ELECTRICAL INSTALLATION DESIGN FOR TWO STOREYS WITH AMENITIES HYPERMARKET

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ABSTRACT

This project is about electrical installation design for hypermarket. The scope includes the basement, parking lot and the inner of hypermarket. The design involved equipments design, size and type of cable design and lastly safety and protection design. The design of electrical equipment design such as lighting, socket outlet, low voltage power supply and telecommunication must design according to the rules and regulation. The primary concern when designing electrical installation in the hypermarket is the safety of the equipments and the safety of the people who use the equipments.

Before designing, a survey to the hypermarkets around Shah Alam had been done to observe the requirement and electrical equipments need to be installed in the hypermarket. Then, all the equipments and the requirements had been studied to get further information. The second phase is designing the equipments such as lighting, socket outlet and cable. For example, lighting must be design according to the standard JKR luminance and the cable size must follow the IEEE Regulations. Finally, the MSB was designed by using the data or demand from the load. After all the designing process was completed, the cost of installation was calculated and the payback period was determined.

KEYWORD

MCB (Main Circuit Breaker), RCCB (Residual Current Circuit Breaker), MCCB (Moulded Case Circuit Breakers), MSB (Main Switch Board).

1.0 INTRODUCTION

The overall area covers by this double storey hypermarket is 18200 m^2 and it consists of several layouts. The layouts are retail outlet, parking area, shopping area, office complex, surau, store and toilet. Each retail outlet covers 85.8 m^2 of area and there are 16 retail outlets in this hypermarket. The electrical design involve in retail outlet is lighting and socket outlet.

The hypermarket also has a large parking area which covers 7280 m^2. The design needs at parking area are flood lighting and street lighting. The largest area in this hypermarket is the shopping area and it covers 8250 m^2. The design involve in that area are display lighting, normal lighting and socket outlet design. Office, surau, store and toilet cover area of 48.4 m^2, 26.5 m^2, 36 m^2 and 7.6 m^2 respectively. The main electrical designs in this area are lighting and socket outlet design.

In conclusion, the design involves lighting designs which cover several types of lighting, socket outlet design and of cause the protection design to protect the equipment and the people who used the equipment.

2.0 EQUIPMENTS DESIGN

2.1 Lighting Design

Lighting designs consist of following criteria which is luminance, illuminances and luminous flux. These criteria determine the number and type of the lamp need to be installed in a certain room. Beside the criteria, the following characteristics are taken into account, the requirements of the occupiers, architectural concepts and building constraints. The lighting control systems should ensure illuminances are not excessive and energy management is exercised.

The fluorescent lamp was largely been used in lighting installation in this hypermarket. It covers in layouts such as parking area, office complex, store, corridor, toilet and smaller room. Fluorescent was chosen mainly because the cost is low. Other advantages are low power consumption, produce low glare and can be simply integrated with energy management controls. Moreover, it suitable with the layouts which need only low illuminances level but has to cover large area which required large quantity of lamps. Two type of fluorescent lamp has been used which are 18W and 36W and were installed in single or double.

For the shopping area, it not wise to use fluorescent lamp because it required high illuminances level which is 500 lux. Mass quantity of fluorescent lamp were needed to cover such high illuminances and when installed it will look untidy. So, the best option is by using Metal Halide lamp. The advantages of Metal Halide lamp are light produced has excellent colour rendering and colour appearance properties, highly efficient and have long service life. The only disadvantage is that it's cost. However, by considering it has long service life and low maintenance cost, Metal Halide lamp still the best option to used in shopping area layout.

2.1.1 Calculation Number of Lamp

1. Room length and room width must be considered to find the room area. The height of the room also must be considered.

2. By using the equation 1, the room index value is calculated.

   Room index $= \frac{LW}{Hm\ (L+W)}$ ------ (1)

3 Base on the value of room index that has been calculated in step 2, the coefficient of the utilization from the table of coefficient of utilization of lamp is defined.

4 From the lumen table below, the desired lumen of the room is defined.

5 By using the equation 2, the installed flux is calculated. In this case the maintenance factor is set to 0.8.

   Installed flux $= \frac{LW \times design\ illuminance}{UF \times MF}$

   ----------- (2)

6 From the table of the illumination which shown in table 2, the lumen of the desired lamp is select and the number of lamp use is calculated by using the equation 3.

   Number of Lamp $= \frac{Installed\ Flux}{LDL}$

   --------- (3)

LIGHTING TYPE	Lumen
Fluorescent 1 x 18W	1325
Fluorescent 1 x 36W	2650
Fluorescent 2 x 36W	5300
Metal Halide 400W	22000

Table 2.1: The standard Lumen level

GENERAL BUILDING AREAS	PANDUAN TEKNIK JKR (Lux)
Corridors	100
Telecommunication room	150
Parking area	30
Office	300
Shop	500
Hypermarkets	500

Table 2.2: the standard Illumination Level

2.1.2 Example of Calculation

Room index $= \frac{LW}{Hm\ (L+W)}$

$= \frac{11 \times 7.8}{4(11+7.8)}$

$= 1.14$

The table in appendix 3 shows that for a Down Light Output Ratio(DLOR) of 50 percent, this combination of room index and reflectance means a utilization factor of 1 (for R.I. is 0.35) and 1.25 (for R.I. is 0.38). So, using probability technique:

$$\frac{1.14-1}{1.25-1} = \frac{UF-0.35}{0.38-0.35}$$

UF = 0.37

A suitable maintenance factor is considered to be 0.8 and the design illuminance is 500 lux.

Installed flux $= \frac{area \times design\ illuminance}{UF \times MF}$

$= \frac{11 \times 7.8 \times 500}{0.37 \times 0.8}$

$= 71500$ lumen

From appendix, the lighting design lumens output of 2 x 36W tubular fluorescent lamp is 5300 lumens

Number of lamps required $= \frac{71500}{5300}$

$= 12$

2.1.3 Summary of Lighting Design

SECTION	Room Index	Installed Flux (lumen)	Number of Lamp
Retail Outlets	1.14	71500	12
Shopping area	5	7417500	340
Office	0.75	48000	9
Parking area	5	497326	188
Store	0.75	4495	12
Surau	0.64	10720	4
Toilet	0.34	2495	4
Corridor	0.34	7840	9

Figure 2.3: Table shows the summary of lighting design

2.2 Socket Outlet Design

IEEE Regulation 533-01-07 requires that provision shall be made so that every portable appliance and portable lighting fitting can be fed from an adjacent and conveniently accessible socket outlet. It should be assumed that the length of flexible cord on portable appliances will be 1.5 to 2m.

All socket outlets should be fitted well above floor level or working surfaces. A minimum clearance of 150 mm is recommended. Switched socket outlets are not essential but are recommended for most locations so as to avoid frequent removal of plugs and consequent arcing and wear on contact.

2.2.1 Radial Circuit

Approximately all the socket outlet in this hypermarket has been design using radial circuit system. There are two types of radial circuit; 20amp circuits wired with 2.5mm^2 cable and 30amp circuits wired with 4mm^2. The principle of the radial circuit is that the mains cable leaves the consumer unit and passes through each socket until it reaches and ends at the last socket. Alternatively, on a ring circuit the mains cable leaves the consumer unit passes through every socket and then returns to the consumer unit. The advantage of the radial circuit is low cost.

2.2.2 Summary of the socket outlet Design

The summary of all sections involved in socket outlet design that has been installed in this hypermarket.

SECTION	NUMBER OF CIRCUIT
Retail Outlets	32
Office	6
PA Room	2
Customer Service Room	1
Telecommunication Room	2
Cashier Counter	13
Store	6
Others	4
Total	**66**

Figure 2.4: Table shows the summary of socket outlet design

2.3 Cable Design

Basically there are eight stages in such a procedure. These are the same whatever the type of installation, be it a cooker circuit or a sub main cable feeding a distribution board in factory. Here the eight basic steps in a simplified form:

1. Determine the design current, I_b
2. Select the rating of the protection, I_n
3. Select the relevant correction factors (CFs)
4. Divide I_n by the relevant CFs to give cable current-carrying capacity, I_t
5. Choose a cable size to suit I_t
6. Check the voltage drop

2.3.1 Calculation of Design Current

1. Copper conductors cable is considered.
2. Ambient air temperature of 30°C is taken. Therefore correction factor for ambient temperature Ca = 1. Using table 4C1.
3. Single circuits in enclosed and clipped direct to a non-metallic surface are considered. Therefore correction factor for grouping Cg = 1. Using table 4B1.
4. The cable is to operate at its rated operating temperature as in tables provided (i.e. 70°C for single core PVC-insulated cables, non-armored, with or without sheath).
5. The cable is not covered by the thermal insulation. Therefore correction factor Ci = l.
6. The length of the cable is 26 meter.

Determination of the size of cable to be used:

In = the nominal current or current setting of the device protecting the circuit against over current.

Iz = the current carrying capacity of a cable for continuous service under the particular installation condition concerned.

Ib = The designed current of the circuit. For example current intended to be carried by the circuit in normal service.

EQUIPMENT	POWER CONSUMPTION PER RETAIL OUTLET (kW)
Lighting	0.864
Socket Outlet	6.922
Total	**7.786**

Table 2.5: Summary of power consumption per retail outlet

$I_b = \frac{7786}{240}$

$= 32.44A$

40A

Chc

protection device.

$Iz = \frac{IN}{CiCaCg}$

$= \frac{40}{1 \times 1 \times 0.8}$

= 40 A

Using table 4D1A the size of the cable is 10mm^2

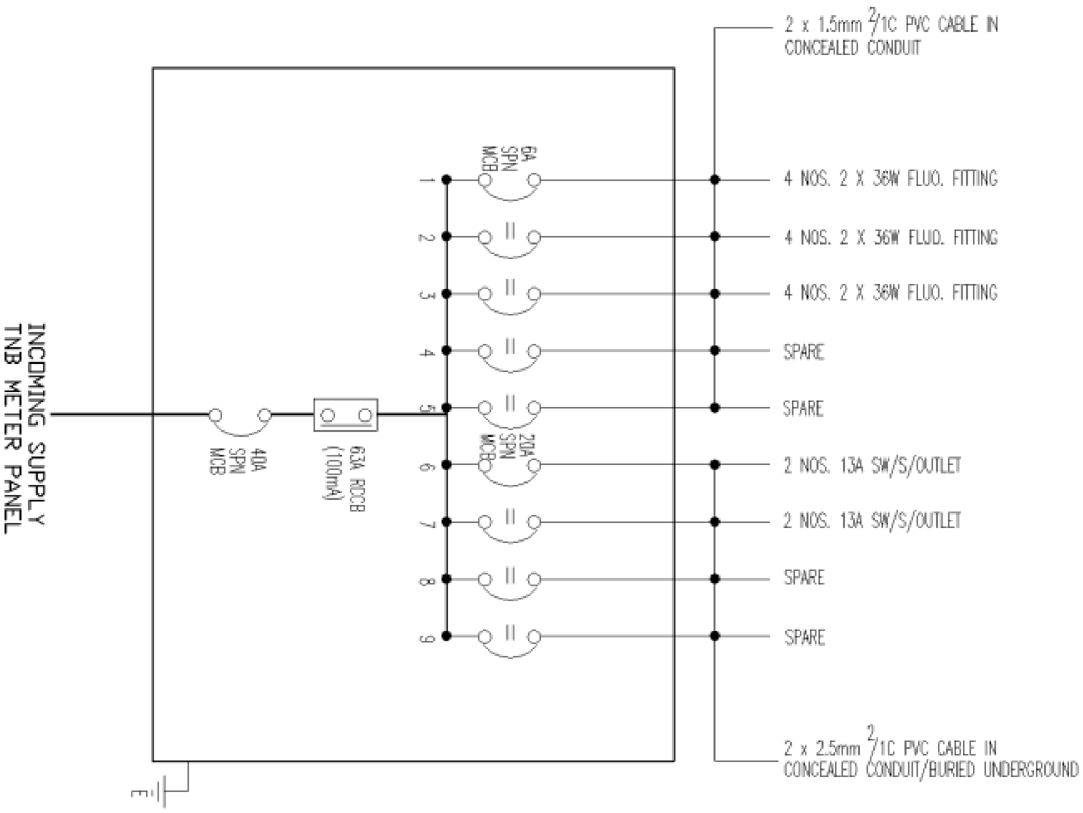
Calculate the voltage drop.

$Vd = \frac{mV \times Ib \times L}{1000}$

$= \frac{4.4 \times 32.44 \times 26}{1000}$

= 3.71 V

Voltage drop must less than 4 % of the nominal supply terminal voltage (240V or 4 1 5V). Since it is 3.71V



3.0 SW BO DE

Usi sup star sup TN sup hyp 415 cable service from LV board from a sub-station. From the value, it is

kVA systems but this rating of 3000 kVA

Figure 2.1: Schematic diagram for Retail Outlet

transformer is hard to find in Malaysia and the price is much higher than installing two transformers with each rated at 1000kVA. The system is protected by 1200 A air circuit breaker.

The MSB1 will supply all electrical power at the ground level which included air conditioning system, retail outlets and lighting at car park area and hall area. The MSB2 will supply electrical power at level one of the hypermarket which included refrigeration system, lighting and the several rooms load such as store room, office complex, surau and toilet. The size and type of the cable also been determined from the maximum demand calculated from the load. From this, the protection also can be determined to protect equipments and people who using the equipments.

4.0 PAYBACK PERIOD

In order to determine the overall cost of the installation, the calculation is divided into three different sections to make the calculation much easier. The sections are equipments and cables in level 1 and level 2, and finally cost of other equipment such as Moulded Case Circuit Breaker (MCCB). All the equipments and cables used are listed so that the calculation task is easier.

In level 1, the cost of lighting installation is RM 42,246.40 and the cost of cabling is RM 17,971.30. So, the total cost of installation in level 1 is RM 60,217.70. In ground floor, the cost of lighting installation and cabling installation are RM 22,564.40 and RM 10,805.35. So, the total cost of installation in ground level is RM 33,369.75. The MCCB cost is RM 29,150.00. By adding all the cost, the electrical installation cost in this hypermarket is RM 122,737.45

The payback period is the simplest method of looking at one or more investment project or ideas. The payback period method focuses on recovering the cost of investment. The payback period represent the amount of time that it takes for a capital budgeting project to recover its initial cost.

$$\text{Payback period} = \frac{Cost\ of\ the\ Project/Investment}{Annual\ Cash\ Inflow}$$

The cost of building a two storey hypermarket is approximately RM 30 millions. This figure was obtained from Mohd Asbi & Associates, which is a consulting engineers and project managers company. This company had designed and supervised a two storey TESCO hypermarket at Saujana Impian, Kajang.

Using TESCO Kajang hypermarket annual cash inflow as benchmarking, the payback period is calculated. The average annual cash inflow for the hypermarket is in around RM 12 millions to RM 15 millions. This figure was obtained from annual report of TESCO Kajang.

$$\text{Payback period} = \frac{Cost\ of\ the\ Project/Investment}{Annual\ Cash\ Inflow}$$

$$= \frac{122{,}737.45 + 30\ millions}{12\ millions}$$

$$= 2.5\ \text{years}$$

5.0 CONCLUSION

In conclusion, the electrical installations in this hypermarket consist of several sections which are equipments design, MSB design, and payback period calculation. The equipments design involves the design of lighting, switch socket outlet and cable design. The equipments were carefully design with respect to the Regulations. Lighting design is followed the JKR Illuminance Standard, and switch socket outlet and cable design followed the IEEE Regulation Standard. Beside the Regulations, several factors such as the requirement of the occupier, architectural concept and building constraint also must be taken into account. In MSB design, the two transformer system has installed because to save the cost, easy to do maintenance and to ensure the quality of the system. After calculation the electrical installation cost, building cost and others cost, the payback period is in 2.5 years. According to the business study, the payback period with less than 3 years is an attractive business. So, the cost of installation is acceptable.

9.0 ACNOWLEDGEMENT

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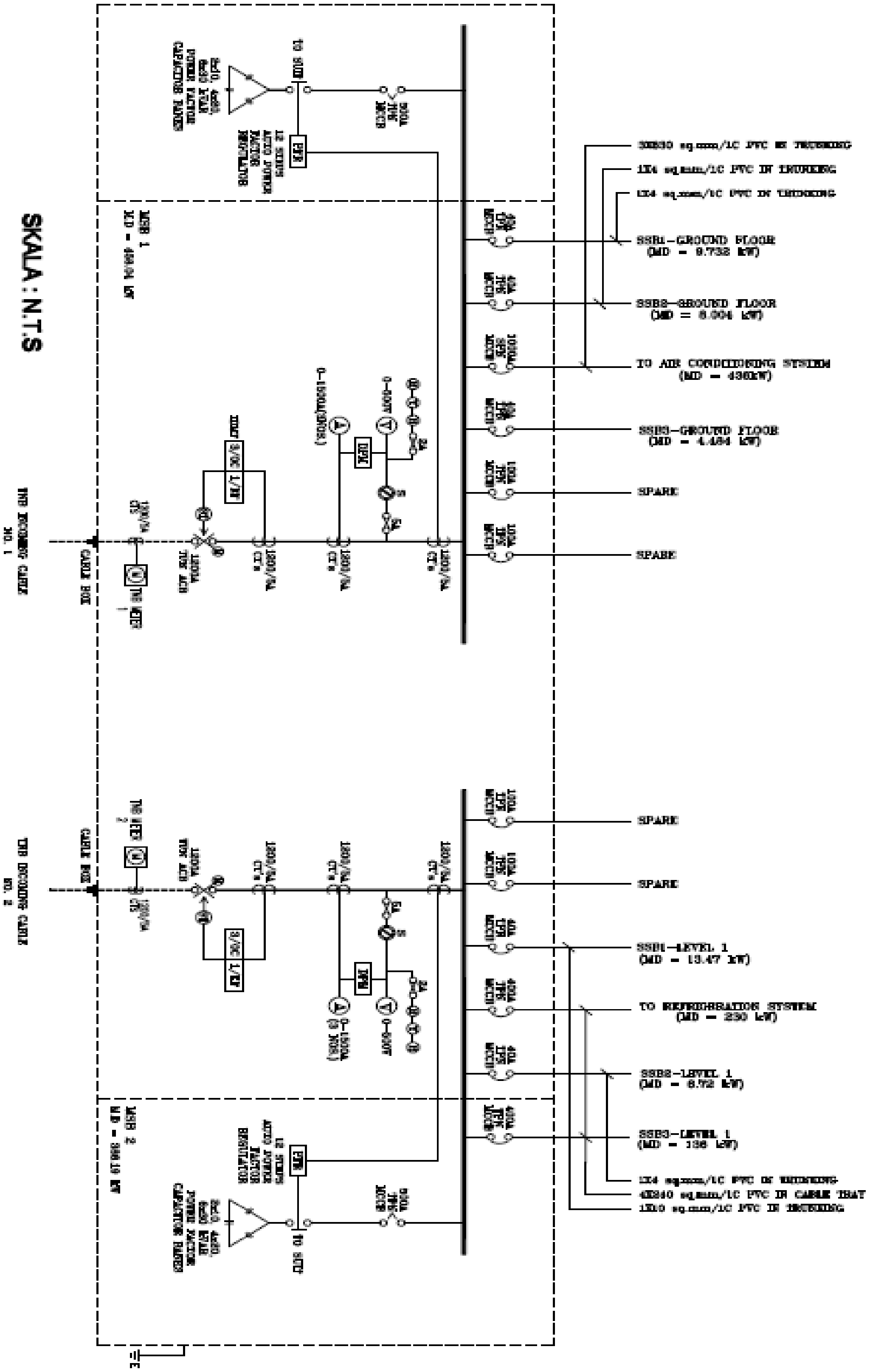

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