodeling building projects, the owner or occupant must first have a concept for the new design, and then the architect or designer can produce a set of building plans. These plans convey all the required information to the local inspection authority and associated building trades so that the construction or remodeling can take place. Because commercial and industrial building contain a number of electrical systems, these plans include specific electrical designs and additional documentation to verify that the design conforms to all required building codes.

II. ELECTRICAL SYSTEM

1) Creating the Electrical Plan

- Interior electrical power plan
- Interior lighting plan
- Exterior electrical site plan
- Documentation (such as panel schedules, electrical calculation, single line diagrams, and lighting system energy requirements)

2) Lighting System

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.

Light is the prime factor in the human life as all activities of human beings ultimately depend upon the light. Where there is no natural light, use of artificial light is made. Artificial lighting is produced electrically, on account of its cleanliness. Ease of control, reliability, steady output, as well as its low cost, is playing an increasingly important part in modern everyday life. Apart from its aesthetic and decorative aspects, good lighting has a strictly utilitarian value in increasing production, reducing workers fatigue, protecting their health, eyes and nervous system, and reducing accidents [2].

3) Lighting Layout Plan

Lighting layout plan includes lighting, switches and switching layout. There are many kind of rooms such as living room, bedroom, dining room, kitchen, common area, study room and etc. This kind of rooms are not same necessary lighting lux levels for (living room - 300lux, common area - 150lux, dining area - 500lux, working area - 700lux,study area - 700lux, bed room - 100lux, kitchen area - 700lux).This lighting lux levels are shown in Myanmar National Building Code (MNBC) part 5A.

4) Interior Lighting Levels

The elements to be considered are:

- the class of room and the service for the illumination is required,
- the luminaries best suited for the service,
- the effect of the colour, and
- The reflection of ceilings and walls together with intensity, distribution, diffusion, colour, intrinsic brightness, glare, shadow, and the like.

5) Lighting Schemes

The lighting scheme may,

- provide adequate illumination,
- provide light distribution all over the work plane as uniform as possible,
- provide light of suitable colour and
- avoid glare and hard shadows as far as possible

The following factors are required to be considered while designing the lighting scheme.

- Illumination level
- Uniformity of illumination
- Colour of light
- Shadows
- Glare
- Mounting height
- Spacing of luminaires
- Colour of surrounding walls [3]

6) Light Sources

Modern light sources are based on one of the following methods of light generation.

- Temperature radiation
- Gas discharge
- Fluorescence [4].

7) Selection of Equipment for Electrical Light Sources

The choice of source for public lighting is guided by the following considerations:

- Luminous flux,
- Economy (determined lumens/watt and life),
- Dimensions of the light sources, and
- Colour characteristics.

The sources normally used in public lighting are;

- Incandescent lamps,
- Mixed incandescent and high pressure mercury vapour lamps,
- High pressure mercury vapour lamps
- Tubular fluorescent lamps,
- Mercury-halide lamps and
- High pressure sodium vapour lamps [1].

8) Measurement of Illumination

As a measurement of quantity use is generally made of concept illumination, expressed in lux units measured at the working surface. For the sake of uniformity in executing the projects, recommendations for the required illumination are essential and are in fact generally applied. Presented in the form of table, values of illuminance state clearly what illumination is required in a given situation.

When using the table, it should be remembered that the visual organs is designed by nature to perceive at illumination values arising out of natural day light. These usually vary from several thousand lux to maximum of 100,000 lux. Moreover, indoors the visual organ is relatively and severely tested; smaller objects must be perceived over longer periods of time than are required out of doors.

The visual acuity of the human being increases as the level of illumination rises; as the latter increases it becomes possible to see smaller objects and perceive large ones with less effort. It is not until a level of 10,000 to 20,000 lux has been reached that visual acuity attains its maximum and the visual organ functions under the most favourable conditions and with the least effort [5].

9) Characteristics of the Illumination

It is not just the light source which determines the character of the illumination; walls and ceilings contribute their share by reflection, which consists mostly of diffuse light. The greater this contribution, the less directional the light will be. The illumination system and the reflection from the ceiling and walls are decisive.

Directed light is characterised by strong shadows, an image rich is contrasts and very plastic effect. By means of directed light, shadows and glow come into being and make contours and shapes of objects clearly visible and easily recognizable. Shadows are characterised by depth (that is to say darkness) and hardness.

For most application, lighting must be tolerably diffuse with directional lighting as a complementary source. The direction of incidence of complementary directional lighting determines the location of shadows and lights. This should be given sufficient attention because the wrong directional incidence cause either direct or indirect glare on the object of vision [5].

III. WIRING AND INSTALLATION SYSTEM

1) Types of Wiring System

According to requirement and suitability, wiring can be classified into indoor wire and outdoor wire. Wiring carried out inside the premises is known as indoor wiring and outside the premises is known as outdoor wiring. Indoor wiring is residential-office and outdoor wiring is flood light wiring. Another method of classification of wiring is concealed wiring and open or exposed wiring. In concealed wiring about 90 percent wiring accessories are inside the wall or floor but in exposed or open wiring, most of the wiring accessories are seen outside.

According to the method of connection adopted in a wiring system wiring can also be classified into tee system of connection and loop back system of connection. In the loop back system, the connection leads to the controlling devices which are incoming terminals to the next point. Generally, for wiring of residential buildings and office buildings, loop back systems of connection are adopted. Wiring systems may be classified as permanent wiring and temporary wiring. Another classification of wiring system is of industrial wiring and non-industrial wiring. Wiring of residential buildings, hostels, office buildings, multi-storage building come under non-industrial wiring, generating station wiring etc, and come under industrial wiring [1].

2) Choice of Wiring System

In deciding the type of wiring system for a particular installation, many factors have to be taken into consideration; amongst these are:

- Whether the wiring is to be installed during the construction of a building, in a completed building, or as an extension of an existing system
- Capital outlay required
- Planned duration of installation
- Whether damp or other adverse conditions are likely to exist
- Type of building
- Usage of building
- Likelihood of alterations and extensions being frequently required.

3) Electrical Installation

Whatever type of electrical equipment is installed, it has to be connected by means of cables and other types of conductors, controlled by suitable switchgear. This is the work which is undertaken by the installation engineer, and no equipment, however simple or elaborate, can be used with safety unless this installation work has been carried out correctly.

There was very little planning of wiring installations in those early days, but now, with supplies from the grid, very large sources of power are introduced into all premises which use electricity, and proper planning and design have become essential.

When planning an installation there are many things which must be taken into account: the correct sizes of cables, suitable switchgear, current rating of overcurrent devices, and the number of outlets which may be connected to a circuit and so on.
The regulations governing installation work can be divided into two categories: statutory regulations and non-statutory regulations.

4) Components of Electrical System

Components of electrical system are light,wire cable, circuit breaker, switches, switch socket outlet, isolator, earth-leakage circuit breaker, transformer, lightning arrester, lightning rod, earthing electrodes.

5) Main Switchboard

In case of main switchboard check and ensure that

- The voltage available is correct.(i.e. within permissible limits of decleared voltage.)
- The main switch is provided close to the point of commencement of supply.

- The fuse of corrected size is provided on the live pole.
- The main switch is easily identified and is easily accessible so that in case of emergency the entire supply to the building can be switched off at once.
- There is a clear working space all-round the board (as mentioned in IE rule 51 i.e. 0.914 metres).
- The phase and neutral wires are clearly marked for identification.
- Caution notice in Hindi or other local language is placed [1].

6) Distribution Boards

The distribution board is an assembly of parts, including one or more fuses or circuit breakers, arranged for the distribution of electrical energy to various circuits or other distribution boards known as submain distribution boards. The boards are usually metal-cased in sheet steel or hard wood-cased in oak or teak. The door may be solid or glazed. The earthing terminal and locking arrangement are invariably provided. The number of ways depends upon the circuits or sub-circuits to be fed. Separate distribution fuse boxes should be provided for light and power circuits. Some manufacturers combine linked switch and distribution boards [1].

7) Lightning protection system

There are three method of lightning protection system. These are following as;

- Angle method – method to determine position of air termination system protection angle method.
- Rolling sphere method-method to determine position of air termination system separation distance; distance between conductive parts where know dangerous parking (flash over) can occur.
- Wire mesh method-method to determine position a mesh on top of a roof of the structure or by creating a mesh with wires at certain distance.

8) Earthing System

A good earthing system is required for:

- protection of buildings and installations against lightning
- safety of human and animal life by limiting touch and step voltages to safe values
- electromagnetic compatibility (EMC) i.e. limitation of electromagnetic disturbances
- Correct operation of the electricity supply network and to ensure good power quality.

9) Testing of Wiring Installations

The test to be performed before a new installation or an addition to existing installation is connected to the supply mains are:

- The insulation resistance between the wiring and earth with all fuses and lamps in and all switches 'on'.
- The insulation resistance between the conductors with all lamps out and all switches 'on'.
- Testing of polarity of non-linked single pole switches.
- Testing of earth continuity path.
- Testing of earth resistance [1].

10) Methods for Lighting Calculation

A number of methods has been employed for lighting calculations, among which three common methods are mentioned.

- Watts per square meter method
- Lumen or light flux method
- Point to point or inverse-square law method

11) Determination of Size of Conductor

There are three points which must be taken into account, while determining the size of conductor for internal wiring for a given circuit [1].

- Minimum size mainly for mechanical reasons
- Current carrying capacity
- Voltage drop

IV. DESIGN AND CALCULATION

1) Essential Factors for Determination of Interior Lighting Layout

There are four essential factors for determination of interior lighting-layout. These factors are described as the following:

a. Room index
b. Utilization factor
c. Maintenance factor
d. Room Reflectances
e. Average Illuminance

a) Room Index

Room index is the ratio of room plan area to half the wall area between the working and luminaire planes.

Room Index = (1)

Where, l = the Length of the room

h = the Height of the luminaries above the working plane

w = the Width of the room

b) Utilization Factor(UF)

Utilization Factor (UF) is the proportion of the luminous flux emitted by the lamps which reaches the working plane. It is a measure of the effectiveness of the lighting scheme. Factors that affect the value of UF are as follows:

- lighting output ratio of luminaire
- fiux distribution of luminaire
- room proportions
- room reflectances
- spacing/mounting height ratio

c) Maintenance Factor (Light Loss Factor)

Light loss factor (LLF) is the ratio of the illuminance produced by the lighting installation at the some specified time to the illuminance produced by the same installation when new. It allows for effects such as decrease in light output caused by

- the fall in lamp luminous flux with hours of use,
- the deposition of dirt on luminaire, and
- reflectances of room surfaces over time.

d) Room Reflectances

The room is considered to consist of three main surfaces:

- the ceiling cavity,
- the walls, and
- The floor cavity (or the horizontal working plane).

e) Average Illuminance

Average illuminance of the interior lighting system can be calculated by applying the following Equation 4.2.

E = (2)

Where,

E = Average illuminance or required illuminance (lux)

F = Lamp luminous flux (Lm) for one fitting

N = Number of fitting (sets)

UF = Utilization factor

LLF = Maintenance factor

A = Area of surface (m2)

2) Layers of Orient Hotel

The orient hotel is designed with four layers. They are

- Basement Floor
- Ground Floor
- Typical First to Fifth Floor
- Roof Floor

3) Design and Calculation Result of Lighting Layout Plan

Figure .1 Lighting Plan for basement Floor

Figure. 2 Lighting Plan for Ground Floor

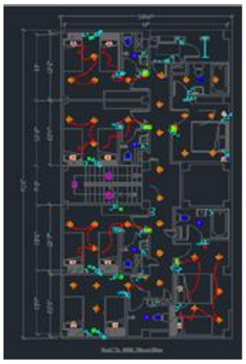

Figure.3 Lighting Plan for Typical First to Fifth Floor

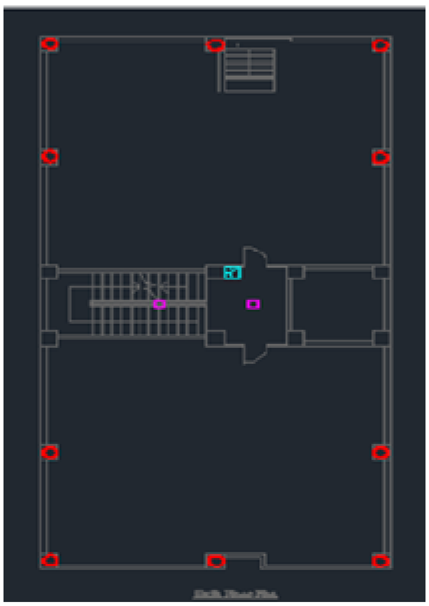

Figure.4 Lighting Plan for Roof Floor

Table .1 Result Data of Lighting Layout Design

Sr.	Room Name	Room Index	U	No. of Fittings (Watt)						E (Lux)	Total Power
				6	18	20	24	36	40		
1	Basement	3.05	0.75	-	-	-	-	-	6	75	240
2	Reception	0.99	0.5	-	-	-	15	-	-	300	360
3	Manager Room	0.7	0.44	-	-	-	8	-	-	300	192
4	Office Room	0.7	0.44	-	-	-	8	-	-	300	192
5	Kitchen	0.7	0.44	-	-	-	-	-	10	700	400
6	Dining Room	0.91	0.5	-	-	-	-	13	-	500	468
7	Buffet Counter	0.53	0.35	-	-	-	-	7	-	500	252
8	Common Passage	0.57	0.35	-	-	-	4	-	-	150	96
9	Common Toilet	0.48	0.35	-	3	-	-	-	-	150	54
10	Control Room	0.34	0.35	-	-	-	-	-	3	700	120
11	Bedroom 1	0.6	0.35	-	4	-	-	-	-	100	72
12	Bedroom 2	0.6	0.35	-	4	-	-	-	-	100	72
13	Bedroom 3	0.6	0.35	-	4	-	-	-	-	100	72
14	Bedroom 4	0.6	0.35	-	4	-	-	-	-	100	72
15	Bedroom 5	0.6	0.35	-	4	-	-	-	-	100	72
16	Bedroom 6	0.7	0.35	-	5	-	-	-	-	100	90
17	Common Passage	0.45	0.35	-	8	-	-	-	-	150	144
18	Stair Case	0.49	0.35	-	-	-	3	-	-	150	72
19	Store & Control	0.38	0.35	-	-	-	4	-	-	300	96
20	Roof	-	-	-	-	10	2	-	-	-	244

4) Design and Calculation Result of Power Layout Plan

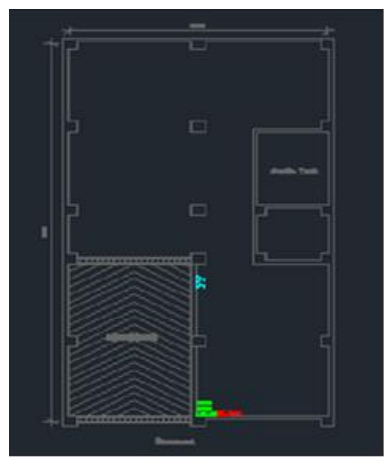

Figure.5 Power layout Plan for Basement Floor

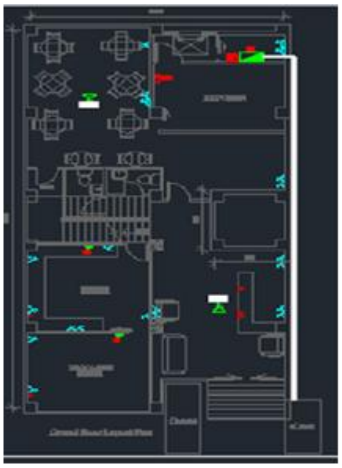

Figure.6 Power layout Plan for Ground Floor

Figure.7 Power layout Plan for Typical First to Fifth Floor

Table.2 Result Data of Power Layout Design

Sr.	Room Name	DF	No. of Fittings(A)		Total Power
			13A	15A	
1	Basement	0.75	2	-	300
2	Reception	0.75	6	1	3138
3	Manager room	0.75	2	1	1046
4	Office Room	0.75	6	1	1646
5	Dining Room	0.75	3	1	2688
6	Kitchen	0.75	-	-	8000
7	Buffet Counter	0.75	2	-	300
8	Control Room	0.75	2	1	1076
9	Bedroom 1	0.75	5	2	3496
10	Bedroom 2	0.75	5	2	3496
11	Bedroom 3	0.75	5	2	3496
12	Bedroom 4	0.75	5	2	3496
13	Bedroom 5	0.75	5	2	3496
14	Bedroom 6	0.75	6	2	4019
15	Common Passage	0.75	3	-	450

Table.3 Results Data of Power Layout Design for Other Load

Sr	Type of Load	No.	HP	Total Power
1	Transfer Pump	1	5	3730
2	Lift Moter	1	10.054	7500
3	Fire Pump	1	1.5	1119
4	Booster Pump	1	1.5	1119
5	Submersible Pump	1	3	2238

5) Main Switch Board, Floor Distribution Boards and Sub-distribution Board Installation

Main Switch Board is divided as eight sub-distribution boards. There are basement DB (DB-B0, ground floor DB (DB-G), first floor DB (DB-FL1), second floor DB (DB-FL2), third floor DB (DB-FL3), fourth floor DB(DB-FL4), fifth floor DB(DB-FL5) and lift DB(DB-Lift). Cable distribution system for Transformer No.2 consists of instruments group.

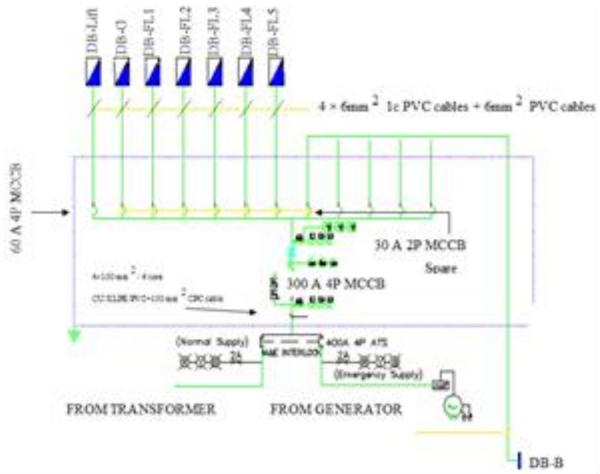

Figure.8 Main Distribution Board Single Line Drawing for Orient Hotel

6) Selection of Transformers

The total power load of Orient Hotel is 153kW.Thus, the actual load is 191.25 kVA and it can be chosen enough the 200 kVA transformer with 11 kV / 0.4 kV, 50 Hz, 0.8 p.f.

V. CONCLUSION

In this paper, results and calculations illustrate that the electrical installation system is suitable topology. In this design, the calculated values of illumination level are nearly round about the standard levels. This paper will provide a means of developing in the design and planning for the preparation of lighting system and wiring distributions. It will require some judgments on the part of the designer to draw the necessary balance. From this paper, technical knowledge and design methods can be contributed regarding lighting, illumination, wiring installation, single drawing.

REFERENCES

[1] J.B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S.K. KATARIA & SONS (Publisher of Engineering & Computer Books), (2012).

[2] Zumtobel Staff, “Lighting Handbook”, 1st Ed., (2004).

[3] “I.E.S.N.A Lighting Handbook”: Reference and Application. Illuminating Engineering Society of North America, (2000).

[4] D.W. Durrant , F. lllum. E.S and T.Eng (CEI). and. “Interior Lighting Design”, 5th Ed., Published jointly by the lighting. Industry Federation Limited and the Electricity Council1, (1977).

[5] H.A.E Keitz, “Light Measurements and Calculations”, Philips Technical Library, Eindhoven, (1952).

[6] www.lightinglab.fi > guidebook > 5 lighting technologies.pdf.com