NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

GRADUATION PROJECT

ELECTRICAL INSTALLATION DESIGN

EE400

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ABSTRACT

This project is prepared as a thesis for graduating in 2006-2007 education year, Near East University Engineering Faculty, Electric and Electronic Engineering department.

This project has been written according to the ring system which mostly follows the English system where the lines are doubled for sockets ring thus, the system implement the IEE English standard

ACKNOWLEDGMENT

I would like to acknowledge and thank to DR.Kadri Buruncuk for being such a great supervisor for helping me all along my project and designing every phase of this application

Special thanks to my family and , chiefly my Mother and Father who simply are the best

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TABLE OF CONTENTS

INTRODUCTION

Today all things in the world depend on the electricity we are living in an electrical zone. Most of the energy that we consume is electrical energy.

When we mention electrical energy, three; important parameter come into mind. These are producing electricity, transmitting and its distribution. The distribution of electricity is the last phase between electrical energy source and consumer...

In this project we are going to discus the distribution of electricity coming from network, tools to be used during this distribution process, calculations done, devices and conductor type to be employed and in addition to this we will cover the material and techniques that will project the people and the business in terms of monetary and Building details construction, plus the fuse earth processes will be explained.

Also in this project we are going to discus the electrical distribution in the swimming pools. Special Conditions, Emergency light and other interested parties.

This project is specific to the building of many blocks resident hold located in Cyprus and having two swimming pools.

This building has Floors consists of 1 and 2 apartment and each having its own lobby, bedroom, bathroom, kitchen and also in each apartment has one to two salon.

To sum up, after doing necessary calculations and preliminary work, the building's internal electrical installation design is sketched.

CHAPTER ONE

THE HOME ILLUMINATION DESIGN

1.1 Over View

In this chapter, a fully detailed explanation is going to be included, thus, new lighting products are not only more energy efficient, they offer many more possibilities to improve the quality of lighting our homes, indoors and out. This chapter looks at some of the new technologies for residential lighting, compares the cost benefits, identifies four basic strategies to apply, then provides specific examples of how to put the new strategies into practice throughout the home rooms.

1.2 Types of Indoor Lighting

An incandescent bulb is usually made of clear or frosted glass, screws into a “medium base” socket, generally lasts from 750 to 1000 hours, and emits a warm white light. The word “incandescent” translated from Latin means “glowing with heat.” Light is produced when the electric current heats the bulb’s filament; 90 percent of the energy is used to heat the filament and only 10 percent goes into making light. Therefore, most of the energy used by the bulb is given off as waste heat, not light.

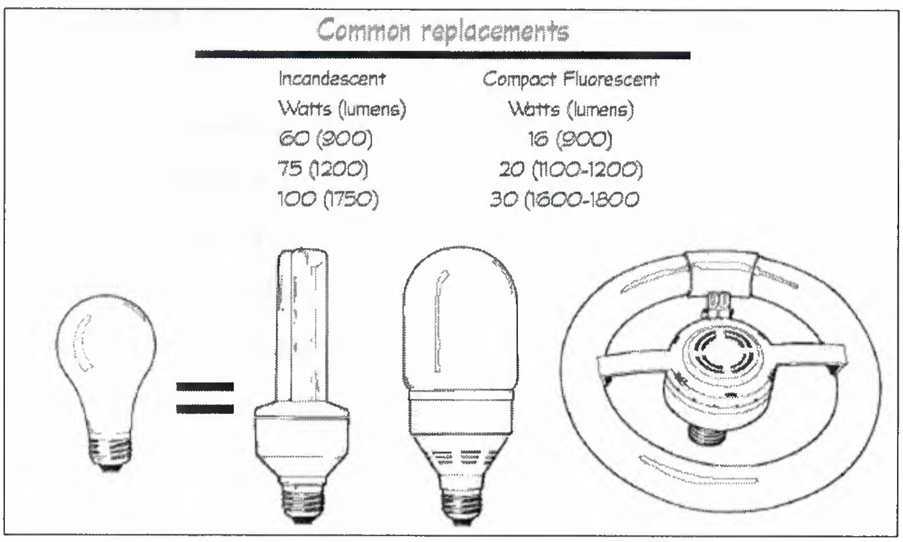


Fig.1.1 Compact fluorescents come in a variety of shapes and sizes to fit different fixtures.

Tungsten-halogen (T-H) is another type of incandescent bulb that provides a whiter light and a higher light output over time than regular incandescent. Unlike earlier versions, the new T-H bulbs will operate on standard household current (120 volts) and screw into standard sockets. The new bulb design, encasing the tungsten filament within a glass capsule, has also eliminated the health risks associated with ultraviolet radiation. Fluorescent light bulbs produce light by activating light-emitting phosphors enclosed within the bulb. The electric current flowing between the electrodes at each end of the bulb stimulates the phosphors that coat the inside of the tube.

This produces more light and less heat for each unit of energy used. All fluorescent lights require a ballast to convert ordinary household current to the proper voltage needed to start and maintain the light. Magnetic ballasts may flicker at start-up, while modern electronic ballasts provide an "instant on" feature. To increase energy efficiency, replace light fixtures that have magnetic ballasts with ENERGY STAR fixtures. Old ballasts may contain PCBs and should be treated as hazardous waste and properly disposed of at a county collection site. If trying to increase energy efficiency, sometimes lower wattage fluorescent linear bulbs can be used in fixtures. Examine the ballast to identify if it will power bulbs of a lower wattage; for example, a ballast may indicate that 34W, 35W or 40W bulbs can be used. When shopping for a replacement fluorescent linear bulb, most people only look for wattage and length. However, it is helpful to know what the rest of the product specifications mean. Product specifications might vary depending on the manufacturer. For example, a product description might list: F32T8/TL730.

The first set of numbers, F followed by 32, is the approximate length of the bulb. The second set of numbers, T followed by 8, indicates the diameter of the bulb, which is measured in one-eighths of an inch increment (a T-8 bulb is 8/8ths or 1 inch in diameter). The smaller the diameter, the more energy efficient the bulb is because it converts more electricity into light. Many manufacturers will abbreviate the numbers for color rendering (amount of illumination) and color temperature (whether a light is "warm" or "cool"). In the previous example, F32T8/TL730, the 7 is an abbreviation for a color rendering of 70 (on a 100-point scale) and the 30 is an abbreviation for a color temperature of 3,000.

Other manufacturers might list the same information as: F032/730K or F32T8/SP30. All of these bulbs offer the same wattage, diameter, color temperature and color rendering. Additionally, some manufacturers describe color rendering and temperature as cool white (CW) or warm white (WW). Fluorescent bulbs should be treated as hazardous waste and properly disposed of at a county collection site. Compact fluorescent light bulbs (CFLs) work the same way as fluorescent linear tube lights. They come in many shapes and sizes and most can replace incandescent bulbs in standard light fixtures. Using CFLs will save money in two ways: they use less energy—75 percent less, and they last longer—10 times longer, than incandescent.

The long-life feature makes CFLs especially useful in light fixtures that are hard to reach, including recessed fixtures, cathedral ceiling fixtures and outdoor fixtures. All CFLs will use less energy than incandescent bulbs, but CFLs with the ENERGY STAR label will offer the most savings. All major manufacturers offer CFLs with the ENERGY STAR label, which means the bulb has met strict requirements for energy efficiency and performance. Reflector lamps (R-lamps), most often seen in recessed ceiling or track lighting fixtures, are either incandescent, halogen or compact fluorescent. The bulb is partially coated with aluminum or silver to direct more light out of the bulb. An improved ver- sion, with more precise reflectors, is the PAR lamp (parabolic aluminized reflector). They are available in spot or flood light versions and are also used outdoors for security or decorative lighting.

High intensity discharge (HID) lamps produce light by passing an electric current through gas under pressure. Because they can operate throughout a wide temperature range they are often used for outdoor security lighting. Mercury vapor lights, known for their blue-green color, have been used for outdoor lighting since the 1930s. They are being replaced, however, by high-pressure sodium lamps, which produce a golden colored light and are very efficient. [1]

1.3 Comparing cost and efficiency

Why would a person spend $5 to $20 to purchase a CFL bulb rather than incandescent for 50 cents? Because CFLs use 75 percent less energy to operate, they last up to 10 times longer, and they produce more lumens (light) per watt (electricity used) than incandescent bulbs. Although CFLs cost more initially, they are a better bargain in the long run.

The two basic pieces of information needed to find the best buy are printed on the light bulb package: watts and lumens. Watts, often the only number people look at when buying a light bulb, indicates how much energy the bulb consumes but nothing about the light output. The average lumens is the amount of light given off by the bulb. To determine a bulb's efficiency, look at the amount of lumens per watt. Surprisingly, some bulbs that are labeled as long-life may last longer, however light output is significantly lower. For example: A 75-watt incandescent bulb uses 75 watts of electricity to provide 1,200 lumens. A 20- watt compact fluorescent uses only 20 watts of electricity, one-fourth the amount, to provide the same 1,200 lumens. To determine the real cost of lighting, add the cost of the bulb (initial cost plus replacements) and the electricity cost. Compare the operating cost of a single 20-watt CFL and a 75-watt incandescent for 10,000 hours. [3]

Table1.1 the operating cost of a single 20-wattCFL and a 75-watt incandescent for 10,000 hours.

	Bulb cost (Initial X replacement)	Electricity cost (10.000 hours)	Total
75W Incand.	1$ X 13 = 13$	48.75 $	61.75 $
20W CFL	20$ X 1 = 20$	13.00 $	33.00$

1.4 Compare Color and Quality of Light

The quality of light produced by a bulb can vary depending on the light source, and is expressed in two ways: color temperature and color rendering. Color temperature (or correlated color temperature, CCT) is measured in degrees Kelvin, and may or may not be listed on the product package. Light bulbs with a number below 3500K are considered "warm," and are more reddish in color; light bulbs with a number above 4000K are considered "cool," and are more bluish in color. Color rendering is measured by the Color Rendering Index (CRI), which rates the amount of illumination compared to a light source with a known CRI. Only lights with the same temperature rating are compared with each other. A simple way to find a light bulb that will produce the best color temperature and color rendering for most lighting needs is to look for an ENERGY STAR light, which will have a CRI of 80 or higher and a color temperature between 2700K and 3000K. [11]

1.5 Evaluating the Home's Lighting Needs

To evaluate the home's current lighting conditions, tour the home in the evening and turn on the lights as you go from room to room. Is each area receiving adequate amounts of lighting? Lighting generally falls into one of three categories:

1.5.1 Accent lighting

Use accent lighting to highlight specific objects, such as artwork, shelves or plants. It can also illuminate wall surfaces in a soft wash of light or accentuate the texture of the surface.

1.5.2 Task lighting

Direct light to specific activity areas with task lighting lamps and fixtures. Lights under cabinets to illuminate kitchen work surfaces or a reading lamp next to that favorite chair are two common examples of task lighting.

1.5.3 Ambient lighting

Distribute light broadly throughout a space with ambient lighting fixtures, such as the traditional single ceiling fixture located in the center of a room. Ambient lighting by itself is still adequate for general activities that are not visually demanding, but will not give the quality of light needed for reading or sewing. To make sure areas of the home meet desired lighting needs, choose and locate accent fixtures first, then choose and locate task lighting fixtures. If additional light is still needed, use ambient lighting fixtures.

1.6 The new technology Using 4 Strategies

Four strategies could be used to perform the new technologies, thus, these are fully detailed listed as following.

1.6.1 Strategy 1

Strategy one is to replace standard incandescent light bulbs with ENERGY STAR labeled CFLs. No other new product in the lighting industry has had as great an impact as the ENERGY STAR labeled CFL. Modern CFLs have taken the best aspects of fluorescents high efficiency and long life while eliminating previous problems of poor color, flicker and noise. Achieve the most benefit by switching to ENERGY STAR labeled CFLs wherever high wattage incandescent bulbs are used more than three hours per day often in the kitchen and family room. Some specialty CFLs can now be used with dimmer switches. More and more types of CFLs will work well outdoors in Minnesota's cold climate.

1.6.2 Strategy 2

Strategy two is to replace standard incandescent ceiling fixtures (especially in the kitchen and laundry area) with ENERGY STAR labeled fluorescent fixtures. ENERGY STAR labeled light fixtures, when used with ENERGY STAR CFLs, help save money on utility bills and offer long life, convenience, better quality and safety than standard fixtures. Over their lifetimes, ENERGY STAR-qualifying fixtures will cost less than half as much to operate and can even eliminate the need to replace up to 40 standard incandescent light bulbs over the life of the fixture. ENERGY STAR-rated fixtures are available in many styles including table lamps, torchieres, wall sconces, under-cabinet lighting and outdoor security lighting. Some indoor fixtures are dimmable or have two-way switches, and all outdoor fixtures have photo sensors (they turn on at night, off in the morning) and some also have motion sensors. Any fixture bearing the ENERGY STAR label must meet safety and reliability guidelines and offer minimum warranties of two years—well above industry standard. In addition, these fixtures operate at much lower temperatures than many traditional lamps so they reduce fire risks. [11]

1.6.3 Strategy 3

Replace incandescent spot and flood lights with "T-H" PAR lamps. Or better yet, with compact fluorescent floodlights. These new arrivals on the market in R-30 and

R- 40 sizes can easily replace many spot and flood lights used indoors. In places where fluorescent lighting cannot be used, tungsten-halogen (T-H) lighting is a good choice. Basically a more efficient form of incandescent lighting, although not as efficient as fluorescent, "T-H" bulbs produce a crisp light that brings out the colors of furnishings. In recessed ceiling or track lighting fixtures, a good replacement is the new generation of ENERGY STAR CFLs with a parabolic aluminized reflector (PAR). These bulbs are up to 75 percent more energy efficient than incandescent reflector lamps. In outdoor fixtures use halogen floodlights with a built-in photo-sensor, which will automatically turn itself on at dusk and off at dawn. This floodlight has a rated life of 3,000 hours, which is 50 percent longer than the typical rated life of regular floodlights. [11]

1.6.4 Strategy 4

Use automatic lighting controls in dining rooms, hallways—or anywhere light is needed. A number of easy-to-install lighting controls are available that will increase lighting flexibility, home security and energy savings:

• Electronic dimmers, especially popular in dining rooms, regulate the brightness of incandescent and tungsten halogen lights and can create an informal, relaxed atmosphere—and they save energy. The lower the brightness, the lower the energy consumption.

• Motion sensing light switches turn lights on and off automatically when someone enters a room, offering "no hands" light control for hallways, bedrooms and other areas where lights are inadvertently left on, or as part of a home security system.

• Electronic timers provide precise, automatic onoff control of light fixtures and are often used for home security. For instance, timers will turn specific lights on automatically at dusk and off at "bedtime" making the house appear occupied when you are away from home. [11]

1.7 Putting the Strategies to Work at Home

Experts know that the right lighting can dramatically change the look and feel of a room. Listed below are several ideas to enhance the beauty of the home and to increase lighting energy efficiency room by room.

1.7.1 In the Kitchen

• Mount low-profile fluorescent tube fixtures under wall cabinets located above work surfaces to provide the required light for food preparation and clean-up. They should be mounted as close to the front of the cabinet as possible to avoid countertop glare. A good choice is a thin T5 fluorescent tube lamp.

• Use recessed ceiling fixtures or track lighting with the new generation of ENERGY STAR CFLPAR bulb or 45-50 watt T-H PAR 38 flood lamps over a work island or open counter. (See Sidebar: Spot or flood lights—What's the difference?)

• Use a pendant fixture over a kitchen table or center island and equip the fixture with an ENERGY STAR labeled CFL approved for dimmer use.

• For ambient lighting, choose ceiling-mounted ENERGY STAR labeled fluorescent fixtures and use ENERGY STAR labeled lamps (choose medium to warm color). Select a ceiling fixture that directs some of the light up toward the ceiling. This minimizes the "gloomy" look of a dark ceiling and can make a small room feel larger. [5]

1.7.2 In the Dining Room

• Combine a decorative fixture or chandelier over the dining table with other fixtures that provide ambient light. A hanging fixture by itself usually becomes a source of glare if it is used to brightly illuminate the entire room.

• Use the new generation of ENERGY STAR CFL-PAR in recessed ceiling or track fixtures as accent lighting to highlight a painting or to illuminate a buffet. CFL floodlights used in recessed cans or similar fixtures can orient the light in a particular direction. A 15-watt CFL is the replacement for a 60 to 65 watt incandescent bulb.

• Install separate dimmer switches for each type of lighting to provide maximum flexibility. [5]

1.7.3 In the Living Room

• Use CFLs with high light-output bulbs in reading lamps next to furniture. The circular style (30-watt) with an electronic ballast will produce 2200 lumens, equivalent to a 150 watt incandescent bulb.

• Use a technological breakthrough—small, bright, and long-life fluorescent reflectors are available today. A 23-watt R-25 reflector is more compact than the 75-watt R-30 reflectors it typically replaces in spotlights and track lights, and it has a rated life of 15,000 hours, which is 50 percent longer than other compact fluorescent reflectors. For track lights or spotlights, particularly those that are hard to reach, there is no better choice. Also use CFL flood lights in recessed fixtures over game tables or activity areas. Add dimmer switches for maximum light control and energy savings.

• Try a lighting technique called "wall washing" for ambient lighting. Look for the new recessed ceiling fixtures made for compact fluorescent lamps or use a decorative wall bracket with fluorescent tube fixtures. Directing the light toward ceilings and walls reflects light throughout the room. (Note: This is not as effective in rooms with dark colored walls.) [5]

1.7.4 In the Bedroom

• Soft, ambient lighting is usually adequate and attractive for bedrooms, with an additional reading lamp or two at the bedside.

• In a master or guest bedroom, install one ENERGY STAR ceiling fixture using two ENERGY STAR 15-20 watt CFLs.

• Adding a light in the closet can be a useful method to avoid lighting the entire room. Although, be aware that there are safety code restrictions to placing fixtures and bulbs too close to clothing or other combustible materials. (See side bar: Closet lights must meet building code.)

• In a child's room use ENERGY STAR ceiling fixtures and ENERGY STAR table lamps, or use ENERGY STAR CFLs in standard lamps. ENERGY STAR CFLs produce up to 90 percent less heat than incandescent bulbs, so they are less of a fire or burn hazard and are much safer to use near children. Additionally, installing motion detectors will ensure that the lights are turned off when the room is not occupied. [5]

1.7.5 In the Bathroom

• Use ENERGY STAR linear fluorescent bulbs and fixtures on both sides of the mirror for the best cosmetic lighting. Fixtures using compact fluorescent bulbs can provide high-color rendering and match the "warm glow" of incandescence while using less energy. A second-best choice would be lighting located above the mirror.

• Provide lighting above bath and shower areas for safety especially in larger bathrooms with ENERGY STAR recessed or surface mounted ceiling fixtures. [5]

1.8 Types of outdoor lighting

Recent developments in outdoor lighting have greatly expanded the possibilities to increase the safety, security and beauty of the home and property as well as saving energy. With Minnesota's cold, northern climate, check the light fixture or bulb for cold weather performance. Installing a new fixture is not required to achieve automatic dusk to-dawn lighting and improve the safety around the property. Many fixtures can use halogen floodlights with a built-in photo-sensor, which will automatically turn itself on at dusk and off at dawn. This floodlight has a rated life of 3,000 hours, which is 50 percent longer than the typical rated life of regular floodlights. Additionally, ENERGY STAR CFL outdoor floodlights are available. These CFLs can provide the same amount of light, last longer, and consume less power than regular incandescent reflector lamps. Low-voltage incandescent or tungsten-halogen fixtures and bulbs are popular for landscape lighting because of their safety (reduced shock hazard), low energy cost, and easy installation. They run on a 12-volt current rather than the standard 120 volts and operate off transformers, similar to doorbells. Choose among tier lights, mushroom lights, floodlights, or high and low walk lights, many of which come mounted on stakes that push into the ground. For greatest efficiency and savings, operate these lights with motion detectors or programmable timers to limit their on-time and energy consumption. Insect lights just don't work! Designed to trap and kill insects (specifically mosquitoes), they would seem a good choice for an outdoor light in Minnesota. Unfortunately, these lights usually attract mosquitoes in such large numbers that the kill rate is ineffective. Ultraviolet and blue wavelengths attract insects yellow repels them. High-pressure sodium lights, with their golden yellow hues, would be a good choice. Or, any bulb with a yellow coating or a fixture with a yellow lens would also work as a repellent. Gas lights with mantles that are heated with natural gas are sometimes still used for outdoor decorative lighting. These lamps give out very little light for the energy consumed. Also, the cost of operating a gas lamp is expensive (four to 16 times as much as incandescent). It would be more economical to convert a gas light to an electric fixture with a low voltage conversion kit that includes a photocell. Or, convert to standard voltage and equip the lamp with photocell and motion detector controls or simply use an ENERGY STAR CFL.

High-pressure sodium lamps (HPS), characterized by a "golden" or yellow colored light, provide a highly efficient means to light wide areas, such as yards and building perimeters, and are a good replacement for older "blue-green" mercury vapor lighting. Recently, fixtures have been developed for high-pressure sodium lights that mount on the sides of outdoor buildings, which would be a good choice for lighting areas around garages, barns or other buildings. In animal production barns it is important to use fixtures rated for high humidity and damp conditions. Solar electric or photovoltaic (PV) cells directly convert sunlight into electrical energy. Solar electric light systems collect and store energy from the sun, then use the energy to produce light at night. They are most useful as an outdoor summertime light, especially for those who would otherwise have to pay for extending electrical wiring into their yards or to a remote site. Although, be aware that not all PV light kits are the same. Before purchasing, make sure the operating characteristics are compatible with Minnesota winter temperatures and the intended use. Lighting controls are useful outdoors as well as indoors:

- Automatic timers allow lights to go off and on at specific times.
- Photocell controls, sensitive to natural light levels, will automatically turn lights on at dusk and off at dawn.
- Motion detectors can turn lights on and off when someone steps in and out of range.
- The best lighting option would be the marriage of a photocell control to energize the system and a motion detector to control the illumination.
- All controls must be protected from the weather. Be sure to check the operating temperature range before installing any outdoor lighting equipment. Higher quality products often include circuitry, which compensates for Minnesota's temperature ranges. [1]

1.9 Calculating the Numbers of Luminaires Needed

When you add a luminaire from a database or PHILLUM file, Calculux can give you a quick estimation of the number of luminaires needed to provide the required illuminance level. The calculation is done according the so called Utilization Factor (UF) method. [4]

1.9.1 Quick Estimation

If you enter the required illuminance level (in the Room dialogue box), Calculux will be able to determine a quick estimation of the number of luminaires needed. This calculation is done for each luminaire individually and is performed according to the UF (Utilization Factor) method described in CIE reports 40 and 52. [4]

$$N = \frac{E * L * W}{NL * F * MF * UF}$$

Where the variables are:

N = number of luminaires needed

E = required illuminance

L = room length

W = room width

NL = number of lamps in each luminaire

F = lamp flux

MF = maintenance factor

UF = utilization factor

1.9.2 Utilization Factor (UF)

The Utilization Factor is calculated according to the lumen method. This method uses the CIE flux code of the luminaire, the room's dimensions and the reflection properties of its surfaces to perform the calculation. The room's dimensions are characterized by the room index K, defined as:

$$K = \frac{L * W}{(H_1 - H_0) * (L + W)}$$

Where the variables are:

L = room length

W = room width

H1 = room height

H0 = height of the working plane

The Utilization Factor can be found when the room index and the reflectance of the room are known. They are tabulated as part of the luminaire photometric data. Strictly speaking, the UF method is only valid if the luminaire arrangement and the room dimensions are exactly the same as those in the CIE reports. However, experience shows that the values are valid for most practical situations. The UF method of calculating the number of luminaires is used as a rough indication. A point calculation can always be performed. For this reason Calculux Indoor only uses the CIE method of calculating the utilisation factor as the differences between it and other methods (DIN, CIBSE, etc.) are quite small. The table below shows an example of room index values for a typical luminaire. [4]

Table 1.2: Utilization Factor Table

room index K	Reflectances (%) for ceiling, walls and working plane										
	80 50 30	80 50 10	70 50 30	70 50 20	70 50 10	70 30 10	50 30 10	50 10 10	30 30 10	30 10 10	0 0 0
0.60	0.39	0.37	0.39	0.38	0.37	0.33	0.33	0.31	0.33	0.30	0.29
0.80	0.46	0.44	0.46	0.44	0.43	0.39	0.39	0.37	0.39	0.36	0.35
1.00	0.52	0.48	0.51	0.50	0.48	0.44	0.44	0.42	0.44	0.41	0.40
1.25	0.57	0.52	0.56	0.54	0.52	0.49	0.48	0.46	0.48	0.46	0.45
1.50	0.61	0.55	0.60	0.57	0.55	0.52	0.51	0.49	0.51	0.49	0.48
2.00	0.66	0.59	0.65	0.62	0.59	0.57	0.26	0.54	0.55	0.54	0.52
2.50	0.70	0.62	0.68	0.64	0.61	0.59	0.58	0.57	0.57	0.56	0.55
3.00	0.72	0.63	0.70	0.66	0.63	0.61	0.60	0.59	0.59	0.58	0.57
4.00	0.75	0.65	0.73	0.68	0.64	0.63	0.62	0.61	0.61	0.60	0.59
5.00	0.76	0.66	0.74	0.69	0.65	0.64	0.63	0.62	0.62	0.61	0.60
	Suspension ratio: 0 Calculated acc. to CIE publication 40 LVW1077000-00										

1.9.3 Uniformity Check

In some instances, the database contains information about the maximum advisable spacing to height ratios of luminaires which provide good uniformity. These values are taken into account in the Quick estimation and can sometimes lead to a greater number of luminaires than required to provide the average illuminance level.

The uniformity check is restricted to checking the minimum numbers in length and width. This check is performed only if the luminaire maximum spacing to height ratio is given in the database. The uniformity check is based on the values as given in the data base. These values are calculated for a grid of 4 times 4 luminaires. The uniformity is calculated in the square of the middle four luminaires (as set out in CIBSE TM5).In practical situations the above conditions are not always met. [7]

1.9.4 Quality Figures

Calculux allows you to show the quality figures of the calculations. Depending on the settings of the Quality Figure tab (see Calculation menu, Presentation...) the following quality figures can be displayed: Average value calculation The average value for a grid is worked out by adding the calculated values of each point and dividing it by the number of grid points (grid dimensions; AB, AC). [7]

$$\text{Average} = \frac{\text{S calculated values for all idividual points}}{(\text{Points AB}) * (\text{Points AC})}$$

Minimum

This is the minimum calculated value.

Maximum

This is the maximum calculated value.

Minimum/maximum

This is the minimum calculated value divided by the maximum calculated value.

Minimum/average

This is the minimum calculated value divided by the average calculated value. Unified Glare Rating according to the CIE tabular method (UGRCIE) This is the Unified Glare Rating under reference conditions as specified in the CIE tabular method.

1.9.5 Report Setup

A very useful feature of Calculux is the report facility. When you have completed a lighting project you can create attractive reports to present the results of the calculations to your customers. By means of the Report Setup you can simply specify the layout of the report and components you wish to include. For example, you can include, a table of contents, 2-D and 3-D project overviews, a summary, luminaire information (including Polar or Cartesian diagram) and/or financial data. For detailed information about your calculation results you can include the following presentation formats:

* Textual Table;
* Graphical Table;
* Iso Contour;
* Filled Iso Contour;
* Mountain Plot.

You can also include a summary of your findings and recommendations about the best lighting solutions. If you wish, you can produce reports in several languages. The order of the calculation results can be altered (see Calculation Presentations dialogue box). However, the order of the presentation formats is governed by Calculux and cannot be altered. Calculux enables you also to print a report in portrait or landscape format with the 2D result views rotated 90°. This option (Report menu, Print Setup, Layout tab) can be very useful. For instance, when a report which has to be printed in portrait format contains a landscape formatted 2D result view which looks relatively small. By selecting 'Rotate presentation for Portrait Printing', the 2D result views will be rotated 90°. Because of the rotation the view can be enlarged. [7]

1.10 Cost Calculations

Calculux allows you to calculate the annual energy, investment, lamp and maintenance costs for the lighting installation in your project. You can view and/or enter the data for calculating the 'annual costs' and the 'total investment' costs of the project. [4]

1.10.1 Total Investment

The Total Investment is the cost of the luminaires, lamps and the installation of the entire lighting project. The Total Investment costs are calculated according to the following formula:

$$\text{Total\_Investment} = \Sigma_{\text{lumtype}}(NT * (LPR + INSTC + (LAPR * NL)))$$

Variables:	Meaning:
INSTC	Installation costs of the particular luminaire type;
LAPR	Lamp price for the particular luminaire type;
LPR	Price of the particular luminaire type;
NL	Number of lamps for the particular luminaire;
NT	Number of luminaires of the particular type;
Σ_{lumtype}	Sum for all luminaires types.

1.10.2 Annual costs

The total annual costs are calculated according to the following formula:

Total Annual Cost = EN + AI + LC + MC

Variables:	Meaning:
EN:	Energy costs per year;
AI:	Annual investments costs for the particular luminaire type;
LC:	Lamp replacement costs per year;
MC:	Maintenance costs per year.

The formulas for these costs are: [4]

$$EN = \frac{KWHPR}{1000} * \Sigma_{swimod}\{\{\Sigma_{lumtype}(NT_{swimod} * LWATT)\} * BRNH_{swimod}\}$$

$$AI = AF * \Sigma_{lumtype}\{NT * (LPR + INSTC)\}$$

$$AF = \frac{R/100}{1 - \{1/[1 + R/100]\}^{**N}}$$

$$LC = \frac{\Sigma_{lumtype}\{NT * NL * LAPR\}}{RP}$$

$$MC = \frac{\Sigma_{lumtype}\{NT * MCL\}}{RP}$$

Variables:	Meaning:
AF	the annuity factor;
$BRNH_{swimod}$	the burning hours per year of the switching mode;
INSTC	the installation cost per luminaire for a particular luminaire type;
KWHPR	the kilowatt-hour price;
LAPR	the lamp price for a particular luminaire type;
LPR	the price per luminaire for a particular luminaire type;
LWATT	the total watts per luminaire for a particular luminaire type;
MCL	the maintenance cost per luminaire for a particular luminaire type;
N	the amortization period (years);
NT	the number of luminaires of a particular type;
NT_{swimod}	the number of luminaires of a particular type per switching mode;
NL	the number of lamps per luminaire for a particular luminaire type;
R	the interest rate (%);
RP	the relamping period (years) for a particular luminaire type;
$\Sigma_{lumtype}$	the sum for all luminaire types.

1.10.3 Cost calculations and light regulation factors

There is no linear relation between the value of the light regulation factor and the power consumption of a luminaire. As a result of this, when light regulation factors are used, the power consumption of the luminaire can not be calculated. So in the cost calculation the energy costs will not be given. [11]

1.11 Maintenance Factor/New Value Factor

The Maintenance Factor is the ratio of the average illuminance on the plane under investigation after a specified period of use of the lighting installation, to the average illuminance obtained under the same conditions for a new installation. It is always equal or less than 1 and is used as a multiplier for calculations, based on luminaire light distribution tables. [8]

In some countries the New Value Factor (or Inverse Maintenance Factor) is used. Calculux allows you to use new value factors instead of maintenance factors. The 'Inverse Maintenance Factor' is always more than or equal to 1. The following maintenance factors are specified:

* General Project Maintenance Factor;
* Luminaire Type Maintenance Factor;
* Lamp Maintenance Factor.

1.11.1 General Project Maintenance Factor

This maintenance factor takes into account a general factor with which all calculation results are multiplied. It acts as a safeguarding factor and must reflect the overall conditions of the room surfaces. The value of the 'Project Maintenance Factor' is always equal or less than 1. [8]

1.11.2 Luminaire Type Maintenance Factor

This maintenance factor takes into account the reduction of light output caused by dirt deposited on or in a luminaire. The rate at which the dirt is deposited depends on the construction of the luminaire and the extent of what dirt is present in the environment. The value of the 'Luminaire Type Maintenance Factor' is always equal or less than 1.

1.11.3 Lamp Maintenance Factor

The Lamp Maintenance Factor value is always equal or less than 1 and consists of two elements:

a) Lamp Survival Factor;

b) Lamp Lumen Depreciation Factor.

a) Lamp Survival Factor

This maintenance factor takes into account the percentage of the lamp failures during a specific number of operation hours. It is only applicable when a group replacement is to be carried out. The 'Lamp Survival Factor' is based on the assumptions about the switching cycle, supply voltage and control gear.

b) Lamp Lumen Depreciation Factor.

This maintenance factor takes into account the fact that the luminous output of all lamps decreases with use. [8]

1.12 Project Description Example

1.12.1 Top Project Overview

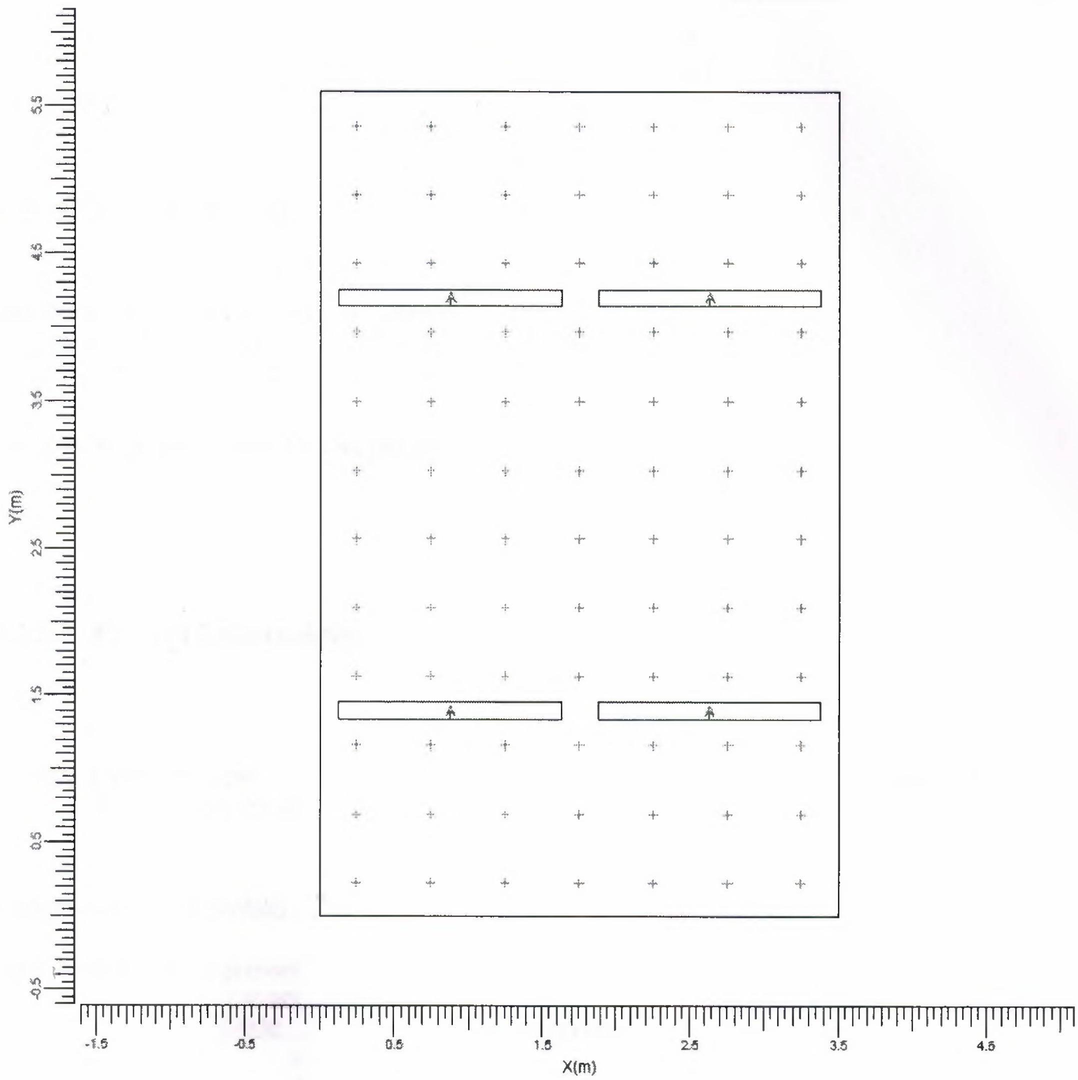


Figure 1.2: Top Project Overview

Width	Length	Height	Working Plane Height	Scale
3.50 m	5.60 m	2.70 m	0.80 m	1:40

1.12.2 Calculation Summary

1.12.2.1 Room Summary

Room Dimensions		
Width	3.50	m
Length	5.60	m
Height	2.70	m
Working Plane Height	0.80	m

Surface	Reflectance
Ceiling	0.50
Left Wall	0.30
Right Wall	0.30
Front Wall	0.30
Back Wall	0.30
Floor	0.10

Room Position (Front Bottom Left)		
X	0.00	m
Y	0.00	m

Total Average Room Surface Luminance (cd/m2):

Ceiling	Left	Right	Front	Back	Floor
4.8	10.6	10.7	9.0	9.0	9.0

The overall maintenance factor used for this project is 0.80.

1.12.2.2 Project Luminaires

Code	Qty	Luminaire Type	Lamp Type	Power (W)	Flux (lm)
A	4	TBS 600/135 C7-60	1 * TL5 35W HE	40.0	1 * 3650

The total installed power: 0.16 (kWatt)

Number of Luminaires Per Arrangement:

Arrangement	Luminaire Code	Power (kWatt)
	A	
Room Block	4	0.16

1.12.2.3 Calculation Results

(Il)luminance Calculations:

Calculation	Type	Unit	Ave	Min/Ave	Min/Max	Result
Working Plane	Surface Illuminance	lux	357	0.59	0.46	Total

1.12.3 Calculation Results

1.12.3.1 Working Plane: Textual Table

Grid	:	Working Plane at Z = 0.80 m
Calculation	:	Surface Illuminance (lux)
Result Type	:	Total

X (m) Y (m)	0.25	0.75	1.25	1.75	2.25	2.75	3.25
5.37	211<	273	307	311	307	274	213
4.90	267	352	390	393	390	354	270
4.44	289	387	419	415	419	388	292
3.97	292	391	424	418	424	393	295
3.50	293	387	430	432	430	389	295
3.03	307	403	453	463>	454	405	309
2.57	307	403	453	463>	454	405	309
2.10	293	387	430	432	430	389	295
1.63	292	391	424	418	424	393	295
1.16	289	387	419	415	419	388	292
0.70	267	352	390	393	390	354	270
0.23	211	273	307	311	307	274	213

Average	Min/Ave	Min/Max	Project maintenance factor
357	0.59	0.46	0.80

1.12.3.2 Working Plane: Iso Contour

Grid	:	Working Plane at Z = 0.80 m
Calculation	:	Surface Illuminance (lux)
Result Type	:	Total

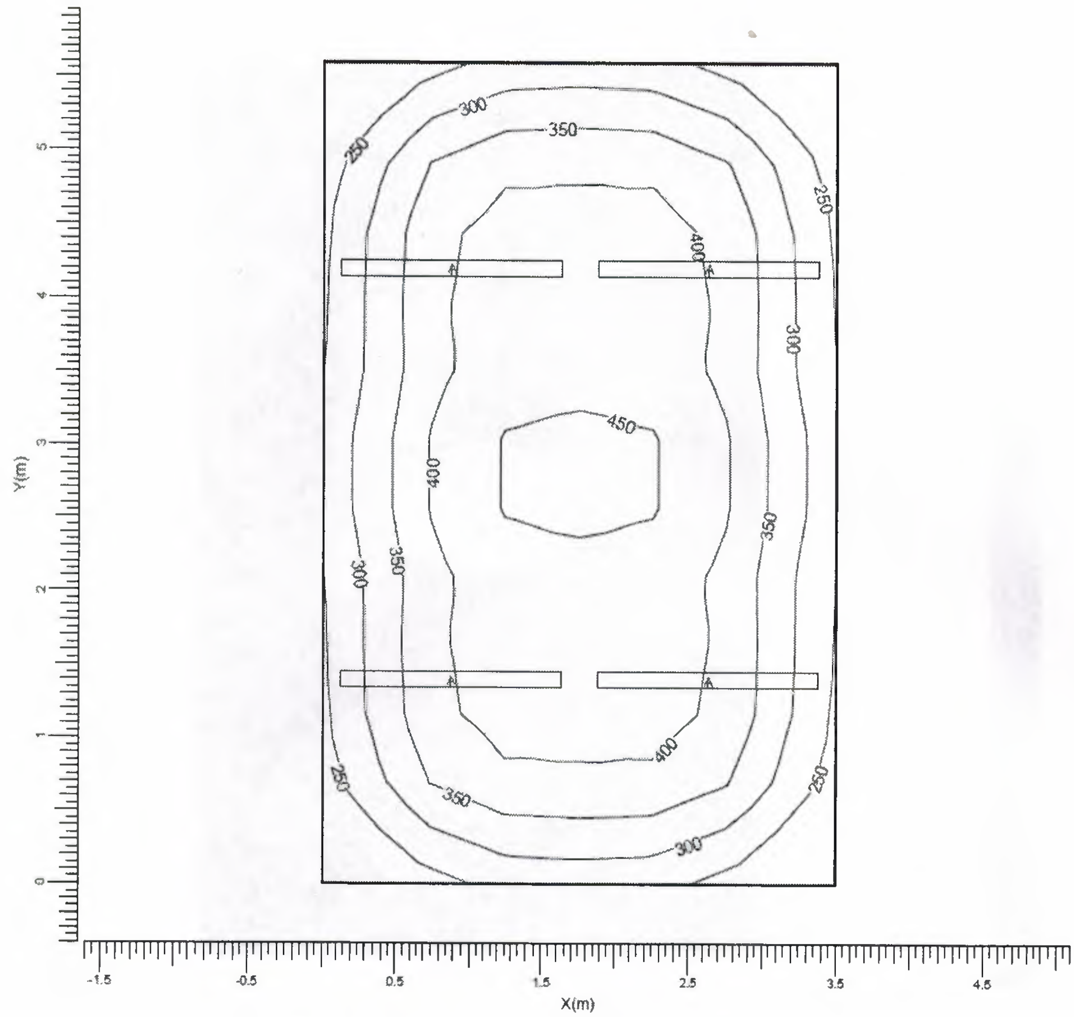


Figure 1.3: Working Plane/ Iso Contour

Average	Min/Ave	Min/Max	Project maintenance factor	Scale
357	0.59	0.46	0.80	1:40

1.12.3.3 Working Plane: Filled Iso Contour

Grid	:	Working Plane at Z = 0.80 m
Calculation	:	Surface Illuminance (lux)
Result Type	:	Total

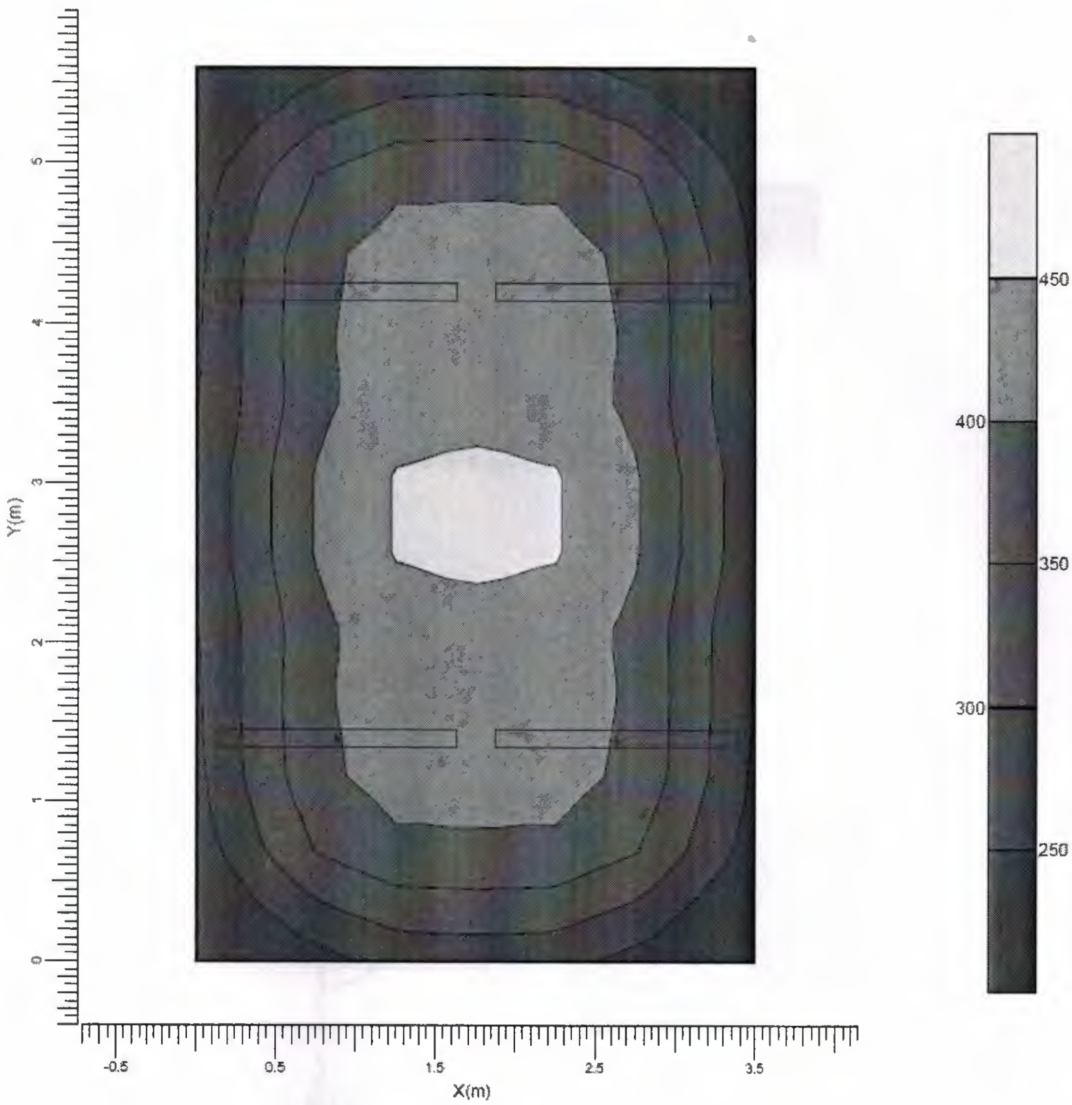


Figure 1.3: Filled Iso Contour

Average	Min/Ave	Min/Max	Project maintenance factor	Scale
357	0.59	0.46	0.80	1:40

1.13 Lamp Circuitry

1.13.1 One way switch

The lamps are controlled as a logical on or off by using switches which are separated to one way and two way according to our lighting demand and the figures below show the circuit diagram of them: [5]

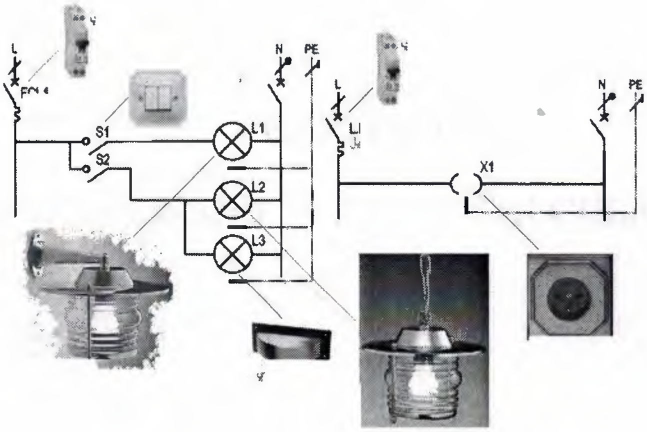


Figure 1.4 Lighting Circuit Diagram

1.13.2 Two ways switch

Lamps could be controlled from sides as following:

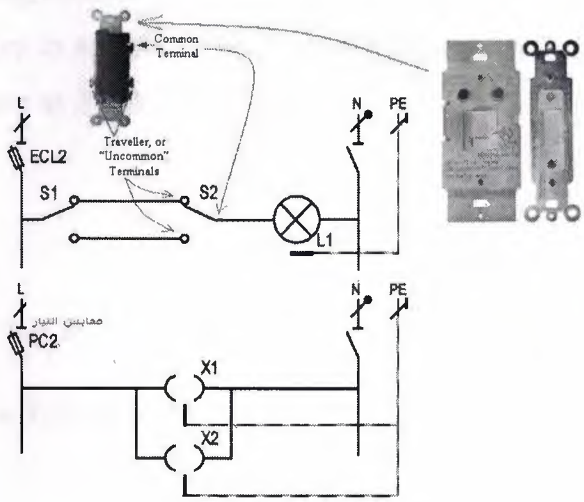


Figure 1.5 Lighting Circuit Diagram

1.14 Summary

In this chapter, a fully detailed explanation had been presented, thus, new lighting products were not only more energy efficient, they offered many more possibilities to improve the quality of lighting our homes, indoors and out. This chapter looked at some of the new technologies for residential lighting, compared the cost benefits, identifies four basic strategies to apply, then provided specific examples of how to put the new strategies into practice throughout the home rooms.

CHAPTER TWO

VOLTAGE AND CURRENT CALCULATIONS

2.1 Over View

This chapter includes a fully detailed explanation where all the voltage and current related topics listed to satisfy the demand of an electrical installation projects designer, thus the main calculations exercises its influence during this chapter.

2.2 VOLTAGE DROP CALCULATION FORMULA

In the design procedure one of the most important things is voltage drop calculations. Voltage drop in any place shouldn't bigger than 3%, where these are listed based on the kind of phase as follows:

2.2.1 For three phases:

$$\% e = \frac{100 \times L \times N}{K \times S \times U^2} < 3 \text{ (must be like this)}$$

Result:

$$\% e = \frac{0.0124 \times L \times N}{S} < 3$$

- L......................: distance of the line (m)
- N.....................: power (KW)
- S......................: conductive cross section (mm^2)
- K.....................: conductive coefficient
- U.....................: voltage (380 volt)
- %e...................: calculation voltage (percent) [4]

2.2.2 for single phase

$$\%e = \frac{200 \times L \times N}{K \times S \times U^2} < 1,5$$

Result:

$$\%e = \frac{0,074 \times L \times N}{S} < 1,5$$

- U....................: voltage (220 volt)

2.3 FORMULAS CURRENT CONTROL:

2.3.1 for three phases:

$$N = \sqrt{3} \times U \times I \times COSØ$$

$$I = \frac{N}{\sqrt{3} \times U \times COSØ}$$

- N................: power (w)
- I..................: current (A)
- U................: voltage (380 volt) [4]

2.3. 2 Single phase:

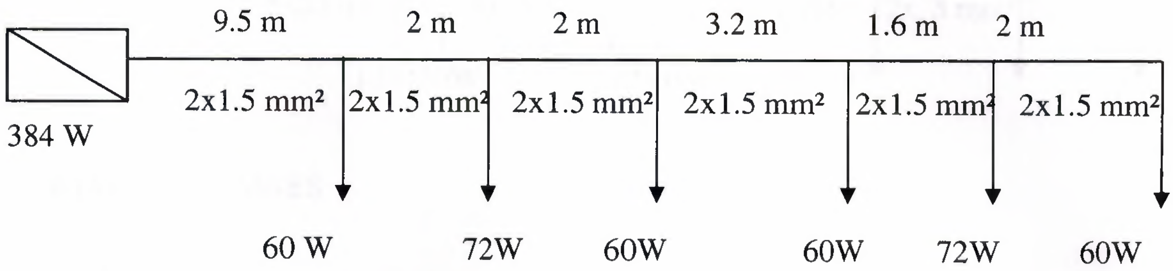
N: U x I x COSØ

$$I = \frac{N}{U \times COSØ}$$

- U.................: voltage (220 volt)

2.4 LIGHTINGS:

TG-1

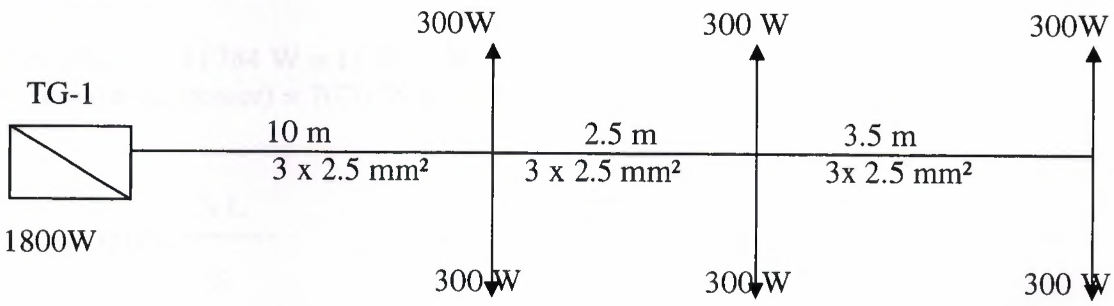


$\%e = 0.074 \times [(9.5 \times 0.384/1.5) + (2 \times 0.324/1.5) + (2 \times 0.252/1.5) + (3.2 \times 0.192/1.5) + (1.6 \times 0.132/1.5) + (2 \times 0.060/1.5)] = 0.285$

0.285 < 1.5 CROSS SECTION IS SUITABLE

$$I = \frac{384}{220} = 1.74 \text{ A [3]}$$

2.5 SOCKET:

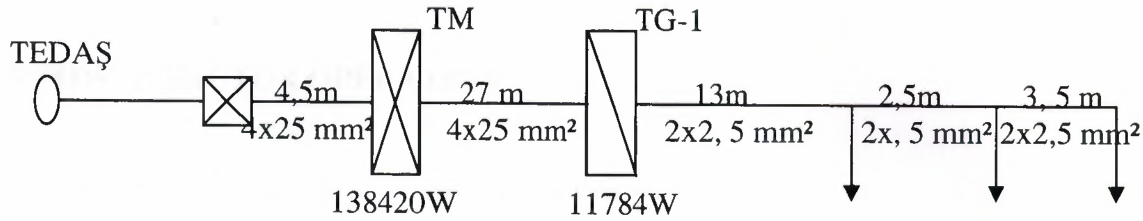


$\%e = 0.074[(10 \times 1{,}8/2{,}5) + (2{,}5 \times 1{,}2/2{,}5) + (3{,}5 \times 0{,}6/ 2{,}5)] = 0{,}683$

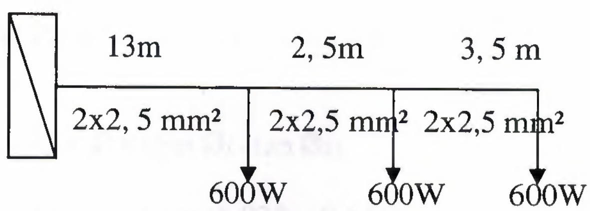
0,683 < 2, 5 SÜITABLE FOR CROSS SECTION

$$I = \frac{1800}{220} = 18.18$$

2.6 THE MAIN CASES VOLTAGE CALCULATION:



- FOR TG-1 CASES



$$\%e1 = 0.074 \frac{N\,L}{S} = 0.074[(10 \times 1,8/2,5) + (2,5 \times 1,2/2,5) + (3,5 \times 0,6/2,5)] = 0,683$$

- FOR COLOMN LINE:

N (set power) = 11784 W = 11,784 kW
N (synchronous power) = 7070 W = 7,070 kW

$$\%e2 = 0,074 \frac{N\,L}{S} = 0.074 \frac{27 \times 7,070}{25} = 0,565$$

- FOR THE MAIN CASES:

N (set power) = 138420 W = 138,420 kW

N (synchronous power) = 83052 W = 83,052 kW

$$\%e3 = 0{,}0124 \frac{N\,L}{S} = 0.0124 \frac{4{,}5 \times 83{,}0}{25} = 0{,}185$$

$\%e = \%e1 + \%e2 + \%e3 = 0,\ 68 + 0{,}565 + 0{,}185 = 1,\ 43 <\% \ 1,\ 5$ is suitable [7]

2.7 POWER FACTOR OPERATION

Total Power...= 138420

$\cos Ø_1$...= 0.7

$\cos Ø_2$...= 0.99

Demand Power....................................= 83052

$$Q = P \times (\tan Ø_1 - \tan Ø_2)$$

$$Q = 83052 \times (1{,}020 - 0{,}142)$$

$$Q = 72919 \text{ VAR}$$

- Q....................: Reactive Power (VAR)
- P....................: Active Power (W)
- Cos Ø.............: Power coefficient

So to using 75 KVAR's panel [7]

2.8 Summary

A fully detailed explanation have been presented in this chapter, where all the voltage and current related topics listed to satisfy the demand of an electrical installation projects designer, thus the main calculations have exercised its influence during this chapter.

CHAPTER THREE
ELECTRICAL INSTALLATION DESIGN

3.1 Over View

Flats and maisonettes are built in large and small complexes with a range of floor levels at both high and high and low rise. The pattern of electrical distribution varies in accordance with the developer's arrangements for metering and the electrical company's distribution system.

3.2 Metering and distribution

This subject requires early discussion with the electricity company and the client. The whole electrical distribution system depends upon who pays the electricity bills and where meters are be sited.

Metering alternatives include:

- ☒ One landlord's metered supply with either unmetered services to tenants or landlord's metering within flatlets,
- ☒ Individual electricity company services to tenants with meters in flats,
- ☒ Individual electricity company services to tenants with central metering.

The last arrangement is usually preferred by the electricity company. There are advantages with centralized meter reading and having the landlord take responsibility for electrical distribution in the building. A disadvantage may be the possibility of vandalism at the central meter room.

This exercise uses the above central metering system. The plan provides the opportunity to design distribution mains to flats and to answer common problems with earthing arrangements for multiple dwellings. [6]

3.3 Building details construction

This is a new development, but the electrical scheme could be adapted for a refurbishment or conversion contract.

- ☒ Design (see Fig.3.1) Three story, four flats per floor on the upper two levels, three flats plus common rooms on the ground floor.
- ☒ Walls

  Externally and between flats, brick or other masonry.

Partition walls within flats, plasterboard on timber studding.

Plastered internally.

- Floors

Ground floor, heavy concrete base, upper floors concrete beams all with 50 mm leveling screed.

- Ceilings

Ground and first floor, plasterboard on battens, Second floor, and plasterboard on timber beams under a pitched roof.

- Lift

Hydraulic mechanism

- Heating

Gas or oil central boiler in each flat and one in the landlord's common room area. [11]

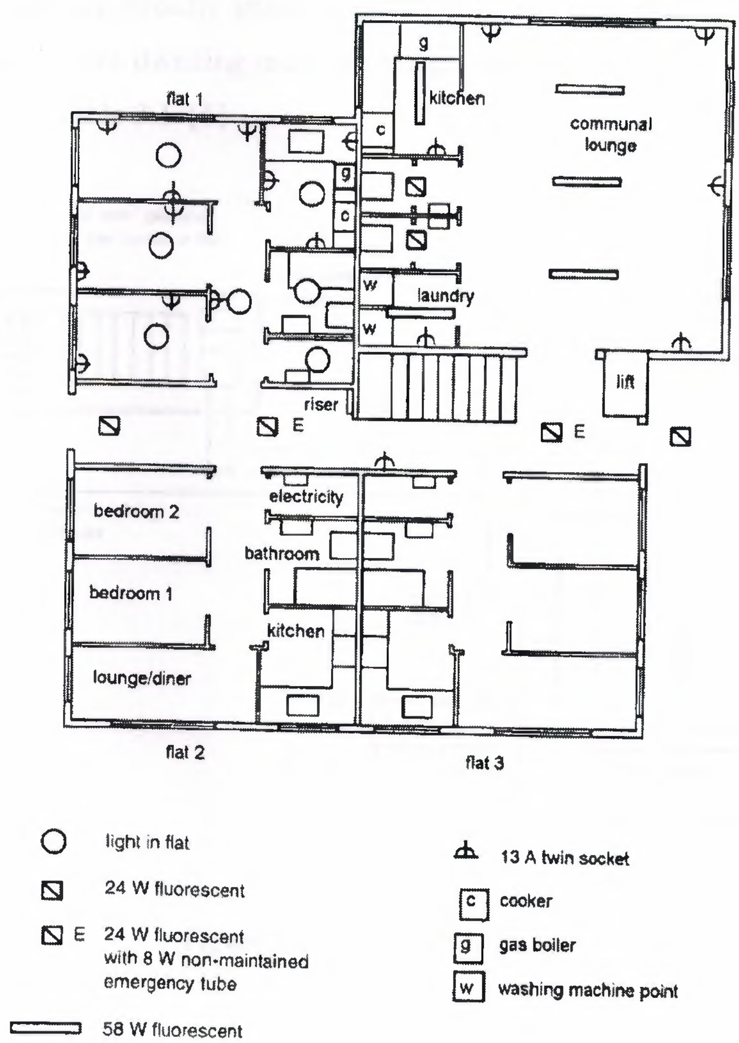


Figure 3.1 Layout of ground floor flats.

3.4 Mains distribution

3.4.1 Main switch fuse

For convenience the mains distribution system and wiring is dealt with in part 2 of this chapter, which covers the landlord's areas. The electricity company's supply tails will connect from the meter into a 63 A switch fuse at the central metering position (See Fig.3.2). Each consumer's supply will be taken through the building to a consumer unit within each flat. [6]

3.5 Electrical requirements in flats

All fiats are similar, with a conventional installation. The number of the outlets is typical and broadly based upon NHBC standards. The fact that we are considering retirement dwelling may encourage the developer to be more generous with outlets than Table 3.1 [6]

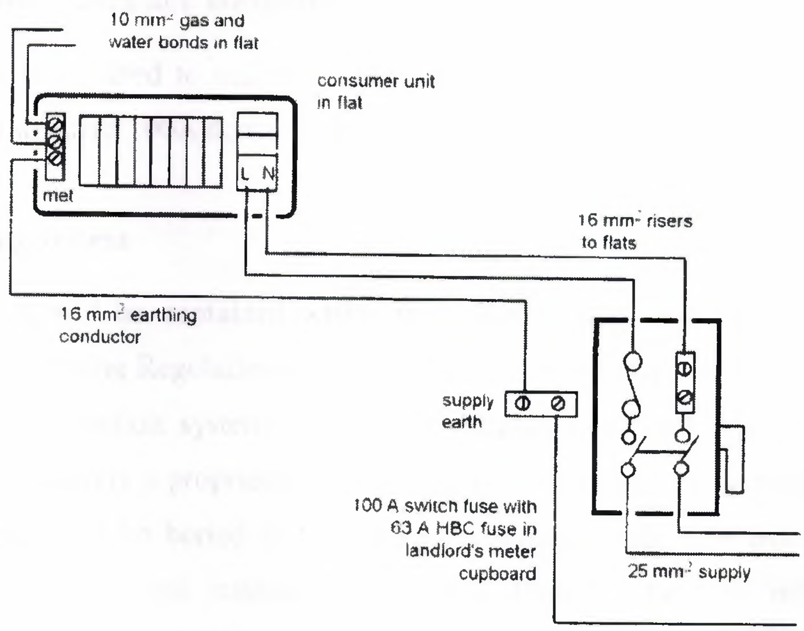


Figure 3.2 Distribution to flats.

Table 3.1 Basic electrical requirements for flats.

Table 3.1 **Basic electrical requirements for flats.**				
Rooms	*Lights*	*13 A sockets (g = gang)* 1 g	2 g	*Other*
Kitchen	1		3	Cooker
Lounge/diner	1	—	3	
Bedroom 1	1	—	2	
Bedroom 2	1	—	2	
Bathroom	1	—	—	
Hallway	1		1	Doorbell Smoke detector

The format for a project Specification for a development of this type is shown in Fig. 3.3. This layout could be used for various schemes with full details completed to suit the work in hand.

3.6 Load assessment and maximum demand

There is no need to make any detailed assessment. The electricity company will give a standard 100A domestic service.

3.6.1 Wiring system

Cables will be contained within the concrete floor and lightweight walls. There are no Wiring Regulations requirements for rewirability but if this is specified a rigid plastic conduit system would be preferable , unsheathed single core pvc cables .Alternatively a proprietary flexible conduit system could be used. A typical system which can be buried in floor screeds utilizes single core pvc cable with special outlet boxes and jointing arrangements. Probably the best "off the shelf" solution, without rewirability, is to use standard Twin – and – earth cable. theoretically, twin-and-earth cable may be buried direct into concrete but for wiring convenience, plastic conduit will be cast into the floor screed. [4]

3.6.1.1 Wiring Hints

Light gauge, rigid PVC conduit is suitable for casting into concrete screeds but care must be taken to prevent damage to the conduit before The concrete is poured. Heavy gauge conduit is more robust but has slightly less cable space.

- ☒ It is essential to have al least 16 mm of concrete cover over plastic conduit. This may be difficult if there are crossovers in the conduit runs, so careful planning of the conduit system layout is necessary to reduce crossovers to a minimum.
- ☒ Ensure that there are draw wires or strings left in all unwired buried conduits. [4]

Project Specification BS 7671				
Name .... Flat No. .... Location .... Reference ..... Date				
240 v 50 Hz. TN-C-S. Supply fuse 100 A BS 1361 or BS 88 PFC less than 16 kA. Earth loop impedance less than 0.35				
Main switch-fuse in meter cupboard 63 A BS 88 fuse Sub main to flat 16 mm² swa 3-core				
Consumer unit in flat BS 5486 or BSEN 60439 Parts 1 & 2 100 A main switch 6 way M6 type B cbs				
Circuits	Rating (A)	Cable size (mm^2)	Max length (m)	Lights/points g=gang
1. Cooker	32	6.0/4.0	39	1
2. Ring 1 kitchen) Boiler)	32	2.5/2.5	84	3 × 2g
3. Ring 2	32	2.5/2.5	84	7 × 2g
4. Lights 1) Bathroom fan)	6	1.0/1.0	59	3
5. Lights 2	6	1.0	59	4
6. Smoke detector	6	1.0	59	

Figure 3.3 Project specifications for a typical flat.

3.6.1.2 Wiring in false ceilings

On the ground and first floors the ceilings are plasterboard fixed to timber battens on the soffit. The use of sheathed cable is acceptable in this space but subject to the same protective requirements as those for cables under floor-boards. The Wiring Regulations require that unprotected cables which do not incorporate a metallic sheath, when installed above plasterboard false ceiling, must be at least 50mm from the underside of the batten. A convenient arrangement to comply with this requirement is to cross-batten the ceiling to give a 75 mm space above the plasterboard. This has the added advantage that cables may be easily routed in any direction with minimal drilling or notching. Cross-battening arrangements should be negotiated early in the contract. Where there are on-site objections from the builder, cables must either be mics, or PVC installed in earthed conduit, or given equivalent physical protection against penetration by nails. This is obviously an expensive alternative to the cross-battening or a notched 75mm batten.

The use of thin metallic or plastic cable capping as physical protection is not adequate in these location. [5]

3.6.1.3 Wiring in roof space

This may be conventional twin-and-earth cable fixed to the timber joists. The roof space will get hot in summer months and it is advisable to keep cables clear of thermal insulation. The lighting load for flats is minimal and no cable derating is necessary. [5]

3.6.2 Cable sizes

All cable loads are relatively low and distances are short. No special factors apply (see Table 3.2).

Table 3.2 Cable sizes and circuitry for flat.

Circuits	*cb rating* (Type B)	*cable size* (mm^2)
Lighting 1	6 A	1.0
Lighting 2	6 A	1.0
Smoke detector	6 A	1.0
Sockets 1	20 A tree	2.5
	or	
	32 A ring	2.5
Sockets 2	32 A tree	4.0
	or	
	32 A ring	2.5
Cooker	32 A	6.0

The cables are contained many kinds as XLP/PVC/NYY according to the missions that standed for|, these are as following in figure 3.4.

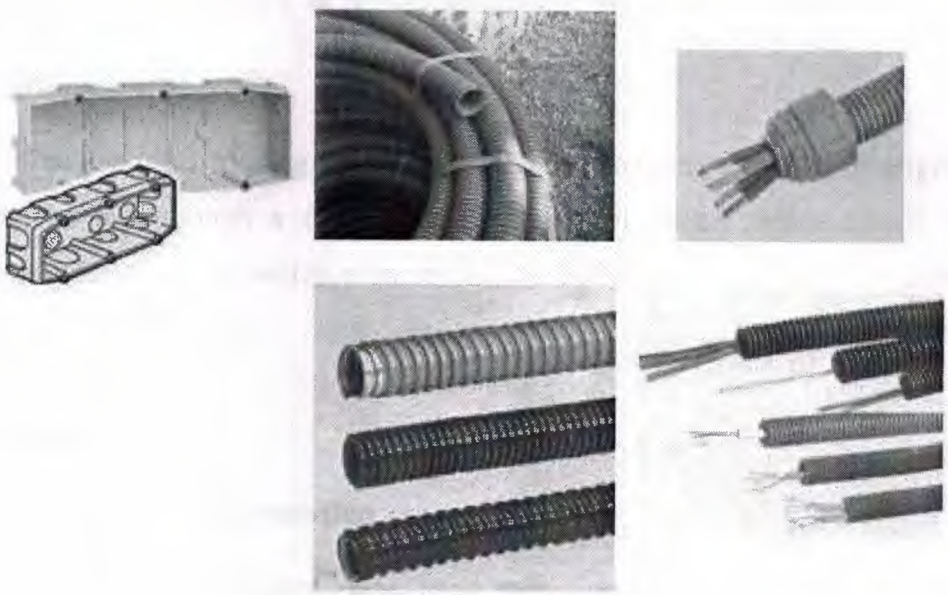


Figure 3.4 The Different Cables Kinds

3.7 Arrangement of circuits

3.7.1 Lighting

Even though these are small flats, there must be more than one lighting circuit per dwelling to ensure that the operation of a single device does not plunge the flat into darkness. This applies to all of dwelling with more than about four lights and is especially important for sheltered accommodation. [11]

3.7.2 Smoke detector

A separate 6 A circuit is required to comply with the building Regulations.

3.7.3 Socket outlets

The kitchen should be considered separately. Either a 32 A rings or 32 A tree system is appropriate for heavy loading. For the rest of the flat a 20 A tree system would be acceptable or a 32 A ring circuit . See Chapter 9 for ideas on circuitry.

3.7.4 Boiler supply

The electrical loading for the gas/oil central heating system is negligible and may be fed through a fused spur on the local socket outlet circuit. British Standards require a switch adjacent to the boiler or programmer to isolate the complete system. [11]

3.8 Consumer unit

3.8.1 Residual current protection

If there are no gardens associated with flats and no likely use of portable equipment out of doors, there is no requirement for any rod protected sockets.
However, many specifiers require 30 mA red protection to all sockets, especially for sheltered accommodation. If red protection is given to sockets it is not acceptable to use a 30 mA rod as a main switch. This could cause nuisance tripping. Protection of sockets should be given separately either with a split bus-bar consumer unit, preferably with combined mcb/ rod units. [5]

3.9 Circuit protection

If it is decided that no rod protection is required, this is one situation where it may be economical for the installer to use rewirable fuses. The subject should be discussed with the client and careful note taken of the long-term maintenance requirements of tenants. Regulations require that equipment shall be suited to the intended purpose. Rewirable fuses are not suitable for disabled or sheltered accommodation. [5]

3.10 Accessibility

The consumer unit must be accessible for the intended occupier. Once again note must be taken of occupier requirements. A similar judgment should be made on the location of the cooker control switch which may be required in an emergency. If a sink waste disposal unit is installed, this must also have an emergency switch conveniently to hand. [5]

3.11 Earthing and bonding

Each flat has a separate electrical installation with a metered supply. An equipotential zone must be set up within the flat. Bonding of a landlord's water and gas mains to the 100 A switch in the remote meter cupboard would not give reliable protection to the installation. It is necessary to take a full size 16 mm2 earthing conductor to the main earthing terminal in the flat. This is shown in Fig.3.2. The supply accompany may permit the use of the third wire in a 16mm2 three-core steel wire armoured cable to be used as an earthing conductor on a pme supply .If a two-core cable is used, a separate 16mm2 earthing conductor will be required. Neither the armouring of an swa cable or the "earth"in a 16mm2 twin and earth cable is large enough for the pme earthing conductor. [1]

3.12 Main earthing terminal

The consumers earthing terminal will be located within, or adjacent to the consumer unit. This is the point where the supply earthing conductor joins the main bonding conductors within the flat. [1]

3.13 Bonding

Standard main bonding requirements apply for 10mm2 connections to incoming water, gas or oil piping. This bonging is to be applied within 600mm of the point of entry into the flat. Supplementary bonding is required in the bathroom. This is best achieved in the adjacent airing cupboard. [1]

3.14 Summery

In this chapter a fully detailed explanation have been provided during the different pattern distribution according to the Belding levels. The manner that enabled us to deal with the electrical parts and where to be used properly.

CHAPTER FOUR

AN INDOOR SWIMMING POOL

4.1 Over View

This is a domestic pool for private use and attached to a house. In general, similar rules apply for larger installations.

These may be complicated by public access requirements and other sports facilities. Only actual swimming pool requirements are studied.

The proposed design could be coupled with the sports centre and provision made for the pool's public use.

This study does not include designs for the electrical control of water treatment and pumping equipment which will be installed.

4.2 Special conditions

A swimming pool is obviously a hazardous area for the utilization of electrical equipment. Extreme care must be taken with arrangements for electrical supplies to pool equipment and the installation in the pool area.

This chapter can only advise on requirements covered by the special sections of the IEE Wiring Regulations devoted to the subjects of swimming pools and saunas. Potential installers should be familiar with these requirements.

Problems related to the appearance of inconvenient but generally harmless' non equipotential pme conditions will be mentioned here with regard to swimming pool facilities.

The subject is given extensive consideration for sports hail showers at the end of Chapter 12. Similar solutions would apply for any swimming pool situation. Only a passing reference is made to an emergency lighting facility. The subject of security, emergency and telephone services should be discussed with the client, especially if usage extends beyond family domestic activities.

A major consideration is the highly corrosive and humid atmosphere. Special care must be taken in the selection of appropriate electrical equipment. The Wiring Regulations specify zones around swimming pool areas where restrictions apply to the installation of electrical equipment. Suggestions are given for the application of these zones to a typical situation. [3]

4.3 Emergency Lighting

There is no requirement for emergency lighting with this private swimming pool, but the subject should be considered .The electricity supply may fail on a dark evening. This would cause hazardous conditions for swimmers, especially children. It is recommended that at least two self-contained emergency luminaries should be provided, one at each end of the pool. [3]

4.4 Other interested parties

Most consultations will be through the client, an architect or the builder. ft is important that a full specification should be prepared in advance of tendering. Some aspects of electrical design affect the pool construction and should be considered before construction starts.

Layout and decorative treatments need to take account of permissible lighting arrangements. The electrical installer must be certain that appropriate advice has been taken horn all relevant authorities.

• *Specialist pool installer*

Electrical requirements for all pool equipment and servicing facilities. ci Electricity company t is the consumer's responsibility to ensure that art adequate supply is available. This job is usually delegated to the electrical installer. The local electricity company may have restrictions regarding the provision of a pme service.

• *Local authority*

If there is any possibility that the pool will be used for public events such as garden paths or fête, the local authority's erwironmental health department should be approached on the subject of safety services.

• *Client's insurers*

are there any special fire and personal safety requirements? [3]

4.5 Building details Construction

•*Design*

A new single storey purpose built structure to be constructed on private land adjoining a large house. Total floor area: approximately 110 m2,

• *Floor*

Concrete, tiled throughout.

• Walls

Brick, fair faced externally and internally. Large glazed areas.

• Roof

Timber frame, lined underside with pinewood ceiling. The ceiling over the pool area is 3 m above floor level. The ceiling over the projecting leisure verandah is 2.25 m above floor level.

• *Changing area*

Walls: building block, tiled throughout.

• *Space and pool water heating* Gas. [5]

4.6 Electrical requirements

Full details of electrical loads are given. The lighting system as shown is f or load assessment only. Manufacturers should be consulted regarding the suitability of products for this corrosive situation.

Table 13.1 **Schedule of equipment.**

All single-phase equipment	
Location	*Single-phase equipment*
Lighting	
Pool area	5 × 150 W SON
Verandah	5 × 100 W recessed downlighters
Plant room	1 × 58 W fluorescent
Changing room	4 × 24 W bulkhead fluorescent
De-humidifiers	2 × 20 A supplies
Plant Room Power	1 × 30 A supply
Socket outlets	
Verandah	1 × twin 13 A
Pool services	2 × 16 A BS 4343
Plant room	1 × twin 13 A
	1 × 16 A BS 4343
Provision for dryer	
Changing room	1 × 2 kW outlet

Figure 4.1: Schedule of equipment.

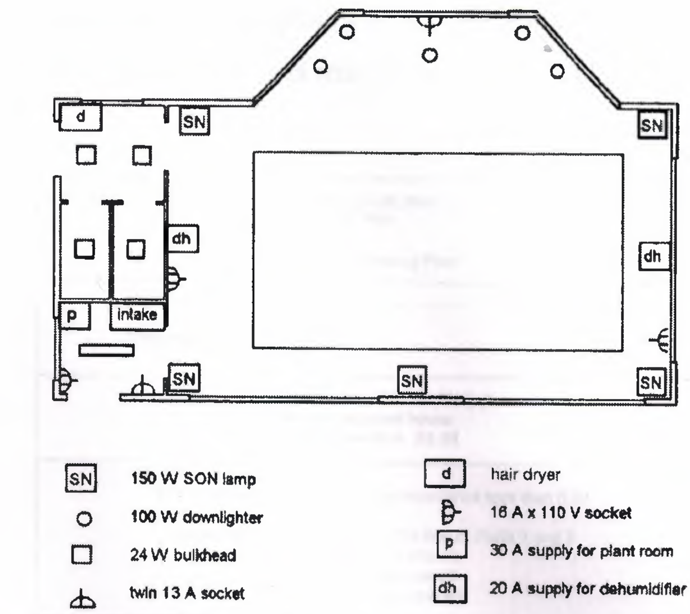


Figure 13.1 Electricity provision in swimming pool.

Figure 4.2: Schedule of equipment.

4.7 Zones

The area surrounding the pool which is in general use may become wet and must be zoned in accordance with standard requirements.

4.7.1 Zone A

This is the water volume within the pool basin including the above-water area up to deck level and any accessible apertures or ledges

- Only 12 *V* maximum SELV (safety, extra low voltage) equipment is permissible. This must be supplied from control gear outside Zones A and B. This will allow only for protection by IPXB (submersible) purpose-made underwater floodlights, each of which must be supplied from its own transformer with an open-circuit voltage not exceeding 18 V.
- The only wiring allowed is for equipment within the zone.
- No accessible metallic junction boxes may be installed Only 12 *V* maximum SELV (safety, extra low voltage) equipment is permissible. This must be supplied from control gear outside Zones A and B. This will allow only for protection by IPXB (submersible) purpose-made underwater floodlights, each of which must be supplied from its own transformer with an open-circuit voltage not exceeding 18 V.

- *The* only wiring allowed is for equipment within the zone.
- No accessible metallic junction boxes may be installed. [11]

Project Specification
BS 7671

Domestic Swimmng Pool

Name...................... Location........................

Reference................ Date....................

Single phase 240 V 50 Hz. TN-C-S
fed from adjacent house
Supply fuse 63 A BS 88

PFC less than 16 kA. Earth loop impedance less than 0.35

Consumer unit BS 5486 or BSEN 60439 Parts 1 and 2
Four type B cbs circuits
One type C cbs circuit
Two 30 mA rcbo circuits

Circuits	cb type	Rating (A)	Cable size (mm^2)	Max length (m)	Lights/points g = gang
1. Lights -SON	C	10	1.5	55	5
2. Lights	B	10	1.5	55	10
3. Sockets 13 A	rcbo	20	2.5	26	2 x 2 g
4. Sockets 16 A	rcbo	20	2.5	26	3
5. Dehumidifier 1	B	20	2.5	26	1
6. Dehumidifier 2	B	20	2.5	26	1
7. Plant room	B	32	6.0	40	1

Figure 4.3. Project specification for swimming pool.

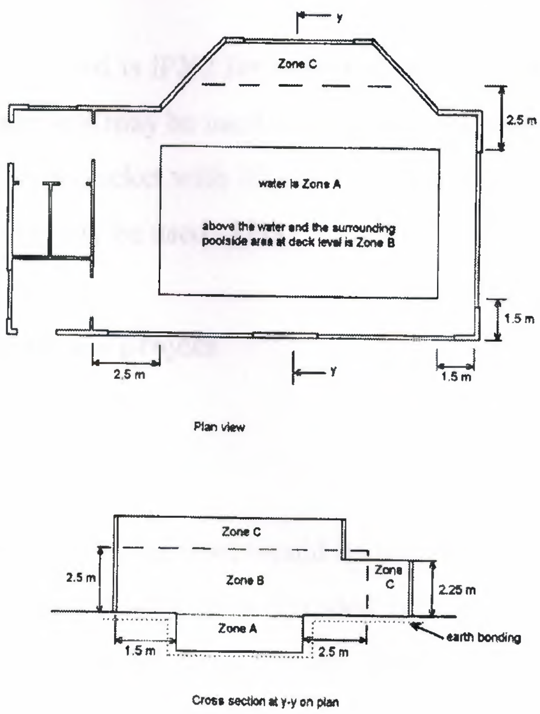


Figure 4.4 Assessment of zones.

4.7.2 Zone B

This is the area above Zone A. extending vertically to an arm's reach height of 2.5 m and full arm span of 2 m horizontally from the poolside. The 2.5 m overhead clearance applies above any steps or poolside raised areas including fountains or diving facilities.

• Only 12 V maximum SELV equipment is permissible, as in Zone A, except that IPX5 (hose proof) minimum protection is adequate.

• The only wiring allowed is for equipment within Zones A and B.

• No switchgear or accessories are permissible except: If a socket outlet is essential and cannot be located outside Zone B, e.g. for a mechanized pool cover, a BS 4343 'Commando' type socket may be installed not less than 1.25 m from the pool edge and at least 0.3 m above the floor. This socket must have 30 mA rcd protections.

•No accessible metallic junction boxes may be installed. [11]

4.7.3 Zone C

This is the reach-out area extending horizontally 1.5 m from Zone B to a similar height of 2.5 m.

• The level of protection required is IPX2 for indoor pools, IPX4 for out- amended door pools and IPXS where water jets may be used for cleaning purposes.

•A 854343 'Commando' type socket with 30 mA rcd protection may be installed.

•Standard SELV equipment may be used . [11]

4.8 Application of zoning to this project

4.8.1 Lighting

Lights on the ceiling above the pool would be more than 2.5 m high and outside any zone; however, this location should be avoided because of access for changing lamps. A better arrangement would be to mount lights at high level on the wall. Luminaries must be out of reach, above 2.5 m minimum height within Zone B. Wall brackets at a lower level are not acceptable except where the poolside deck extends horizontally beyond 2.0 m. On the project in question, the first 0.5 m of the low ceiling in the verandah area comes within Zone B and must be avoided for ceiling-mounted luminaries. [4]

4.8.2 Lighting switches

Switchgear may be installed in Zone C but to avoid long-term corrosion problems a better location is in the ventilated changing area.

4.8.3 Socket

The Regulations require that all sockets must be of the BS 4343 'Commando' style, with 30 mA protection and that they must be located more than 2 m from the poolside. This, therefore, limits their location to one end wall or the verandah area. The sockets shown are for use with pool cleaning equipment at the insistence of the customer, one 13 A 30 mA rcd-protected socket is required for a radio and tape player. This has been positioned on the farthest wall, at the extremity of Zone C.

It probably contravenes the Wiring Regulations and a note to that effect will be added to the completion certificate. Extreme care must be taken in accepting any deviation from the regulations. [4]

4.8.4 Dehumidifiers

These may be mounted as fixed appliances in Zone C areas provided that they are of a type specifically intended for use in swimming pool areas. Protection on a 30 mA rcd circuit is essential with a wired connection to the supply, not a plug and socket.

4.9 Changing room/Shower area

Swimming pool zoning does not apply in these locations. Regulations applicable to showers will apply. These include:

- 13 A socket outlets are not permitted; neither is provision for the connection of portable appliances. If a hair dryer is required this should be of the wall mounted type with a hot air nozzle or flexible hose. 35 3535 shaver units are permitted.
- Lighting switches must be out of reach of a person using the shower, or pull-cord operated.
- Heaters with exposed elements must be out of reach of a person using the shower. [4]

4.10 Loading and diversity

The Wiring Regulations offer no guidance on this type of installation.

4.10.1 Lighting

It is probable that all lights will be used together. No diversity will be allowed. For current loading calculations, discharge lamp ratings should be multiplied by 1.8 to take into account control gear losses.

Pool SOL lighting	$\frac{5 \times 150 \times 1.8}{240}$	= 5.6 A
Verandah spotlights	$\frac{5 \times 100}{240}$	= 2.1 A
Changing room	$\frac{4 \times 24 \times 1.8}{240}$	= 0.7 A
Plant room	$\frac{1 \times 58 \times 1.8}{240}$	= 0.4 A
	Total lighting load	= 8.8 A

4.10.2 Dehumidifiers

These do not work continuously and the 20 A requirement is probably excessive. Assume 75% diversity.

$2 \times 20 \times 75\% = 30$ A

4.10.3 Socket outlets and hair dryer

There is no heating load. All sockets are for occasional use

Assume 30 A maximum load at 33% diversity = 20 A

Total maximum demand = 59 A

A 60 A single-phase supply will be adequate.

4.11 Wiring systems

Corrosion is the major consideration. The Wiring Regulations specify that a surface wiring system shall not employ the use of metallic conduit or trunking, amended or an exposed metallic cable sheath in Zones A or B.

- Steel conduit and trunking is excluded completely.
- Mineral insulated cable (mics) with a continuous PVC sheathing may be acceptable provided that exposed copper or brass is protected at terminations. Severe corrosion may be encountered where mics enters steel enclosures. For this reason it has been ruled

out for this project.

•Steel wire armoured, PVC-sheathed cable would be acceptable provided that terminations could be protected against corrosion. In this instance the only large load that would warrant the use of this cable is the short run in the plant room for pool equipment.

• Twin and earth sheathed cables would be appropriate but in some areas surface wiring would require additional non-metallic cover for protection and appearance reasons. If sheathed cables are buried beneath plaster- work in these damp conditions, plastic capping should be used.

•Plastic conduit and trunking systems are ideally suited to these conditions and will be the chosen materials. Wherever possible non-metallic enclosures should be used. [11]

4.12 Cable sizes

Provided that thermal insulation can be avoided, there are no special limitations requiring derating factors to be applied. Cables installed in plastic conduit or trunking will not be heavily loaded.

There may be a large group of mixed size cables in trunliing near the distribution board. The 32 A supply for the plant room should be kept separate. This will be the case if swa cable is used for this short run. [11]

4.13 Distribution board

A single-phase eight-way distribution board is adequate and this should have a non-metallic enclosure. Two lighting circuits are shown to avoid icon venience in the event of the failure of one. SON discharge lamps do take a surge on start-up and type 3 or C circuit-breakers are advisable.

The 13 A sockets and the outlet for a hair dryer may be run from one single module 20 A combined cb/rcd (rcbo). Similar rcd protection is required for the BS 4343 sockets and a 16 A rating rcbo will give adequate protection.

Although perhaps not strictly essential, rcd protection may be given to the dehumidifiers that are located in potentially wet areas. It should be noted that an rcbo is a single pole device and the neutral remains connected after fault disconnection. It may be considered desirable to have double pole rcd protection.

This will require a double cb space for each unit in the distribution board. Apart from on the SON lighting circuit all other circuit-brealcers should be type B, and unless the electricity company insists on aTT supply, no other rcd protection is necessary. It is not advisable to give overall sensitive rcd protection in this situation where loss of lighting could be hazardous to pool users. [5]

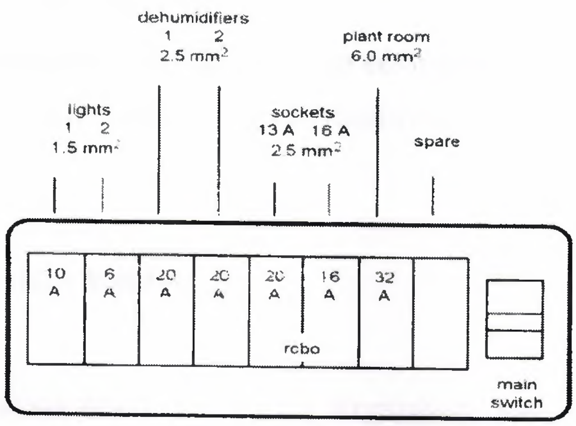


Figure 4.5 Distribution board and cable size.

4.14 Isolation

The facility for isolation of all circuits will be at the distribution board. The main switch must have a lock-off facility and it is suggested that at least one suitable mcb lock should be provided for future use at the distribution board.

4.15 V supply

A 1 kVA 240/1 10 V transformer will be located in the plant room adjacent to the distribution board. It is important to check that the 110 V winding has a mid-point earth connection. There is no requirement for switching at BS 4343 sockets.

This subject should be discussed with the client. It may be considered that switched sockets would provide speedy disconnection in an emergency situation. However, it may not always be safer to have a switch, which may encourage a user of cleaning equipment or a motorized pool cover to leave a plug permanently inserted.

It is obviously safer to remove the plug for equipment not in use Even reduced low voltage at 55 V to earth can be lethal in these wet surroundings. [5]

4.16 Earthing

Subject must be carefully considered. All conventional earthling and main bonding should be carried out in accessible locations where connections may be separated for periodic testing. Earthing clamps to piping should be of the S43-03 non-corrosive type, usually color coded blue.

Those coded red are not suitable for damp environments. Cable terminations at earth clamps should be crimped to ensure reliability throughout the life of the installation. [7]

4.16.1 Local supplementary bonding

This is one location where the Wiring Regulations seek local supplementary bonding. Apart from using the word local there is no regulatory guidance on how this should be achieved. There is no requirement for a special supplementary bonding cable to be taken back to the distribution board, only that exposed conductive parts and extraneous conductive parts should be interconnected.

The definition of extraneous conductive part mentions parts that may introduce a potential into an otherwise equipotential zone.

It is clear that wall, floor mounted or removable handrails only have the local potential and therefore do not need bonding.

Metalwork entering from outside the building should be cross-bonded to the local system In the project under examination it is suggested that the dehumidifiers should have cross-bonding to other exposed conductive parts of electrical equipment and earthy metalwork.

This would include all structural steel or metallic plumbing within the zone. [7]

4.16.2 Floor grid

The amendment to 857671 states that where there is a metal grid in the solid floor it shall be supplementary bonded. The earlier obligatory requirement for this grid has been removed. This is obviously a point that needs discussion with the builder at an early date in the contract. This grid must be cross- bonded to the equipotenfial bonding system by means of accessible and reliable connections. Where there is more than one earthing grid the subject of interconnection should be carefully planned with access covers over sunken inspection traps. [7]

4.17 Summary

This chapter has been included with all the related topics to swimming pool electrical installation from the point of British standard system view , the manner that enables us to design our swimming pool electric installation properly.

CONCLUSION

At the first when I start the project, I hadn't predicted that I have difficulties in this level. However, it is not easy that is seen from outside, because in real life, calculations are placed specific formulation and there is no searching in detail. I tried to get calculations in detail because my purpose is that project should include collect and permanent information.

In project electric interior installation was drawn, after necessary information's were given for illuminating calculations for that, electrical requirement, wire cross section were calculated with falling down of necessary voltage and calculating of current control. In this project the list of the cost and summary of reconnaissance were generated. And also generating of swimming pool instillation and calculations, lighting, wiring system. The ring systems which mostly follow the English system are used.

Auto-Cad programmed has recently an importance place in engineering field in terms of facilities with providing of developing computer technology. Therefore, I got interior installation, loading schedule, column diagram with preferring Auto-Cad 2006 programmed in drawing this project and also I used Microsoft office programmed

This project helps me to see conditions of jobs in business life and process of electrical project drawn in market. I think that learnt working conditions with main frame in market and in addition with taken theory education in university

This project helps me in future work.

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