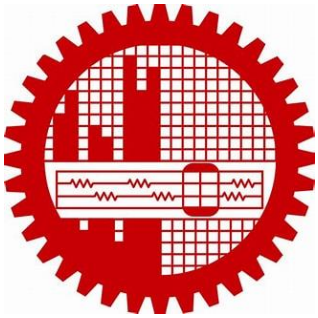
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Department of Electrical and Electronic Engineering



Course No.: EEE 414

Course Title: Electrical Services Design Laboratory

Electrical Services Design Project

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Project Objective:

The objective of this project is-

- to get acquainted with the floor-planning of a typical multi-storied residential building.
- to familiarize yourself with various fittings and fixtures used in each compartment of the building.
- to learn how to systematically draw the conduit layout of the building.
- to understand and draw the switchboard connections (including emergency)
- to calculate and place appropriate components in the switchboard diagrams (e.g. circuit breaker, transformer, generator of particular ratings)
- to learn the electrical designing procedure of a lightning protection system.

Design Steps:

The project was carried out according to the following design steps:

1. Ground floor and typical floor plan of a three-story building
2. 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

Theory:

Calculation of required light in a room of a typical building considers different factors of that room.

Light Requirement :

Let,

Room length = L (in meters)

Room width = W (in meters)

N = Number of lights required

E = Luminance level required (lux). This parameter will vary depending on the type of room (e.g. bedroom, kitchen)

F = Average luminous flux from each light source (lumen)

UF = Utilization factor (allowance for light distribution of the luminaire and the room surfaces)

MF = Maintenance factor (allowance for reduced light output due to deterioration)

Then, following is the equation used to calculate required Lumen in a room,

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

The maintenance factor, MF is taken as 0.8, that is 20% of the light is assumed to be deteriorated due to dust, aging etc.

Calculation of Utilization Factor:

To calculate the utilization factor, we first need to calculate the room index.

Room index is defined by the following formula:

$$\text{Room Index} = \frac{L * W}{\text{Mounting Height} * (L + W)}$$

Where,

Mounting height = Luminaire height – Work plane height = 9 ft – 3 ft = 6 ft = 1.828 meter

We also need to know the surface reflectance of ceiling (C), wall (W) and floor (F) of the room. Typically, they are chosen as C = 0.7, W = 0.5 and F = 0.2.

Table 1: Utilisation Factors

Room reflectances			Room index								
C	W	F	0.75	1.00	1.25	1.50	2.00	2.50	3.00	4.00	5.00
0.7	0.5	0.2	NA	0.61	0.65	0.67	0.70	0.71	0.73	0.74	0.75

From the tabular data shown above, we can readily determine the utilization.

factor for a particular room index for the given C, W and F values.

Fan Requirement

The number of fans required; M is determined by the following formula [1]:

$$M = \frac{L * W(\text{in sq. ft})}{100}$$

Required Luminance Value for Each Room:

Room Type	E(lux)
Dining Space	150
Living Room	70
Kitchen	200
Bedroom	70
Veranda	50
Storeroom	50
Bathroom	100
Stair	100
Lobby	70
Garage	100
Guard Room	70
Electrical Room	100

Legend for Conduit:

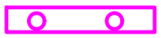
Symbol	Wire Rating(rm)	Current Rating
C1	2x1.5 BYM	5A
C2	4x1.5 BYM	5A
C3	6x1.5 BYM	5A
C4	8x1.5 BYM	5A
C5	10x1.5 BYM	5A
C6	12x1.5 BYM	5A
C7	14x1.5 BYM	5A
C8	2x4BYM + 4 BYA ECC	15A
C9	2x6 BYM + 6 BYA ECC	20A
C10		
C11		

Different bulb with their Lumen and Watt Rating:

Light Type	Symbol	Watt Rating (W)	Lumen Rating (Lumen)
LED Bulb	L	12	1200/1250
		16	1600
		25	4000
LED Tube	TLA	12	1250
		16	1600
Ceiling Light	CLA	12	840
		24	2500

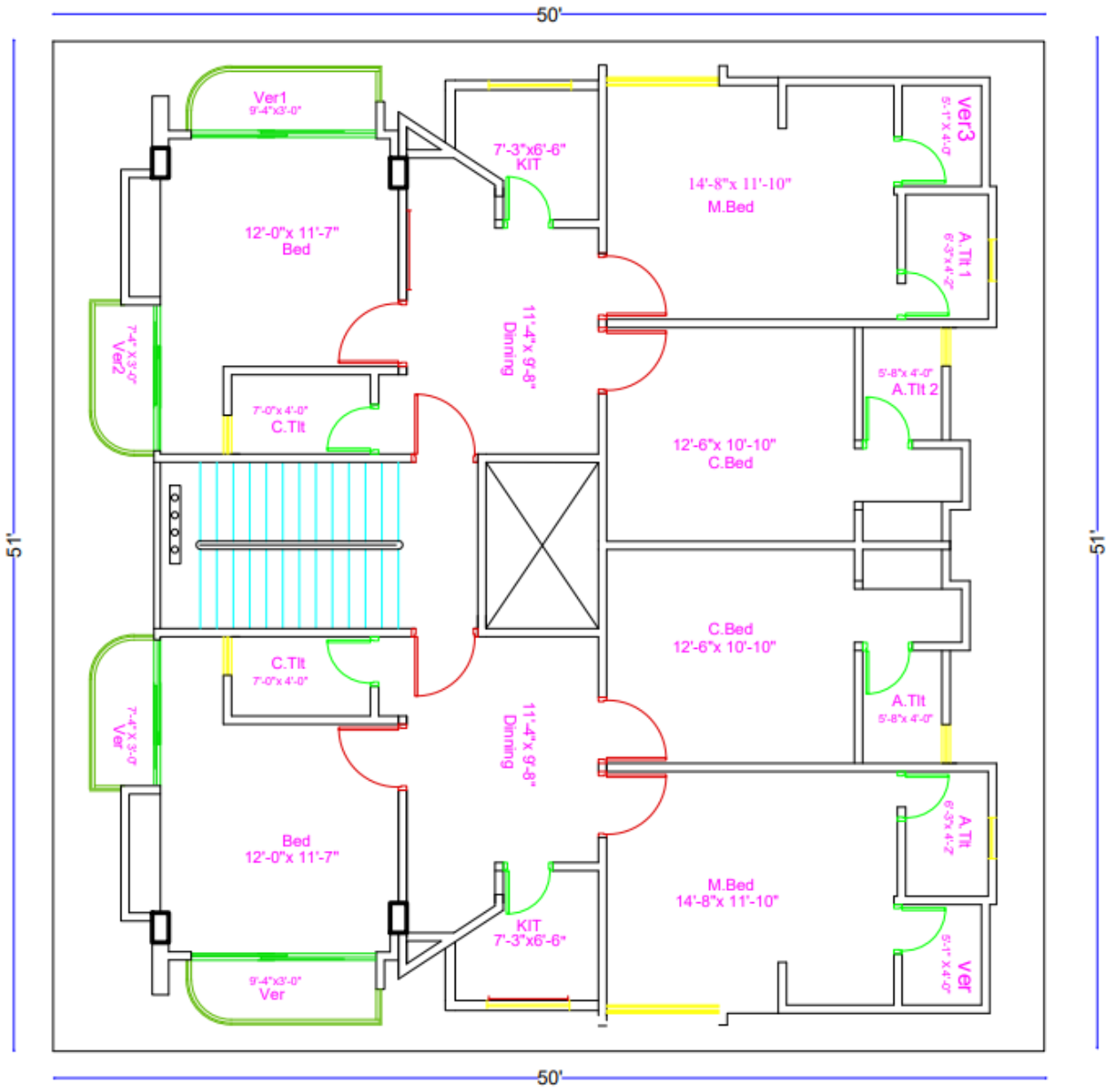
Fixture Legend:

The types of different fixtures used along with their placement and symbol are presented below:

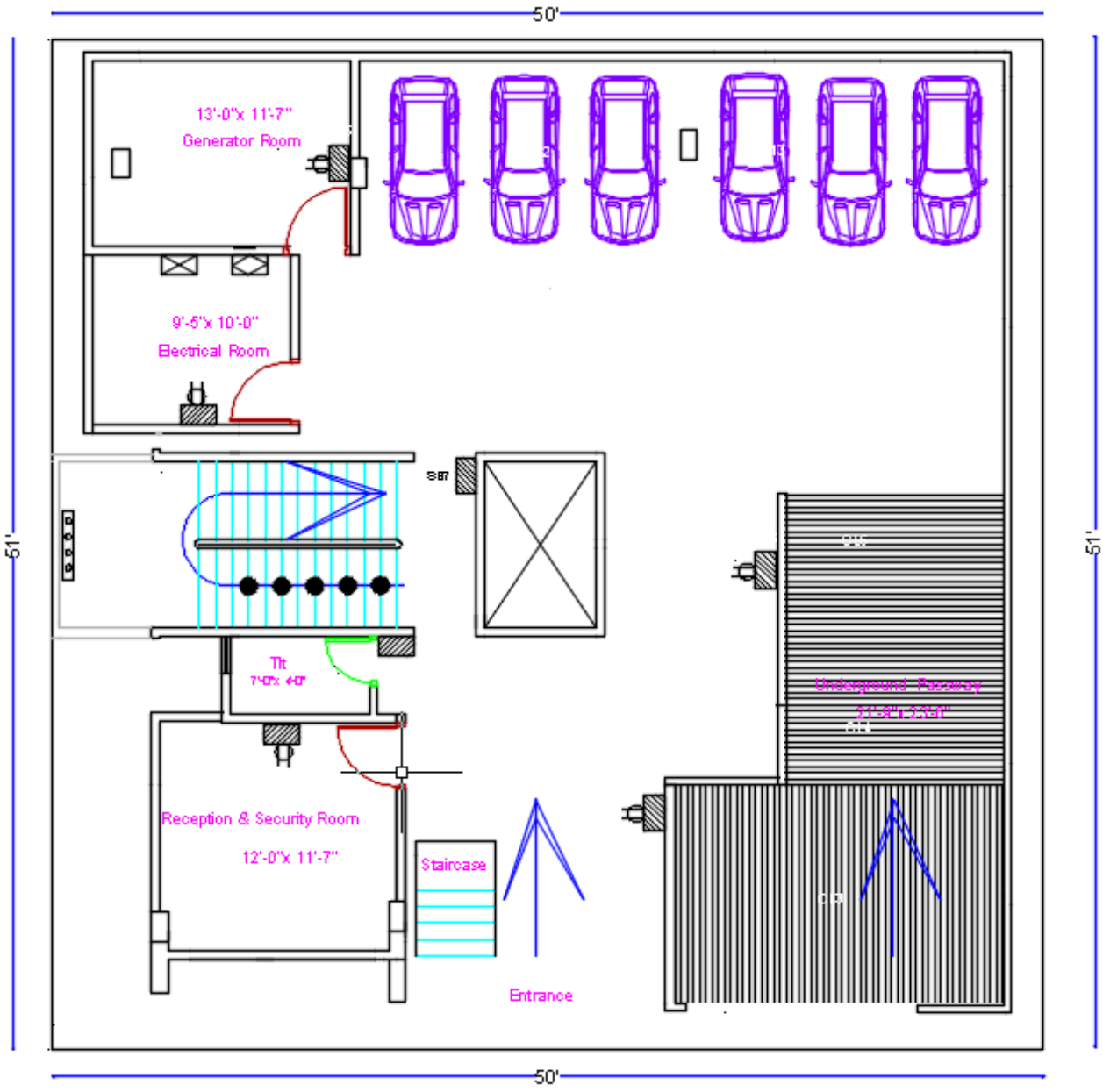
Description	Height	Caption	Symbol
Wall Mounted Light	Lintel	LLA/LLB	
Ceiling Light	Ceiling	CLA/CLB	
Wall Mounted Tube Light	Lintel	TLA	
Ceiling Mounted Tube Light	Ceiling	TLB	
Fan (56” diameter)	Ceiling	F	
Switch Board	Mid wall	SB	
Sub Distribution Board	Mid wall	SDB	
Main Distribution Board	Mid wall	MDB	
Exhaust Fan (8” diameter)	Lintel	Ex	
2 Pin Socket	Mid Wall	SS	
2 Pin TV Socket	Lower	TS	
3 Pin Socket 20A	Lintel	P	

Layouts:

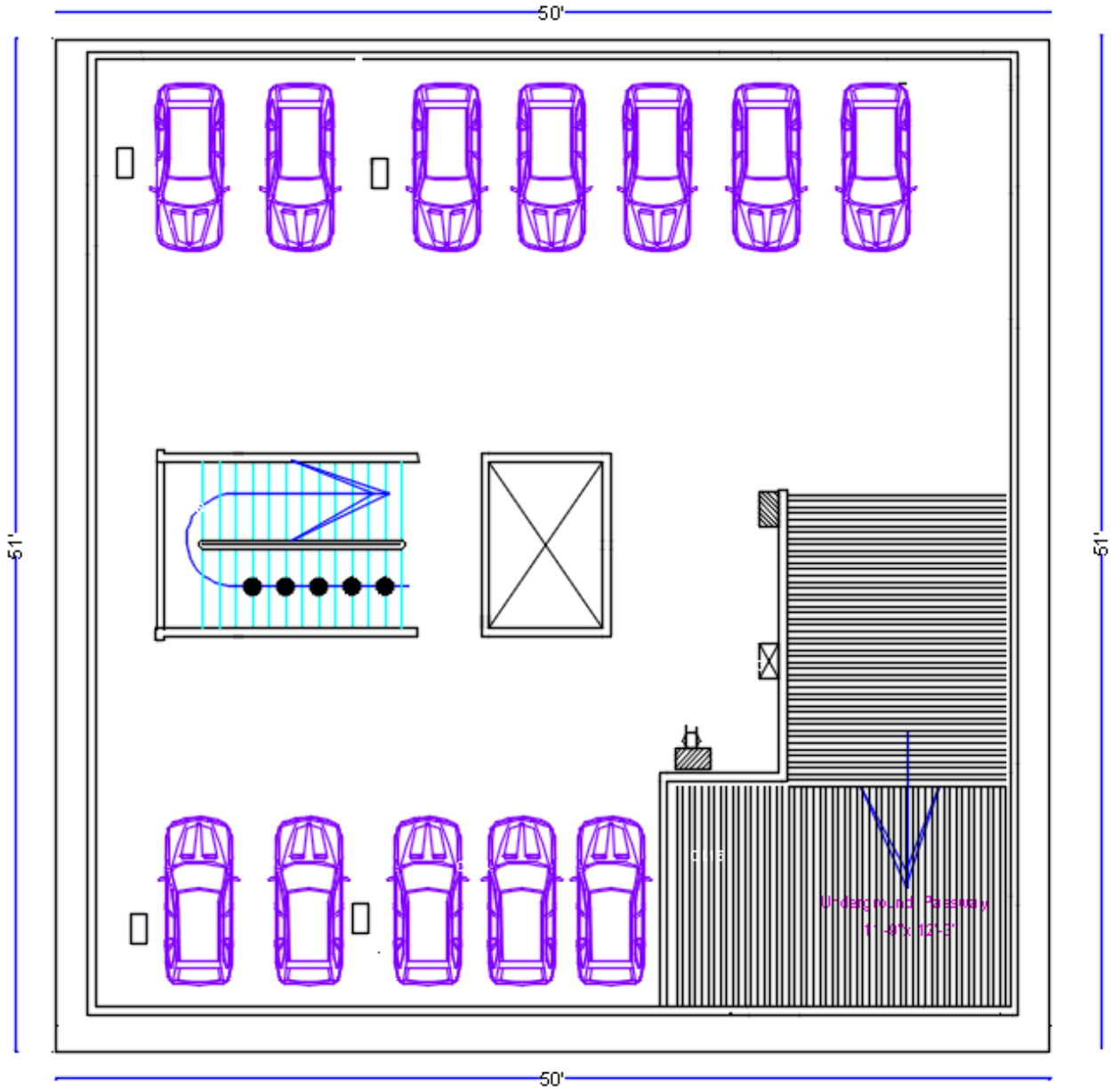
Typical Floor:



Ground Floor:



Underground:



Calculation of number of lights and fans:

Master bedroom:

L = 14’ 8” = 4.471 meters

W = 11’ 10” = 3.6068 meters

Mounting Height = 10’ – 2’ – 3’ = 5’ = 1.524 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{4.471*3.6068}}{\mathbf{1.524*(4.471+3.6068)}} = 1.31$

From the chart,

UF = 0.655 MF = 0.8

E = 70 lux F = 1600 lumen (Wall mounted LED and LED tube-light)

Then, number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{70*4.471*3.6068}}{\mathbf{1600*0.655*0.8}} = 1.34 \approx 2$

And number of fans, $M = \frac{\mathbf{L(inft)*W(in\ ft)}}{\mathbf{100}} = \frac{\mathbf{14'8" * 11' 10"}}{\mathbf{100}} = 1.73 \approx 1$

Common bedroom:

L = 12’ 6” = 3.81 meters

W = 10’ 10” = 3.302 meters

Mounting Height = 10’ – 2’ – 3’ = 5’ = 1.524 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{3.81*3.302}}{\mathbf{1.524*(3.81+3.302)}} = 1.16$

From the chart,

UF = 0.63 MF = 0.8

E = 70 lux F = 1600 lumen (Wall mounted LED and LED tube-light)

Then, number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{70*3.81*3.302}}{\mathbf{1600*0.63*0.8}} = 1.09 \approx 2$

And number of fans, $M = \frac{\mathbf{L(inft)*W(in\ ft)}}{\mathbf{100}} = \frac{\mathbf{12'\ 6"*10'\ 10"}}{\mathbf{100}} = 1.35 \approx 1$

Bedroom:

L = 12” = 3.6576 meters

W = 11’ 7” = 3.5306 meters

Mounting Height = 10’ – 2’ – 3’ = 5’ = 1.524 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{3.6576*3.5306}}{\mathbf{1.524*(3.6576+3.5306)}} = 1.178$

From the chart,

UF = 0.63 MF = 0.8

E = 70 lux F = 1600 lumen (Wall mounted LED and LED tube-light)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{70*3.6576*3.5306}}{\mathbf{1600*0.63*0.8}} = 1.12 \approx 2$

And number of fans, $M = \frac{\mathbf{L(inft)*W(in\ ft)}}{\mathbf{100}} = \frac{\mathbf{12*11'\ 7''}}{\mathbf{100}} = 1.39 \approx 1$

Dining :

L = 11’ 4”= 3.4544 meters

W = 9’ 8” = 2.9464 meters

Mounting Height = 10ft – 2ft – 4ft = 4ft = 1.2192 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{3.4544*2.9464}}{\mathbf{1.2192*(3.4544+3.2.9464)}} = 1.3$

From the chart,

UF = 0.655 MF = 0.8

E = 150 lux (Dining Table) F = 4000 lumen (Wall mounted LED and LED tube-light)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{150*3.4544*2.9464}}{\mathbf{4000*0.655*0.8}} = 0.72$

But we will use 2 LED lights so that the whole dining space is covered nicely.

And number of fans, $M = \frac{\mathbf{L(inft)*W(in\ ft)}}{\mathbf{100}} = \frac{\mathbf{11'\ 4''*9'\ 8''}}{\mathbf{100}} = 1.09 \approx 1$

Kitchen:

L = 7’ 3”= 2.2098 meters

W = 6’ 6” = 1.9812 meters

Mounting Height = 10’ – 2’ – 4’ = 4’ = 1.2192 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{2.2098*1.9812}}{\mathbf{1.2192*(2.2098+1.9812)}} = 0.8568 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 200 lux F = 4000 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{200*2.2098*1.9812}}{\mathbf{4000*0.61*0.8}} = 0.4485 \approx 1$

Common Toilet:

L = 7 ft= 2.1336 meters

W = 4 ft = 1.2192 meters

Mounting Height = 10’ – 2f’ – 3’ = 5’ = 1.524 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{2.1336*1.2192}}{\mathbf{1.524*(2.1336+1.2192)}} = 0.51 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 70 lux F = 1600 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{70*4.471*3.6068}}{\mathbf{1600*0.655*0.8}} = 1.34 \approx 2$

Attached Toilet – 1:

L = 5’ 8” = 1.7272 meters

W = 4’ = 1.2192 meters

Mounting Height = 10’ – 2’ – 3’ = 5’ = 1.524 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{1.7272*1.2192}}{\mathbf{1.524*(1.7272+1.2192)}} = 0.469 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 100 lux F = 1200 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{100*1.7272*1.2192}}{\mathbf{1200*0.61*0.8}} = 0.6595 \approx 1$

Attached Toilet – 2:

L = 6’ 3” = 1.905 meters

W = 4’ 2” = 1.27 meters

Mounting Height = 10’ – 2’ – 3’ = 5’ = 1.524 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{1.905*1.27}}{\mathbf{1.524*(1.905+1.27)}} = 0.5 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 100 lux F = 1200 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{100*1.905*1.27}}{\mathbf{1200*0.61*0.8}} = 0.4131 \approx 1$

Veranda - 1:

L = 9’ 4” = 2.8448 meters W = 3’ = 0.9144 meters

Mounting Height = 10’ - 3’ = 7’ = 2.1336 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{2.8448*0.9144}}{\mathbf{1.524*(2.8448+0.9144)}} = 0.324 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 840 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{50*2.8448*0.9144}}{\mathbf{840*0.61*0.8}} = 0.317 \approx 1$

Veranda - 2:

L = 7’ 4” = 2.2352 meters W = 3’= 0.9144 meters

Mounting Height = 10’ - 3’ = 7’ = 2.1336 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{2.2352*0.9144}}{\mathbf{1.524*(2.2352+0.9144)}} = 0.3 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 840 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{50*2.2352*0.9144}}{\mathbf{840*0.61*0.8}} = 0.249 \approx 1$

Veranda - 3:

L = 5’ 1” = 1.5494 meters W = 4’ = 1.2192 meters

Mounting Height = 10’ - 3’ = 7’ = 2.1336 meters

Room index = $\frac{\mathbf{L*W}}{\mathbf{Mounting\ Height*(L+W)}} = \frac{\mathbf{1.5494*1.2192}}{\mathbf{1.524*(1.5494+1.2192)}} = 0.32 \approx 1$

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 840 lumen (Wall mounted LED)

Then, Number of lights, $N = \frac{\mathbf{E*L*W}}{\mathbf{F*UF*MF}} = \frac{\mathbf{50*1.5494*1.2192}}{\mathbf{840*0.61*0.8}} = 0.23 \approx 1$

Reception Room:

L = 12’ = 3.6576 meters

W = 11’ 7” = 3.5306 meters

Room index = 0.98

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 1600 lumen (25W fluorescent bulb)

Then, Number of lights, $\mathbf{N = \frac{E \times L \times W}{F \times UF \times MF} = \frac{50 \times 3.6576 \times 3.5306}{1600 \times 0.61 \times 0.8}} = 0.81 \approx \mathbf{1}$

Number of fans ,$\mathbf{M = \frac{L \times W}{100} = \frac{12 \times 11.58}{100} = 1.38 \approx 1}$

Electrical Room:

L = 10’ = 3.048 meters

W = 9’ 5” = 2.8702 meters

Room index = 0.82

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 1250 lumen (40W ceiling light)

Then, Number of lights, $\mathbf{N = \frac{E \times L \times W}{F \times UF \times MF} = \frac{50 \times 2.8702 \times 3.048}{1250 \times 0.61 \times 0.8}} = 0.71 \approx \mathbf{1}$

No ceiling fan is required in this room. We have used an exhaust fan here.

Generator Room:

L = 13’ = 3.9624 meters

W = 11’ 7” = 3.5306 meters

Room index = 1.02

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 1250 lumen (40W ceiling light)

Then, Number of lights, $N = \frac{E*L*W}{F*UF*MF} = \frac{50\times3.9624\times3.5306}{1250\times0.61\times0.8} = 0.89 \approx \mathbf{1}$

No ceiling fan is required in this room. We have used an exhaust fan here.

Toilet:

L = 7’ = 2.1336 meters

W = 4’ = 1.2192 meters

Room index = 0.54

From the chart,

UF = 0.61 MF = 0.8

E = 50 lux F = 1250 lumen (40W tubelight)

Then, Number of lights, $N = \frac{E*L*W}{F*UF*MF} = \frac{50\times2.1336\times1.2192}{1250\times0.61\times0.8} = 0.54 \approx \mathbf{1}$

Garage (excluding reception room,generator room, electrical room and toilet):

L = 50’ = 15.54 meters

W = 51’ = 15.5448 meters

Room index – 1 = 2.28 Room index – 2 = 2.42

From the chart,

UF1 = 0.71 UF2 = 0.73

MF = 0.9 E = 100 lux

F = 2500 lumen (ceiling mounted tubelights)

Then,Number of lights, $\mathbf{N} = \frac{\mathbf{E \times L1 \times W1}}{\mathbf{F \times UF1 \times MF}} + \frac{\mathbf{E \times L2 \times W2}}{\mathbf{F \times UF2 \times MF}}$

$= \frac{\mathbf{100 \times 11.2776 \times 6.57}}{\mathbf{2500 \times 0.71 \times 0.8}} + \frac{\mathbf{100 \times 11.2776 \times 8.96}}{\mathbf{2500 \times 0.73 \times 0.9}} = 4.63*5+6.15*7 = 13$

Underground Garage:

L = 50’ = 15.54 meters

W = 51’ = 15.5448 meters

Room index = 4.22

From the chart,

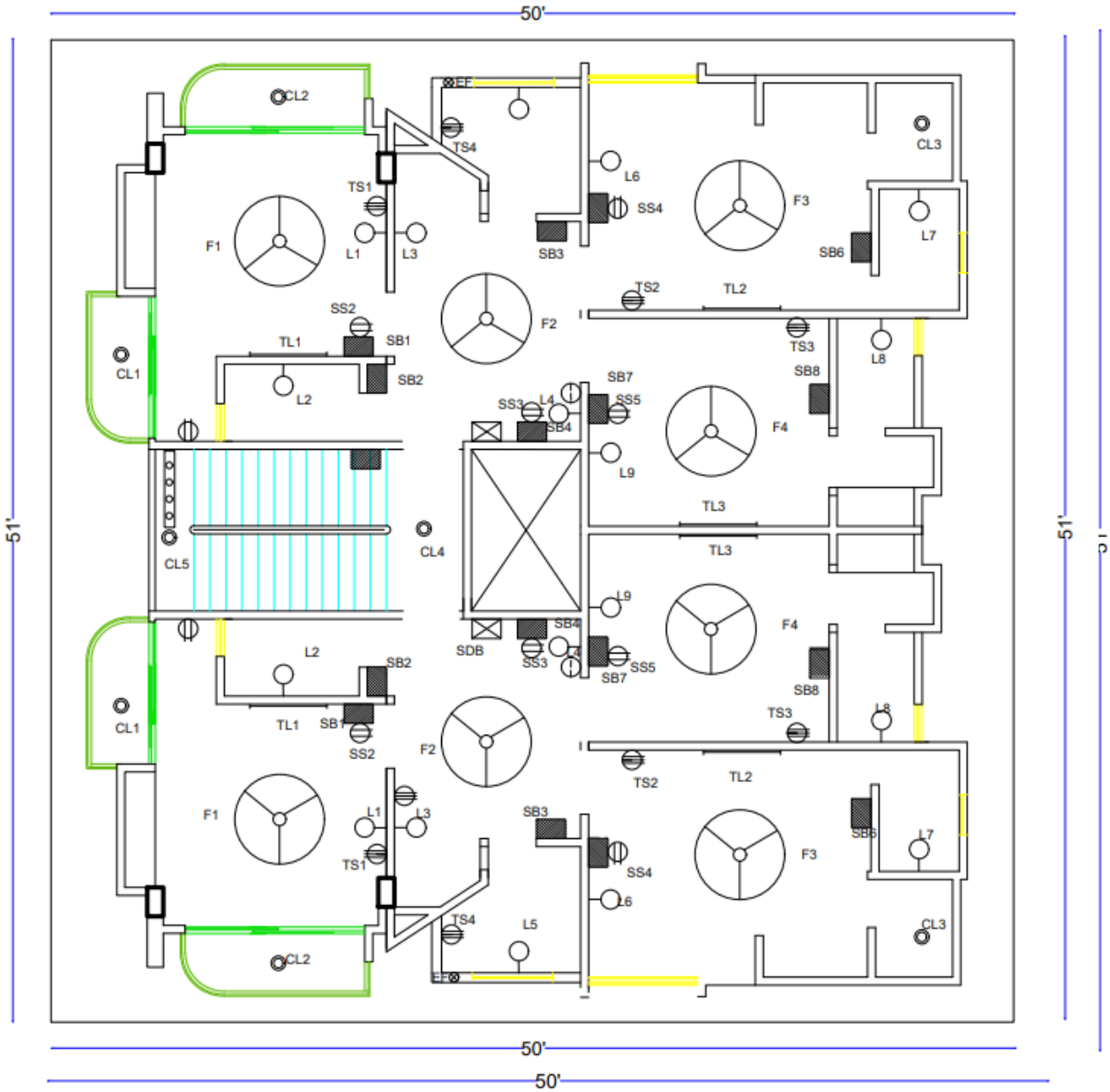
UF = 0.75 MF = 0.9

E = 100 lux F = 2500 lumen (ceiling mounted tubelights)

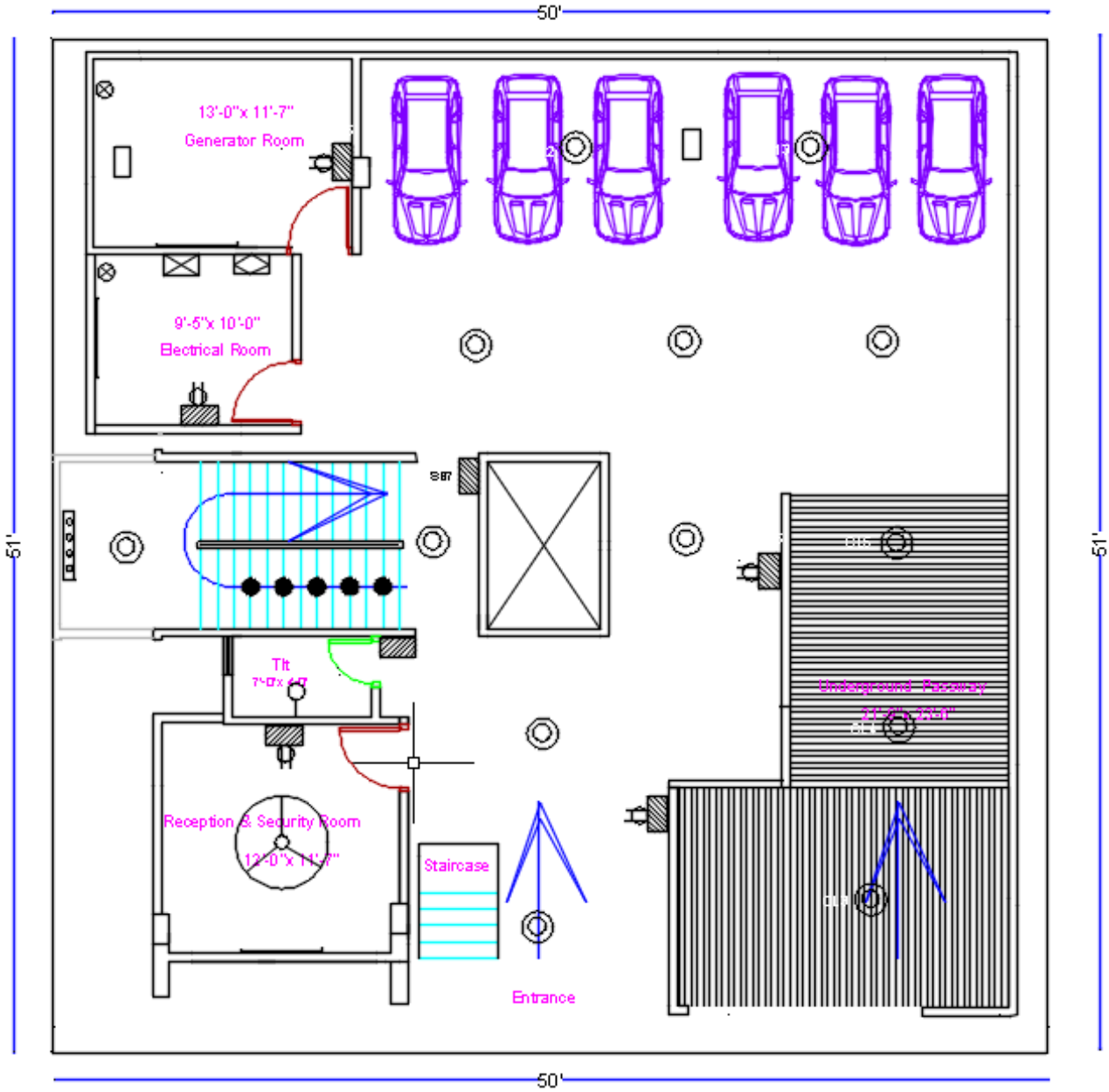
Then, Number of lights, $N = \frac{\mathbf{E * L * W}}{\mathbf{F * UF * MF}} = \frac{\mathbf{100 \times 15.24 \times 15.5448}}{\mathbf{2500 \times 0.75 \times 0.9}} = 14.22 \approx \mathbf{15}$

Layout with fixtures and fittings:

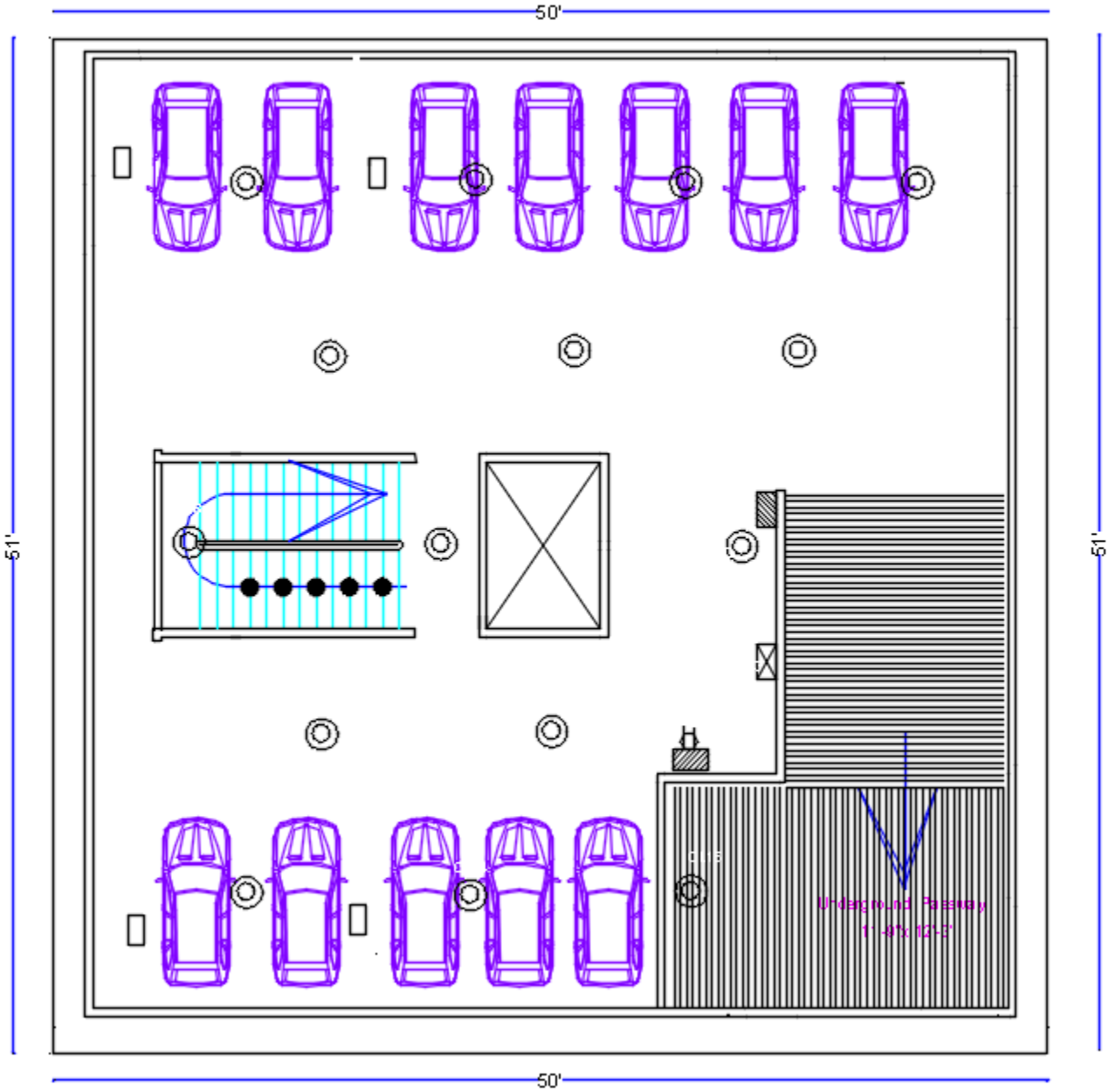
Typical floor:



Ground Floor:



Underground:



Calculation of Conduits:

Formula for ampere rating, $\mathbf{I = \frac{P}{V*pf}}$

Pf = 0.9 is considered on an average.

Following is the table for wattage rating of various components.

Light Type	Symbol	Watt Rating (W)
LED Bulb	L	12
		16
		25
LED Tube	TL	16
Ceiling Light	CL	12
		24
Ceiling Fan	F	80
Exhaust Fan	EF	40

Example switchboard calculation:

An example calculation for switchboard SB1 which is situated in Bedroom.

Components in this switchboard – 1*16 W Wall mounted LED Bulb, 1*16 W LED Tubelight, 1 x 80 W Ceiling Fan and 2 * 2 Pin socket.

Current for LED Bulb $I = \frac{P}{V*pf} = \frac{16}{220*0.9} = 0.08$ A

Current for Ceiling Fan, $I = \frac{P}{V*pf} = \frac{80}{220*0.9} = 0.404$ A

For two-pin sockets, current would be 5A for each.

So, all switchboard to component connection should be 2 x 1.5 rm BYM, 5A conduction capacity.

Total current of SB1 = $0.08 + 0.404 + 5 * 2 = 10.484$ A

So, SDB to SB1 connection should be 2 x 4 rm BYM + 1 x4 rm BYM ECC, 10A conduction capacity.

Typical floor:

Room Name	Circuit No	Switchboard	Fixture	Power (W)	Current Rating	Wire Rating
Bedroom	CKT1	SB1	F1 L1 TL1 CL1 CL2 SS1 SS2	80 16 16 12 12 1000 1000	0.404 0.081 0.081 0.061 0.061 5 5	
				Total	**10.688**	**C8**
Common toilet	CKT2	SB2	L2	12	0.061	
				Total	**0.061**	**C8**
Dining Master bedroom Child bedroom Kitchen Adjacent toilet-1 & 2	CKT3	SB3	L5 EF	25 40	0.126 0.202	
		SB5	F3 TL2 L6 SS4	80 16 16 1000	0.404 0.081 0.081 5	
		SB6	L7 CL3	12 12	0.061 0.061	
		SB7	L9 TL3 F4 SS5	16 16 80 1000	0.081 0.081 0.404 5	
		SB8	L8	12	0.061	
				Total	**11.6438**	**C8**
Dining	CKT4	SB4	F2 L3 L4 SS3	80 25 25 1000	0.404 0.126 0.126 5	
				Total	**5.656**	**C8**
Staircase	CKT5	SB9	CL4 CL5	24 24	0.121 0.121	
				Total	**0.242**	**C8**
Total Current 28.2908A						

SDB-1 Power Circuits			
Room Name	**Power Socket**	**Current Rating (A)**	**Wire Rating**
Master Bedroom	TS2	20	C9
Child Bedroom	TS3	20	C9
Bedroom	TS1	20	C9
Kitchen	TS4	20	C9

Considering an activity factor of 0.8 for regular loads and 0.3 for power sockets, we get

Total current rating from MDB to SDB for a single unit= 28.2908*0.8 + 4*20*0.3 = 46.632A.

So, for one floor, total current = 46.632*2 = 93.264A

Breaker rating: 100A SP MCCB **Wire rating**: 2x70rm BYM+70rm BYM ECC

Typical floor emergency:

Room Name	Circuit No	Switchboard	Fixture	Power (W)	Current Rating	Wire Rating
Bedroom	CKT1	SB1	F1 L1 TL1	80 16 16	0.404 0.081 0.081	
				Total	**0.566**	**C8**
Common toilet	CKT2	SB2	L2	12	0.061	
				Total	**0.061**	**C8**
Dining Master bedroom Child bedroom Kitchen Adjacent toilet-1 & 2	CKT3	SB3	L5	25 40	0.126 0.202	
		SB5	F3 TL2 SS4	80 16 1000	0.404 0.081 5	
		SB6	L7	12	0.061	
		SB7	L9 F4	16 80	0.081 0.404	
		SB8	L8	12	0.061	
				Total	**6.42**	**C8**
Dining	CKT4	SB4	F2 L3 SS3	80 25 1000	0.404 0.126 5	
				Total	**5.53**	**C8**
Staircase	CKT5	SB9	CL5	24	0.121	
				Total	**0.121**	**C8**
Total Current 12.698						

ESDB-1 Power Circuits			
Room Name	**Power Socket**	**Current Rating (A)**	**Wire Rating**
Master Bedroom	TS2	20	C9
Child Bedroom	TS3	20	C9

Considering an activity factor of 0.8 for regular loads and 0.3 for power sockets, we get

Total current rating from MDB to SDB for a single unit = 12.698*0.8 + 2*20*0.3 = 24.698A

Breaker rating: 50A SP MCCB **Wire rating:** 2x25rm BYM+ 25rm BYA ECC

Ground Floor:

Room Name	Circuit No	Switchboard	Fixture	Power (W)	Current Rating	Wire Rating
Entrance	CKT1	SB1	CL1 CL2 CL6 CL8 CL9 SS1	24 24 24 24 24 1000	.126 .126 .126 .126 .126 5	
Total					**5.63**	**C8**
Reception And Security Room	CKT1	SB2	TL1 F1 SS3	16 80 1000	0.081 .36 5	
Total					**5.441**	**C8**
Toilet & stair	CKT1	SB3	L1 CL10 CL11	12 24 24	.061 0.126 0.126	
Total					**0.313**	**C8**
Electrical Room	CKT1	SB4	TL2 F2(exhaust) SS4	12 40 1000	0.061 0.18 5	
Total					**5.24**	**C8**
Parking Area	CKT2	SB5	SS2 CL12 CL13 CL7 CL5 CL4 CL3	1000 24 24 24 24 24 24	5 0.126 0.126 0.126 0.126 0.126 0.126	
Total					**5.75**	**C8**
Generator Room	CKT3	SB6	F3(exhaust) TL2 SS5	40 12 1000	0.18 0.061 5	
Total					**5.24**	**C8**
Lift	CKT4	SB7		18000	27.04	
Total					**27.04**	**C11**
Pump	CKT5	SB8		5000	8.41	
Total					**8.41**	**C10**
Total Current 63A						

Considering an activity factor of 0.8 for regular loads and 0.3 for power sockets, we get

Total current rating from MDB to SDB for a ground floor = 63 * 0.8 = 50.45A

Breaker rating: 60A SP MCCB **Wire rating:** 2x35rm BYM+ 35rm BYA ECC

Ground Floor Emergency:

Room Name	Circuit No	Switchboard	Fixture	Power (W)	Current Rating	Wire Rating
Entrance	CKT1	SB1	CL1 CL8 SS1	24 24 1000	.126 .126 5	
				Total	**5.252**	**C8**
Reception And Security Room	CKT1	SB2	F1 TL1 SS3	80 16 1000	.36 .081 5	
				Total	**5.44**	**C8**
Toilet	CKT1	SB3	L1 CL10	12 24	0.061 0.126	
				Total	**0.187**	**C8**
Electrical Room	CKT1	SB4	TL2 F2 SS4	12 40	.0.061 .18 5	
				Total	**5.241**	**C8**
Parking Area	CKT2	SB5	CL5 CL7 SS2	24 24	0.126 0.126 5	
				Total	**Total=5.252**	**C8**
Generator Room	CKT3	SB6	F3 TL2 SS5	40 12	.18 .061 5	
				Total	**5.241**	**C8**
Lift	CKT4	SB7		18000	27.04	
				Total	**27.04**	**C11**
Pump	CKT5	SB8		5000	8.41	
				Total	**8.41**	**C10**
Total Current 62A						

Considering an activity factor of 0.8 for regular loads and 0.3 for power sockets, we get

Total current rating from MDB to SDB for a ground floor emergency = 62*0.8 = 49.4A

Breaker rating: 50A SP MCCP **Wire rating:** 2x25rm BYM+25rm BYM ECC

Underground:

Room Name	Circuit No	Switchboard	Fixture	Power (W)	Current Rating	Wire Rating
Parking Area	CKT1	SB1	CL1	24	.126	
			CL2	24	.126	
			CL3	24	.126	
			CL4	24	.126	
			CL5	24	.126	
			CL6	24	.126	
			CL7	24	.126	
				Total	**0.882**	**C8**
Parking Area	CKT2	SB2	SS1	1000	5	
			CL8	24	.126	
			CL9	24	.126	
			CL10	24	.126	
			CL11	24	.126	
			CL12	24	.126	
			CL13	24	.126	
			CL14	24	.126	
			CL15	24	.126	
				Total	**6.008**	**C8**
Total Current 6.89A						

Considering an activity factor of 0.8 for regular loads and 0.3 for power sockets, we get

Total current rating from MDB to SDB for a underground = 6.89*0.8 = 5.512A

Breaker rating: 10A SP MCCP **Wire rating:** 2x2.5rm BYM+2.5m BYM ECC

Underground emergency:

Room Name	Circuit No	Switchboard	Fixture	Power (W)	Current Rating	Wire Rating
Parking Area	CKT1	SB1	CL3 CL6 CL7	24 24 24	.126 .126 .126	
				Total	**0.37**	**C8**
Parking Area	CKT2	SB2	CL9 CL13 CL14 CL15 SS1	24 24 24 24 1000	.126 .126 .126 .126 5	
				Total	**5.5**	**C8**
Total Current 5.87A						

Considering an activity factor of 0.8 for regular loads and 0.3 for power sockets, we get

Total current rating from MDB to SDB for a underground emergency = 5.87*0.8 = 4.7A

Breaker rating:10A SP MCCP Wire rating: 2x2.5rm BYM+2.5m BYM ECC

Per phase current from MDB:

Per phase current from typical floors + Per Phase current from ground floor + Per phase current from underground: $\frac{46.632*18}{3} + \frac{27.6*0.8}{3} + 27.04 * 0.8 + 8.41 * 0.8 + \frac{5.512}{3} = 317.349A$

So, 425A SP MCCB Circuit breaker is needed.

Per phase current from EMDB:

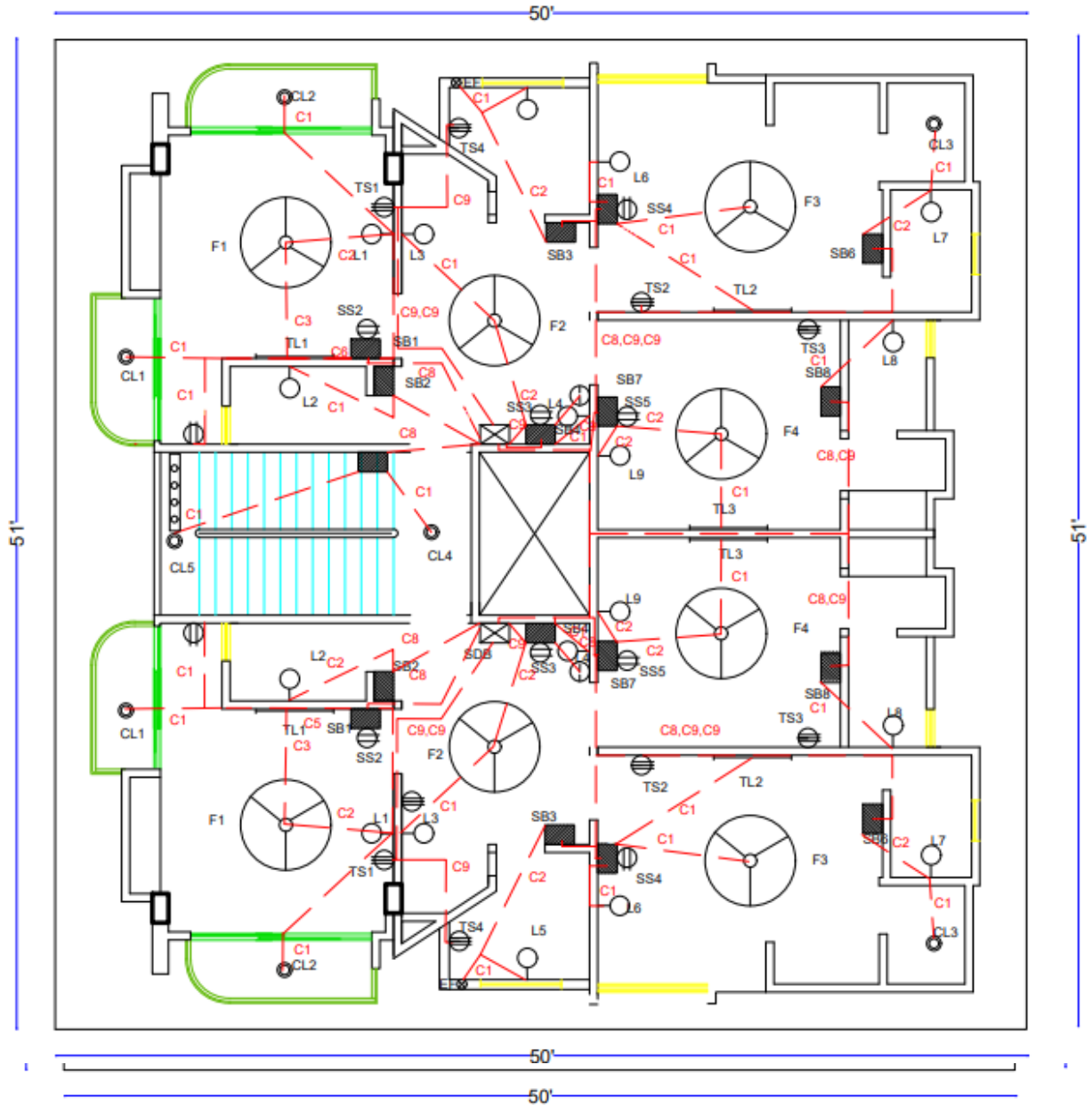
Per phase current from typical floors + Per Phase current from ground floor + Per phase current from underground: $\frac{24.698*18}{3} + \frac{26.5*0.8}{3} + 27.04 * 0.8 + 8.41 * 0.8 + \frac{5.512}{3} = 185.452A$

So, 200A SP MCCB Circuit breaker is needed.

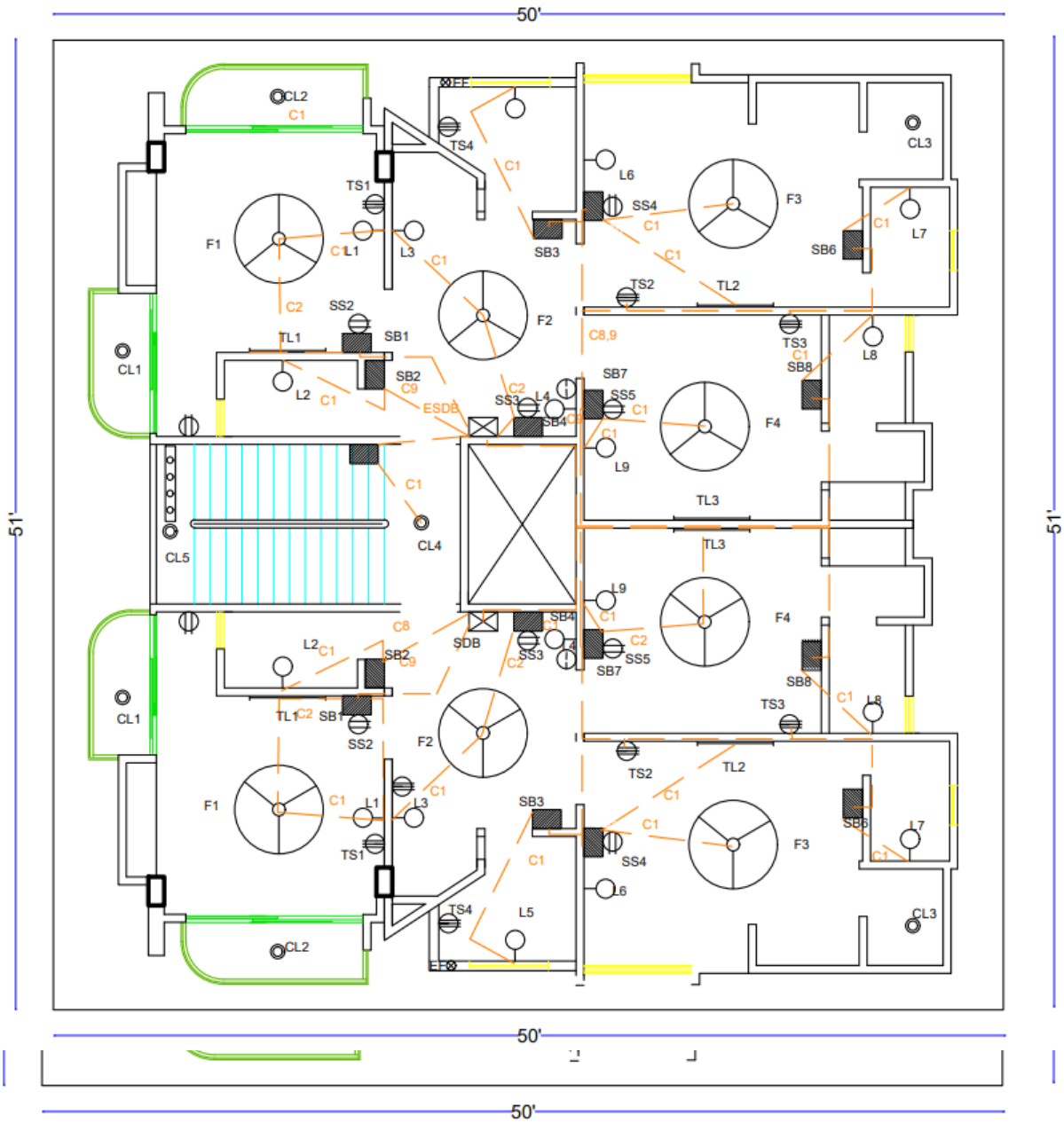
Layout with regular conduits and emergency conduits:

Typical Floor:

Regular:

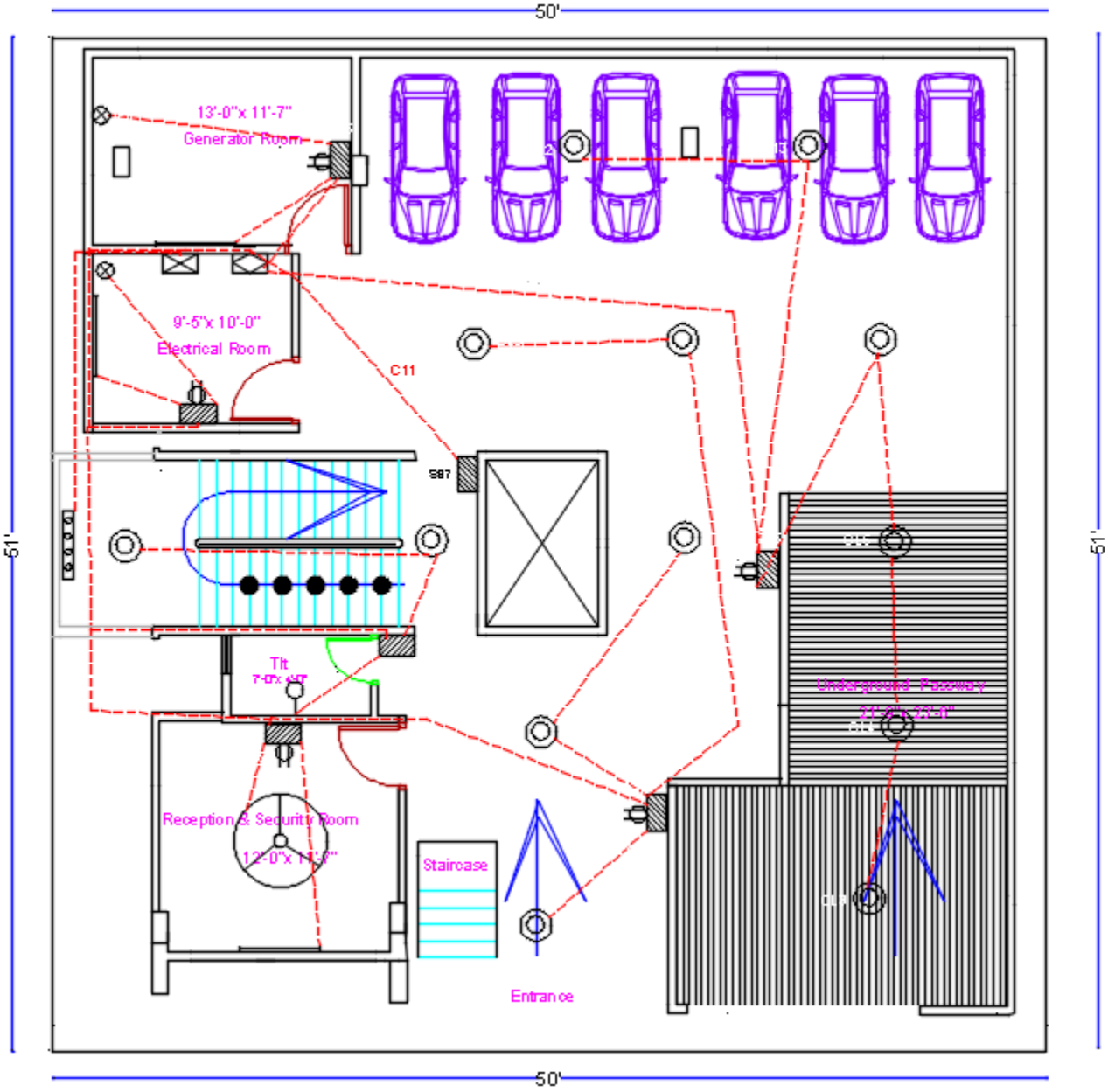


Emergency:

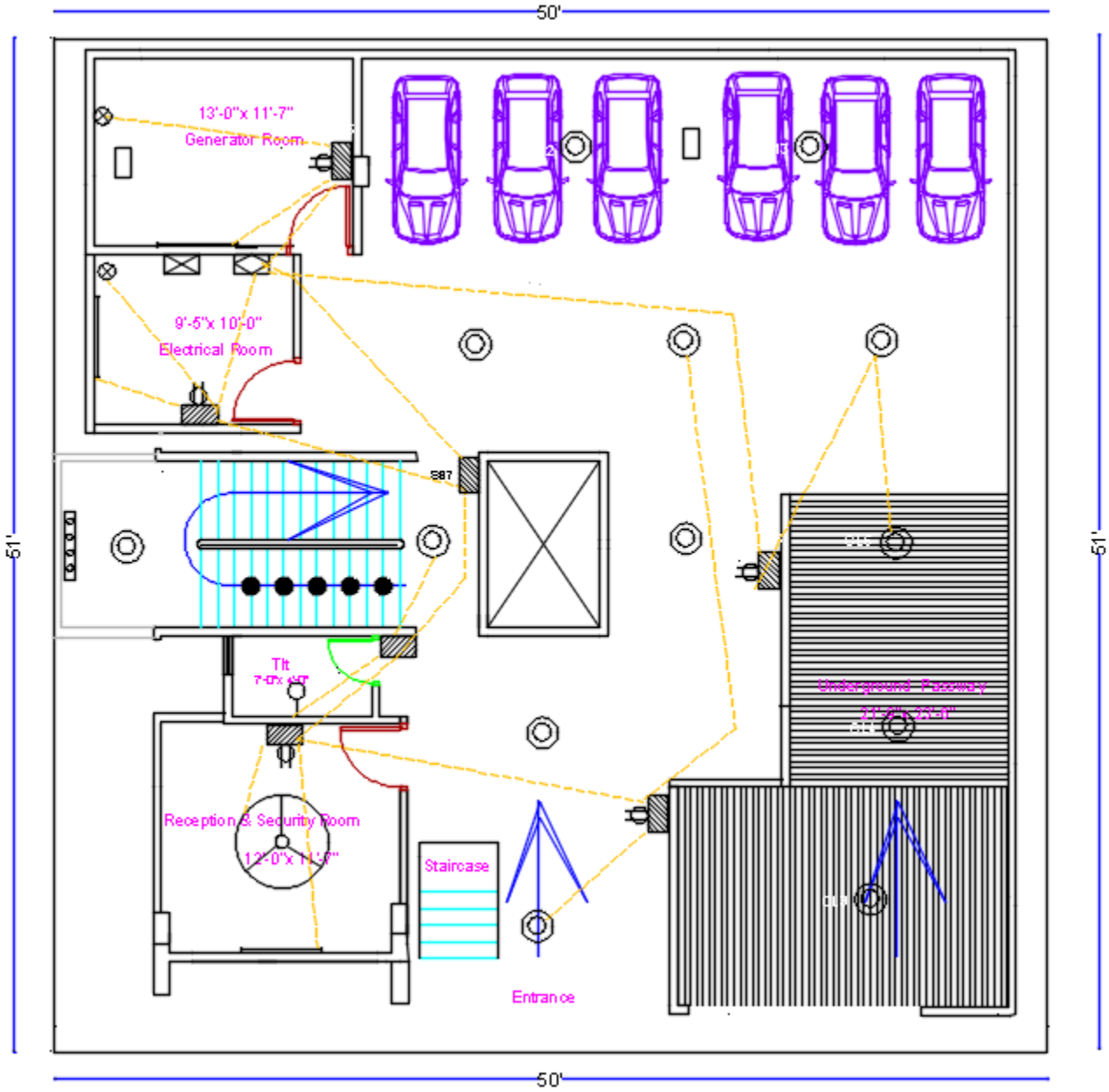

50'
51'
51'
50'
50'
CL2
C1
TS4
EF
CL3
TS1
L6
SS4
F3
F1
C1
L1
L3
SB3
SB6
L7
C1
C1
TS2
TL2
C2
SS2
F2
C8,9
TS3
L8
TL1
SB1
C1
CL1
SB2
C9
L2
C1
C2
SS3
L4
SB4
SB7
SS5
F4
ESDB
C1
L9
C1
TL3
CL5
CL4
TL3
L9
C8
SB4
C1
F4
L2
C1
SB2
C9
SDB
C2
SS3
C2
SS5
SB7
SB8
TS3
C1
L8
CL1
TL1
C2
SB1
SS2
F2
TS2
TL2
C1
F1
C1
L1
L3
SB3
C1
SS4
F3
SB6
L7
TS1
C1
L6
TS4
L5
CL3
CL2
EF

Ground Floor:

Regular:

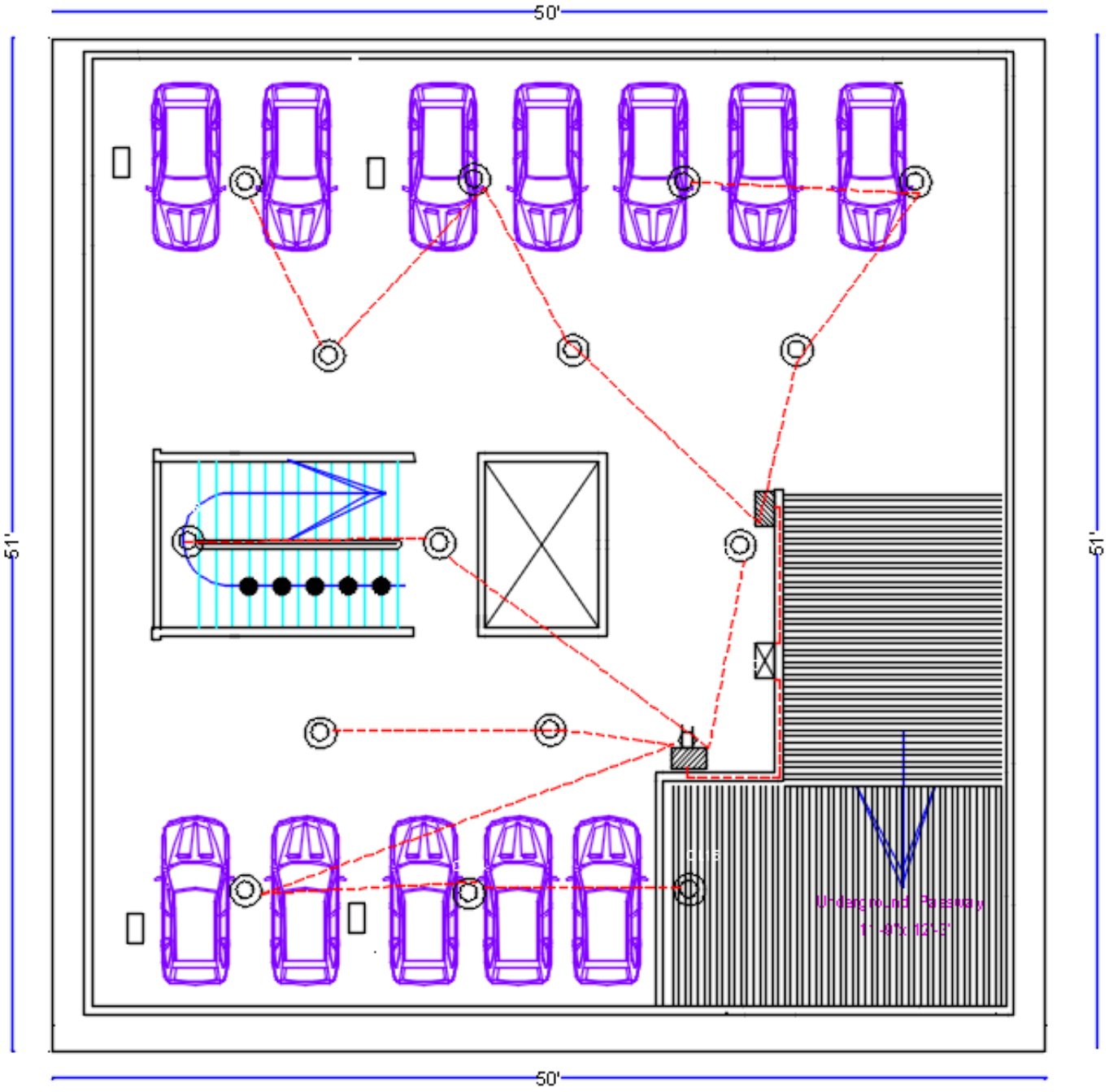


Emergency:

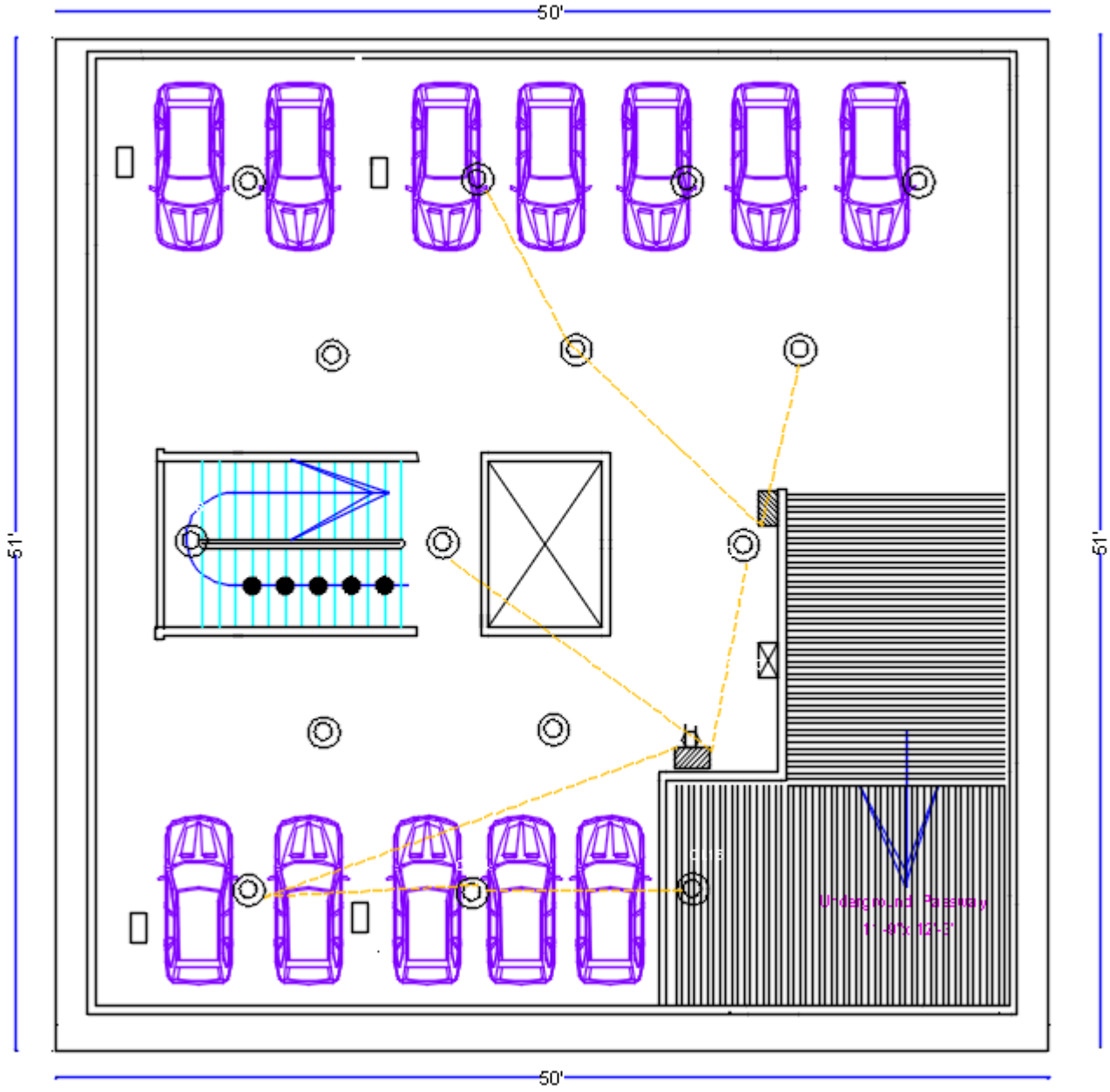

50'
51'
13'-0"x 11'-7"
Generator Room
9'-5"x 10'-0"
Electrical Room
Tlt
Reception & Security Room
Staircase
Entrance
50'
51'

Underground:

Regular:



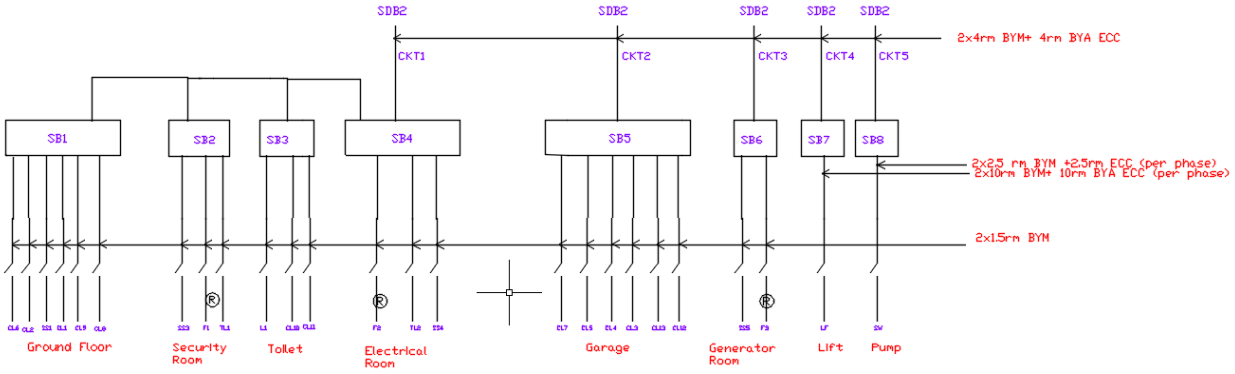
Emergency:



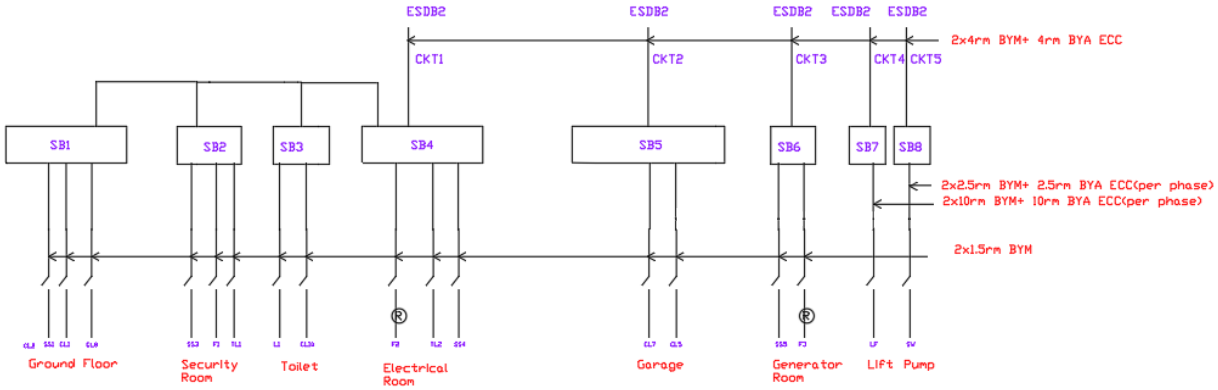
Circuit Diagrams:

GROUND FLOOR:

SDB:

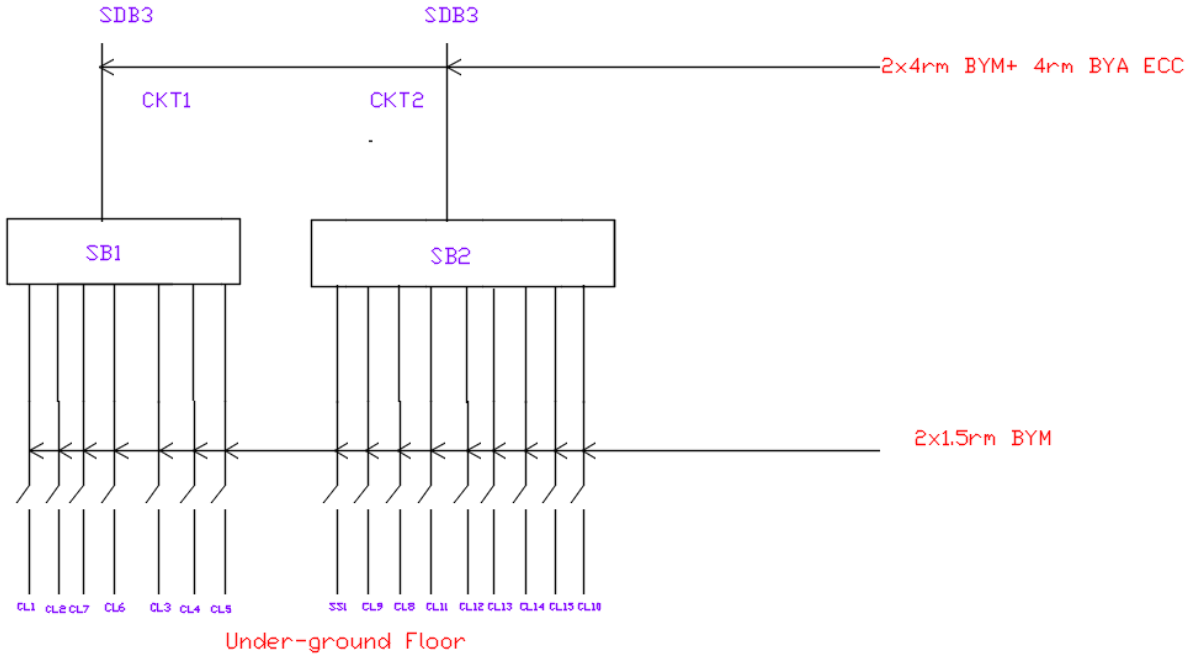


ESDB:

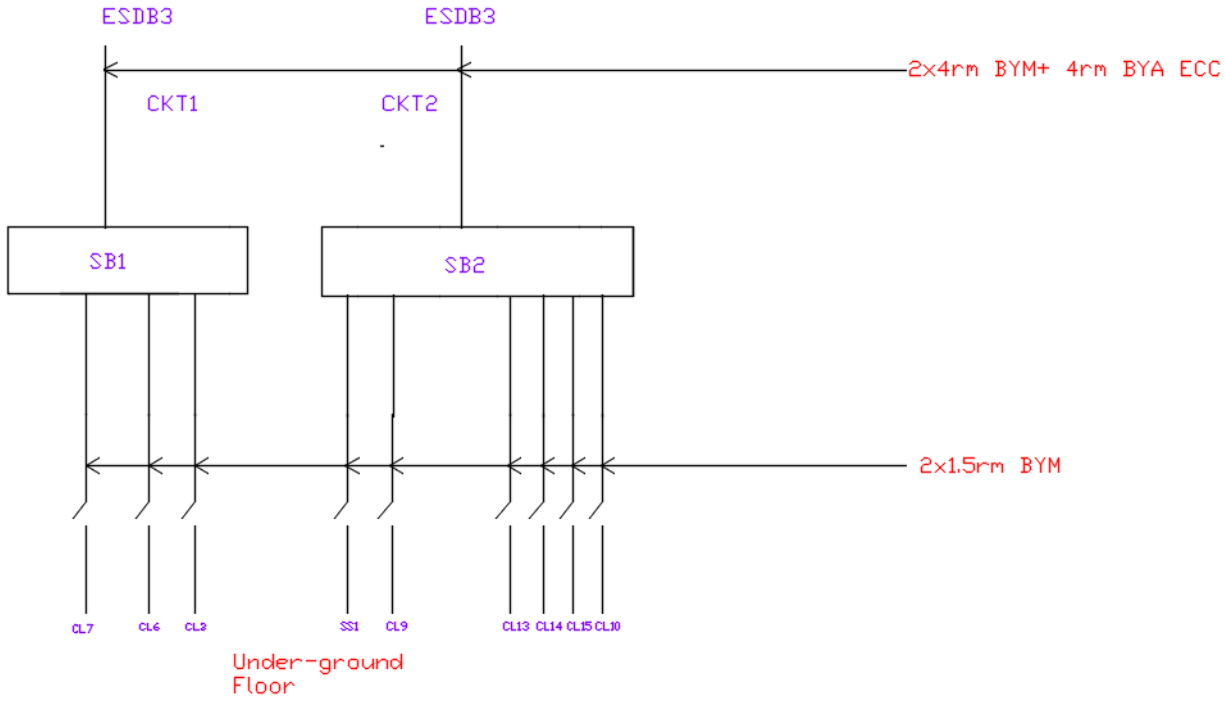


UNDERGROUND:

SDB:

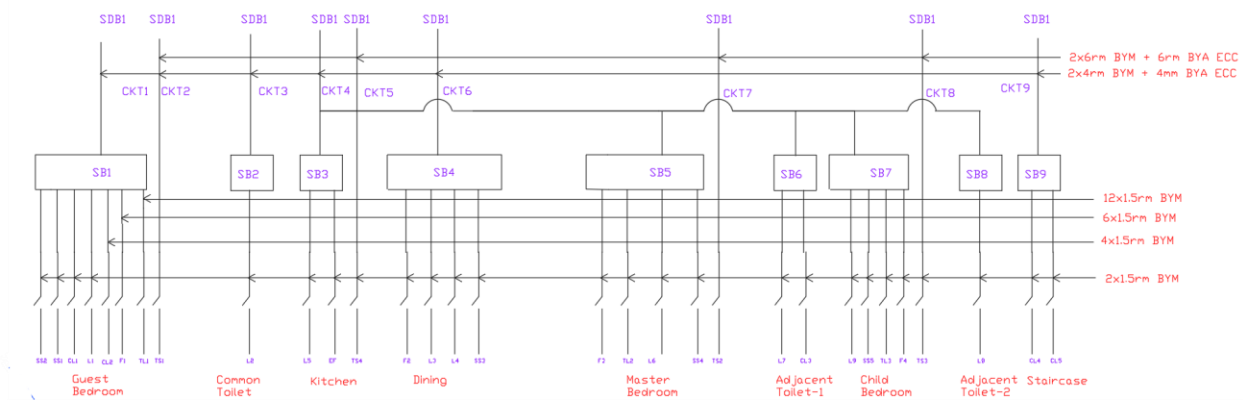


ESDB:

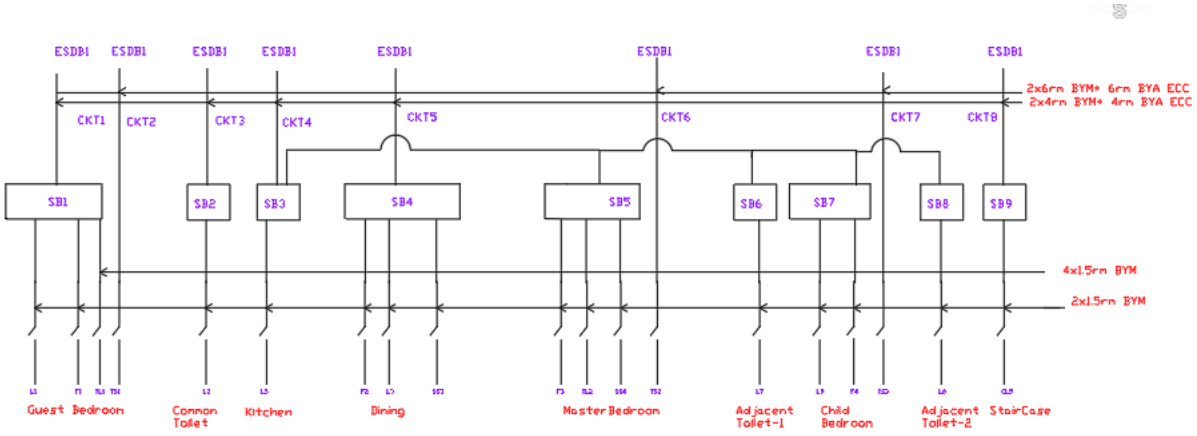


Typical Floor:

SDB:

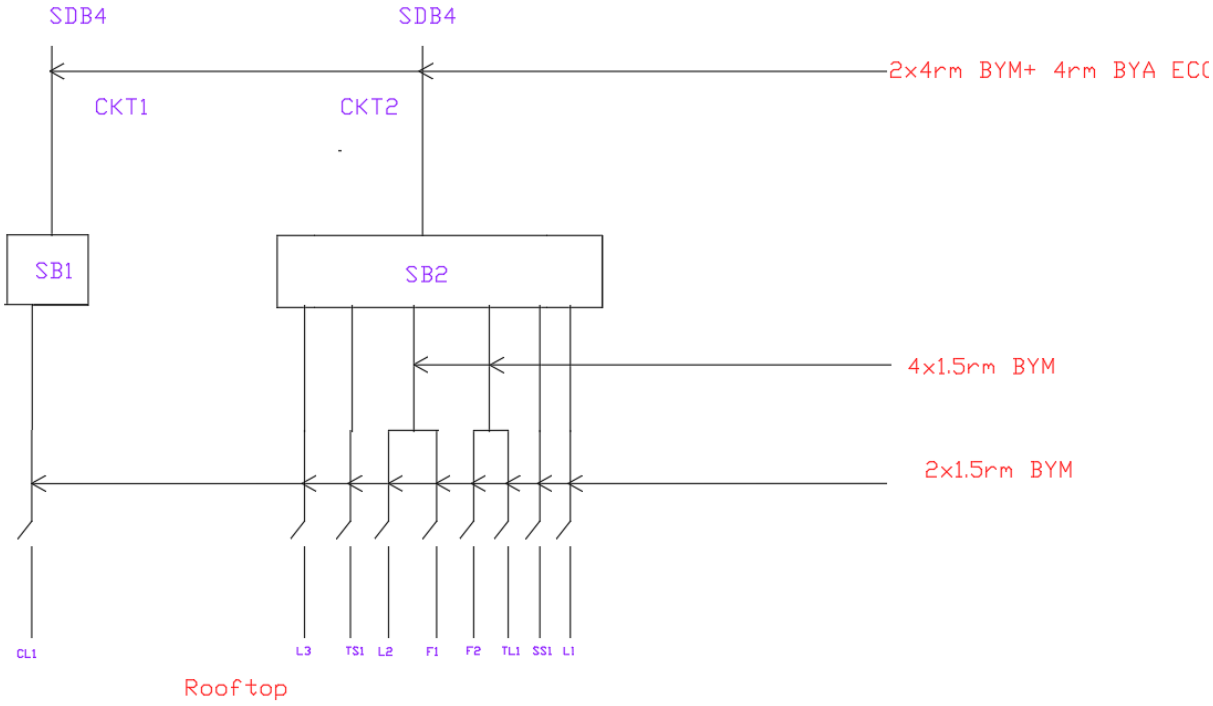


ESDB:

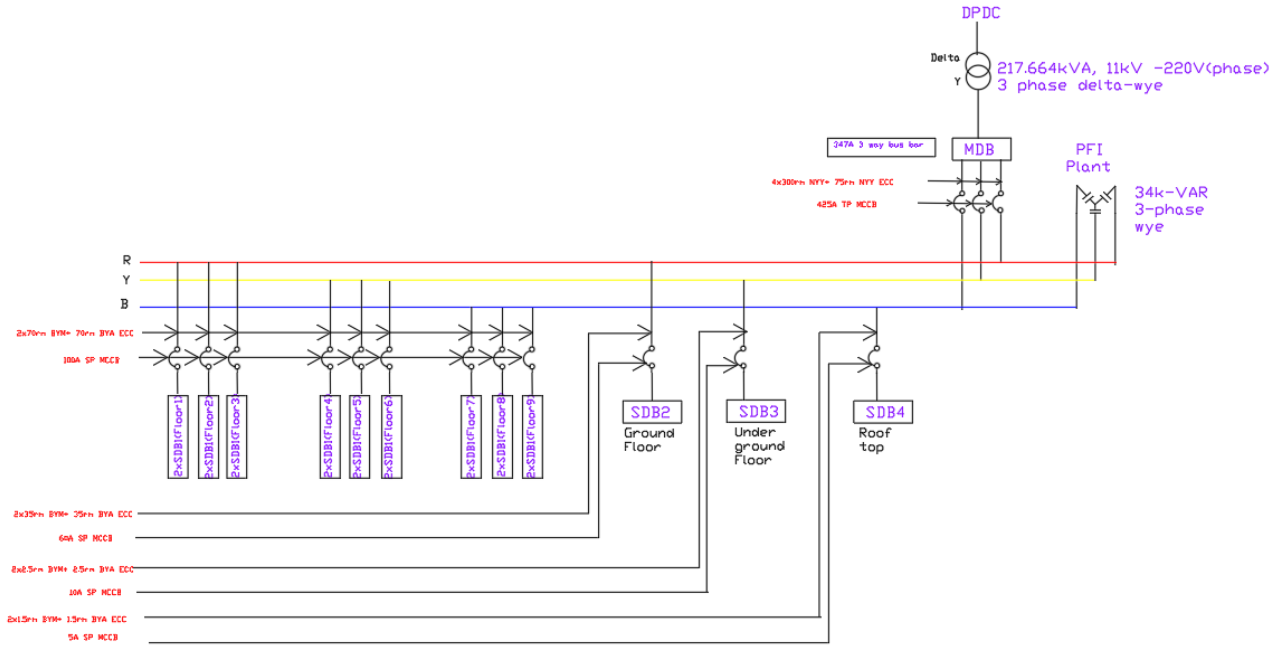


Rooftop:

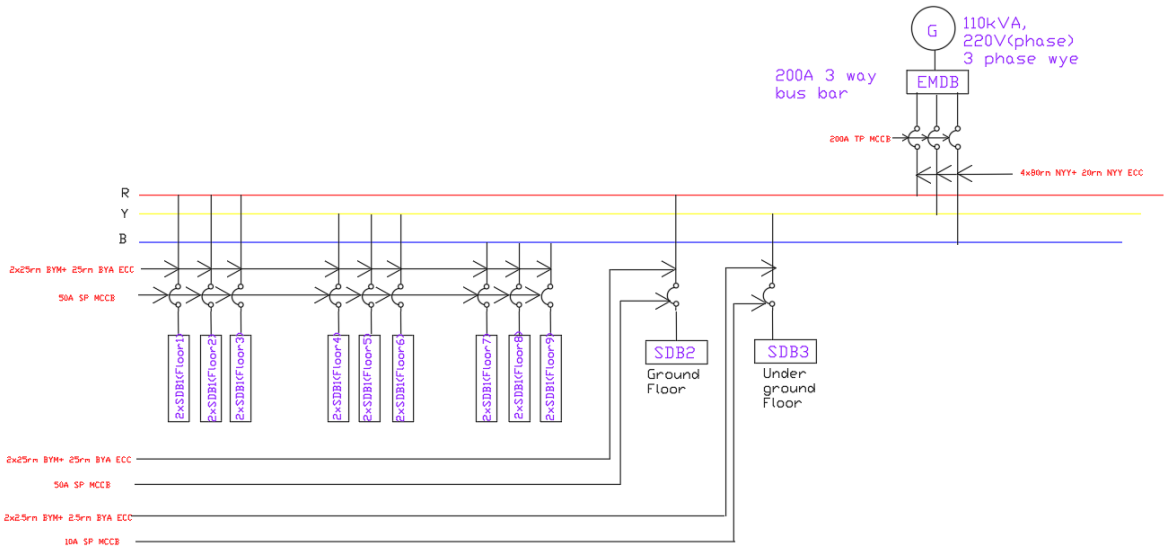
SDB:



MDB:



EMDB:



Roof Calculation:

Lightning Arrestor :

Rod Height = 2ft

Roof perimeter = 2x(45.75 + 48.5) = 188.5FT

We place arrestors 23.5ft apart, requiring 3 arrestors along the length of the roof perimeter, 3 arrestors along the width, and 1 on the corner of the lift wall.

Down conductor:

Total Area = 2218.875sq ft = 206.14 sq m

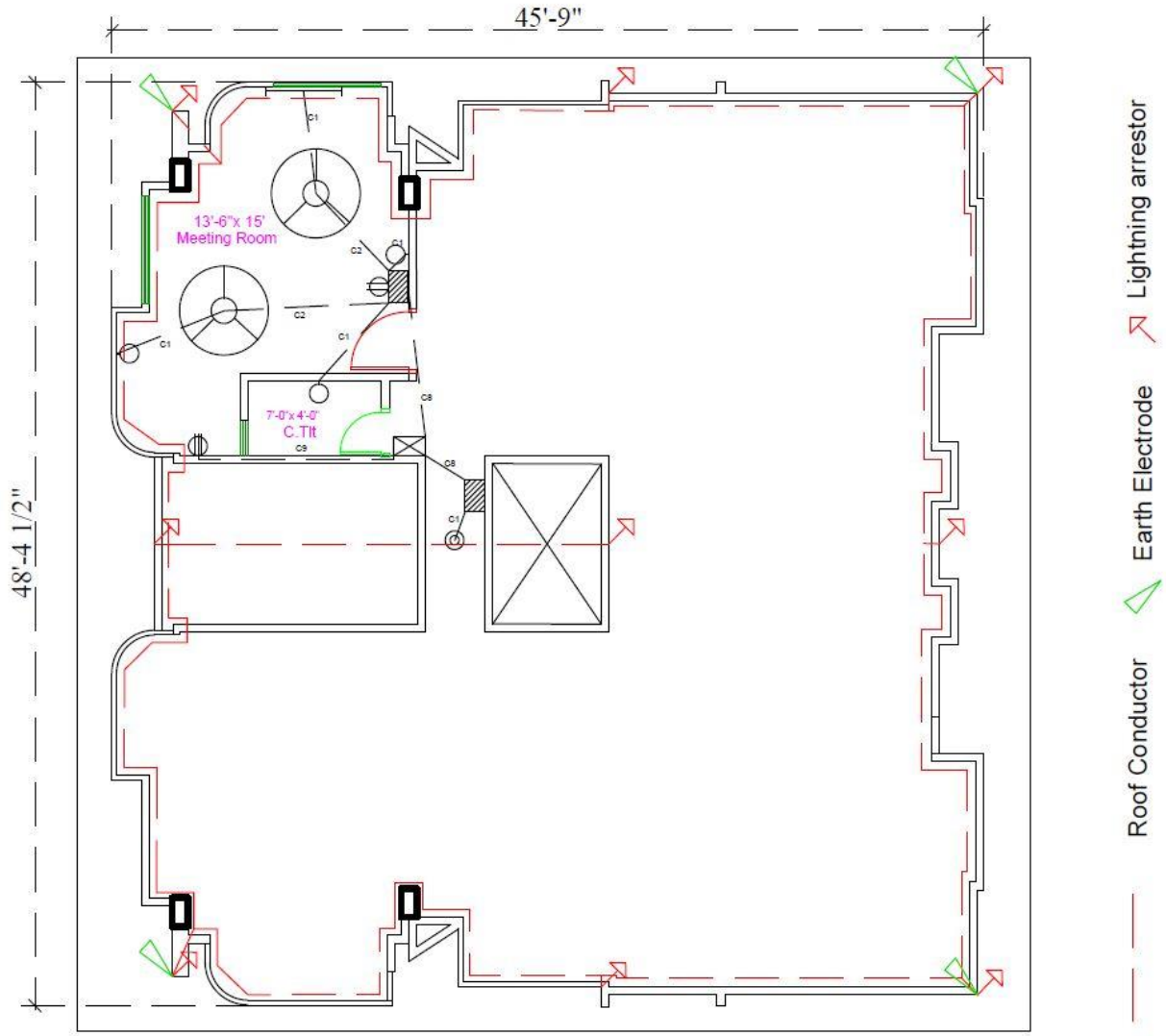
Number of down conductors- 1 conductor for first 80msqr

(206.14-80)/100 = 1.26 that means 2 extra conductors of 100m.

Thus we need to use total of 3 down conductors as well as ground electrodes. Earth termination resistance of ground electrodes – 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.



Calculation for Transformer:

Per Phase current from MDB = 317.349A

Voltage = 220V

Pf = 0.95

So, transformer rating = 3*220*317.349*0.95 = 201.25kVA

Since transformer rating is greater than 200kVA, separate substation is required.

Calculation for PFI Plant:

For improving PFI from 0.9 to 0.95

Worst case reactive power for 0.9Pf

$Q_{worst} = P\sqrt{\frac{1}{0.9^2} - 1}$ = 101kVAR

Best case reactive power for 0.95Pf

$Q_{best} = P\sqrt{\frac{1}{0.95^2} - 1}$ = 67kVAR

PFI plant rating = $Q_{worst} - Q_{best}$ = 101– 67 = 34kVAR

Calculation for generator:

Per Phase current from EMDB = 185.452A

So, rating of the generator = 3*220*185.452*0.95=114.9kVA ≈ 115kVA

Ref:

- https://ssgeshop.com/shop/super-star-led-lux-eye-safe/
- https://ssgeshop.com/shop/ac-led-20-watt-4ft-daylight-t-8-compact/
- https://www.displayspecifications.com/en/model-power-consumption/78e8d13
- https://vision.com.bd/fan/exhaust-fan/vision-exhaust-fan-8-en-2/