BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

BUET

Department of Electrical and Electronic Engineering

Course No: EEE 414 Group No: 2

Course Title: Electrical Service Design Section: A1

Project Report

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Objective:

The project aims to achieve the following objectives:

• Gain familiarity with floor-planning for multi-storied residential buildings.

• Understand the use of various fittings and fixtures in different compartments of the building.

• Learn to systematically draw conduit layouts for the building.

• Understand and create switchboard connections, including emergency setups.

• Calculate and place appropriate components in switchboard diagrams, such as circuit breakers, transformers, and generators, based on specific ratings.

• Learn the electrical design process for a lightning protection system.

Design Steps:

The project followed these design steps:

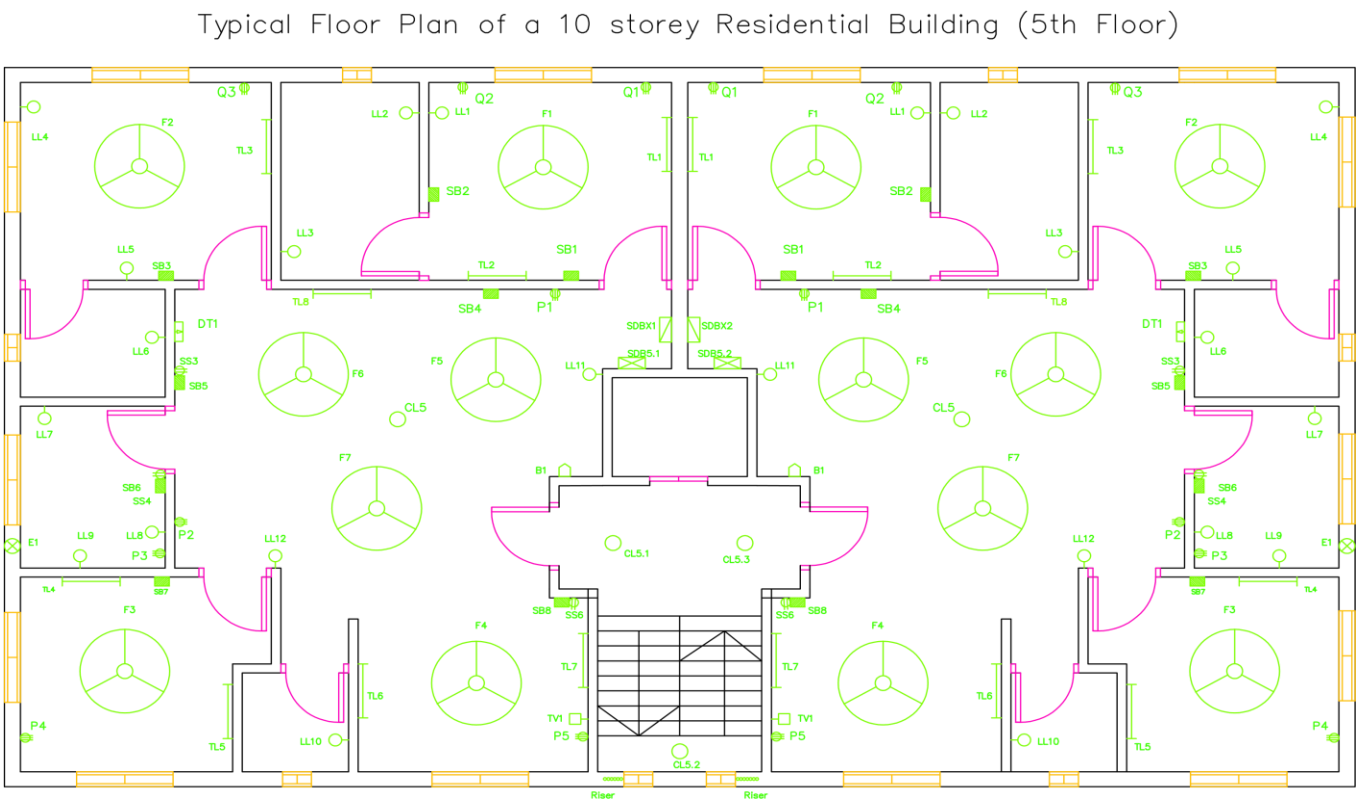
1. Ground floor, basement, and typical floor plan of a ten-storied two-unit building.

2. Calculation and design of fittings and fixtures for each floor.

3. Conduit layout planning for each floor.

4. Switchboard and distribution board diagram.

5. Lightening protection system (LPS) design.



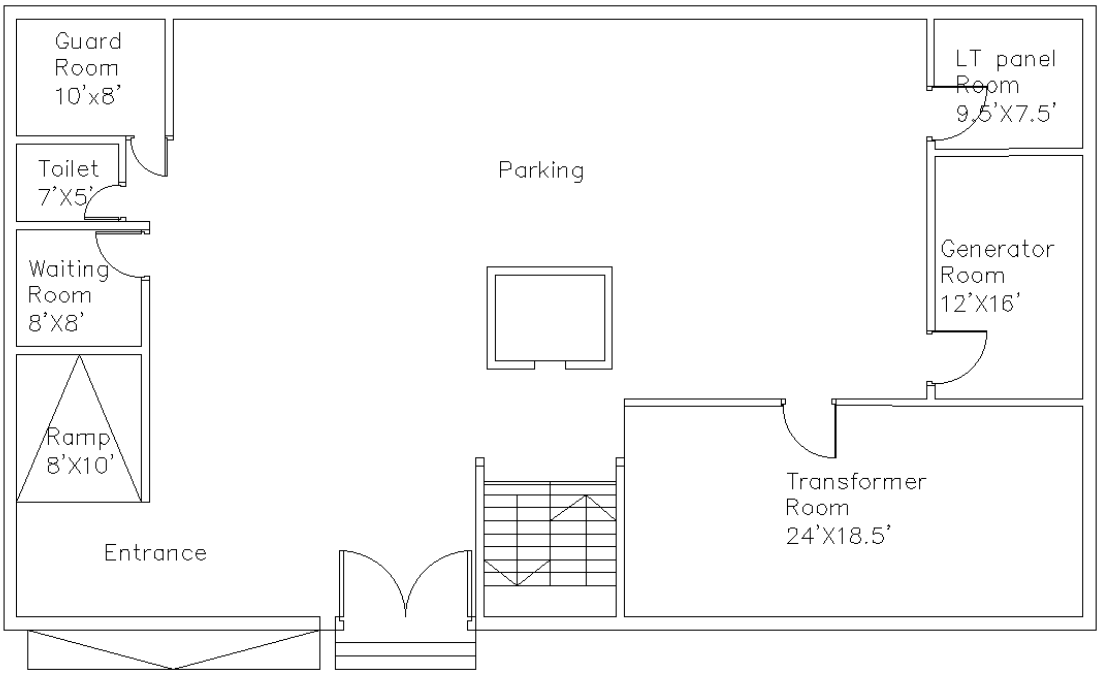


Figure: Ground layout

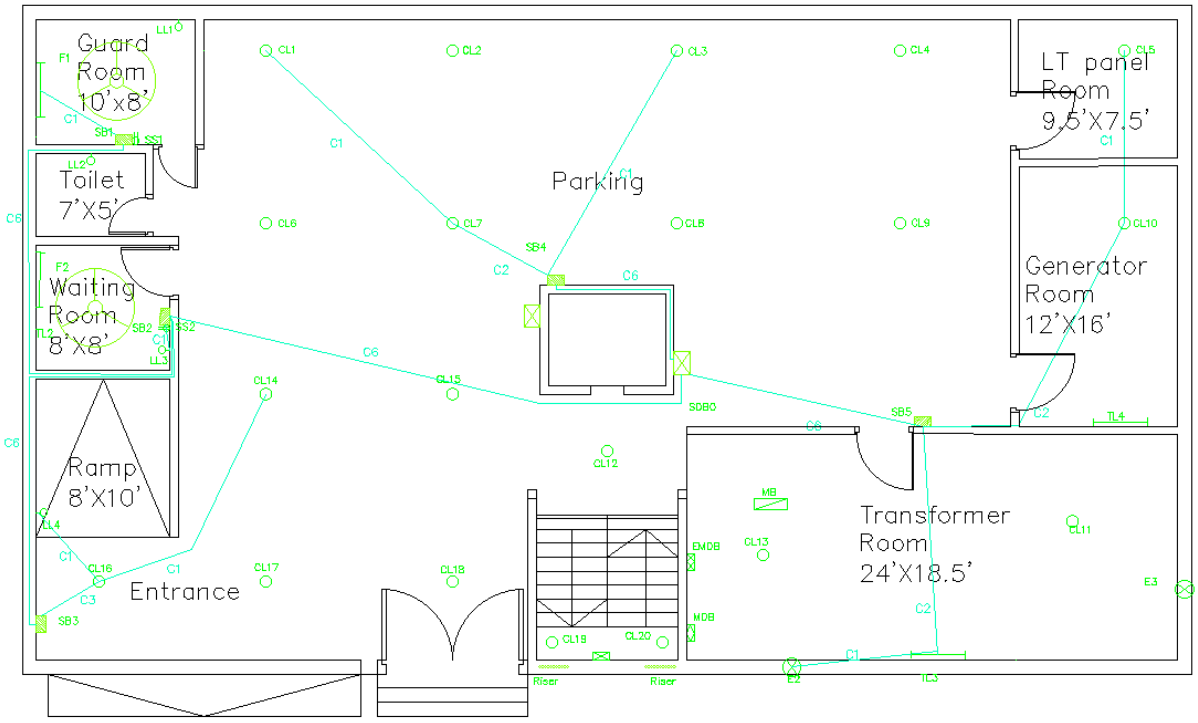


Figure: Ground layout with normal conduit

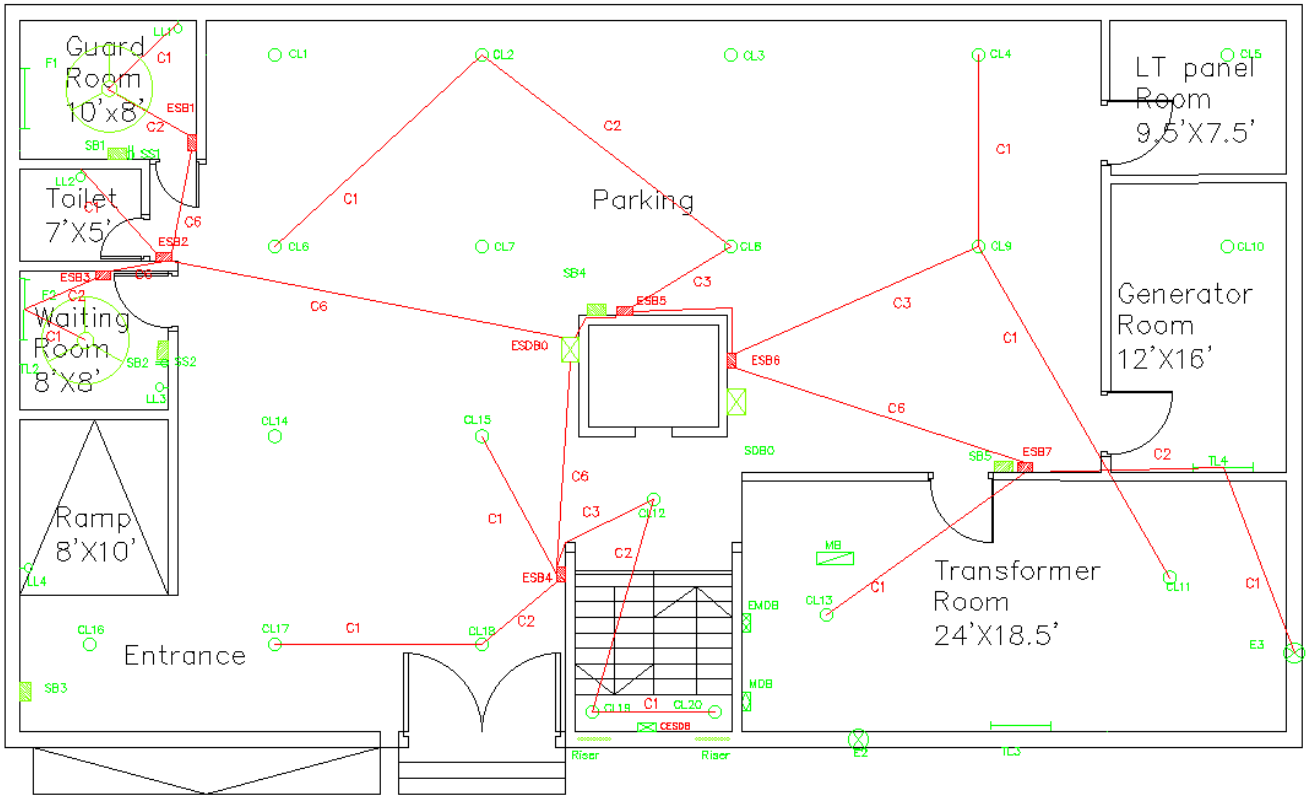


Figure: Ground Floor with Emergency conduit

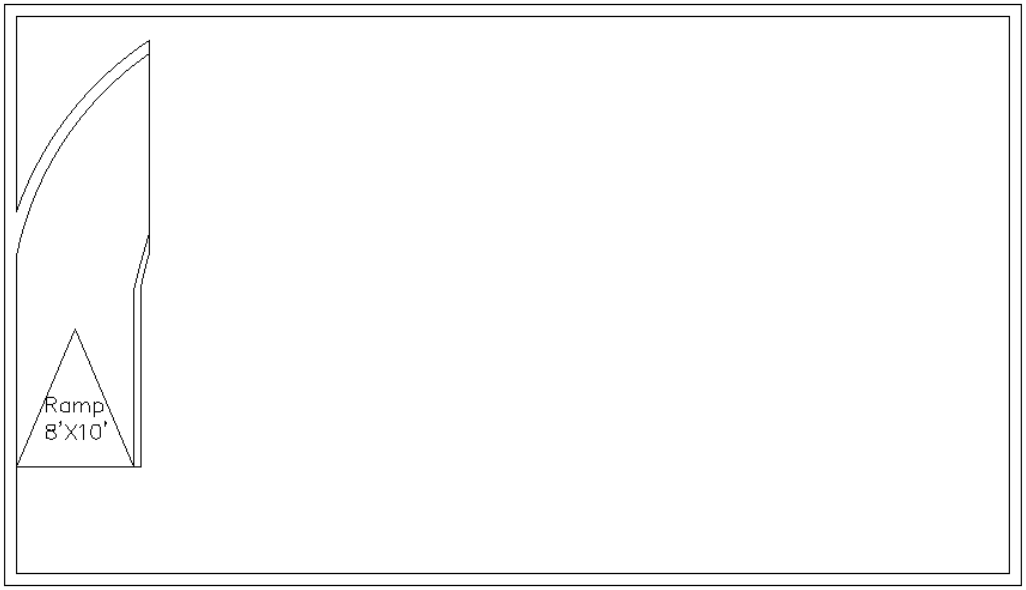


Figure: Basement layout

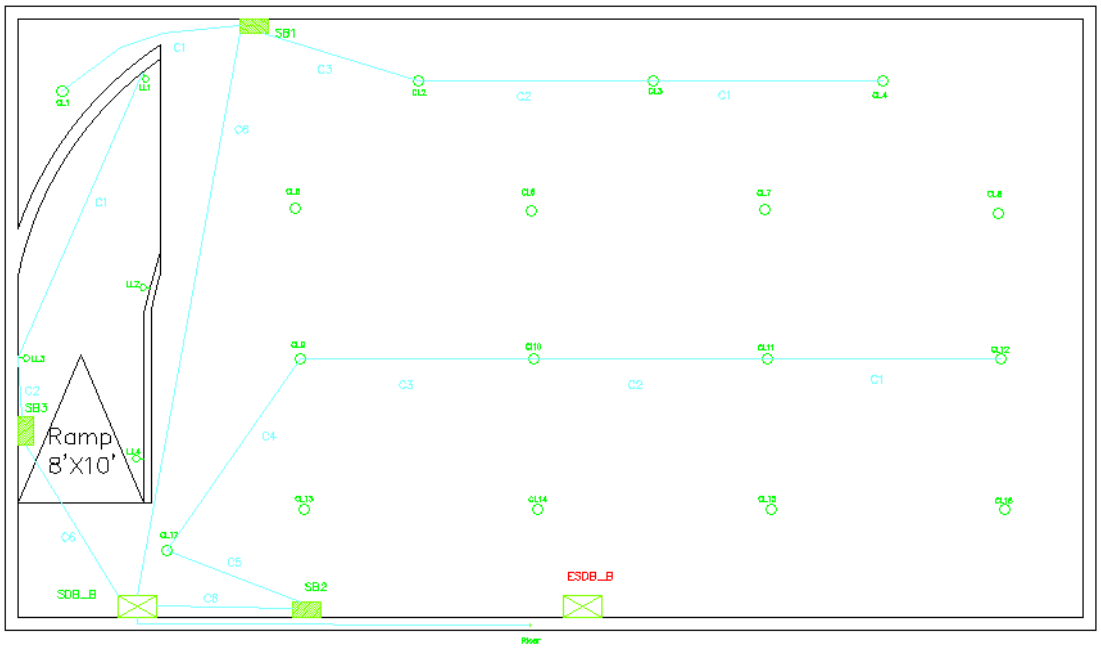


Figure: Basement with normal conduit

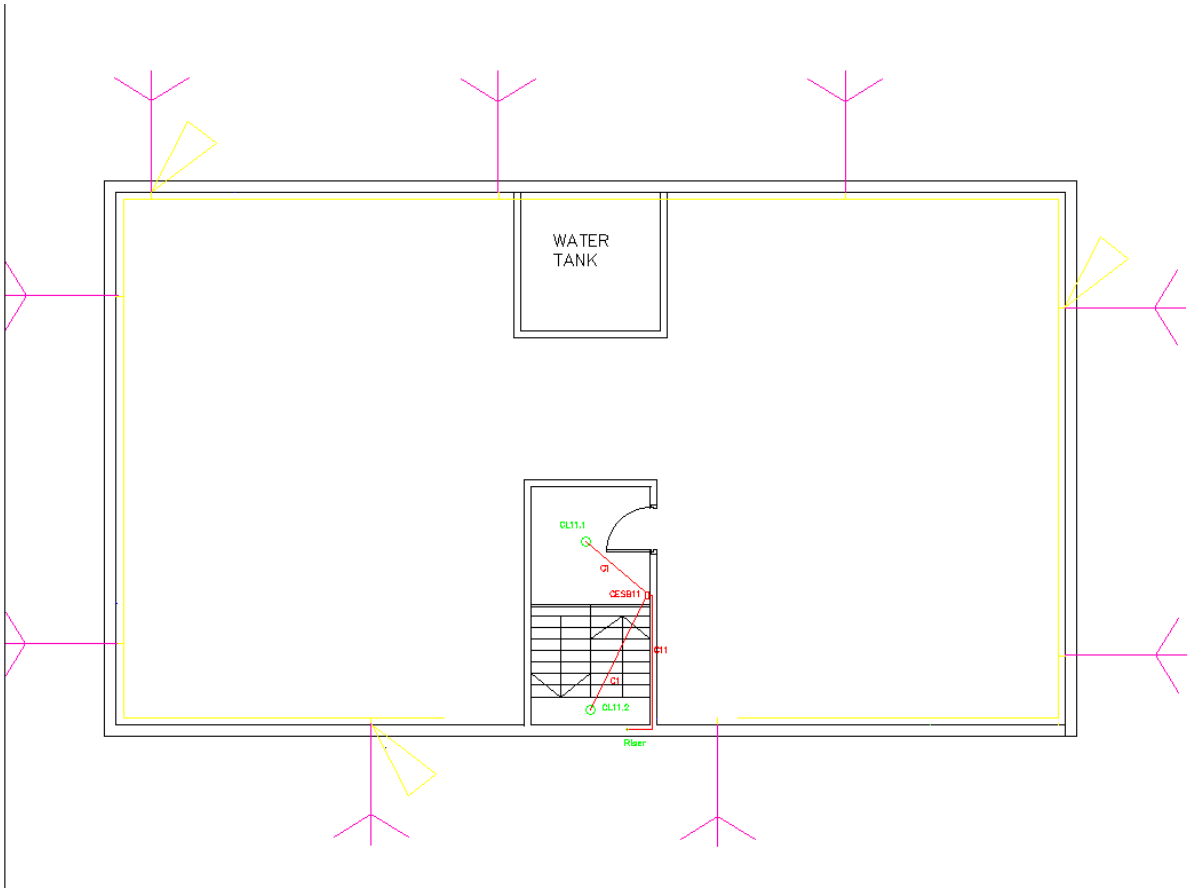


Figure: Roof plan

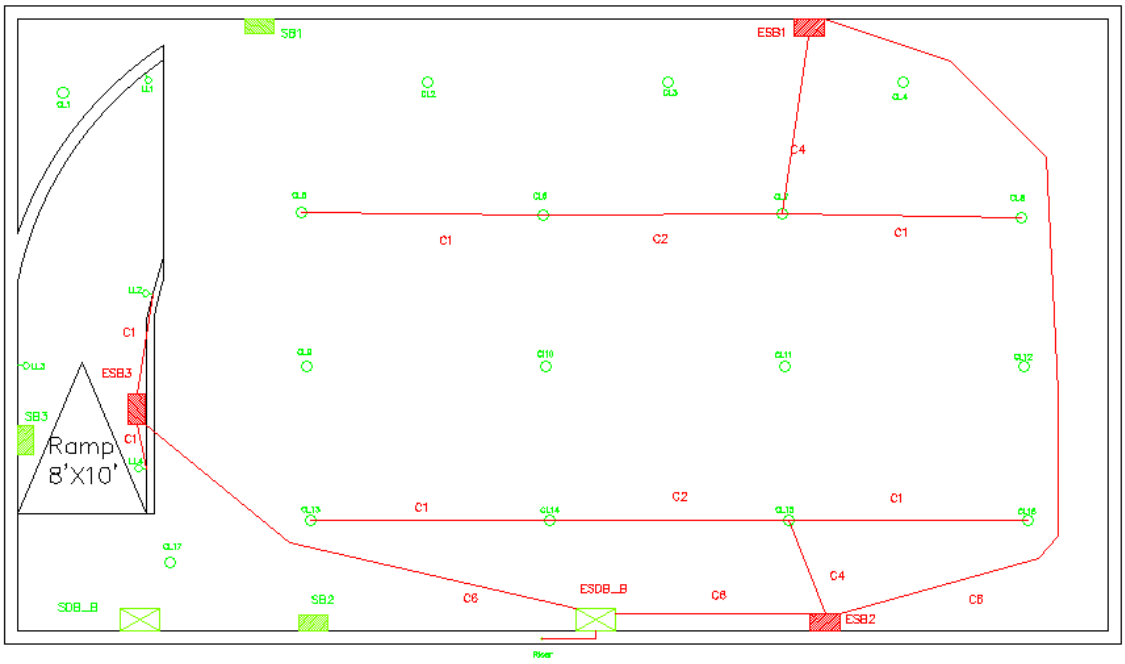
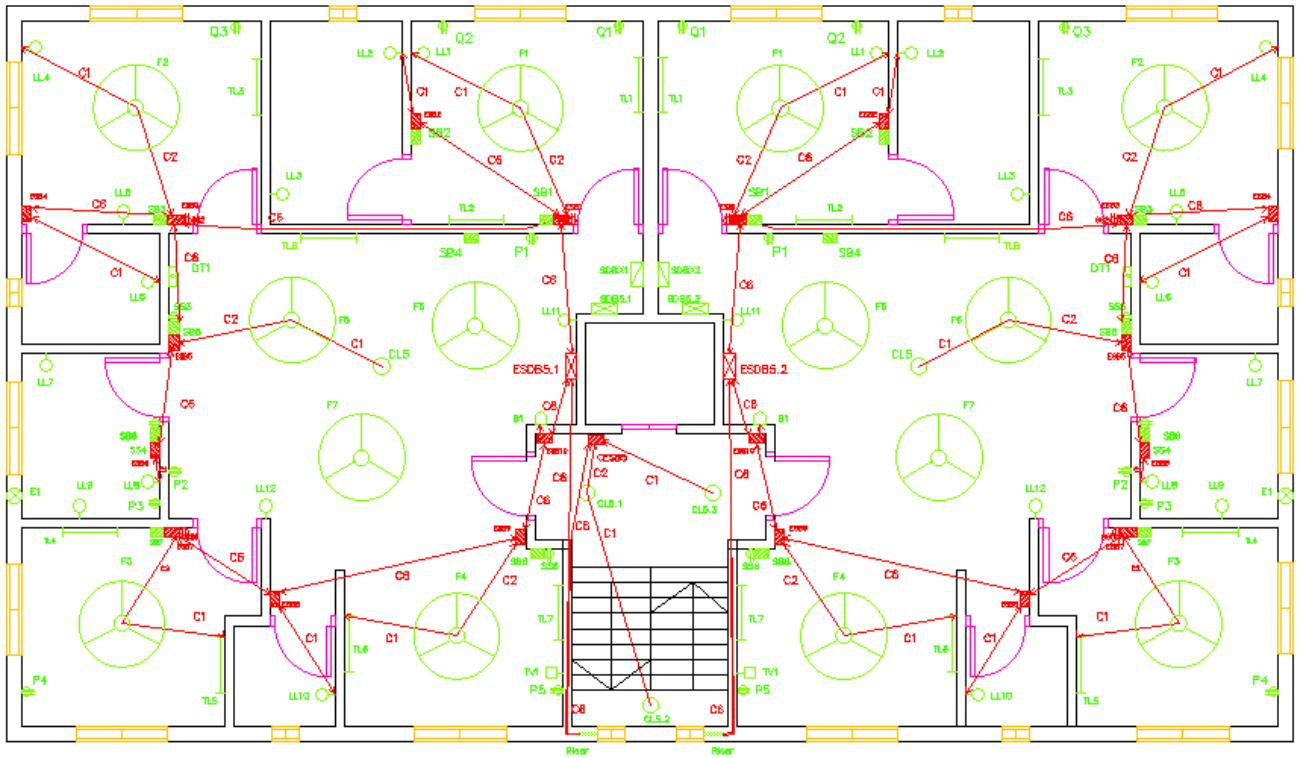
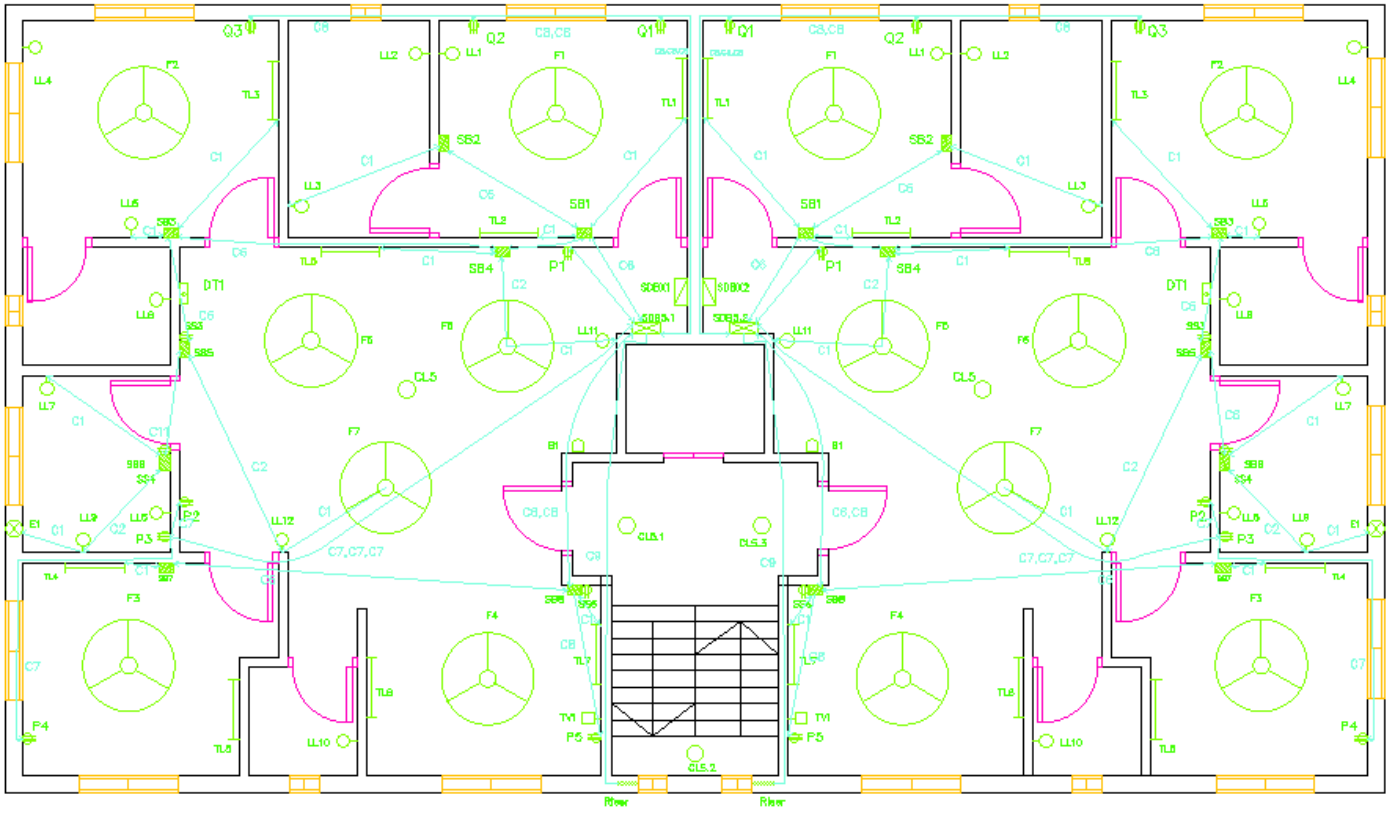


Figure: Basement with Emergency conduit

Typical Floor Plan of a 10 storey Residential Building (5th Floor)



Typical Floor Plan of a 10 storey Residential Building (5th Floor)



Fittings and Fixture:

Fixture Legend:

Description	Height	Caption	Symbol
Wall Mounted Light	Lintel	LL	
Ceiling Light	Ceiling	CL	
Wall Mounted Tube Light	Lintel	TL	
Fan (56" diameter)	Ceiling	F	
Switch Board	Mid wall	SB	
Sub Distribution Board	Mid wall	SDB	
Main Distribution Board	Mid wall	MDB	

Description	Height	Caption	Symbol
Exhaust Fan (8" diameter)	Lintel	E	
2 Pin Socket	Mid wall	SS	SS
2 Pin TV Socket	Lower	TS	TS
Antenna Socket	Skirting	T	
3 Pin Socket 20A	Lintel	S	S

Abbreviations:

Symbol	Description
L (in meters)	Room length
W (in meters)	Room width
F (lumen)	Average luminous flux from each light source
E (lux)	Luminance level required
UF	Utilization factor (allowance for light distribution of the luminaire and the room surfaces) C = Ceiling factor W = Wall factor F = Floor Factor
MF	Maintenance factor (allowance for reduced light output due to deterioration)

Formula:

Symbol	Formula
Number of lights required, (N)	$\mathrm{N} = \frac{E * L(meter) * W(meter)}{F * UF * MF}$
Number of fans required, (M)	$\mathrm{M} = \frac{L(ft) * W(ft)}{100}$
Mounting Height	Mounting height(meter) = Luminaire height – Work plane height
Room Index, (RI)	$RI = \frac{L(meter) * W(meter)}{Mounting\ Height\ (meter) * (L + W)}$
Total Lumen (N∗ F)	$\mathrm{N} * \mathrm{F} = \frac{E * L(meter) * W(meter)}{UF * MF}$

Calculations for light bulbs and fans:

Formula for light bulbs: $E = \frac{n \times N \times F \times UF \times LLF}{A}$ (A in m^2)

Formula for Fan = $\frac{A}{100}$ (A in sqft)

Bedroom 1:

Area = 12'-7" x 11' = 138.42 sqft = 12.86 m^2

Illuminance, E= 150 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tubelight

Number of lights, N=?

$$N = \frac{E\ \times A}{n \times F \times UF \times LLF}$$

$$=>\ N = \frac{150\ \times 12.86}{1 \times 1250 \times 0.7} =\ 2.2044\ \approx 3$$

So, total 3 lights are needed.

We are choosing 1 light bulb and 2 tube lights for this requirement.

Number of Fans = $\frac{A}{100}$ ($A\ in\ sqft$) = $\frac{138.42}{100} = 1.3842 \approx 1$

So, 1 fan is enough for this room.

Bedroom-1														
Length	**Width**	**Area (ft2)**	**Area (m2)**	**Lux**	**UF**	**Lumen**	**Comp-onent**	**Quantity**	**Power**	**Total Power**	**Current**	**Total Current**	**Wire**	**SB1 to Sb10**
12'7"	11'	138.4167	12.8593	150		1250	LED	1	40		0.259			
				150		1250	TL	2	20		0.129			
							Fan	1	100		0.64935			
							2-pin	1	100	260	0.64935	1.6883		C11

Bedroom 2:

Area = 13' x 11' = 143 sqft = 13.2847 m^2

Illuminance, E= 150 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tubelight

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{150 \times 13.2847}{1 \times 1250 \times 0.7} = 2.2773 \approx 3$$

So, total 3 lights are needed.

We are choosing 2 light bulbs and 1 tube light for this requirement.

Number of Fans = $\frac{A}{100}$ ($A\ in\ sqft$) = $\frac{143}{100} = 1.43 \approx 1$

So, 1 fan is enough for this room.

Bedroom-2														
Length	Width	Area (ft2)	Area (m2)	Lux	UF	Lumen	Compo -nent	Quantity	Power	Total Power	Current	Total Current	Wire	SB3 to SDB
13'	11'	143	13.2851	150		1250	LED	2	40		0.259			
				150		1250	TL	1	20		0.129			
							Fan	1	100		0.64935			
							2-pin	1	100	260	0.64935	1.6883		C13,19

Bedroom 3:

Area = 11' x 10'- 10" = 119.17 sqft = 11.07 m^2

Illuminance, E= 150 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent tube light

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{150 \times 11.07}{1 \times 1250 \times 0.7} = 1.9 \approx 2$$

So, total 2 lights are needed.

We are choosing 2 tube lights for this requirement.

Number of Fans = $\frac{A}{100}$ $(A\ in\ sqft) = \frac{119.17}{100} = 1.1917 \approx 1$

So, 1 fan is enough for this room.

Bedroom-3														
Length	Width	Area (ft2)	Area (m2)	Lux	UF	Lumen	Compo -nent	Quantity	Power	Total Power	Current	Total Current	Wire	SB7 TO SB8
				150		1250	TL	2	40		0.259			
							Fan	1	100		0.64935			
							2-pin	1	100		0.64935	1.558		

Drawing Room:

Area = 11'-11" x 9'-8" = 115.19 sqft = 10.7 m^2

Illuminance, E= 150 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent tube light

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{150 \times 10.7}{1 \times 1250 \times 0.7} = 1.83 \approx 2$$

So, total 2 lights are needed.

We are choosing 2 tube lights for this requirement.

Number of Fans = $\frac{A}{100}$ $(A\ in\ sqft) = \frac{115.19}{100} = 1.1519 \approx 1$

So, 1 fan is enough for this room.

Drawing Room														
Length	Width	Area (ft2)	Area (m2)	Lux	UF	Lumen	Compo -nent	Quantity	Power	Total Power	Current	Total Current	Wire	SB9 to SDB
11'11"	9'8"	115.194	10.7019	150		1250	LED	0	0		0			
				150		1250	TL	2	40		0.259			
							Fan	1	100		0.6493			
							2-pin	1	100	240	0.6493	1.558		C11

Dining Room:

Area = 22'-2" x 15'-6" = 343.58 sqft = 31.91 m^2

Illuminance, E= 150 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F_1= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tubelight)

Let, Number of lights, $N_1 = 3$

Flux, F_2= 3000 Lumen (30 W CFL light)

Let, Number of lights, $N_2 = 1$

Now,

$$N1 \times n \times F1 \times UF \times LLF \; + \; N2 \times n \times F2 \times UF \times LLF \; = E \times A$$

$$=> 3 \times 1 \times 1250 \times 0.7 + 1 \times 1 \times 3000 \times 0.7 = 150 \times 31.91$$

$$=> 4725 \; \approx 4786.5$$

So, total 4 lights are needed as specified above.

We are choosing 2 light bulbs and 1 tube light both of 20W (1250 Lumen) and 1 CFL light (30W – 3000 Lumen) for this requirement.

Number of Fans = $\frac{A}{100}$ $(A \; in \; sqft) = \frac{343.58}{100} = 3.4358 \; \approx 3$

So, 3 fan is enough for this room.

Dining Room															
Length	**Width**	**Area (ft2)**	**Area (m2)**	**Lux**	**UF**	**Lumen**	**Compo -nent**	**Quantity**	**Power**	**Total Power**	**Current**	**Total Current**	**Wire**	**SB5 to SB3**	**SB10 to SDB**
22'2"	15'6"	343.583	31.92				LED	2	40		0.259				
							TL	1	20		0.13				
							Fan	3	300		1.948				
							2-pin	1	100		0.6493				
							CL	1	20	480	0.13	3.117		**C11**	C11

Kitchen:

Area = 7'-6" x 9' = 67.5 sqft = 6.271 m^2

Illuminance, E= 200 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tubelight

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{300 \times 6.271}{1 \times 1250 \times 0.7} = 2.15 \approx 3$$

So, total 3 lights are needed.

We are choosing 3 light bulbs for this requirement.

Toilet 1:

Area = 7'-2" x 11' = 78.833 sqft = 7.3238 m^2

Illuminance, E= 200 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tube light

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{200 \times 7.3238}{1 \times 1250 \times 0.7} = 1.674 \approx 2$$

So, 2 lights are needed.

We are choosing 2 light bulbs for this requirement.

Toilet-1

Length	Width	Area(ft2)	Area(m2)	Lux	UF	Lumen	Component	Quantity	Power	Total Power	Current	Total Current	Wire	SB2 to SB1
7'2"	11'	78.833	7.3238				LED	2	20	40	0.259	0.259		C11

Toilet 2:

Area = 7'-6" x 6' = 45 sqft = 4.1806 m^2

Illuminance, E= 100 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tubelight

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{100 \times 4.18}{1 \times 1250 \times 0.7} = 0.477 \approx 1$$

So, 1 light is needed.

We are choosing 1 light bulb for this requirement.

Toilet-2														
Length	Width	Area(ft2)	Area(m2)	Lux	UF	Lumen	Component	Quantity	Power	Total Power	Current	Total Current	Wire	SB4 TO SB3
7'6"	6'	45	4.1806				LED	1	20	20	0.129	0.129		C11

Toilet 3:

Area = 5'-6" x 5'-6" = 30.25 sqft = 2.8103 m^2

Illuminance, E= 100 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tubelight

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{100 \times 2.8103}{1 \times 1250 \times 0.7} = 0.32 \approx 1$$

So, 1 light is needed.

We are choosing 1 light bulb for this requirement.

Toilet-3														
Length	Width	Area (ft2)	Area (m2)	Lux	UF	Lumen	Component	Quantity	Power	Total Power	Current	Total Current	Wire	SB8 TO SDB
5'6"	5'6"	30.25	2.8103				LED	1	20	20	0.129	0.129		C9,10,20

Guard Bedroom:

Area = 10' x 8' = 80 sqft = 7.432 m^2

Illuminance, E= 150 lux

Light loss factor and Utilization factor, LLFxUF=0.7

Number of lights per illuminaire, n=1

Flux, F= 1250 Lumen (20 W Energy saving bulb and Fluorescent Tube light

Number of lights, N=?

$$N = \frac{E \times A}{n \times F \times UF \times LLF}$$

$$=> N = \frac{150 \times 7.432}{1 \times 1250 \times 0.7} = 1.27 \approx 2$$

So, total 2 lights are needed.

We are choosing 2 light bulbs and 1 tube light for this requirement.

Number of Fans = $\frac{A}{100}$ $(A\ in\ sqft) = \frac{80}{100} = 0.8 \approx 1$

So, 1 fan is enough for this room.

Guard Room													
Length	Width	Area (ft2)	Area (m2)	Lux	UF	Lumen	Component	Quantity	Power	Total Power	Current	Total Current	Wire
7'6"	9'6"	71.25	6.6193				LED	1	20		0.129		
							TL	1	20		0.129		
							Fan	1	100		0.649		
							2-pin	1	100	240	0.649	1.556	

Similarly, Calculations of Guard Toilet , Corridor-1 and Corridor-2 have been brought.

Guard Toilet													
Length	**Width**	**Area(ft2)**	**Area(m2)**	**Lux**	**UF**	**Lumen**	**Component**	**Quantity**	**Power**	**Total Power**	**Current**	**Total Current**	**Wire**
5'	6'6"	32.5	3.0193				LED	1	20	20	0.129	0.129	

Corridor-1 and Corridor-2														
Length	**Width**	**Area (ft2)**	**Area (m2)**	**Lux**	**UF**	**Lumen**	**Compo -nent**	**Quantity (Per Unit)**	**Power**	**Total Power**	**Current**	**Total Current**	**SB10 to Riser**	
12'6"	5'9"	71.875	6.6774				LED	1	20		0.129			**Corridor - 1**
8'6"	2'	17	1.5793				LED	1	20	40	0.129	0.259	C11	**Corridor - 2**

Conduit Legend:

Symbol	Containing Power Cable + ECC	Conduit Size (Diameter)	Current Rating
C1	2 x 1.5 rm BYM	3/4"	5A
C2	4 x 1.5 rm BYM	3/4"	5A
C3	6 x 1.5 rm BYM	3/4"	5A
C4	8 x 1.5 rm BYM	1"	5A
C5	10 x 1.5 rm BYM	1"	5A
C6	2 x 1.5 rm BYM + 1.5 rm BYA ECC	3/4"	5A
C7	2 x 4 rm BYM + 4 rm BYA ECC	3/4"	15A
C8	2 x 6 rm BYM + 6 rm BYA ECC	1"	20A
C9	2 x 70 rm BYM + 70 rm BYA ECC	1.25"	100A
C10	2 x 16 rm BYM + 16 rm BYA ECC	1.25"	40A

Calculations for Conduits:

Formula for Ampere Rating, $I = \frac{P}{V \times pf}(A)$

Pf = 0.7 is considered on average.

Energy Saving Bulb, P = 20W

Tube Light, P = 20W

Ceiling Fan, P = 100W

Switchboard 2pin Socket, P = 100W(max)

Ceiling Light, P = 20W

All internal wiring was below 5A rating. So, $2 \times 1.5\ rm$ BYM is used in all internal wiring.

For Switchboard-to-switchboard connections $2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used.

To Sub Distribution Board (SDB)

CKT1 Rating

Total Power, P = $20 + 20 + 20 + 100 + 20 + 20 + 100 + 100 + 20 + 20 + 20 + 20 + 100 + 50 = 650W$

Estimated Power, P_{est} = P× $Diversity\ Factor = 650 \times 0.7 = 455W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{455}{0.7 \times 220} = 2.9545\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT2 Rating

Total Power, P = $20 + 100 + 20 = 140W$

Estimated Power, P_{est} = P× $Diversity\ Factor = 140 \times 0.7 = 98W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{98}{0.7 \times 220} = 0.6363\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

To Emergency Sub Distribution Board (ESDB)

CKT1 Rating

Total Power, P = 100+20+100+20+100+20+100+20+100+20+20 = 620W

Estimated Power, P_{est} = P× $Diversity\ Factor = 620 \times 0.7 = 434W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{434}{0.7 \times 220} = 2.8181\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT2 Rating

Total Power, P = 20 + 100 + 20 + 20 + 100 + 100 + 20 = 380W

Estimated Power, P_{est} = P× $Diversity\ Factor = 380 \times 0.7 = 266W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{266}{0.7 \times 220} = 1.7272\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

Calculations for SDB (Typical Floor):

SDB load = Total Load×0.7 + Total P Socket load×0.5 + Total Q Socket load×0.3

Total Load = CKT1 load + CKT2 load = 650 + 140 = 790W

Total P Socket load = 5×3000 = 15kW (Each P Socket load is considered 3000W)

Total Q Socket load = 3×4000 = 12kW (Each Q Socket load is considered 4000W)

SDB load = 790×0.7 + 15000×0.5 + 12000×0.3 =11653W

$$SDB\ Current, I = \frac{\text{SDB load}}{pf \times V} = \frac{11653}{0.7 \times 220} = 74.6688\ A < 100A$$

So, 100A SP MCCB is needed from SDB to MDB.

$2 \times 70\ rm\ BYM + 70\ rm\ BYA\ ECC$ are used for this connection.

Summary of Typical Floor:

Circuit No.	Room Name	Switch Board	Fixture	Power (W)	Estimated Power(W)	Current Rating (A)	Breaker to SDB Rating (A)
CKT1	Bedroom-1	SB1	TL1(Tube Light)	20	455	2.954545455	5A
			TL2(Tube Light)	20			
	Toilet-1	SB2	LL3(Bulb)	20			
	Dining Room	SB4	LL11(Bulb)	20			
			F5	100			
			TL8	20			
		SB5	LL12	20			
			F7	100			
			SS3	100			
	Bedrrom-2	SB3	TL3	20			
			LL5	20			
	Kitchen	SB6	LL7	20			
			LL9	20			
			SS4	100			
			E1	50			
	Total Power			**650**			
CKT2	Dining Room	SB8	TL7	20	98	0.6363636364	5A
			SS6	100			
	Bedroom-3	SB7	TL4	20			
	Total Power			**140**			

Calculations for ESDB (Typical Floor):

ESDB load = Total Load×0.7 + Total P Socket load×0.5 + Total Q Socket load×0.3

Total Load = CKT1 load + CKT2 load = 620 + 380 = 1000W

There is no P and Q Socket Load in emergency.

ESDB load = 1000×0.7 + 0×0.5 + 0×0.3 =700W

$$ESDB\ Current, I = \frac{\text{ESDB load}}{pf \times V} = \frac{700}{0.7 \times 220} = 4.5454\ A < 5A$$

So, 5A SP MCCB is needed from ESDB to EMDB.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

Summary for Emergency Floor:

Emergency Sub Distribution Board (ESDB) Fixtures							
Circuit No.	**Room Name**	**Switch Board**	**Fixture**	**Power (W)**	**Estimated Power(W)**	**Current Rating (A)**	**Breaker to SDB Rating (A)**
CKT1	Bedroom-1	ESB1	F1	100	434	2.818181818	5A
			LL1	20			
			SS1	100			
	Toilet-1	ESB2	LL2	20			
	Bedroom-2	ESB3	F2	100			
			LL4	20			
			SS2	100			
	Toilet-2	ESB4	LL6	20			
	Dining Room	ESB5	F6	100			
			CL5	20			
	Kitchen	ESB6	LL8	20			
	Total Power			**620**			
CKT2	Drawing Room	ESB10	B1	20	266	1.727272727	5A
		ESB9	F4	100			
			TL6	20			
	Toilet-3	ESB8	LL10	20			
	Bedroom-3	ESB7	F3	100			
			SS5	100			
			TL5	20			
	Total Power			**380**			

Calculations for SDB(Ground floor):

CKT1 Rating

Total Power, P = $20 + 20 + 20 + 20 + 100 + 100 + 100 = 380$W

Estimated Power, P_{est} = P× $Diversity\ Factor = 380 \times 0.7 = 266W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{266}{0.7 \times 220} = 1.7272\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT2 Rating

Total Power, P = 20+20+20 = 60W

Estimated Power, P_{est} = P× $Diversity\ Factor = 60 \times 0.7 = 42W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{42}{0.7 \times 220} = 0.2727\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT3 Rating

Total Power, P = 20 + 20 + 20 + 50 = 110W

Estimated Power, P_{est} = P× $Diversity\ Factor = 110 \times 0.7 = 77W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{77}{0.7 \times 220} = 0.5A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

$$SDB\ Current, I = \frac{\text{SDB load}}{pf \times V} = \frac{385}{0.7 \times 220} = 2.5\ A < 5A$$

Summary for Typical Ground Floor:

Sub Distribution Board (SDB0) Fixtures							
Circuit No.	**Room Name**	**Switch Board**	**Fixture**	**Power (W)**	**Estimated Power(W)**	**Current Rating (A)**	**Breaker to SDB Rating (A)**
CKT1	Ramp	SB0.3	LL4	20	385	2.5	5A
	Entrance		CL14	20			
			CL16	20			
	Waiting Room	SB0.2	LL3	20			
			SS2	100			
	Guard Room	SB0.1	SS1	100			
			TL1	20			
CKT2	Parking	SB0.4	CL3	20			
			CL1	20			

			CL7	20			
CKT3	Generator Room	SB0.5	CL10	20			
	LT Panel room		CL5	20			
	Transformer Room		E2	50			
			TL3	20			
Total Power				**550**			

Calculations for ESDB(Ground floor):

CKT1 Rating

Total Power, P = 20 + 20 + 20 + 100 + 100 = 260W

Estimated Power, P_{est} = P× $Diversity\ Factor = 260\times 0.7 = 182W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{182}{0.7 \times 220} = 1.1818A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT2 Rating

Total Power, P = 20+20+20+20+20+20 = 120W

Estimated Power, P_{est} = P× $Diversity\ Factor = 120\times 0.7 = 84W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{84}{0.7 \times 220} = 0.5454\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT3 Rating

Total Power, P = 20 + 20 + 20 = 60W

Estimated Power, P_{est} = P× $Diversity\ Factor = 60\times 0.7 = 42W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{42}{0.7 \times 220} = 0.2727\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT4 Rating

Total Power, P = 20 + 20 + 20 = 60W

Estimated Power, P_{est} = P× $Diversity\ Factor = 60 \times 0.7 = 42W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{42}{0.7 \times 220} = 0.2727A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT5 Rating

Total Power, P = 50 + 20 + 20 = 90W

Estimated Power, P_{est} = P× $Diversity\ Factor = 120 \times 0.7 = 63W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{63}{0.7 \times 220} = 0.40909\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

$$ESDB\ Current, I = \frac{\text{ESDB load}}{pf \times V} = \frac{413}{0.7 \times 220} = 2.6818\ A < 5A$$

5A SP MCCB is needed from ESDB to EMDB.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

Summary for Emergency Ground Floor:

Emergency Sub Distribution Board (ESDB0) Fixtures							
Circuit No.	**Room Name**	**Switch Board**	**Fixture**	**Power (W)**	**Estimated Power(W)**	**Current Rating (A)**	**Breaker to SDB Rating (A)**
CKT1	Waiting Room	ESB0.3	TL2	20	413	2.681818182	5A
			F2	100			
	Toilet	ESB0.2	LL2	20			
	Guard Room	ESB0.1	LL1	20			
			F1	100			
CKT2	Entrance	ESB0.4	CL15	20			
			CL18	20			
			CL17	20			
			CL12	20			
	Stair		CL19	20			
			CL20	20			
CKT3	Parking	ESB0.5	CL2	20			
			CL6	20			
			CL8	20			
CKT4	Parking	ESB0.6	CL4	20			
			CL19	20			
	Transformer Room		CL11	20			
CKT5	Transformer Room	ESB0.7	CL13	20			
			E3	50			
	Generator Room		TL4	20			
Total Power				**590**			

Calculations for SDB (Basement):

CKT1 Rating

Total Power, P = $20 + 20 + 20 + 20 = 80$W

Estimated Power, P_{est} = P× $Diversity\ Factor = 80 \times 0.7 = 56W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{56}{0.7 \times 220} = 0.3636 < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT2 Rating

Total Power, P = 20+20+20+20+20= 100W

Estimated Power, P_{est} = P× $Diversity\ Factor = 100 \times 0.7 = 70W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{70}{0.7 \times 220} = 0.4545\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT3 Rating

Total Power, P = 20 + 20= 40W

Estimated Power, P_{est} = P× $Diversity\ Factor = 40 \times 0.7 = 28W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{28}{0.7 \times 220} = 0.1818\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

$$ESDB\ Current, I = \frac{\text{ESDB load}}{pf \times V} = \frac{154}{0.7 \times 220} = 1A < 5A$$

So, 5A SP MCCB is needed from SDB to MDB.

So, $2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

Summary for Typical Basement:

Sub Distribution Board (SDBB) Fixtures							
Circuit No.	**Room Name**	**Switch Board**	**Fixture**	**Power (W)**	**Estimated Power(W)**	**Current Rating (A)**	**Breaker to SDB Rating (A)**
CKT1	Basement	SB1	CL1	20	154	1	5A
			CL2	20			
			CL3	20			
			CL4	20			

CKT2		SB2	CL9	20			
			CL10	20			
			CL11	20			
			CL12	20			
			CL17	20			
CKT3		SB3	LL1	20			
			LL3	20			
Total Power				**220**			

Calculations for ESDB (Basement):

CKT1 Rating

Total Power, P = 20 + 20 + 20 + 20 = 80W

Estimated Power, P_{est} = P× $Diversity\ Factor = 80\times 0.7 = 56W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{56}{0.7 \times 220} = 0.3636 < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT2 Rating

Total Power, P = 20+20+20+20= 80W

Estimated Power, P_{est} = P× $Diversity\ Factor = 80\times 0.7 = 56W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{56}{0.7 \times 220} = 0.3636\ A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\ rm\ BYM + 1.5\ rm\ BYA\ ECC$ are used for this connection.

CKT3 Rating

Total Power, P = 20 + 20= 40W

Estimated Power, P_{est} = P× $Diversity\ Factor = 40\times 0.7 = 28W$

$$I = \frac{\text{Pest}}{pf \times V} = \frac{28}{0.7 \times 220} = 0.1818\,A < 5A$$

So, Breaker to SDB wire rating 5A.

$2 \times 1.5\,rm\,BYM + 1.5\,rm\,BYA\,ECC$ are used for this connection.

$$ESDB\ Current, I = \frac{\text{ESDB load}}{pf \times V} = \frac{140}{0.7 \times 220} = 0.9090A < 5A$$

5A SP MCCB is needed from SDB to MDB.

So, $2 \times 1.5\,rm\,BYM + 1.5\,rm\,BYA\,ECC$ are used for this connection.

Summary for Emergency Basement:

Emergency Sub Distribution Board (ESDB) Fixtures							
Circuit No.	**Room Name**	**Switch Board**	**Fixture**	**Power (W)**	**Estimated Power(W)**	**Current Rating (A)**	**Breaker to SDB Rating (A)**
CKT1	Basement	ESB1	CL5	20	140	0.9090909091	5A
			CL6	20			
			CL7	20			
			CL8	20			
CKT2		ESB2	CL13	20			
			CL14	20			
			CL15	20			
			CL16	20			
CKT3		ESB3	LL2	20			
			LL4	20			
Total Power				**200**			

Calculation for EMDB:

EMDB load = Total ESDB load × 0.7 + $Lift\ Load\ X$0.7 + Total ground ESDB Load + Total Basement ESDB Load + Rooftop Load

Total ESDB Load = 20X ESDB load

EMDB Current = $\frac{EMDB\ Load}{Voltage * pf}$

Power Factor, pf = 0.7

ESDB Load = 700W

Lift Load = 5kW

EMDB load = 20*700 + 5kW * 0.7 + 413 + 154 + 2*20 = 18.107kW

EMDB Current = $\frac{18.107}{3*220*0.7} = 39.192\ A < 40\ A$

So, 40A TP MCCB is needed from EMDB to MDB

A 20kW Generator is used to supply the EMDB Load through an ATS.

Calculations of Generator:

Table 8.1.24: Recommended Area for Standby Generator Room

Capacity (kW)	Area (m^2)
1 × 25	20
1 × 48	24
1 × 100	30
1 × 150	36
1 × 300	48
1 × 500	56

We used 17.93 m^2 area for our 20 kW generator.

Calculation for MDB:

MDB Load = Total SDB Load*0.7 + EMDB*0.7 + Ground SDB Load + Basement SDB Load

Total SDB Load = 20*SDB Load = 20*11653 W = 233.06kW

EMDB Load = 18.107kW

Ground SDB Load = 385W

Basement SDB Load = 140W

MDB Load = 20*11653 + 18107 + 385 + 140 = 251.692kW

MDB Current = $\frac{251.692}{3*220*0.7} = 544.7878A$

So , 600 A TP MCCB is needed from MDB to Main Line.

Calculations of Transformer:

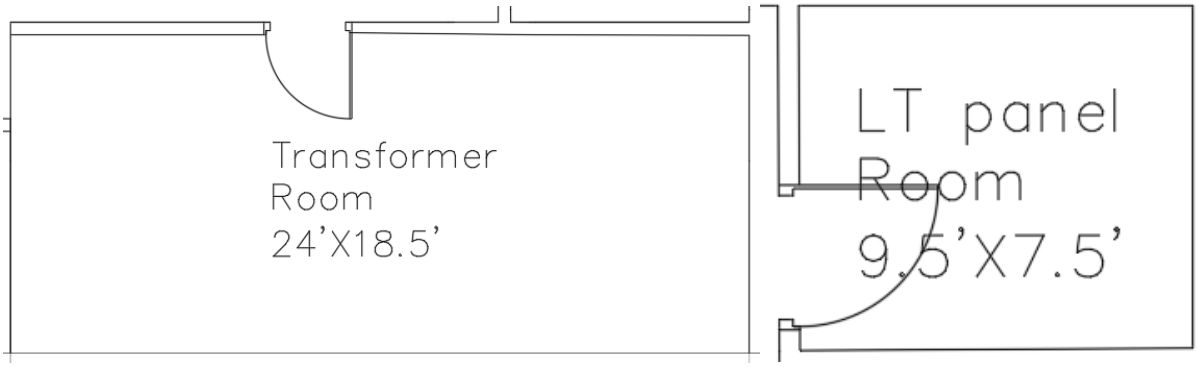
S =3VI = 3*220*544.78778 = 359.559kVA

So, 11/0.415 kV, 50Hz, 360kVA, DYN 11, Oil Immersed Transformer with 4-6% Impedence is needed.

Table 8.1.23: Recommended Area for Transformer and Substation of Different Capacities

Capacity of Transformer (kVA)	Transformer Area (m^2)	Total Substation Area (with HT, LT Panels & Transformer Room but without Generators), (m^2)
1 × 150	12	45
1 × 250	13	48
2 × 250	26	100
1 × 400	13	48
2 × 400	30	100
3 × 400	40	135
2 × 630	26	100
3 × 630	40	190
2 × 1000	40	180
3 × 1000	45	220

Our 360kVA transformer we used in total 47.86m^2 area.



Calculations of Lift:

Total Lift Load = 5 kW

Lift Load Current = $\frac{5000}{sqrt(3)*220*0.7} = 10.822A$

So , 15 A TP MCCB is needed to connect with EMDB.

Calculations of Pump:

Pump Power = 3kW

Current = $\frac{3000}{sqrt(3)*220*0.7} = 11.24A$

So , 15 A TP MCCB is needed to connect with EMDB.

Lightning Protection System (LPS) Design:

LPS Design Parameters:

Lightning Arrestor:

Rod Height = 2m

Roof Perimeter = 2 x (40 + 70) = 220ft

If we place arrestors 25ft apart, the number of required arrestors will be -

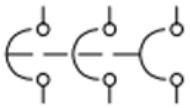
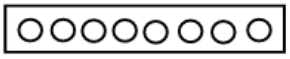
So, total L.A needed=220/25=8.8≈9

We will place 1 conductor for the first 80 sq.m and 1 conductor per 100 sq.m for the rest.

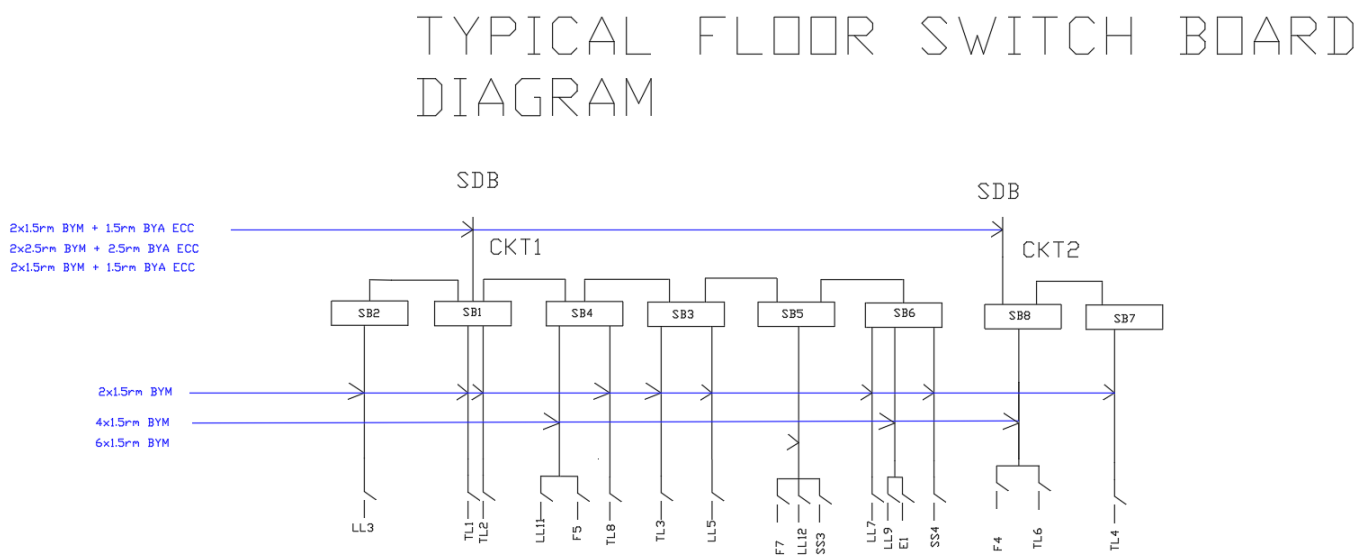
Number of required down conductors = (80/80) +((260.12-80)/100) = 2.8 ≈3

Thus, we use total of 3 down conductors as well as ground electrodes. Earth termination resistance of ground electrodes is less than 10 ohms. Roof Conductors Roof conductors are placed 6" away from the roof railing connecting all the lightning arrestors to the down conductors.

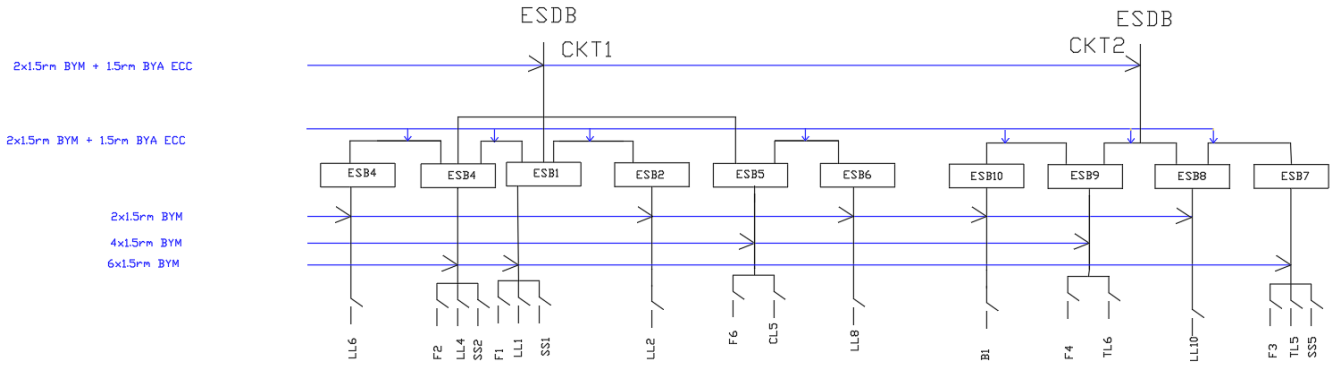
Switch Board Legend:

Description	Symbol
Switch	
Single Pole Circuit Breaker (SP MCCB)	
Triple Pole Circuit Breaker (TP MCCB)	
Delta to Wye Transformer	
Generator	G
Busbar	

Conclusion: In this project, we undertook the design of a ten-storey, two-unit building, including floor plans, electrical fixtures, and conduit layouts. Additionally, we created switchboard connection diagrams illustrating the distribution of incoming electric power throughout the building. These diagrams featured wire schedules and protective equipment like circuit breakers. To safeguard against electrical surges from lightning strikes, we incorporated a lightning protection system into the design. Through this project, we gained valuable experience in designing electrical services for residential buildings.



TYPICAL FLOOR EMERGENCY SWITCH BOARD DIAGRAM



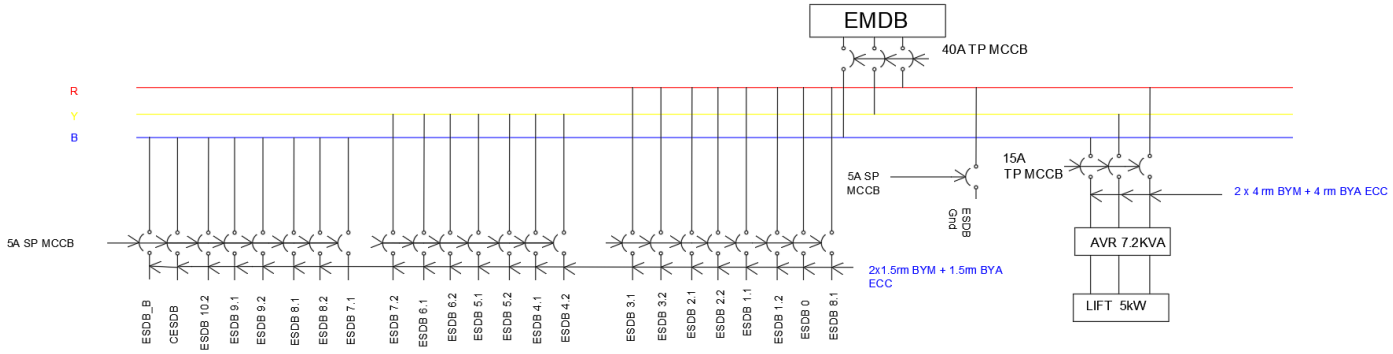


Figure: EMDB Diagram

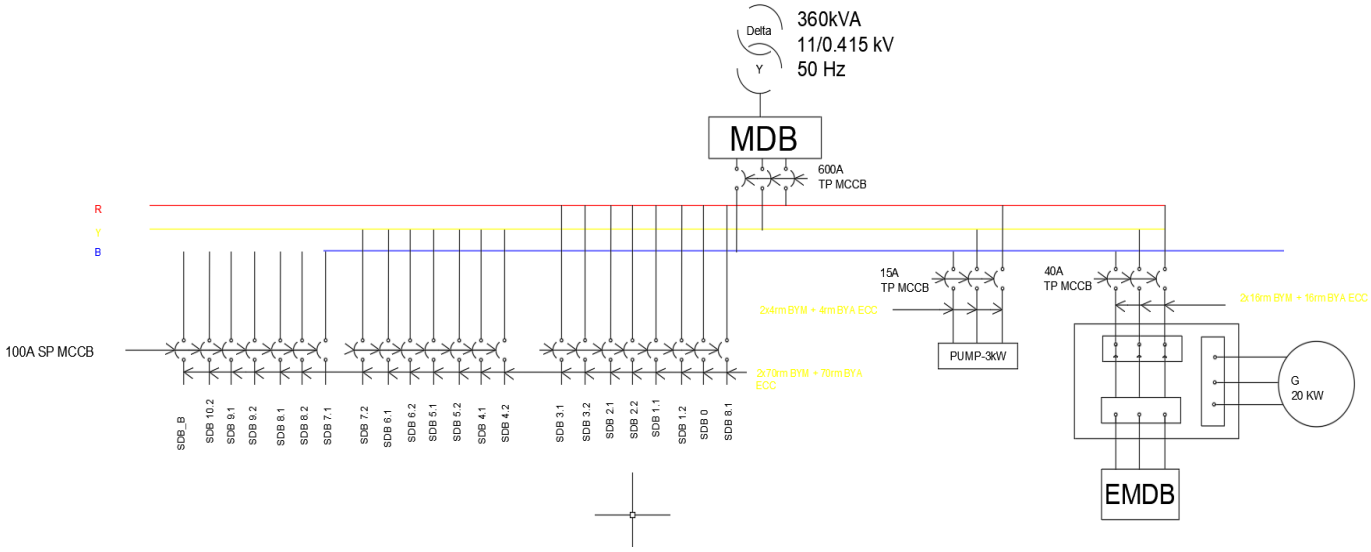
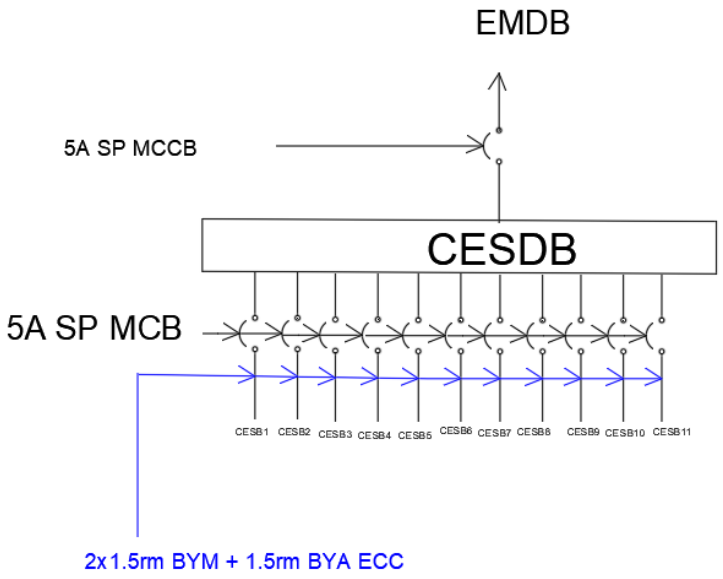


Figure: MDB Diagram

For All the Common Appliances of Different Floor



For Typical Floor