ELECTRICAL SERVICES DESIGN OF A PROPOSED HOTEL

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DEDICATION

This project is Dedicated to Almighty God, my Dear Parents Engr(chief) and Mrs Ateasi Obadiah Ali and my friend Late Mr Istifanus Tokan.

DECLARATION

I ALI NYANGWARIMAM OBADIAH, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This project examines the Electrical services Design of a proposed Hotel. Electrical services design entails the production of a standard electrical format with a clear view of accessories, equipment and facilities provided in the scheme, on paper prior to the start of actual construction work. The factors that were considered during the design include safety, economy, comfort of the client in selecting and placement of equipment. The number of luminaries in each room depends on the required illumination and other factors such as maintenance factor and utilization factor. Tungsten and fluorescent lamps where commonly used because of their economic value in terms of life span and cost. The loads were properly balanced in the Distribution boards to avoid overloading and fire outbreaks. The fittings were properly placed in accordance to IEE regulation and accessibility to the client.

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CHAPTER ONE

INTRODUCTION

The increasing demand on the available inadequate generated power in Nigeria has raised a serious concern. Therefore there is an urgent need to increase the amount of generated electric power as well as indulge in proper planning so that the increasing load demand can be met. If electricity is not well utilized or designed it can lead to fire outbreaks resulting in the loss of lives and properties. Therefore proper planning ensures the safety of a building as well as its occupants. The planning of electricity in buildings is what is often referred to as electrical services design.

Electrical services design entails the production of a standard electrical format with a clear view of accessories, equipment and facilities provided in the scheme, on paper prior to the start of actual construction work. In electrical services design the concept formulation is based on thoughts, ideas and goals that are gathered from the design brief with respect to the functional and site requirement into a unique parameter based on appreciation, experience not leaving out the needed design criteria. [1]

The focus of this project shall be the electrical services design of a hotel. A hotel is a building or institution which provides various services such as lodging, meals, laundry etc for both traveling and the public alike for financial reward. Proper electrical services engineering is concerned with the provision of utility and environmental comfort for the occupants of the built structure as well as safety and economy for the clients.

The electrical design includes the design of power distribution system, lightning system as well as energy saving. Proper lightening is necessary for the purpose of illumination, display and ambience, safety and security. This study necessitates the provision of lightening to meet various requirements and also to provide an understanding of the various lightening tools available which are responsible for proper visual environment. Energy saving of the electric power shall be put into consideration.

1.1 AIMS AND OBJECTIVES

1. To learn how electrical wiring information is conveyed to the electrician.
2. To develop familiarity with working drawings and specifications, electrical symbols and drawing notation used in standard.
3. To explain how the electrical services design of a hotel will be safe, convenient and economical to the client and environment.
4. To develop familiarity with safety, maintainability and durability in electrical services design.

1.2 PROJECT MOTIVATION

The motivation behind this project is to rise up to the need of quality electrical services design engineers, technological advancement in the field as well as strict adherence to IEE regulations so as to ensure safety of human lives and properties.

1.3 SCOPE OF STUDY

This project shall be limited to the complete electrical services design of a hotel. The design will include power distribution, cabling, lightening for the purpose of illumination, energy saving, etc. The proposed hotel to be electrically serviced has four floors (ground, first, second and third floors) with the following: offices, stores, kitchen, restaurant, bar, about 126 rooms, etc.

Chapter one covers the introduction, chapter two involves the literature review and the theoretical background, chapter three is the theory of designs, chapter four is the design implementation and costing, finally chapter five contains the conclusion and recommendations.

1.4 PROBLEM DEFINITION AND METHODOLOGY:

This project work is an attempt at the design of a complete electrical service for a Hotel.

The design process involves:

1. The development of the working drawing/site layout.
2. The power design.
3. The lighting design.
4. Calculation of the entire load from (2) & (3) above.
5. The cable design.

CHAPTER TWO

LITERATURE REVIEW

The Electrical Age was born in 1881 when Thomas Edison invented the incandescent lamp. Porcelain wiring cleats were not used in the very early days of house wiring. They simply strung insulated-covered wires along the walls using wooden knobs and blocks of wood to attach the wires and ran them to the center of the room to drop a light down from the ceiling. Houses often only had one light bulb per room and only the important rooms had a need for expensive light bulbs. It was more of a novelty. Electricity quickly caught one and prices of bulbs, wiring, and electric power dropped allowing more and more people to afford the luxury of electric light. Wooden cleats, knobs, light bulb holders, and other wooden electrical devices were widely used and often resulted in fires from the early use of electricity.

In less than 10 years it became obvious that electric power and light bulbs were something more than a fad. By 1891, the insurance companies refused to tolerate wooden wiring devices because of the fire hazard. Porcelain wiring devices had to be used to get insurance. The produced a huge demand for porcelain wiring devices with several manufacturers offering to meet the demand. The National Board of Fire Underwriters founded the Underwriters' Laboratories, Inc. (UL) in 1894 to formulate safety standards for the industry and in 1897, the first National Electrical Code was published. [2]

Today, in this twenty-first century, more recent developments in technology shows great improvement in the lighting and power distribution of electricity in various types of buildings.

Electrical service design follows standards that guide the designer to ensure that the IEE regulations are obeyed to ensure safety of lives and properties.

2.1 HISTORY OF STUDY

Mankind has made use of light for thousands of years. From the primitive use of fire to simple oil lamps then to the more sophisticated gas and electric lights that are more familiar to our lifetimes. Before electricity was made available as a means of lighting one's home the most common method was either by candlelight or by gas. All the lights before electricity relied on a flame, which caused problems such as bad smells, uncomfortable heat, dirt or the taking of oxygen from the air. Electricity on the other hand opened up new opportunities [3].

A major practical problem with the development of electric lighting was the need to find a suitable source of electricity that was not expensive. Michael Faraday established the principle of electromagnetic induction in 1831 which led eventually to electric generators that could produce electricity in large quantities at a modest cost. On this discovery scientists were able to experiment with electricity and lighting [3].

The filament lamp was not invented by one person, improvements and experiments were carried out by many. For instance, Joseph Swan and Thomas Edison's joint efforts amalgamated in the Edison and Swan United Electric Light Company Ltd in 1883. It was only until the late 1870s that a practical lamp was created. By the end of the nineteenth century electric lighting usually meant arc lamps for outdoor use and the filament lamp the preferred light for indoors[3]. The initial spread of electricity in Britain was slow and as it was so much more expensive than gas the ordinary person could not afford it. It was not until about 1911, when metal filament lamps had been perfected, that electric lighting became more widely available.

Even by the time of the First World War electric lighting was still enjoyed by the rich minority. It was only until the passing of the Electricity (Supply) Act of 1926 that real progress was made in distribution. This Act set up a Central Electricity Board with the power to standardize the generation of electricity, evenly distribute stations and to create a national grid to connect different sources of supply and extend them to the countryside [3].

Despite the slow start, electric lighting soon became very popular. Some of the more affluent households could not even wait to benefit from the advantages of electric lighting and had them installed before an electric light station was present in their neighborhood. Ignorance however, prevailed as to how electricity actually worked as they were so used to gas and oil lamps. Signs, were placed alongside the fittings to instruct users and to put their minds at ease that the electric lights were in no way injurious to their health [3].

By the 1930s, electric lighting was becoming not only more affordable but more fashionable within the home. Books were published to reflect this trend and to advise the discerning homeowner on how to get the best out of their lighting. [3]

2.2 THEORETICAL BACKGROUND

2.2.1 ILLUMINATION AND LIGHTING SYSTEMS

Light is a form of energy which radiates from a source in a waveform. It is part of a whole family of electromagnetic wave whose wave length is the distance between the peaks of the wave energy. Natural light from the sun or the artificial light from a tungsten lamp has become a very important aspect of human existence. Lighting serves two main functions which are

(i) It helps us to recognize objects as quickly as possible and in sufficient details.

(ii) It helps us to see our surroundings clearly and it contributes to making work places in which we can work or take part in relevant and productive activities safe.

The importance of light to our everyday life cannot be over looked as it plays a vital role in productivity. [3]

2.2.2 LAMP/LUMINARIES

Lamps are devices for obtaining light from electricity on the other hand luminaries are equipments that contain the lamp. The purposes of luminaries are:-

a. Connecting the lamp to the electricity supply.

b. Controlling the light emitted by the lamp

c. Protecting the lamp from a has tile environment

d. Providing a fixture of satisfactory appearance.

The intensity distribution of light from a luminaries dependant on the shape/ design of the luminaries. There are varieties of lamps available to the lighting designer. Since interior lighting design is centered on lamp/ luminaries, the designer must appreciate the kinds of lamp at his disposal.

Lamps can be classified into 3 main categories namely:- incandescent- filament lamp, gaseous discharge lamp, and mercury blended-light lamp.

Conversely this project work shall limit itself to the incandescent lamp and discharge lamp based on the level of illumination needed.[5]

2.2.2.1 INCANDESCENT-FILAMENT LAMPS

In incandescent filament lamps light is produced by means of a filament of carbon, tungsten, or other metals, heated by an electric current. The filament is designed so that it reaches a temperature at which it generates light energy as well as heat energy, which means that the filament glows or is incandescent and hence the lamp is called an incandescent one. The color rendering quality or incandescent lamp emits at continuous spectrum. Incandescent lamps is popularly used in homes and other areas due to its higher efficiency, Longer life span, low initial cost, flexibility in variety of sizes, types and wattage since many of the lamps are interchangeable, adjustment in light pattern and intensity are easily accomplished at any point in time[1].

2.2.2.2 DISCHARGE LAMPS

Discharge lamps depend upon electric discharge in gases and metallic vapors. They usually have much higher luminous efficiencies them filament lamps, upon 100/m/w. the color of the light produced depends upon the type of gas or metallic vapor contained within the tube. They are expensive as Compared to the filament lamps and also a longer life span[1].

2.3 COMMON LIGHTING TERMS

2.3.1 LUMINOUS INTENSITY (SYMBOL I) OR CANDLE POWER

This is a technical term used in describing the strength of a source of light or an illuminating surface which emits light in a given direction. The unit is candela abbreviated as "Cd".

$I = F/w$

Where w = solid angle.

2.3.2 LUMINOUS FLUX (SYMBOL Ø].

This is a technical term for describing the amount of light emitted by a source or received by a surface. It is the light radiated out per second from a body in a form of luminous light waves. It is a sort of power unit

Its unit is the LUMENS (LM)

Let A and d be measured in the same units that is A in square metres and d in metres then amount of light falling on A will be

$$Ø = AI/d^2 \text{ lumens} \qquad (1)$$

If A, I and d were unity then the amount of light will be one lumen. That is one lumen is the luminous flux falling on unit area illuminated by a source with luminous intensity of one candela.[4]

2.3.3 ILLUMINANCE (Symbol E)

This is a measure of the concentration of the light falling on a surface. It is the flow density received on a surface or the luminous flux incident per unit area and is expressed in lux. illuminance E is directly proportional to the luminous intensity (I) of the source and is also inversely proportional to the square of the distance of the surface from the source[4]

2.3.4 LUMINANCE

This is the term used for expressing the intensity of the light emitted in a given direction per unit area of a luminous or reflecting surface. It is expressed in lumens per square meter, that is candela per square metre.[4]

2.3.5 LUMINOSITY

When the eye receives a great of light from an object, it is said to be bright. Brightness is an important quantity in illumination. The term luminosity sometimes referred to as brightness is the visual sensation associated with the amount of light emitted from a given area.[4]

2.3.6 SERVICE ILLUMINANCE

This is the mean illuminance throughout the life of an installation and the average over the relevant area of an installation. This area may be the whole area of a working place in an interior or the area of the visual task and its immediate surroundings. It is expressed in lux. Tables giving the standard service illuminance for different types of working environments have been developed internationally.

The values depend on the type of duty or service being carried out in a working area. The tables showing the typical values for the different types of service or duty are available in IES Handbook, lighting system design catalogue etc.

2.3.7 GLARE

This represents the discomfort or impairment of vision experienced when parts of the visual field are excessively bright in relation to the general surroundings. Glare is caused either by too much light entering the eye from the wrong direction or by something being too bright in relation to other surfaces in the normal field of view. The following are a number of terms used for expressing the amount of glare and these terms include

(i) Disability glare: - the type of glare, prevents the observe from seeing details

(ii) Discomfort glare: - this is the type of glare that causes visual discomfort, but might not impair ability to see details

(iii) Direct glare: - this glare in caused when excessively bright parts of the visual fuels are seen directly.[4]

2.3.8 CO-EFFICIENT OF UTILIZATION (CU)

A portion of the lumen output from the source is lost in the fitting itself while some of the output are directed to the walls and ceilings. The utilization factor dearly slows that the light reaching the working plane to be illumination is reduced and this informs the installation designer to increase the power of the light source in order to achieve the desired lighting and illumination for the working plane.[4]

2.3.9 MAINTENANCE FACTOR (M.F)

Dust and dirt of fittings greatly affect the output of fittings. Thus only a percentage of illumination is obtained from a dusty and installation when compared to a perfectly dean installation. Maintenance factor was put in place to cater for this type of associated problems.

Sometimes, a depreciation factor is given instead of the maintenance factor. This factor is merely the inverse of the MF. Thus

Depreciation factor = 1/maintenance

2.3.10 SPACING AND HEIGHT RATIO

Correct mounting height of fittings is of paramount importance. Incorrect mounting height and spacing could cause glare as excessive height is bound to affect the paramount since the large space between the fitting may result in a fall-off of luminance at the working plane midway between adjacent fittings.

The luminance between the luminaries most not be allowed to fall below 70% of the value directly below the fitting. For electrical service design of hotel, spacing to mounting height ratio of 1: 1, 1:1.2, 1: 1.5 above the working source is considered adequate for the location.

2.4 LIGHT SOURCES

The light output from a source depends on the type of source, as well as configuration. The selection of any lighting source is of great importance in any lighting design. Thus, the selection is made according to their quality by considering the following

(i) Appearance

(ii) Flux procedure

(iii) Heat output

(iv) Light distribution

(v) Life span

(vi) Efficiency

(vii) Brighness

(viii) Shadow effect and incidence of light

(ix) Color properties

(x) Installation cost (economy) consideration

(xi) Cost of power consumed

(xii) Effects of glaring

The order of importance of the above factors depends on their applications; but in most cases light distribution takes precedence over others. For example fluorescent fitting have higher efficiency, save cost of power consumed, generate less heat than the incandescent lamp, but is more expensive to install,

Therefore, in designing an interior lighting system, the choice is always between the incandescent and fluorescent fitting and their advantages and disadvantages are the factors to be considered.[4]

2.5 CABLES

Cable is defined as an electric conductor covered by an insulating substance. This insulating substance is a non conducting material e.g. rubber, PVC, mica etc. The use of cables for electric power transfer is growing rapidly due to its technical advantages over the bare conductor.[3]

The cable consists of conductor made into single or several strands and surrounded by an insulator. The strands are made to form a helix twisting the pitch of which is so adjusted that the whole cross sectional area of the cable is at right angle to its horizontal axis. The strands are so bounded together to form a circular configuration.[3] Cable help us make electrical connections and Electricity is being transmitted via cables to equipments or appliances. The I.E.E regulations stipulates that all cable must be so selected as to be carry their rated currents without deterioration. To this end cables should not be too small so as to have a large internal voltage drop.

2.6 FINAL SUB-CIRCUIT

A final sub-circuit is a circuit which is connected to any way of a distribution fuse board or switch fuse feeding one or more points without the intervention of a further distribution fuse board. There are five types of final sub circuit, which are as follows

1. A sub-circuit with a rated capacity not exceeding 15A.
2. A sub- circuit with a rated capacity exceeding 15A.
3. A sub- circuit feeding 13A fused plugs
4. A sub- circuit feeding florescent and other types of electric discharge Lighting.
5. A sub- circuit feeding a motor or rotating electrical machine.[6]

2.6.1 FINAL SUB- CIRCUITS RATED HIGHER THAN 15A

Planning stages entails the consideration of the following :-

1. final sub- circuits higher them 15A most feed only one point
2. No diversity factor is applicable in these type of circuits
3. Final sub- circuits feeding more than one point should feed points with separate fused plugs protecting individual appliance fed from such plugs.

2.6.2 FINAL SUB-CIRCUITS WITH RATED CAPACITY NOT EXCEEDING 15A.

The planning stages entail the consideration of the following.

a. The choice of optimum member of points with clearance from the consumer.

b. Sub-division of load points into lighting and power circuits.

c. Calculation of anticipated aggregate current demand per point

d. Calculation of total current rating of each final sub-circuit.

e. Choice of cable size with consideration of voltage drop, bunching and ambient temperature.

2.6.3 FINAL SUB-CIRCUIT FEEDING MOTORS

The following should be observed when considering motor circuits.

a. An unlimited number of motors may be connected to a final sub-circuit, the rated capacity of which does not exceed 15A

b. Only one motor may be connected to a final sub- circuit with a rated capacity exceeding 15A.

2.7 ARRANGEMENT OF CIRCUITS

2.7.1 RADIAL CIRCUIT

A radial circuit is a final sub- circuit in which the conductor runs straight from the distribution board to the individual load points.

2.7.2 RING CIRCUIT

A ring circuit is a final sub-circuit in which the conductor runs from distribution boards, through various socket outlets (load points) back to the same terminals of the distribution board, it thus forms a loop connection.

2.7.3 SPUR CIRCUIT

A spur circuit is a branch circuit from a ring circuit. It is a radial circuit taking its source from a socket outlet in a ring circuit.[6]

2.8 ILLUMINATION CALCULATION BY LUMEN METHOD

The lumen method assumes that in a room or working space. The whole output of the lamp in lumen is available to give a fairly uniform level of illumination at the working plane, that is desktops etc. the formula for the calculations can be derived as follows

Let A = Area to be illuminated in m^2

Ea = the desired illuminance in Lm/m^2 (LUX)

Therefore, the total lumens required will be give n as

I = (Ea x A) lumens……………………………………………………………………………(i)

The lumens method considered various aspect of light distribution such as the coefficient of utilization (CU), Absorption factor (Abs), maintenance factor (MF) and the spacing height ratio because 100% efficient lighting system is never possible. Taking the identified factors into consideration, the total lumens required for the room is given as

$$Ø = \frac{E_a}{CU \times MF \times ABS} \quad \text{……………………………………………………(ii)}$$

One of the simplest formulas for obtaining the number of lighting in a lighting system design is given as

$$N = \frac{E_A \times A}{Ø \times MF \times CU} \quad \text{……………………………………………………(iii)}$$

Where Abs is assumed to be unity and Ø is the flux produced per fitting or light output per fitting.

The number of fittings required can be obtained from the formula:

$N = (L \times W) \;/\; (ms)^2$ ……………………………………………………(iv)

Where L = Length of room

W = Width of the room

Ms = Maximum spacing between fittings.

N = Total number of luminance required

E = illuminance level chosen after consideration of IES code

A = the Area

the initial lumens output of each luminaire is (given in manufacturer's specification)

MF = Maintenance factor (light loss factor)

UF = the utilization factor

CHAPTER THREE

THEORY OF DESIGN

3.1 SITE DESCRIPTION

This project involves a proposed hotel to be built in Enugu state. The building consists of four floors with 126 rooms which contains the following spaces; Entrance hall, Restaurant, Bar, Salon, Offices, Rooms, Kitchen, Conference hall, Conference Room, Toilets etc.

The below diagram depicts the representation of the electrical services design process into the Hotel.

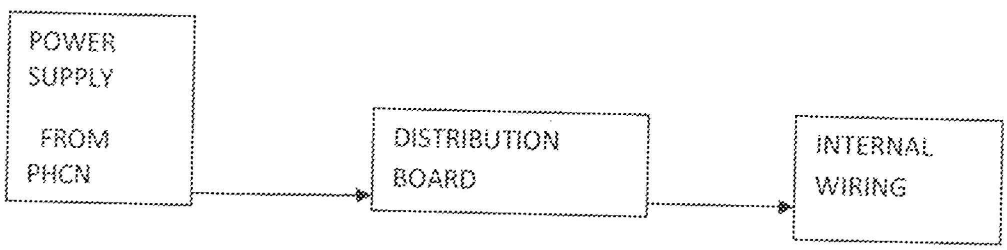

Fig 3.1 BLOCK DIAGRAM SHOWING THE POWER DISTRIBUTION

3.2 POWER DISTRIBUTION

3.2.1 INCOMING POWER SUPPLY

The main electricity supply into the hotel from Power Holding Company of Nigeria (PHCN) passes through the main switch to the distribution board containing fuses, earth leakage circuit breaker and overload equipments.

The IEE regulation has definite rules guiding final sub-circuits. The rules are necessary to ensure that wiring to sub-circuits and fuse protection is such that satisfactory results are obtained.

3.5 DISTRIBUTION BOARD

The distribution board is a panel from which the final sub-circuits are drawn. They are classified according to standard sizes, maximum correct carrying capacity, phases and number of ways. Examples include 12 ways 100A TPN, 6ways 60A TPN etc.

3.6 INTERIOR LIGHTING DESIGN

The complete design of lighting installation which is rather complicated entails the knowledge of the following basic design parameters:

i. The sectional drawing of the rooms of the building plan.

ii. Details of the ceiling construction.

iii. Service requirement of room.

iv. Operating conditions such as temperature, dust etc

v. Tabulated data from IES and the manufactures of the lighting fittings.

The simplest design method is based on calculating the number of light lumens required for a work plane. From this, the number of fittings and their arrangement is determined; however the steps in design are summarized below

1. Choose the illumination (E) required in the room.
2. select a suitable mounting lighting fitting.
3. select a suitable mounting height.
4. Calculate the number of lamp required.[3]

Due to the large number of spaces to be calculated for, only a few spaces will be shown to illustrate how the figures on the table where arrived at.

3.6.1 SAMPLE OF GROUND FLOOR CALCULATIONS

$$N = \frac{E_a \times A}{\emptyset \times Cu \times Mf}$$

$\emptyset = flux\ produced\ per\ fitting,$

Mf=0.8, Cu= 0.8

1. KITCHEN

$$N = \frac{300 \times 168.48}{2 \times 2650 \times 0.80 \times 0.80} = 14.90 \cong 15$$

2. ENTRANCE HALL

$$N = \frac{120 \times 624.91}{4 \times 1050 \times 0.80 \times 0.80} = 27.90 \cong 28$$

3. CONFERENCE ROOM

$$N = \frac{500 \times 95.89}{4 \times 1050 \times 0.80 \times 0.80} = 17.80 \cong 18$$

4. GENERAL OFFICE

$$N = \frac{500 \times 58.63}{4 \times 1050 \times 0.80 \times 0.80} = 10.90 \cong 11$$

5. MD'S OFFICE

$$N = \frac{500 \times 23.04}{4 \times 1050 \times 0.80 \times 0.80} = 4.20 \cong 4$$

3.6.2 FIRST, SECOND AND THIRD FLOOR PLAN CALCULATIONS

1. CHALET A

$$N = \frac{50 \times 23.04}{575 \times 0.80 \times 0.80} = 3.18 \equiv 3$$

2. CHALET B

$$N = \frac{50 \times 20.16}{575 \times 0.80 \times 0.80} = 2.74 \equiv 3$$

3. MEETING ROOM

$$N = \frac{500 \times 107.28}{4 \times 1050 \times 0.80 \times 0.80} = 15$$

Table 3.1 and 3.2 below show the types of lamp chosen for each room and the calculation of the number of lamps required in each room space in the entire Hotel.

TABLE 3.1 SUMMARY OF GROUND FLOOR CALCULATIONS

APARTMENT	WIDTH(m)	LENGTH(m)	AREA (m)	ILLUMINATION FACTOR	LUMEN FACTOR	NUMBER OF LUMINAIRE	TYPE OF LAMP TO BE USED
CARPORT	18.17	8.45	153.54	30	1160	6	1 × 100W incandescent lamp
ENTRANCE	8.43	2.43	20.48	30	1160	1	1 × 100W incandescent lamp
RESTAURANT	22.51	15.63	351.16	100	2650	10	2 × 40W fluorescent fitting with prismatic diffuser.
OFFICE 1	4.80	5.39	25.87	500	2650	4	2 × 40W fluorescent fitting with prismatic diffuser.
SEVERY	4.80	6.22	29.86	300	2650	3	2 × 40W fluorescent fitting with prismatic diffuser.
ENTRANCE HALL	27.17	23.00	624.91	120	1050	27	4 × 20W fluorescent light with mirror bite louver.
BAR	9.54	8.55	79.03	150	1160	6	1 × 100W ceiling mounted lamp fitting
BAR COUNTER	9.54	3.29	39.29	300	2650	3	1 × 40W fluorescent lamp fitting
BAR STORE	4.22	4.26	17.98	150	2650	2	1 × 40W fluorescent lamp fitting
SALON	6.27	5.01	31.41	500	2650	5	2 × 40W fluorescent fitting with prismatic diffuser.
SHOPS	4.22	7.02	29.62	500	2650	4	2 × 40W fluorescent fitting with prismatic diffuser.
OFFICE 2 & 3	4.24	4.80	20.35	500	2650	3	2 × 40W fluorescent fitting with prismatic diffuser.
TOILET	2.38	2.00	4.76	50	575	1	1×60W incandescent lamp fitting
TOILET PASSAGE	1.38	7.02	9.69	100	2650	1	1 × 40W fluorescent lamp fitting
TOILET OUT ROOM	3.30	3.56	11.75	50	1160	1	1×60W ceiling mounted fitting
STORE A	3.19	2.00	6.38	150	2650	1	1 × 40W fluorescent lamp fitting

OFFICE 3	9.47	4.58	43.37	500	2650	6	2 × 40W fluorescent fitting with prismatic diffuser
KITCHEN	13.62	12.37	168.48	500	2650	25	2 × 40W fluorescent fitting with prismatic diffuser
CHIEF CHEF	3.85	7.05	27.14	300	2650	2	2 × 40W fluorescent fitting with prismatic diffuser.
CCTV/PABX	4.18	4.22	17.64	250	2650	1	1 × 40W fluorescent lamp fitting
CONTROL PANEL	4.20	3.23	13.57	250	2650	1	1 × 40W fluorescent lamp fitting
ROOM SERVICE	4.20	4.24	17.81	250	2650	1	1 × 40W fluorescent lamp fitting
STORE B	4.00	4.25	17.00	150	2650	1	1 × 40W fluorescent lamp fitting
STORE C	4.24	3.32	14.08	150	2650	1	1 × 40W fluorescent lamp fitting
STORE D	4.20	3.48	14.62	150	2650	1	1 × 40W fluorescent lamp fitting
CONFERENCE HALL	17.78	33.83	601.50	750			4 × 20W fluorescent light with mirror bite louver.
BACK STAGE	9.40	1.50	14.10	100	1160	2	1× 100W lamp fitting
STORE E	6.22	4.43	27.55	75	2650	1	1 × 40W fluorescent lamp fitting
CHANGE ROOM	3.00	3.00	9.00	50	2650	1	1 × 40W fluorescent lamp fitting
CONFERENCE ROOM	13.64	7.03	95.89	500	1050	14	4 × 20W fluorescent light with mirror bite louver.
GENERAL OFFICE	8.34	7.03	58.63	500	1050	11	4 × 20W fluorescent light with mirror bite louver.
JANITOR	2.55	2.55	6.50	200	2650	1	1 × 40W fluorescent lamp fitting
CORRIDOR	1.50	2.55	3.83	100	1160	1	1 × 100W lamp fitting
CHANGE ROOM	4.20	2.07	8.69	50	1160	1	1 × 60W incandescent lamp fitting

TOILET	1.20	1.50	1.80	50	575	1	1×60W incandescent lamp fitting
MD"S OFFICE	4.80	4.80	23.04	500	1050	4	4 × 20W fluorescent light with mirror bite louver.
MD OFFICE TOILET	3.07	2.00	6.14	50	575	1	1×60W incandescent lamp fitting
MD"S STAFF	4.20	6.43	27.01	500	1050	3	4 × 20W fluorescent light with mirror bite louver.
OFFICES	4.20	4.80	20.16	500	1050	4	4 × 20W fluorescent light with mirror bite louver.
OFFICES TOILET	2.48	2.00	4.96	50	575	1	1×60W incandescent lamp fitting

TABLE 3.2 SUMMARY OF FIRST, SECOND AND THIRD FLOOR PLAN

APARTMENT	WIDTH(m)	LENGTH(m)	AREA (m)	ILLUMINATION FACTOR	LUMEN FACTOR	NUMBER OF LUMINAIRE	TYPE OF LAMP TO BE USED
CHARLET A	4.80	4.80	23.04	50	575	4	1 × 60W (WALL BRACKET LIGHTING FITTING)
CHARLET A TOILET	3.07	2.00	6.14	50	575	1	1 × 60(CEILING MOUNTED TOILET SPHERICAL LIGTING FITTING)
CHARLET B	4.20	4.80	20.16	50	575	3	1 × 60W(WALL BRACKET LIGHTING FITTING)
CHARLET B TOILET	2.48	2.00	4.96	50	575	1	1 × 60W(CEILING MOUNTED TOILET SPHERICAL LIGHTING)
ROOM	2.43	4.80	11.66	50	575	2	1 × 60W(WALL BRACKET LIGHTING FITTING)
ROOM TOILET	1.00	2.00	2.00	50	575	1	1 × 60W(CEILING MOUNTED TOILET

							SPHERICAL LIGHTING FITTING)
MEETING ROOM	8.61	12.46	107.28	500	1050	15	4 × 20W (FLOURESCENT FITTING WITH MIRROR BITE LOUVRE)
PASSAGE	2.00	34.73	69.78	50	2650	4	1 × 40W (FLOURESCENT FITTING WITH PRISMATIC DIFFUSER)

3.7 SOCKET OUTLET DESIGN

The 13A and 15A socket outlets are placed in each room in positions where the are supposedly needed. The number of socket outlets that are placed in each room depends on the number of appliances required in the Hotel rooms, Business suites, Meeting rooms etc.

3.8 LOAD BALANCING AND CALCULATION

Connections to the various sub-circuits and heavy loads are made through separate WAYS on the Distribution Board to Avoid overload. The tables 3.3 - 3.10 show the load balancing in the various Distribution Boards and the Calculations used to arrive at the current rating of the Distribution Boards and the cable selection. Spares are left in the Distribution Boards to allow for future expansion in order to avoid overloading in the Hotel Premises.

TABLE 3.3 LIGHTING AND POWER DISTRIBUTION FOR GROUND FLOOR(DB-A)

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (w)	Fuse Rating (A)	Diversity Factor	Load Estimate (W)	Cable Size (mm^2)	POWER DISTRIBUTION IN EACH PHASE		
									RED	YELLOW	BLUE
LA1	Lighting	9	4 x 20	720	10	0.75	540	1.5	540		
LA2	Lighting	13	4 x 20	1040	10	0.75	780	1.5		780	
LA3	Lighting	12	4 x 20	960	10	0.75	720	1.5			720
LA4	Lighting	12	4 x 20	960	10	0.75	720	1.5	720		
LA5	Lighting	12	4 x 20	960	10	0.75	720	1.5		720	
LA6	Lighting/fans	11	4 x 20	880	10	0.75	660	1.5			660
LA7	Lighting	14	1x60w	840	10	0.75	630	1.5	630		
PSA1	13A S.S.O	6	200	1000	15	0.75	750	2.5		750	
PSA2	13A S.S.O	6	200	1000	15	0.75	750	2.5			750
PSA3	13A S.S.O	6	200	1000	15	0.75	750	2.5	750		
PSA4	13A S.S.O	6	200	1000	15	0.75	750	2.5		750	
PSA5	13A S.S.O	5	200	1000	15	0.75	750	2.5			750
PSA6	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSA7	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSA8	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSA9	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSA10	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSA11	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSA12	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSA13	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSA14	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSA15	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSA16	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSA17	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSA19	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
LIFT 4	Lift	1	4500	4500	50	1	4500	10.0		2000	
									900		4500

										2000	
											600
									13540	**15000**	**15980**

CALCULATIONS FOR DB-A

Total Power (P_T) = 13540+ 15000 + 15980

= 44,520W

Line Voltage (V_L) = 415V

Power Factor = cos ∅ = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3}\times V_L\times COS\emptyset} = \frac{44520}{1.732\times 415\times 0.8}$ =77.42A

Distribution fuse chosen: 80A, 10 WAYS TPN

16mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.4 LIGHTING AND POWER DISTRIBUTION FOR THE GROUND FLOOR DB-B

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (w)	Fuse Rating (A)	Diversity Factor	Load Estimate	Cable Size	POWER DISTRIBUTED IN EACH PHASE		
									RED	YELLOW	BLUE
LB1	Lighting	15	2x40 1x60	920	10	0.75	828	1.5	690		
LB2	Lighting	12	2x40	960	10	0.75	720	1.5		720	
LB3	Lighting	9	2x40	720	10	0.75	540	1.5			540
LB4	Lighting	10	2x40	800	10	0.75	600	1.5	600		
LB5	Lighting	8	2x40	640	10	0.75	480	1.5		480	
LB6	Lighting	8	100	800	10	0.75	600	1.5			600
PSB1	13A S.S.O	4	200	800	15	0.75	600	2.5	600		
PSB2	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSB3	15A S.S.O	1	2000	2000	20	1	2000	2.0			2000
PSB4	13A S.S.O	5	200	1000	15	0.75	750	2.5	750		
PSB5	13A S.S.O	5	200	1000	15	0.75	750	2.5		750	
PSB6	13A S.S.O	5	200	1000	15	0.75	750	2.5			750
PSB7	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSB8	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSB9	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSB10	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
CCU1	COOKER	1	3000	3000	30	1	3000	6.0		3000	
CCU2	COOKER	1	3000	3000	30	1	3000	6.0			3000
CCU3	COOKER	1	3000	3000	30	1	3000	6.0	3000		
LIFT 1	Lift	1	4500	4500	50	1	4500	10.0		4500	
LIFT 2	Lift	1	4500	4500	50	1	4500	10.0			4500
LIFT 3	Lift	1	4500	4500	50	1	4500	10.0	4500		
spare										2000	
spare											900
									14140	**15450**	**14290**

CALCULATIONS FOR DB-B

Total Power (P_T) = 14,140 + 15,450 + 14,290

= 43880W

Line Voltage (V_L) = 415V

Power Factor = $\cos \emptyset = 0.8$

$$\text{Line current } (I_L) = \frac{P_T}{\sqrt{3} \times V_L \times COS\emptyset} = \frac{43880}{1.732 \times 415 \times 0.8} = 76.31A$$

Distribution fuse chosen: 80A, 8WAYS TPN

16mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.3 LIGHTING AND POWER DISTRIBUTION FOR GROUND FLOOR DB-C

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (W)	Fuse Rating (A)	Diversity Factor	Load Estimate (W)	Cable Size (mm^2)	POWER DISTRIBUTION EACH IN PHASE		
									RED	YELLOW	BLUE
LC1	Lighting	11	4 x 20	880	10	0.75	660	1.5	660		
LC2	Lighting	10	4 x 20	800	10	0.75	600	1.5		600	
LC3	Lighting	13	4 x 20	1040	10	0.75	780	1.5			780
LC4	Lighting	14	1 x 60	840	10	0.75	630	1.5	630		
LC5	Lighting	8	4 x 20	800	10	0.75	600	1.5		600	
LC6	Lighting/fans	8	4 x 20	800	10	0.75	600	1.5			600
LC7	Lighting	11	4 x 20	880	10	0.75	660	1.5	660		
LC8	Lighting	12	4 x 20	960	10	0.75	720	1.5		720	
LC9	Lighting	8	4 x 20	800	10	0.75	600	1.5			600
LC10	Lighting	12	4 x 20	960	10	0.75	720	1.5	720		
LC11	Lighting	12	4 x 20	960	10	0.75	720	1.5		720	
LC12	Lighting	7	4 x 20	560	10	0.75	420	1.5			420
LC13	Lighting	7	4 x 20	560	10	0.75	420	1.5	420		
LC14	Lighting	7	4 x 20	560	10	0.75	420	1.5		420	
LC15	Lighting	7	4 x 20	560	10	0.75	420	1.5			420
LC16	Lighting	7	4 x 20	560	10	0.75	420	1.5	420		
LC17	Lighting	7	4 x 20	560	10	0.75	420	1.5		420	
LC25	Lighting	8	4 x 20	640	10	0.75	480	1.5			480
LC26	Lighting	10	1x60	600	10	0.75	450	1.5	450		
PSC1	15A S.S.O	1	2000	1000	15	1	2000	4.0		2000	
PSC2	15A S.S.O	1	2000	1000	15	1	2000	4.0			2000
PSC3	13A S.S.O	5	200	1000	15	0.75	750	2.5	750		
PSC4	13A S.S.O	5	200	1000	15	0.75	750	2.5		750	
PSC5	13A S.S.O	5	200	1000	15	0.75	750	2.5			750
PSC6	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSC7	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	

PSC8	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSC9	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSC10	13A S.S.O	4	200	800	15	0.75	600	2.5		600	
PSC11	13A S.S.O	4	200	800	15	0.75	600	2.5			600
PSC12	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSC13	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSC14	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSC15	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSC16	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSC17	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
									12,710	**12,830**	**12,650**

CALCULATIONS FOR DB-C

Total Power (P_T) = 12,710+ 12830 + 12650

= 38,190W

Line Voltage (V_L) = 415V

Power Factor = cos Ø = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3}*V_L\times COS\emptyset}$ = $\frac{38,190}{1.732\times415\times0.8}$ =66.41A

Distribution fuse chosen: 80A, 12 WAYS TPN

16mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.6 LIGHTING AND POWER DISTRIBUTION FOR FIRST, SECOND AND THIRD FLOORS DB-D

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (w)	Fuse Rating (A)	Diversity Factor	Load Estimate (W)	Cable Size (mm^2)	POWER DISTRIBUTION EACH IN PHASE		
									RED	YELLOW	BLUE
LD 1	Lighting	17	1x60	1020	10	0.75	765	1.5	765		
LD 2	Lighting	13	1x60	780	10	0.75	585	1.5		585	
LD 3	Lighting	10	4x20	800	10	0.75	600	1.5			600
LD 4	Lighting	9	4x20	720	10	0.75	540	1.5	540		
PSD 1	13A S.S.O	5	200	1000	15	0.75	750	2.5		750	
PSD 2	13A S.S.O	5	200	1000	15	0.75	750	2.5			750
PSD 3	13A S.S.O	4	200	800	15	0.75	600	2.5	600		
PSD 4	13A S.S.O	4	200	800	15	0.75	600	2.5		600	
PSD 5	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSD 6	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSD 7	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSD 8	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSD 9	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSD 10	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSD 11	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSD 12	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSD 13	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSD 14	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
WHD 1	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHD 2	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHD 3	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHD 4	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHD 5	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHD 6	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHD 7	Water heater	1	2000	2000	20	1	2000	4.0	2000		
Spare										900	

Spare											900
Spare									900		
Spare										2000	
Spare											2000
									14,805	**14,835**	**16,250**

CALCULATIONS FOR DB-D

Total Power (P_T) = 14,805+ 14,835 + 16,250

= 45890W

Line Voltage (V_L) = 415V

Power Factor = cos Ø = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3} \times V_L \times COS\emptyset} = \frac{44890}{1.732 \times 415 \times 0.8} = 79.81A$

Distribution fuse chosen: 80A, 12WAYS TPN

16mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.7 LIGHTING AND POWER DISTRIBUTION FOR FIRST, SECOND AND THIRD FLOORS DB-E

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (W)	Fuse Rating (A)	Diversity Factor	Load Estimate (W)	Cable Size (mm^2)	POWER DISTRIBUTION EACH IN PHASE		
									RED	YELLOW	BLUE
LE 1	Lighting	15	1x60	900	10	0.75	675	1.5	675		
LE 2	Lighting	17	1x60	1020	10	0.75	765	1.5		765	
LE 3	Lighting	9	1x40	360	10	0.75	270	1.5			270
PSE 1	13A S.S.O	5	200	1000	15	0.75	750	2.5	750		
PSE 2	13A S.S.O	5	200	1000	15	0.75	750	2.5		750	
PSE 3	13A S.S.O	5	200	1000	15	0.75	750	2.5			750
PSE 4	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSE 5	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSE 6	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSE 7	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSE 8	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSE 9	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSE 10	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSE 12	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSE 11	13A S.S.O	2	200	400	15	0.75	300	2.5			300
WHE 1	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHE 2	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHE 3	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHE 4	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHE 5	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHE 6	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHE 7	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHE 8	Water heater	1	2000	2000	20	1	2000	4.0		2000	
Spare	Water heater	1	2000	2000	20	1	2000	4.0			2000
									13,425	13,515	11,320

CALCULATION FOR DB-E

Total Power (P_T) = 13,425+ 13,515 + 11,320

= 38,260W

Line Voltage (V_L) = 415V

Power Factor = cos Ø = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3} \times V_L \times COS\emptyset} = \frac{38260}{1.732 \times 415 \times 0.8}$ =67.53A

Distribution fuse chosen: 80A, 8 WAYS TPN

16mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.8 LIGHTING AND POWER DISTRIBUTION FOR FIRST, SECOND AND THIRD FLOORS DB-F

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (W)	Fuse Rating (A)	Diversity Factor	Load Estimate (W)	Cable Size (mm^2)	POWER DISTRIBUTION EACH IN PHASE		
									RED	YELLOW	BLUE
LF 1	Lighting	17	1x60	1020	10	0.75	765	1.5	765		
LF 2	Lighting	15	1x60	900	10	0.75	675	1.5		675	
LF 3	Lighting	17	1x60	1020	10	0.75	765	1.5			765
PSF 1	13A S.S.O	5	200	1000	15	0.75	750	2.5	750		
PSF 2	13A S.S.O	5	200	1000	15	0.75	750	2.5		750	
PSF 3	13A S.S.O	5	200	1000	15	0.75	750	2.5			750
PSF 4	13A S.S.O	5	200	1000	15	0.75	750	2.5	750		
PSF 5	13A S.S.O	2	200	400	15	0.75	300	2.5		300	
PSF 6	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSF 7	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSF 8	15A S.S.O	1	2000	2000	20	1	2000	4.0.		2000	
PSF 9	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSF 10	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSF 11	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSF 12	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSF 13	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSF 14	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSF 15	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSF 16	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSF 17	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
WHF 1	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHF 2	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHF 3	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHF 4	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHF 5	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHF 6	Water heater	1	2000	2000	20	1	2000	4.0		2000	

WHF 7	Water heater	1	2000	2000	20	1	2000	4.0			2000
Spare									900		
Spare										2000	
Spare											900
									15,165	**15,725**	**16.415**

CALCULATIONS FOR DB-F

Total Power (P_T) = 15,165+ 15,725 + 16,415

= 47,305W

Line Voltage (V_L) = 415V

Power Factor = cos Ø = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3}\times V_L\times COS\emptyset} = \frac{47,305}{1.732\times 415\times 0.8}$ =83.27A

Distribution fuse chosen: 100A, 10 WAYS TPN

25mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.9 LIGHTING AND POWER DISTRIBUTION FOR FIRST, SECOND AND THIRD FLOORS DB-G

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (W)	Fuse Rating (A)	Diversity Factor	Load Estimate (W)	Cable Size (mm^2)	POWER DISTRIBUTION EACH IN PHASE		
									RED	YELLOW	BLUE
LG 1	Lighting	16	1x60	960	10	0.75	720	1.5	720		
LG 2	Lighting	10	1x40	400	10	0.75	300	1.5		300	
PSG 1	13A S.S.O	4	200	800	15	0.75	600	2.5			600
PSG 2	13A S.S.O	4	2000	800	15	0.75	600	2.5	600		
PSG 3	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSG 4	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSG 5	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSG 6	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
WHG 1	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHG 2	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHG 3	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHG 4	Water heater	1	2000	2000	20	1	2000	4.0			900
Spare									900		
Spare										900	
Spare											900
Spare									2000		
Spare										2000	
Spare											2000
									8220	**9200**	**9500**

CALCULATION FOR DB-G

Total Power (P_T) = 8220+ 9200 + 9500

= 26,920W

Line Voltage (V_L) = 415V

Power Factor = cos Ø = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3} * V_L \times COSØ} = \frac{26,920}{1.732 * 415 * 0.8}$ =46.82A

Distribution fuse chosen: 60A, 6 WAYS TPN

10mm^2 multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

TABLE 3.10 LIGHTING AND POWER DISTRIBUTION FOR FIRST, SECOND AND THIRD FLOORS DB-H

Circuit Number	Description	Number of points per circuit	Point Load (W)	Total Load (W)	Fuse Rating (A)	Diversity Factor	Load Estimate	Cable Size (mm^2)	POWER DISTRIBUTION EACH IN PHASE		
									RED	YELLOW	BLUE
LH 1	Lighting	16	1x60	960	10	0.75	720	1.5	720		
LH 2	Lighting	18	1x60	1080	10	0.75	810	1.5		810	
LH 3	Lighting	13	1x60	780	10	0.75	585	1.5			585
PSH 1	13A S.S.O	5	200	1000	15	0.75	750	2.5	750		
PSH 2	13A S.S.O	5	200	1000	15	0.75	750	2.5		750	
PSH 3	13A S.S.O	4	200	800	15	0.75	600	2.5			600
PSH 4	13A S.S.O	4	200	800	15	0.75	600	2.5	600		
PSH 5	13A S.S.O	3	200	600	15	0.75	450	2.5		450	
PSH 6	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSH 7	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSH 8	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSH 9	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSH 10	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSH 11	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSH 12	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSH 13	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
PSH 14	15A S.S.O	1	2000	2000	20	1	2000	4.0		2000	
PSH 15	15A S.S.O	1	2000	2000	20	1	2000	4.0			2000
PSH 16	15A S.S.O	1	2000	2000	20	1	2000	4.0	2000		
WHH1	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHH2	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHH3	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHH4	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHH5	Water heater	1	2000	2000	20	1	2000	4.0			2000
WHH6	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHH7	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHH8	Water heater	1	2000	2000	20	1	2000	4.0			2000

WHH9	Water heater	1	2000	2000	20	1	2000	4.0	2000		
WHH10	Water heater	1	2000	2000	20	1	2000	4.0		2000	
WHH11	Water heater	1	2000	2000	20	1	2000	4.0			2000
									16,070	**16,010**	**17,185**

CALCULATION FOR DB-II

Total Power (P_T) = 16,070+ 16,010 + 17,185

= 49,265W

Line Voltage (V_L) = 415V

Power Factor = cos Ø = 0.8

Line current (I_L) = $\frac{P_T}{\sqrt{3} * V_L \times COS\emptyset} = \frac{49,265}{1.732 \times 415 \times 0.8}$ =86.67A

Distribution fuse chosen: 100A, 12 WAYS TPN

$25mm^2$ multi-core armoured PVC insulated (COPPER CONDUCTOR) is chosen from IEE regulation page 155

Table 3.11 SUMMARY OF DISTRIBUTION BOARD

S/NO	DESCRIPTION OF DISTRIBUTION BOARD	CALCULATED LOAD CURRENT(A)	CABLE SIZE(mm^2)	DISTRIBUTION FUSE BOARD RATING
1.	DB-A	77.42	16	80A, 12 WAYS TPN
2.	DB-B	76.31	16	80A, 8WAYS TPN
3.	DB-C	66.41	16	80A, 12 WAYS TPN
4.	DB-D	79.81	16	80A, 12 WAYS TPN
5.	DB-E	67.53	16	80A, 8WAYS TPN
6.	DB-F	83.27	25	100A, 12 WAYS TPN
7.	DB-G	46.82	10	60A, 6 WAYS TPN
8.	DB-H	86.67	25	100A, 12 WAYS TPN
9.	DB-D1	79.81	16	80A, 12 WAYS TPN
10.	DB-E1	67.53	16	80A, 8WAYS TPN
11.	DB-F1	83.27	25	100A, 12 WAYS TPN
12.	DB-G1	46.82	10	60A, 6 WAYS TPN
13.	DB-H1	86.67	25	100A, 12 WAYS TPN
14.	DB-D2	79.81	16	80A, 12 WAYS TPN
15.	DB-E2	67.53	16	80A, 8WAYS TPN
16.	DB-F2	83.27	25	100A, 12 WAYS TPN
17.	DB-G2	46.82	10	60A, 6 WAYS TPN
18.	DB-H2	86.67	25	100A, 12 WAYS TPN
19.	DB-D3	79.81	16	80A, 12 WAYS TPN
20.	DB-E3	67.53	16	80A, 8WAYS TPN
21.	DB-F3	83.27	25	100A, 12 WAYS TPN
22.	DB-G3	46.82	10	60A, 6 WAYS TPN
23.	DB-H3	86.67	25	100A, 12 WAYS TPN
	TOTAL	**1676.54**		

3.9 CALCULATION FOR TOTAL CURRENT AND CABLE SELECTION

Total load current = 1676.54

Line voltage=415V

Power factor = 0.8

Total power in KW = $3 \times V_L \times I_L \times \cos\emptyset$

$$= 3 \times 415 \times 1676.54 \times 0.8 = 1669833.84W = 1669.8KW$$

Total rating of load in KVA= $\frac{1669.8}{0.8}$ =2,087.3KVA

$$\frac{V_1}{V_2} = \frac{I_2}{I_1}$$

Where v_1 = primary voltage

v_2 = secondary voltage

I_2 = secondary current

I_1 = primary current

$$\frac{11000}{415} = \frac{1900}{I_1}$$

$$I_1 = \frac{415 \times 1900}{11000} = 71.68A$$

Cable Size chosen = $3 \times 50mm^2$

3.10 DIVERSITY FACTOR.

This is a factor used in electrical services design that is based upon the assumption that the entire connected load won't be ON at the same time. However diversity should not be applied for final sub-circuits.the application of diversity allowance is clearly stated in Electrical Installation Regulation 30(1-2). This allowance is as a result of special knowledge and experience.

3.11 PROTECTIVE DEVICES

Protective devices are used in order to secure the lighting and power distribution within the Hotel so as to ensure safety of lives and properties. Below is listed the protective devices and their functions.

3.11.1 FUSES

The simplest form of protection is the fuse, which takes a number of forms: semi-enclosed (re-wireable) fuses, cartridge fuses and high breaking capacity (HBC) fuses. Each consists of a fuse element that is designed to melt when the fuse operates. The fuse, 'the best friend of the electrical engineer', is the 'weakest link' of an electrical installation.

A fuse only blows on a fault in an electrical installation. It is therefore not only necessary for a fuse that has blown to be replaced but it is essential that the cause of the failure of the fuse first be investigated.

3.11.2 MECHANICAL SWITCH

A mechanical switch is a "device capable of making, carrying and breaking current under normal circuit conditions". This in contrast to a circuit breaker, which can also operate under specified abnormal circuit conditions such as those of short-circuit. An isolator (disconnector) is a mechanical switch used for "cutting off an electrical installation, a circuit or an item of equipment from every source of electrical energy", as may be required for maintenance.

3.11.3 MINIATURE CIRCUIT BREAKERS

The miniature circuit breaker (MCB) is a tripping device which acts as a switch and fuse for automatic protection of low voltage distribution system. The tripping action is either thermal or magnetic.

The load current flows through the thermal and electromagnetic mechanisms. In normal operation the current is insufficient to activate either device but when an excessive current occurs, the mechanism trips.

CHAPTER FOUR

DESIGN IMPLEMENTATION AND COSTING

4.1 DRAWINGS.

The electrical services drawing shall be used as a guide to carry out the installations. The drawings shows the electrical notations used to represent the various electrical fittings, the position the fittings should be installed as well as the number of fittings required in each room. Where additional installations are to be made the current and cable size should be considered.

4.2 DISCUSSION OF DISTRIBUTION BOARD CONNECTIONS.

Connections to the various sub-circuits were made through separate WAYS in the Main Distribution Board. In this project a letter coding for connections through the fuses in the MDB to the loads is adopted as shown below:

- L - for lighting circuits, including ceiling fans, connected (in groups) through one WAY of 10A in the MDB. (The lamps and ceiling fans are put in groups - L1, L2, L3 etc. and each group, connected to a sub-circuit in 1.5 mm^2 conductor wiring)
- PS - 13 A socket outlets with rated load of 200 W, through 15 A fuse or CB in 2.5 mm^2 conductor wiring.
- PS - 15 A socket outlets and rated loads of 2000W, each (C1, C2, C3 etc.) connected through 20 A fuse or CB with 4 mm^2 cables.
- CCU - cooker and rated loads of 3 kW each (D1, D2, D3 etc.) connected through 30 A fuse or CB with 6 mm^2 cables.

* WH – water heater rated 2000W each, connected through 20A fuse or CB with $4mm^2$.

The design carried out resulted in substantial saving of connecting cables by placing the distribution board at the centre where the various sub-circuits can easily connect and by placing the sockets at supposed points where they are needed.

4.3 CHOICE OF LAMPS

The choices of lamps to be used in each hotel space was done putting into consideration the required illumination in the working space. Fluorescent lamps were used because they require little power consumption of about 40 W or 20 W and an average efficiency of 50 lumens per watt and they have an average lifetime of 7500 hours.

Filament lamps were also commonly used because of their longer life span and low cost, thus reducing the cost of maintenance.

4.4 DESIGN OF FITTINGS

The fittings where placed considering the IEE Regulations and the convenience of the client. Every live conductor in the installation shall be protected by a protective device, a fuse or a circuit breaker fitted at the point of power input to ensure safety.

IEE Regulation 601-08-01 requires that no electrical equipment (certainly not a socket outlet) must be installed in the interior of a bathroom or shower cubicle. The obvious reason for this precaution is the fact that contact with moisture will dramatically reduce the resistance of the human body, from over 10 kΩ when dry to less than 3 kΩ when wet. It is known that a current greater than 50 mA passing through the human body can be fatal. IEE Regulation 601-08-01 requires that all switches and other means of control be inaccessible to a person using a fixed bath and shower.

Table 4.1 **BILL OF ENGINEERING MEASUREMENT AND EVALUATION**

S/NO	MATERIALS	MANUFACTURER	QUANTITY	UNIT PRICE(#)	TOTAL (#)
1.	1.5mm copper conductor	NIGERIAN MADE	26195m	35	916,815
2.	2.5mm copper conductor	NIGERIAN MADE	4626m	55	254,430
3.	4.0mm copper conductor	NIGERIAN MADE	7965m	90	716,850
4.	6.0mm copper conductor	NIGERIAN MADE	120m	140	16,800
5.	10mm copper conductor	NIGERIAN MADE	150m	250	37,500
6.	6-way Distribution Board		4	5000	20,000
7.	8-way Distribution Board		5	7500	37,500
8.	12-way Distribution Board		14	13000	182,000
9.	Earth Leakage Circuit Breaker		20	5000	100,000
10.	10A Miniature Circuit Breaker		46	450	20,700

11.	15A Miniature Circuit Breaker		57	450	25,650
12.	20A Miniature Circuit Breaker		254	450	114,300
13.	30A Miniature Circuit Breaker		3	450	1,350
14.	50A Miniature Circuit Breaker		4	450	1,800
15.	25mm diameter of PVC pipes	NIGERIAN MADE	32000	100	3,200,000
16.	Fan hooks		18	50	900
17.	Ceiling Fan	NewClime	18	4500	81,000
18.	13A Socket outlet	Tenby	281	400	112,400
19.	13A double Socket Outlet	Tenby	25	700	17,500
20.	15A Socket Outlet	Tenby	183	550	100,650
21.	100w bulkhead fitting		14	800	11,200
22.	60w wall bracket		288	400	115,200
23.	60W Ceiling mounted fitting.		30	500	15,000
24.	5 × 60W Chandelier	Newclime	3	10000	30,000
25.	4×20W fluorescent light with mirrobite louvre.	philips	212	2500	530,000
26.	2×40W fluorescent fitting	philips	101	4500	454,500

	with prismatic diffuser.				
27.	60W Bed lamp		117	4500	526,500
28.	1 gang,1 way switch	Tenby	196	200	39,200
29.	1 gang,2 way switch	Tenby	24	200	4,800
30.	2 gang,1 way switch	Tenby	136	350	47,600
31.	2 gang,2 way switch	Tenby	15	350	5,250
32.	60W tungsten filament		335	40	13,320
33.	2feet fluorescent bulb	philips	224	150	33,600
34.	4feet fluorescent bulb	philips	257	200	51,400
35.	Telephone outlet		144	450	64,800
36.	Television outlet		144	450	64,800
37.	Cooker control unit		3	1500	4,500
38.	1×20W fluorescent fitting	philips	12	1350	16,200
39.	1×40W fluorescent fitting	philips	55	1550	82,250
40.	TV Cable	NIGERIAN MADE	18000	12	216,000
41.	Miscellaneous				250,000
					8,534,265

4.5 CONDUIT WIRING.

Conduit system of wiring is to be used for the entire wiring of the Hotel premises. In conduit wiring a tube or pipe is used to enclose PVC insulated cables. Metallic and non-metallic conduits are supplied in lengths from 3m to 4m. Common standard sizes are: 16, 20, 25 and 32 mm external diameters, but 25mm diameter shall be used.

4.6 TESTING OF THE ELECTRICAL INSTALLATIONS

Tests and measurements should be carried out on the electrical installation for three main reasons, viz.:

(i) to ensure that the electrical installation in a completed building is free from faults and it conforms with the IEE regulations;

(ii) to diagnose the cause of failure and to locate the exact position of breakdown;

(iii) to ensure (by means of regular tests and measurements) that an electrical installation remains in a sound working condition throughout its life. (The IEE Regulation attaches considerable importance to periodic inspection and testing of equipment– routine maintenance)

4.7 TESTING OF NEW INSTALLATIONS

Before connecting a new electrical installation to the supply, i.e. before being energized, an inspection and some tests are required to indicate the quality and safety of the work. These tests include:

(a) Insulation Resistance; This is the resistance between the following parts of an installation:

- A phase line and the consumer's earth terminal measured with 500 V D.C. across the line conductor and the earth terminal.
- A phase line and neutral measured with 500 V D.C. across the line and the neutral conductors, with the neutral link removed.
- One phase line and another measured with 500 V D.C. across the line conductors.
- Live part and metal frame of an appliance or equipment with 500 V D.C. across the live conductor and the metal frame.

For each sub-circuit, the test is made with lamps and all other appliances and loads disconnected and fuses and switches closed. Where the removal of an appliance is not practicable, all the associated local switches should be open. The insulation resistance in (I) – (iii) should be not less than 1 MΩ as measured with a merger; in (iv) it is to be not less than 0.5 MΩ.

(b) Earth Continuity Conductor (ECC) resistance

This is the resistance between the earthing point in the socket outlet and the consumer's earthing terminal, measured for each sub-circuit. It should not exceed 0.5 Ω where the ECC is partly or wholly of cable sheath, steel conduit or metal pipe, and 1 Ω where it is a separate copper or aluminium conductor.

(c) Earth-fault loop impedance

This is the resistance of the path of fault current from the live-conductor connection of the equipment or appliance to the metal conductive parts, along the ECC to the consumer`s earthing lead and thence to the consumer's earth electrode. From here to the path continues to the general mass of the earth and to the NEPA earth electrode connected to the neutral of the supply transformer, through the transformer winding and along the supply line through the consumer's wiring back to the fault. This path is called the line-earth loop .

(d) Earth electrode resistance

The measurement of Earth Electrode Resistance has been described under sub-section 4.7.1. The values will vary according to terrain and season.

4.8 EARTHING OF ELECTRICAL INSTALLATIONS

4.8.1 EARTH ELECTRODE RESISTANCE

The resistance to earth of an electrode will depend upon its shape, size and resistance of the soil. A copper rod about 1 m long is used as an earth electrode (See Fig. 7.1A). It is sunk into the ground at a convenient position and then connected securely to the earth-continuity conductor (circuit protective conductor) through the earth lead. The connection to the earth electrode should be firm and secure in a 'trap` that can be opened for inspection and removal to allow for measurement of the earth electrode resistance. A warning sign to prevent unauthorized disconnection of the earth lead should be displayed.

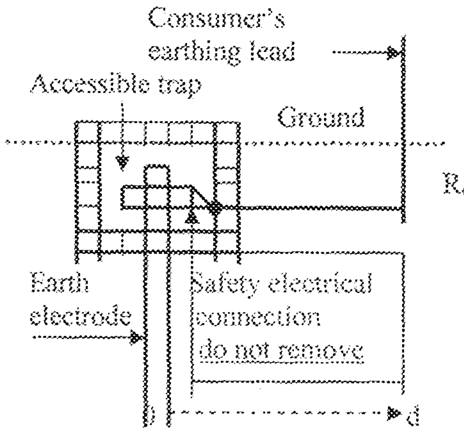

FIG. 7.1A EARTH ELECTRODE
SUNK INTO THE GROUND

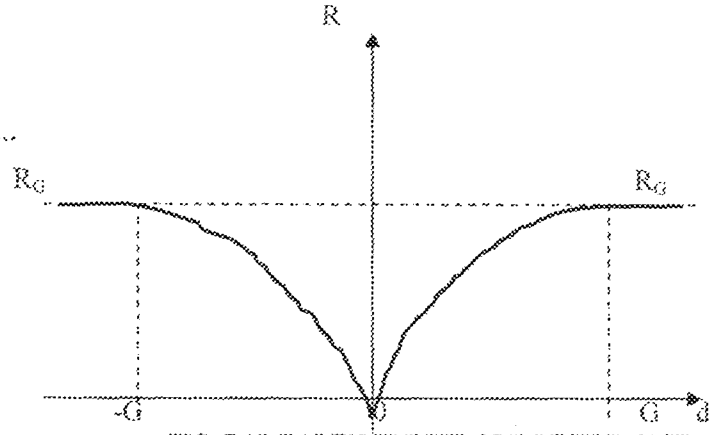

FIG. 7.1B EARTH ELECTRODE RESISTANCE
R AS A FUNTION OF DISTANCE d

The resistance R to earth is determined by passing an alternating current I between a fixed earth electrode and a movable earth electrode distance d apart, and measuring the voltage V developed between them. As the distance d is increased, the resistance R = V/I increases rapidly in the vicinity of the fixed earth electrode. At a distance G the electrode resistance levels and remains practically constant at R_G. If R is plotted against d, positive and negative curves, as shown in Fig. 8.1B, are obtained. The area of the circle of radius G with centre at the fixed earth electrode (Fig. 8.1B) is the resistance area of the electrode. This is the region of soil in the vicinity (5 – 10 m) of the fixed earth electrode. Beyond this region the resistance becomes constant and R_G is the earth electrode resistance. The value of R_G depends on the nature of the terrain and has seasonal variation.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION.

5.1 LIMITATIONS

Due to the fact that the project is yet to be executed , the limitations are the design not being implemented due to time constraints and the varying market prizes of the electrical fittings which may result in implementation cost varying.

5.2 CONCLUSION

The electrical services design of the proposed Hotel was conclusively carried out bearing in mind the observance of the IEE Regulation to ensure safety of lives and properties, rising up to the technological advancement of electrical services lighting design system, energy saving and also considering economic factors. A total load currents calculated to be used by the distribution board is 1676.54A. Fluorescent lamps and tungsten filament lamps were used because of its Longer life span, low initial cost, flexibility in variety of sizes and higher efficiency thus saving the cost of maintenance.

5.3 RECOMMENDATION

The following are the recommendations in view of future work in respect to this project.

1. No additional load may be made to the authorized load without ascertaining the current rating and the existing conductor.
2. Strict adherence be made during installation to ensure that the IEE regulation is obeyed.

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APPENDIX 10

TABULATED LAMP DATA

The data in the following tables are correct at the time of going to press, but progress in lamp technology is continuous. It will therefore be advisable to consult the manufacturer concerned to obtain latest data for the lamp(s) being considered for a lighting scheme. See also Bibliography (Electric Lamps).

(a) Electric Discharge Lamps (see B.S. 1270, 1853, 3677, 3767)

Type and Wattage	Bulb Shape	Dimensions: Length, mm Maximum	Dimensions: Diameter, mm Maximum	Approx. Watts Loss in Choke	Lighting Design Lumens	Cap
Mercury						
MB 80	Elliptical and Pear	166·5	81	15	3700	ES or 3-pin B.C.
MB 125	Elliptical and Pear	183·5	91	20	4900	ES or 3-pin B.C.
MB 250	Tubular	225	51	25	10 500	GES
MB 400	Tubular	335	51	35	18 800	GES
MB 1000	Tubular	392	68	70	49 000	GES
MB 1000	Isothermal	380	167	50	52 000	GES
MBI 400	Elliptical and Tubular	292	122	†	25 000	GES
MBI 750	Tubular	254	18·3	†	67 500	Special
MBI 2000	Tubular	435	101·5	80	120 000	GES
Fluorescent Mercury						
MBF 50	Elliptical	130	56	15	1750	ES or 3-pin B.C.
MBF 80	Elliptical and Round	166·5	81	15	3720	ES or 3-pin B.C.
MBF 125	Elliptical	183·5	91	20	5200	ES or 3-pin B.C. or GES
MBF 250	Elliptical	227	91	25	11 000	GES
MBF 400	Elliptical	292	122	35	20 000	GES
MBF 700	Elliptical	358	157	50	33 500	GES
MBF 1000	Elliptical	410	181	70	52 000	GES
MBF 2000	Elliptical	445	187	80	115 000	GES
MBFR 250		250	184	25	10 250 (a)	GES
MBFR 400		305	185	35	17 200 (a)	GES
MBFR 700		330	210	50	30 800 (a)	GES
MBFR 1000		380	250	70	45 000 (a)	GES
Tungsten Mercury						
MBT 100	Elliptical	150	75	—	1150	ES or BC
MBT 160	Pear	185	85	—	2500	ES or BC
MBT 250	Pear	240	115	—	4840	ES or GES
MBT 500	Pear	280	135	—	11 000	GES
MBFT/MBTL 160	Pear	185	85	—	2500	BC or ES
MBFT/MBTL 250	Pear	240	115	—	4840	GES
MBFT/MBTL 500	Pear	280	135	—	11 000	GES
Low Pressure Sodium						
Preferred Types						
SOX 35	Tubular	310	51	20	4200	BC
SOX 55	Tubular	425	51	20	7000	BC
SOX 90	Tubular	525	65	30	11 900	BC
SOX 135	Tubular	775	65	[illegible]	20 000	BC
SOX 180	Tubular	1120	65	45	28 500	BC
SLI 140	Tubular	902	38	20	20 000	Bi-pin
Non-preferred Types						
SOI 45	Tubular	237	52	24	3830	BC
SOI 60	Tubular	310	52	24	[illegible]	BC
SOI 85	Tubular	425	52	25	6460	BC
SOI 140	Tubular	528	67	29	10 640	BC
SLI 60	Tubular	419*	38	(A) 14 (B) 18	5700	Bi-pin
SLI 200	Tubular	902*	38	(A) 30 (B) 45	20 000	Bi-pin
High Pressure Sodium						
HPS 250	Elliptical	232	100	30	19 500	GES
HPS 310	Tubular	292	53	30	25 000	GES
HPS 400	Elliptical	292	100	42	34 000	GES
	Tubular	272	53	40	38 000	GES
HPS 600	Tubular	340	53	65	54 000	GES
HPS 1000	Tubular	410	91	110	85 000	GES

(a) Mean value of manufacturers' published figures.
* Distance from cap face to end of opposite cap pins.
(A) Switch start circuit. (B) Starterless circuit.
† Data under consideration

b) Tubular Fluorescent Lamps

Nominal Lamp Watts	Nominal Length mm	Nominal Tube Diameter mm	Approx. Total Circuit Watts*	Lighting Design Lumens (Warm White)	Caps
4	150	15	10	135	Miniature Bi-pin
6	225	15	12	235	Miniature Bi-pin
8	300	15	15	330	Miniature Bi-pin
13	525	15	21	640	Miniature Bi-pin
15	450	25	40†	610	Bi-pin
15	450	38	40†	550	Bi-pin
20	600	38	50†	1030	Bi-pin
20 (B)	600	38	115**	870	Recessed single-contact
30	900	25	40	1750	Bi-pin
30	900	38	40	1700	Bi-pin
40	600	38	85†	1550	Bi-pin
40	1200	38	50	2610	Bi-pin
40 (B)	1200	38	115‡	2140	Recessed single-contact
50	1500	25	70	3100	Bi-pin
65	1500	38	80	4400	Bi-pin
80	1500	38	95	4500	Bi-pin or B.C.
65	1800	38	85	5200	Bi-pin
85	2400	38	100	6400	Bi-pin
125	2400	38	140	8300	Bi-pin or B.C. or recessed double-contact

Circular Lamps

22	210 mm dia.	29	31	850	4-pin
32	305 mm dia.	32	41	1500	4-pin
40	406 mm dia.	32	50	2150	4-pin

* For switch-start circuits.
† For two lamps in series on 200/250V.
** For two lamps in series with one ballast lamp on 240V.
‡ Including ballast lamp.
(B) Refers to MCFB lamp(s) for filament-ballast circuit.
(a) Cool White (Daylight) colour.

Where the supply of electricity is paid for by a fixed quarterly charge based on the installed electrical load, plus a charge per unit consumed, the fixed quarterly charge is seldom if ever calculated by the Electricity Board on the nominal lamp watts.

If the charge is based on watts load it is normally the total circuit watts, not the lamp watts alone. In many cases, however, in order to promote the most economic use of the generating plant and distribution network, the fixed charge is based on the volt-amps (VA) drawn from the mains, and this will depend both on the circuit watts and the circuit power factor.

For example, the circuit wattage of a 65W lamp is about 80 watts. It may be assumed that the power factor of the circuit has been improved to a value of 0·85 by the inclusion of the normal power factor capacitor, in which case the volt-amps drawn from the mains are $\frac{80}{0 \cdot 85} \approx 94$ VA.

LIGHTING DESIGN LUMENS FOR LAMPS OTHER THAN WARM WHITE

The approximate lighting design lumens for lamp colours other than Warm White may be obtained by applying the following multiplier to the relevant figure for Warm White.

White	1·0
Warm White	1·0
Daylight	0·95
Natural	0·75
De luxe Warm White	0·65
Colour Matching (Northlight)	0·65
Colour 34	0·65
Kolor-rite	0·65
Graphica 47	0·6
De luxe Natural	0·55
Softone 27	0·55
Trucolour 37	0·5
Artificial Daylight	0·4

Where a precise figure of lumen output is desired, the manufacturer of the lamp in question should be consulted.

(c) Standard Incandescent Lamps

(i) Pear Shape, Pearl and Clear (see B.S. 161 and 555)

Watts	Finish	Nominal Dimensions		Light Centre Length, mm	Standard Cap	Lighting Design Lumens		
		Length mm	Diameter mm			At 110V	At 240V	At 240V
						Single Coil	Single Coil	Coiled Coil
25	Pearl	105	60	75	B.C.	225	200	...
40	Pearl	105	60	75	B.C.	435	325	390
60	Pearl	105	60	75	B.C.	735	575	665
100	Pearl	{105 / 125	60 / 70	75 / 90}	B.C.	1395	1160	1260
150	Pearl	150	80	120	B.C.	2250	1960	—
200	Clear	161·5	80	131·5	E.S.	3160	2720	—
300	Clear	233	110	178	G.E.S.	5040	4300	—
500	Clear	233	110	178	G.E.S.	8150	7700	—
750	Clear	300	150	225	G.E.S.	—	12 400	—
1000	Clear	300	150	225	G.E.S.	—	17 300	—
1500	Clear	335	170	250	G.E.S.	—	27 800	—

Inside White lamps are available for the 200/250V range in 40, 60, 100, 150 and 200W rating, having a lumen output approximately 10% less than the corresponding lamps above. Also lamps with pink enamel-glazed bulbs or pink internal coatings in 60, 100 and 150W ratings.

(ii) Mushroom Shape, Inside White (see B.S. 555)

Watts	Finish	Dimensions		Standard Cap	Approx. Initial Lumens 240V
		Length mm	Diameter mm		
40	Inside White	103·5	61	B.C.	380
60		109·5	61	B.C.	640
100		109·5	69	B.C.	1220
150		124·5	78	B.C.	1890

(d) Reflector Lamps*

Watts and Type		Max. Dimensions		Cap
		Overall Length, mm	Diameter mm	
75 and 100	Spotlight	{140 / 141·5	98 / 98	B.C. / E.S.
150 / 150	Spotlight / Floodlight }	183·5	127·5	E.S.

* A number of other types and sizes of reflector spotlamps and floodlamps are made by individual manufacturers, to whom reference should be made.

Illumination data is given in Appendix 8.

(e) Pressed Glass Spot and Floodlamps*

Type and Watts	Maximum Dimensions		Cap
	Overall Length, mm	Diameter, mm	
PAR-38 100	137·5	122	E.S.
150	137·5	122	E.S.

100W PAR-38 Floodlamps also available in Red, Yellow, Blue and Green

Type and Watts	Overall Length, mm	Diameter, mm	Cap
PAR-56 300 Medium Flood	132	179	GLX152 } Mogul End Prong
300 Wide Flood	132	179	GLX154
300 Narrow Spot	132	179	GLX154

	Standard service illuminance lux (See page 51)	Position of measurement	Limiting glare index	Colour appearance of light source	Colour rendering group (See page 60)	Notes

eral building areas

tion areas						
passageways	100 scalar	1·2 m above floor	22	Intermediate or warm	BDEFGHIJKL	Scalar illuminance to be not less than ⅓ horizontal planar illuminance in adjacent areas, and not less than 120 lux if there is no daylight
angel)	150	Floor	—	..	BDEHIJL	
	150	Treads	—	..	BDEFGHIJKL	Restrict disability glare: see Section 2.5.1
	150	Treads	—	..	..	Avoid specular reflections on treads
vered ways	30	Ground	—	..	EFGJKLM	Illuminance should be compatible with adjacent lit areas
as						
alls, lobbies, waiting	150 scalar	1·2 m above floor	—	Intermediate or warm	BDEFGHIJKL	See Section 20 for equivalent planar illuminance. See also Section 2.2.5?
sks	500	Desk	19	..	..	
s	300	Desk	16	..	..	Limit luminance to assist view out at night
s See SI No 1172: The Food Hygiene (General) Regulations 1970						
s	(150)	Floor	—	Intermediate or warm	BDJL	
	500	Working surface	22	..	..	Position luminaires relative to working areas. Proof luminaires may be required
l and first aid centres						
rooms, treatment areas	500	Desk or bed	—	Intermediate or warm	BDJ	Examination lighting should be provided
ores	100	Vertical on shelves	—	..	BDJL	
s	150	Bed	—	..	BDJ	Restrict luminance seen by recumbent patient
or						
d entrance or exit gates	150	Working plane	—	Intermediate or warm	EFGJKLMN	Working plane varies according to requirements
s and exits	30	Ground	—	..	..	
actory roads	See BSCP 1004					
ockyards	30	Working plane	—	..	..	Consider obstructions. Vertical surfaces often important
l covered ways	50	Ground	—	..	..	Illuminance should be compatible with adjacent lit areas
estaurants See SI No 1172: The Food Hygiene (General) Regulations 1970						
, cafeterias, dining rooms	300	Tables	22	Intermediate or warm	BDHIJKL	
ooms						
, locker and cleaners' loakrooms, lavatories	150	Floor	—	Intermediate or warm	EJL	
ms	150	Table height	19	Warm	HIJ	Change in character from general

es and hotels

	Standard service illuminance lux (See page 50)	Position of measurement	Limiting glare index	Colour appearance of light source	Colour rendering group (See page 60)	Notes
	50	Working plane	—	Intermediate or warm	BDHIJ	In all home areas, attention should be given to the lighting of room surfaces. Luminaires should be selected and positioned to give occupants a compromise between attractive 'sparkle' and unwanted glare. Dimming is useful for changing atmosphere. Additional mirror lighting required in bedrooms
	150	Task	—	,,	,,	
…ng	300	,,	—	,,	,,	
…onged reading	300	,,	—	,,	,,	
	50	Floor	—	,,	,,	
	150	Bed	—	,,	,,	
	300	Working surface	—	,,	,,	
	100	Floor	—	,,	,,	Additional mirror lighting required. Enclosed luminaires should be used
…landings	150	Floor	—	,,	,,	High luminances should be screened from view when ascending or descending stairs
	100	Treads	—	,,	,,	
	300	Bench	—	,,	BDHIJL	
	50	Floor	—	,,	,,	
…(old people's)	Illuminances must be increased 50–100 per cent above recommendations for Homes. Particular attention must be paid to avoiding glare and to revealing steps and obstructions. Two-way switches should be installed for through-ways, stairs, etc					
	75 scalar	1·2 m above floor	19	Intermediate or warm	BDFGHIJ	
	300	Desk	19	,,	,,	
	150	Table	—	,,	BDHIJL	Flexibility of control required to achieve variety in lighting
…llrooms,						
	100	Table	—	,,	BDHIJ	Additional table lighting may be required
	300	Desk	—	,,	,,	
	100 scalar	1·2 m above floor	16	,,	,,	Additional table lighting may be required
	150	Table	19	,,	,,	
	150	Floor	—	,,	BDHIJL	Additional mirror lighting required
…throoms	See Homes					
	See General building areas					
	100	Floor	—	Warm	JL	
	300	Working plane	—	Intermediate or warm	EJL	
	150	Floor	—	,,	,,	