BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Department of Electrical and Electronic Engineering

EEE 414

Project Report

Project Title:

Electrical Service Design of a 3375 square-feet (1687.5 square feet each unit) 6-storied Building.

Course No: EEE 414 **Group No: 03**

Course Title: Electrical Service Design Laboratory **Section:** B1

Level: 4

Term: 2

Submitted To:

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Date of Submission: 08- 03 -2024

1. Introduction:

Electrical service design indicates the systematic process of planning, designing, and implementing electrical systems and infrastructure to meet specific requirements and standards. This encompasses a wide range of activities including selecting appropriate equipment and components, designing the layout of electrical distribution networks, ensuringcompliance with safety codes and regulations, and optimizing the overall performance and efficiency of the electrical system. The goal of electrical service design is to create reliable, efficient, and safe electrical installations that support the needs of various applications, such as residential, commercial, industrial, and institutional buildings.

This project aims to design an electrical connection in a 6-storied building. Throughout this project, we dived into various aspects of electrical service design, including load calculations, conduit planning, wire selection, and fittings optimization.

2. Objectives

(1) Fittings (Light, Fan, Exhaust Fan, Ceiling Light, Switch Board) Calculation and Placement.

(2) Conduit Planning and Calculation.
(3) Emergency Supply Design

(4) Load analysis and Circuit Breaker Calculation for EMDB MDB

(5) Lighting Protection System (LPS) Design.

3. Limitations and Considerations

(1) Light Fan Numbers are optimized if calculations show some extraordinary values (eg. 2 Fans are used instead of 3 from a practical point of view).

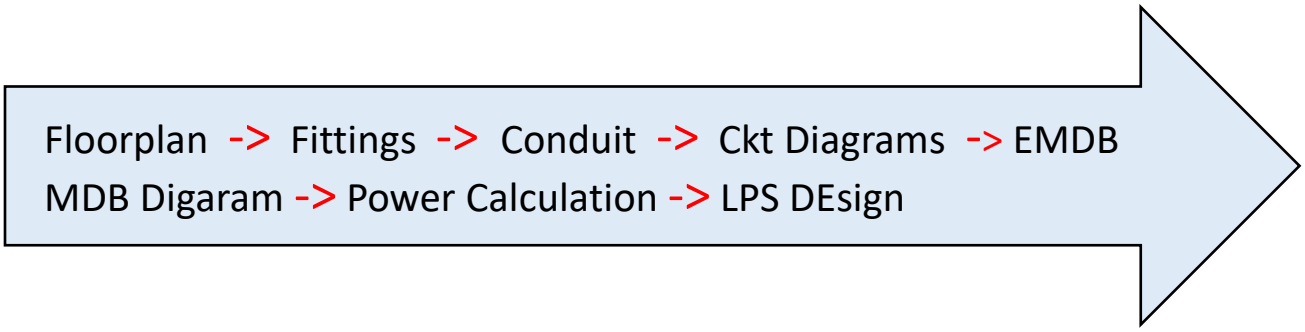
(2) Utilization Factor (UF) is found from the chart by interpolation.

(3) Circuit Breaker raring are chose keeping safety in main concern.

(4) It is assumed that 90% loads will be ON at most.

(5) Power factor 0.9 is chosen.
(6) Lift and Pump ratings are chosen from previous reports.
(7) Mounting height = Luminaire height – Work plane height = 9 ft – 3 ft = 6 ft = 1.828 meter and MF = 0.8 is used.

3. Design Steps

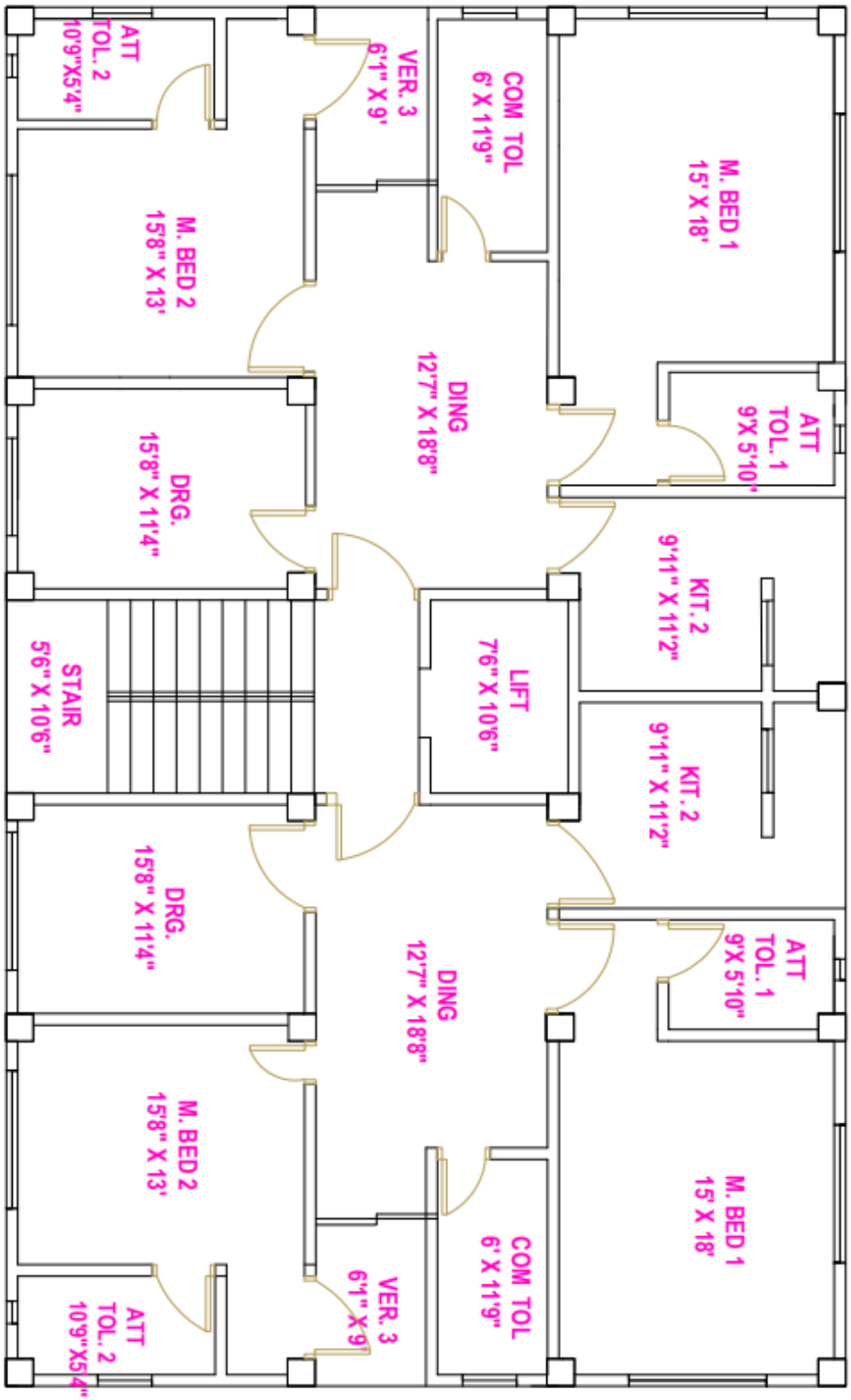


4. Individual Contribution in Each Design Steps

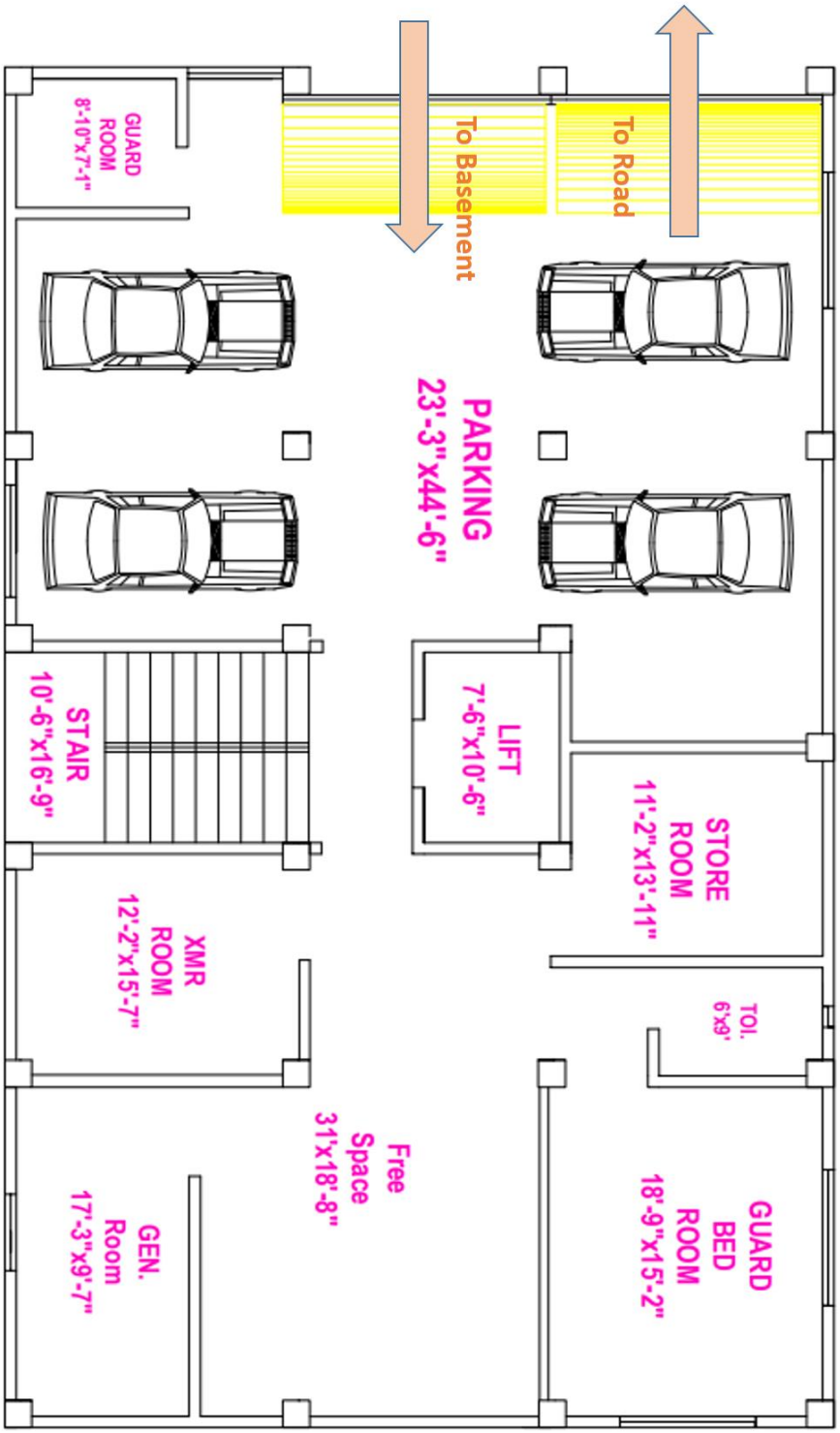
Design Step	**1806067**	**1806091**	**1806092**	**1806093**	**1806095**	**1806097**
Floorplan		Y		Y	Y	
Fittings	Y	Y		Y		Y
Conduit			Y			Y
Ckt Diagram					Y	Y
MDB EMDB			Y			Y
Power Calculation	Y			Y	Y	
LPS	Y		Y		Y	
Report	Y	Y	Y	Y	Y	Y

5. Proposed Floorplan: Conditions met (each side > 1200 sq feet) with lift.

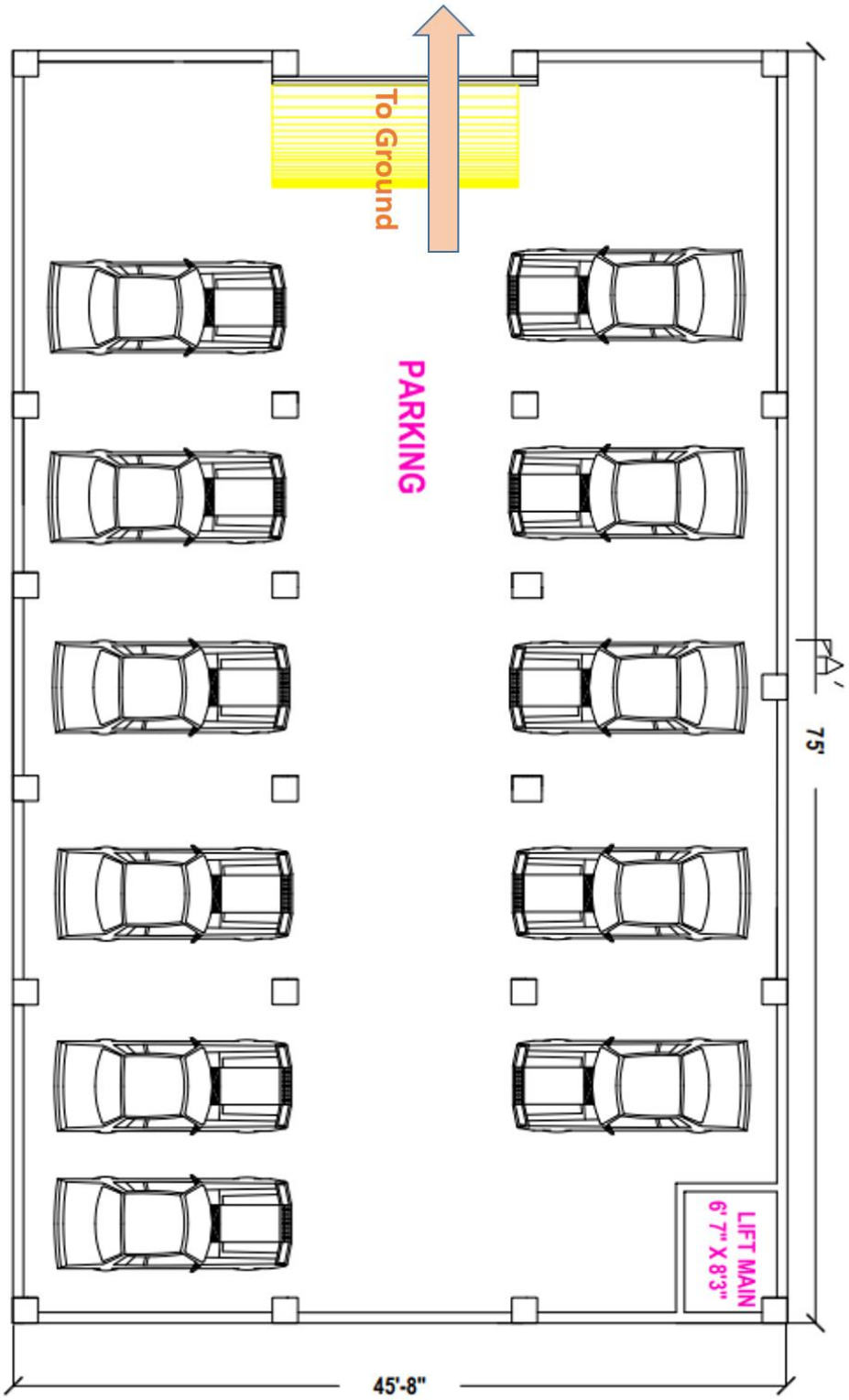
(i) Main Floorplan: 2 Bedroom, 3 toilets, Drawing, Dining, Kitchen, Balcony



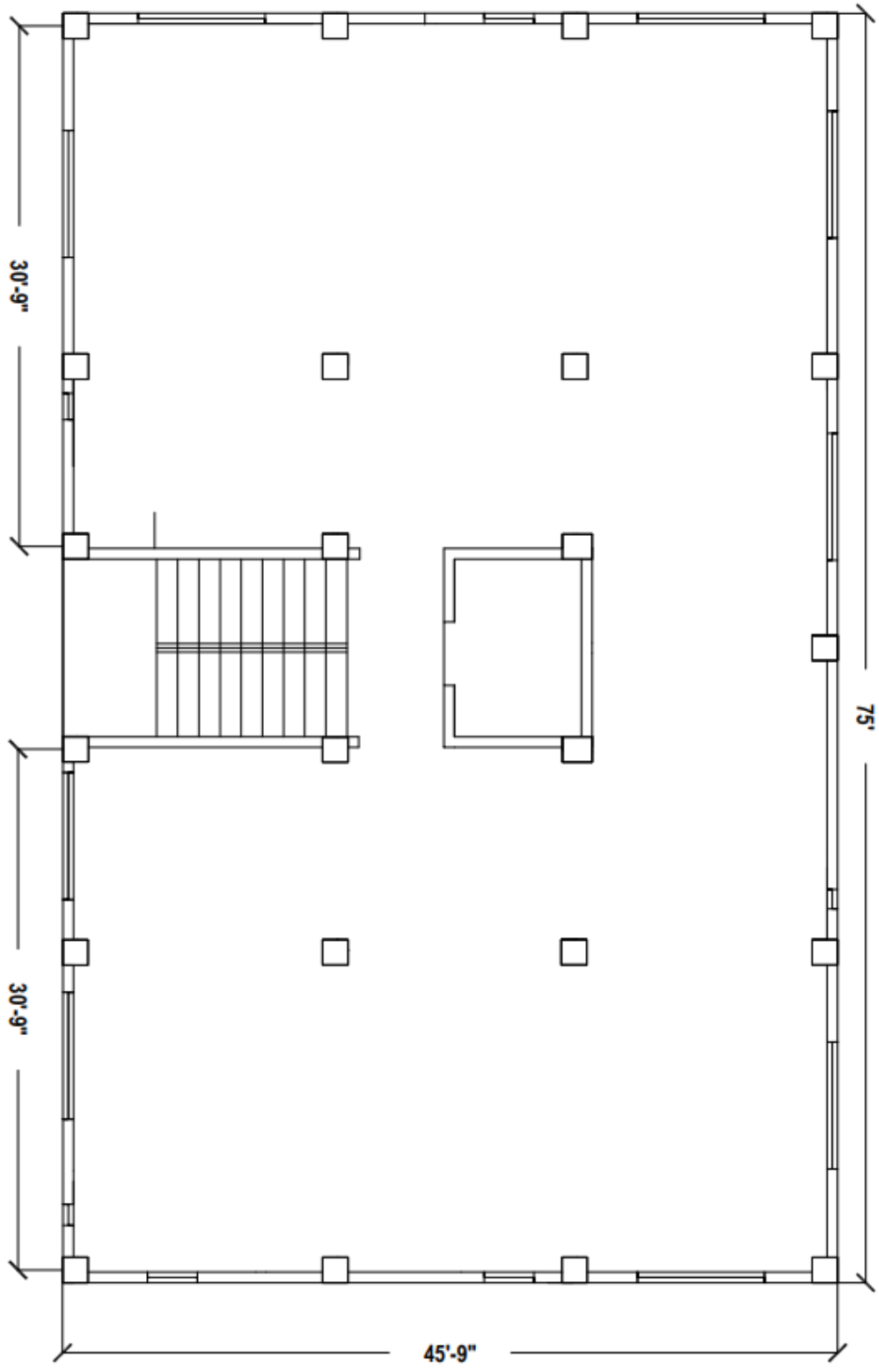
(i) Ground Floorplan: Guard room, Store room, Transformer and Generator room.



(iii) Basement: Parking, Lift maintenance room.



(iv) Roof: Parking, Lift maintenance room.



5. Fittings Calculation:

(i) Summary of Calculations

Floor Type	Room Type	Luminous Flux(lm)	E (lux)	Length (ft-inch)	Width (ft-inch)	Length (m)	Width (m)		Area (m^2)	Room Index (RI)	Utilization Factor (UF)	Number of lights (N)		Number of fans (M)
Typical Floor	Dining	1250	150	18'-8"	12'-7"	5.69	3.84		21.8496	1.25	0.55	5.9		2.4
	Drawing Room	1250	70	11'-4"	15'-8"	3.45	4.77		16.4565	1.1	0.51	2.2		1.8
	Kitchen	1250	200	11'-2"	9'-11"	3.4	3.02		10.268	0.87	0.46	4.5		N/A
	Master Bedroom 01	1250	100	18'	15'	5.49	4.57		25.0893	1.36	0.58	4.3		2.7
	Master Bedroom 02	1250	100	13'	15'-8"	3.96	4.77		18.8892	1.18	0.53	3.5		2
	Veranda	1250	50	9'	6'-1"	2.74	1.85		5.069	0.6	0.39	0.6		N/A
	Attached Toilet	1250	100	5'-10	9'	1.79	2.74		4.9046	0.59	0.39	1.3		N/A
	Attached Toilet 2	1250	100	5'-4"	10'-9"	1.63	3.27		5.3301	0.6	0.39	1.4		N/A
	Common Toilet	1250	100	11'-9"	6'	3.58	1.82		6.5156	0.66	0.41	1.6		N/A
Ground Floor	Tranformer Room	1250	50	12'-2"	15'-7"	3.71	4.75		17.6225	1.14	0.52	1.7		N/A
	Generator Room	1250	50	17'-3"	9'-7"	5.26	2.92		15.3592	1.03	0.5	1.5		N/A
	Guard Toilet	1250	100	6'	9'	1.83	2.74		5.0142	0.6	0.39	1.3		N/A
	Guard Room	1250	70	7'-1"	8'-10"	2.16	2.69		5.8104	0.66	0.41	1		0.6
	Parking	1250	100	23'-3"	44'-6"	7.09	13.56		96.1404	2.55	0.86	11		N/A
	Guard Bedroom	1250	100	18'-9"	15'-2"	5.72	4.63		26.4836	1.4	0.59	4.5		2.9
	Store room	1250	100	11'-2"	13'-11"	3.4	4.24		14.416	1.03	0.5	2.9		N/A
	Ramp Portion	1250	100	6'	29'	1.83	8.84		16.1772	0.83	0.45	3.6		
Basement	Stairs	3200	100	10'-6"	16'-9"	3.2	5.11		16.352	0.98	0.49	1.3		N/A
	Lift Maintainance R	1250	100	6'	6'	1.83	1.83		3.3489	0.5	0.37	0.9		N/A
	Basement	1250	100	73'-9"	44'-6"	22.48	13.56		304.829	4.63	1.36	22		
Rooftop	Rooftop	1250	100						0					

(ii) Sample Calculation

Calculation shown for **Dining Room**

Room Index:

L = 18'-8" = 5.69 meters
W = 12'-7" = 3.84 meters

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

$$\text{Room Index, RI} = \frac{\text{L(meter)} * \text{W(meter)}}{\text{Mounting Height (meter)} * (\text{L} + \text{W})} = \frac{5.69 * 3.84}{1.828 * (5.69 + 3.84)} = 1.25$$

Utilization Factor:

Using Interpolation, Taking 2 points in the Utilization Factor Chart,

$$\frac{Y - Y1}{Y2 - Y1} = \frac{X - X1}{X2 - X1} \equiv \frac{5 - 1.3}{5 - 1.25} = \frac{0.6 - X}{0.6 - 0.55}$$

- $X = 0.55$

Utilization factor for the dining room UF = 0.55

Number of Lights:

MF = 0.8

From the Lumen and Lux charts,

E = 150 Lux for Dining

F = 1250 Lumen Bulb is chosen

$$\text{Number of lights, N} = \frac{E * L * W}{F * UF * MF} = \frac{150 * 5.69 * 3.84}{3200 * 0.55 * 0.8} = 5.9 \approx 6$$

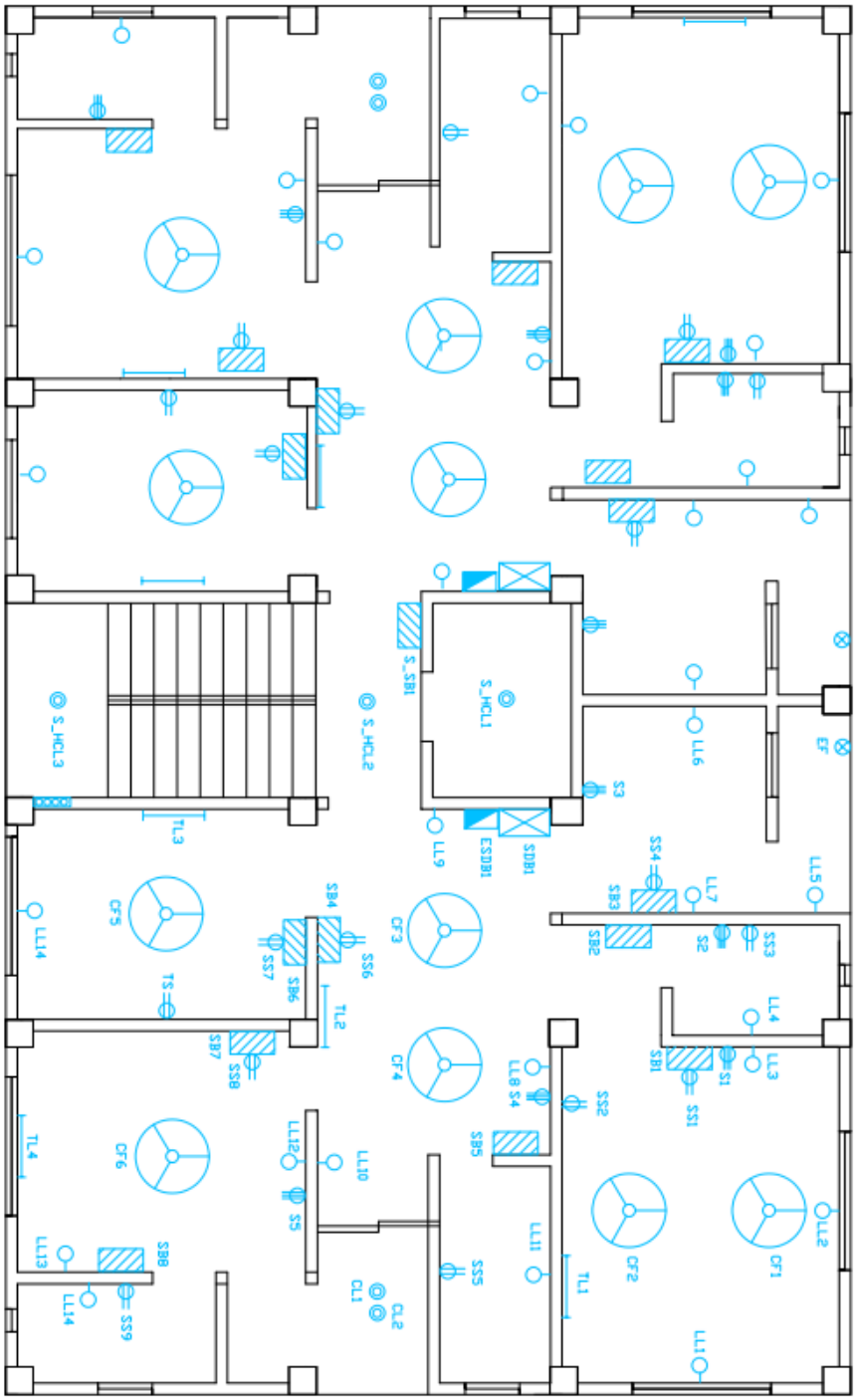
Number of Fans:
L = 18’-8” = 5.69 meters
W = 12’-7” = 3.84 meters

$$\text{Number of Fans, M} = \frac{\text{L(in ft)} * \text{W(in ft)}}{100} = \frac{234.88}{100} = 2.34 \approx 2$$

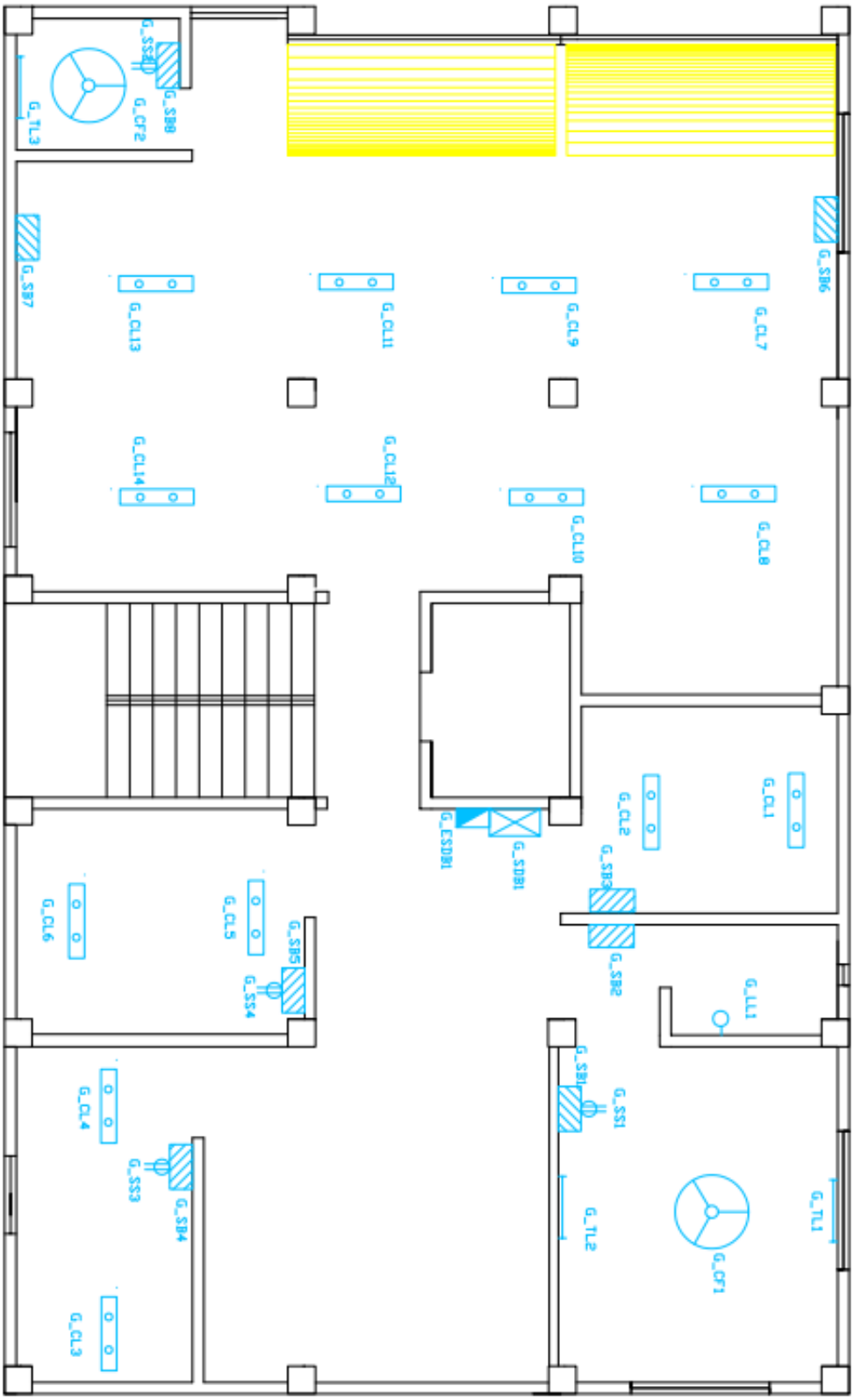
Here, from a practical point of view and for optimum placement we considered only 2 fans instead of 3 in Dining.

(iii) Floorplan with Fitting and Fixtures

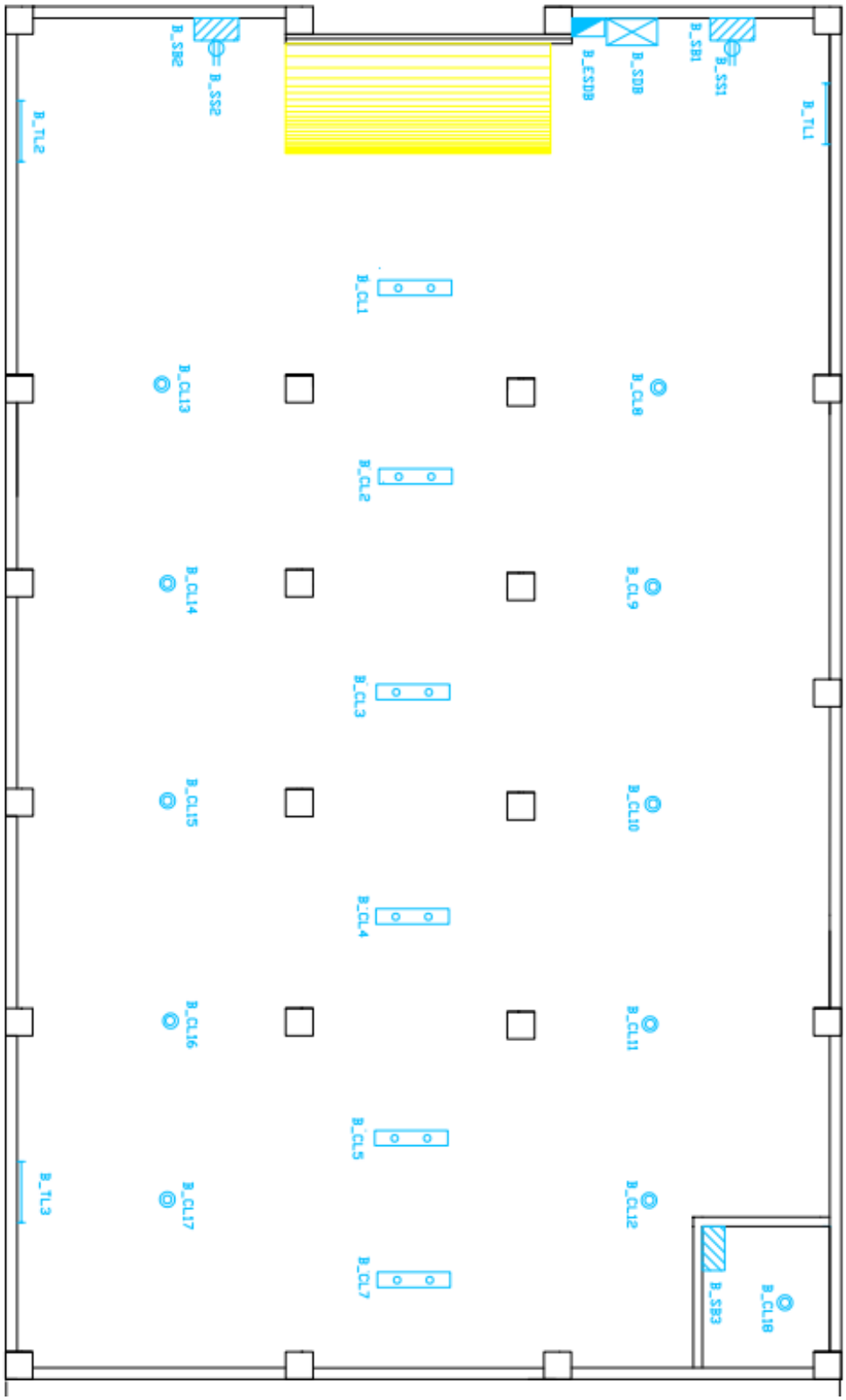
(a) Main Floorplan: Doors are not shown for better view. Only one unit is named for calculation as both units are same.



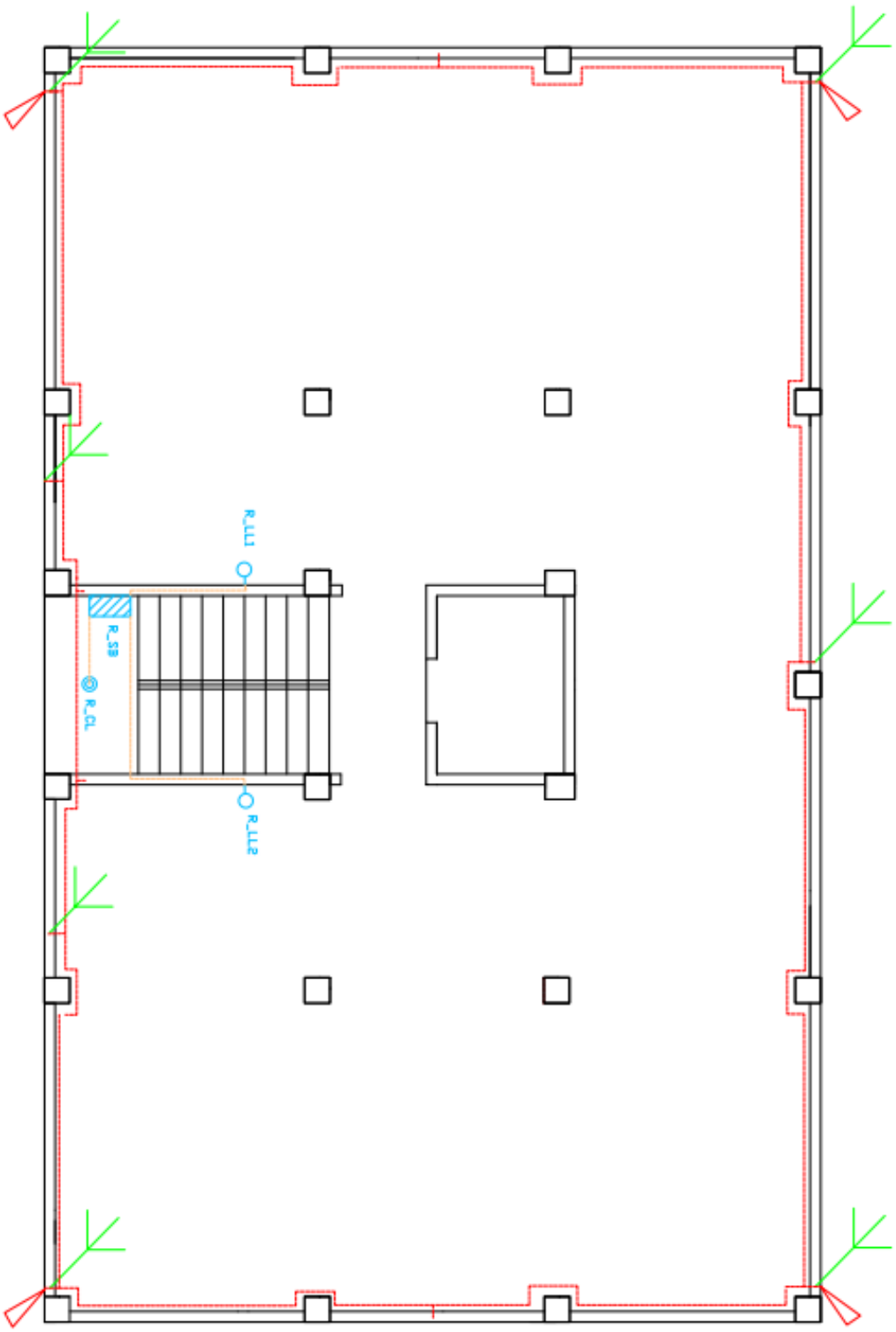
(b) Ground Floorplan:



(c) Basement:


B_SB2
B_SS2
B_ESDB
B_SDB
B_SB1
B_SS1
B_TL1
B_TL2
B_CL1
B_CL13
B_CL8
B_CL2
B_CL14
B_CL9
B_CL3
B_CL15
B_CL10
B_CL4
B_CL16
B_CL11
B_CL5
B_TL3
B_CL17
B_CL12
B_CL7
B_SB3
B_CL18

(c)Roof: Lights are added for lighting the roof at night.



6. Conduit Planning and Calculations (Fittings to SDB and ESDB)

(i) Main Floorplan: Green wires are Fittings to SB. Yellow are DB to SDB. Red wires are for Emergency.

Chart-01: SDB-1 Summary

Room Name	Circuit No.	Switch Board	Fixture	Power	Current Rating	Total		Wire Rating	Breaker To SDB
Master Bedroom 1	CKT1	SB1	LL2 LL3 SS1 SS2 CF2 TL1	20 20 - - 75 20	.101 .101 5 5 .3788 .101	10.6818	10.6818	C9	15A
Common Toilet	CKT2	SB5	SS5	-	5	5	5	C8	10A
Attached Toilet 1 Kitchen	CKT3	SB2	SS3	-	5	5	10.303	C9	15A
		SB3	SS4 LL7 EF	- 20 40	5 .101 .202	5.303			
Dinning	CKT4	SB4	LL9 LL10 CL1 CF3 LL8 SS6	20 20 20 75 20 -	.101 .101 .101 .3788 .101 5	5.7828	5.7828	C8	10A
Drawing	CKT5	SB6	SS7 TS LL14	- - 20	5 5 .101	10.101	10.101	C9	15A
Master Bedroom 2 Attached Toilet 2	CKT5	SB7	LL12 CL2 SS8 LL13	20 20 - 20	.101 .101 5 .101	5.303	10.303	C9	15A
		SB8	SS9	-	5	5			

Chart-02: SDB-1 Power Circuits Summary

Room Name	Power Socket	Current Rating	Wire Rating
Master Bedroom 1	S1	20A	C10
Attached Toilet 1	S2	15A	C9
Dinning	S4	15A	C9
Master Bedroom 2	S5	20A	C10

S_HCL3
S_HCL2
S_SB1
S_HCL1
TL3
LL9
SSDB1
SSDB1
LL6
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LL7
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LL13
LL14
TL4
CF6
CF5
CF4
CF3
TL2
TS
C8
C9
C10
C9,C8
C9,C10

Chart-03: ESDB-1 Summary

Room Name	Circuit No.	Switch Board	Fixture	Power	Current Rating	Total		Wire Rating	Breaker To SDB
Master Bedroom 1	CKT1	SB1	CF1 LL1	75 20	.3788 .101	.4889	.7919	C1	5A
Attached Toilet 1		SB2	LL4	20	.101	.101			
Kitchen		SB3	LL5 LL6	20 20	.101 .101	.202			
Dining	CKT2	SB5	LL11	20	.101	.101	.101	C1	5A
Dining	CKT3	SB4	SS6 CF4 TL2	- 75 20	5 .3788 .101	5.4899	6.5677	C9	15A
Drawing		SB6	CF5 TT3	75 20	.3788 .101	.4899			
Master Bedroom 2		SB7	CF6 TL4	75 20	.3788 .101	.4899			
Attached Toilet 2		SB8	LL14	20	.101	.101			

Chart-02: ESDB-1 Power Circuits Summary

Room Name	Power Socket	Current Rating	Wire Rating
Kitchen	S3	15A	C9

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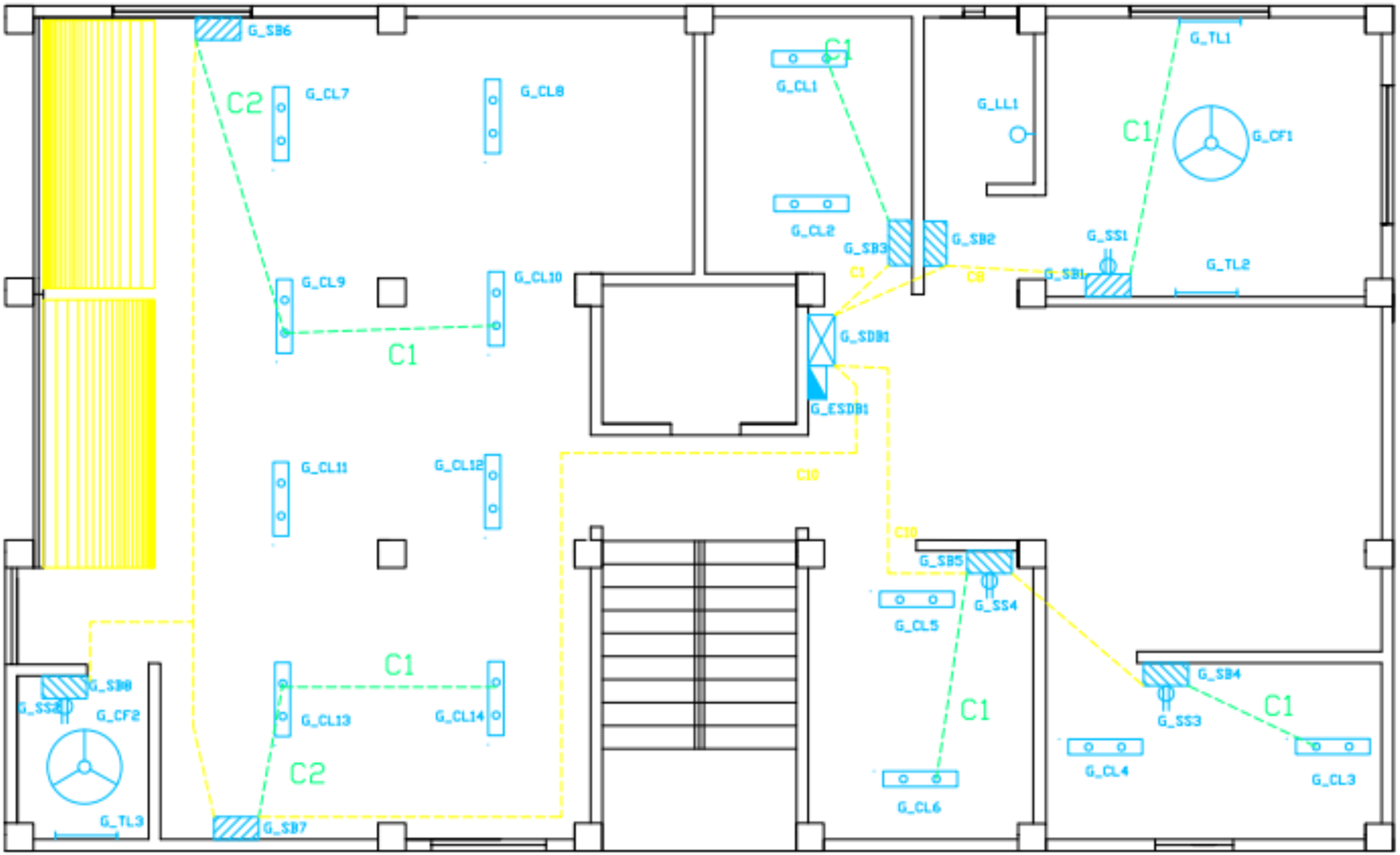
(ii) Ground Floorplan

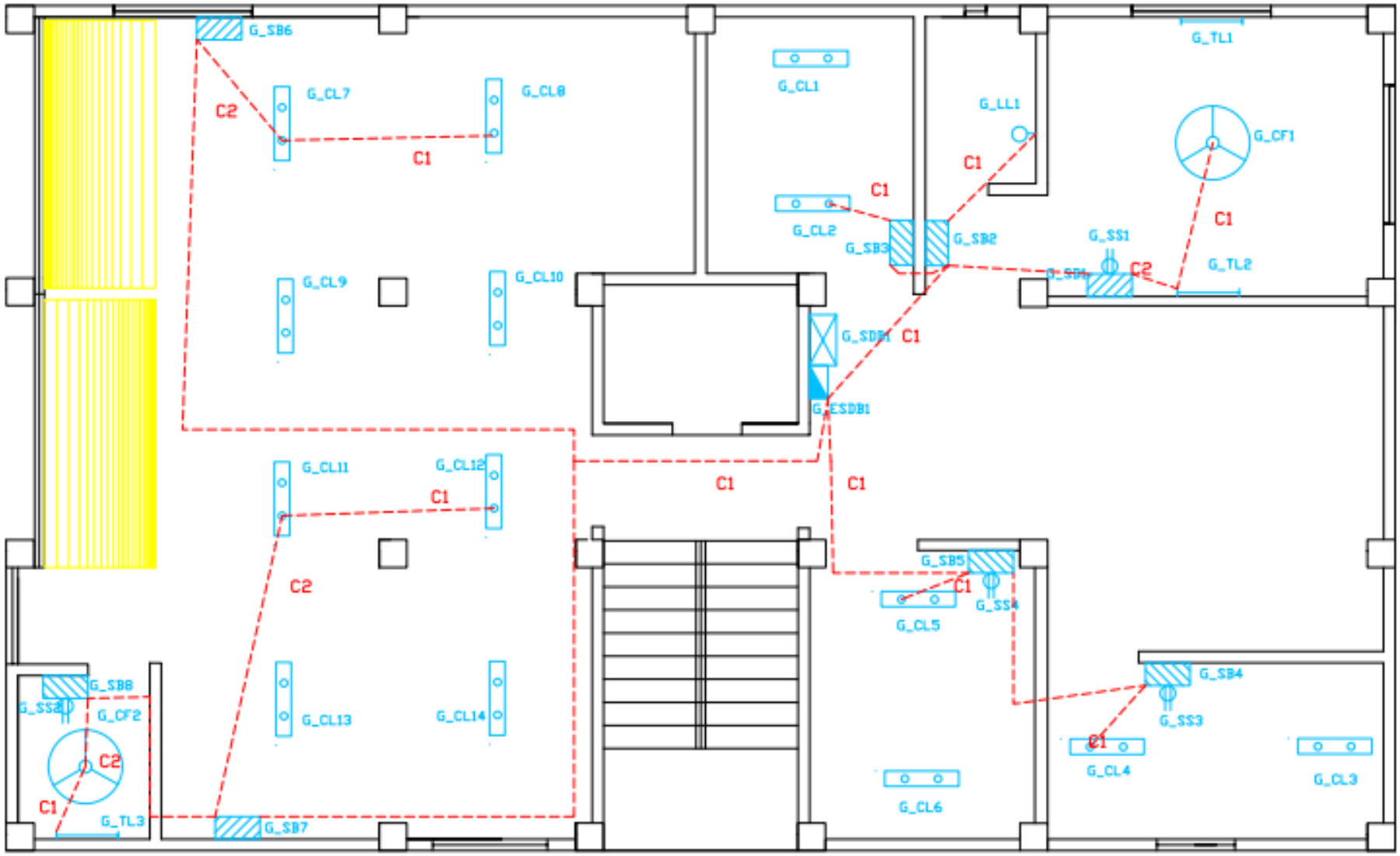
Chart-03: SDB-0 Summary

Circuit	Switch Board	Fixture	Power	Current Rating	Total per SB	Total	Wire Rating	Breaker to SB
CKT1	G-SB1	G-TL1 G-SS1	20 -	.101 5	5.101	5.101	C8	10A
	G-SB2	-	-	-	-	-	-	-
CKT2	G-SB3	G-CL1	20	.101	.101	.101	C1	5A
CKT3	G-SB4	G-CL3	20	.101	.101	5.202	C8	10A
	G-SB5	G-SS4 G-CL6	- 20	5 .101	5.101			
CKT4	G-SB6	G-CL9 G-CL10	20 20	.101 .101	.202	5.404	C8	10A
	G-SB7	G-CL13 G-CL14	20 20	.101 .101	.202			
	G-SB8	G-SS2	-	5	5			

Chart-04: ESDB-0 Summary

Circuit	Switch Board	Fixture	Power	Current Rating	Total per SB	Total	Wire Rating	Breaker to SB
CKT1	G-SB1	G-TL2 G-CF1	20 75	.101 .3788	.4798	.6818	C1	5A
	G-SB2	G-LL1	20	.101	.101			
	G-SB3	G-CL2	20	.101	.101			
CKT2	G-SB4	G-CL4	20	.101	.101	.202	C1	5A
	G-SB5	G-CL5	20	.101	.101			
CKT3	G-SB6	G-CL7 G-CL8	20 20	.101 .101	.202	.8838	C1	5A
	G-SB7	G-CC11 G-CC12	20 20	.101 .101	.202			
	G-SB8	G-CF2 G-TL3	75 20	.3788 .101	.4798			
CKT4	S-SB1	S-HCL2 S-HCL3	20 20	.101 .101	.202	1.212	C1	5A


G_SB6
G_CL7
G_CL8
G_CL9
G_CL10
G_CL11
G_CL12
G_CL13
G_CL14
G_SB8
G_SS2
G_CF2
G_TL3
G_SB7
C1
C2
G_CL1
G_LL1
G_TL1
G_CF1
G_CL2
G_SB3
G_SB2
G_SS1
G_SB1
G_TL2
G_SDB1
G_ESDB1
C8
C10
G_SB5
G_SS4
G_CL5
G_CL6
G_SB4
G_SS3
G_CL4
G_CL3


G_SB6
G_CL7
G_CL8
G_CL1
G_TL1
G_LL1
G_CF1
G_CL2
G_SB3
G_SB2
G_SS1
G_TL2
G_CL9
G_CL10
G_SDB1
G_ESDB1
G_CL11
G_CL12
G_SB5
G_SS4
G_CL5
G_SB4
G_SS3
G_CL4
G_CL3
G_CL6
G_SB8
G_SS2
G_CF2
G_CL13
G_CL14
G_TL3
G_SB7
C1
C2

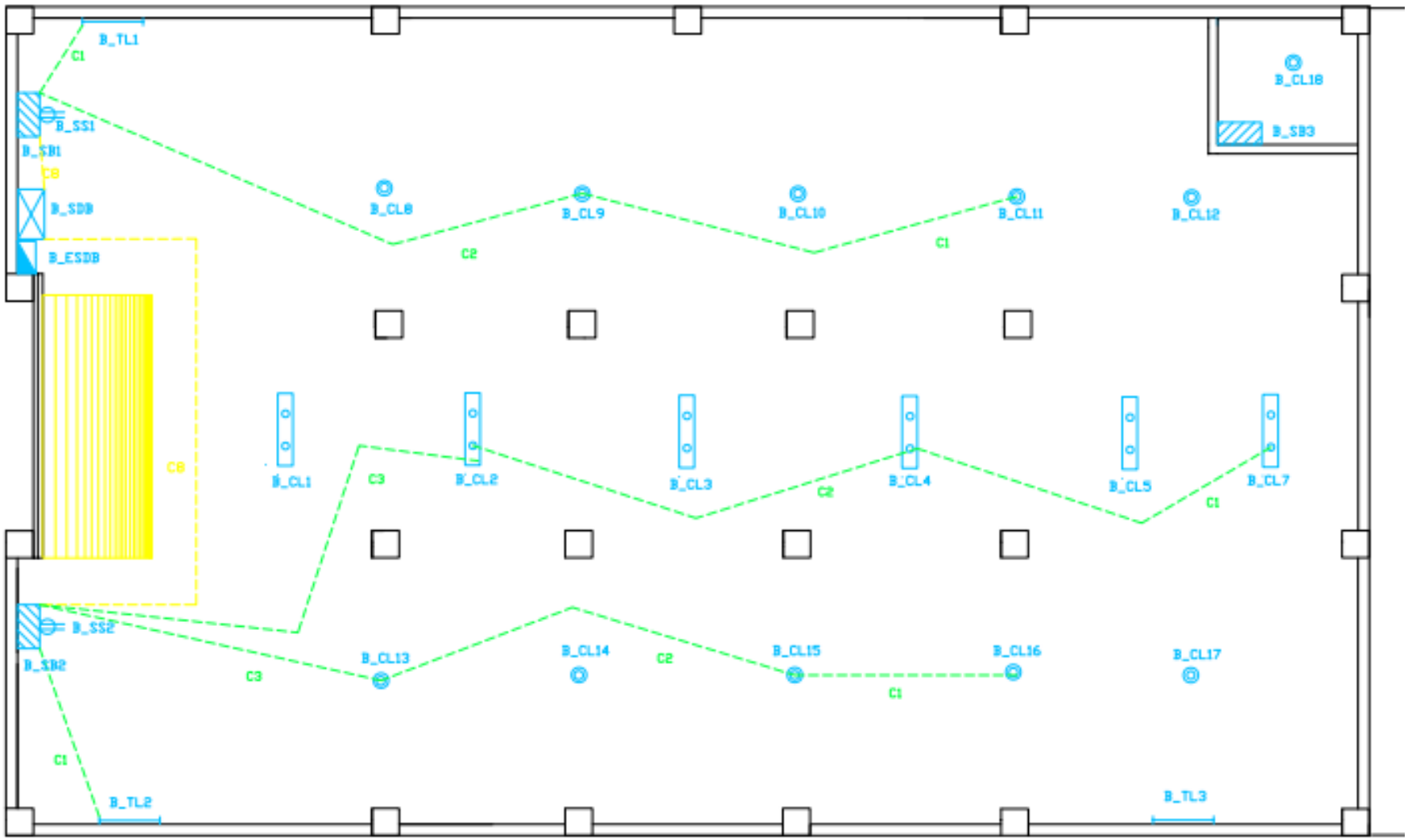
(ii) Basement

Chart-05: SDB Basement Summary

Circuit	Switch Board	Fixture	Power	Current Rating	Total per SB	Wire Rating	Breaker to SB
CKT1	B-SB1	B-SS1 B-TL1 B-CL9 B-CL11	- 20 20 20	5 .101 .101 .101	5.303	C8	10A
	B-SB2	B-SS2 B-TL2 B-CL13 B-CL15 B-CL16 B-CL2 B-CL4 B-CL7	- 20 20 20 20 20 20 20	5 .101 .101 .101 .101 .101 .101 .101	5.707	C8	10A

Chart-06: ESDB Basement Summary

Circuit	Switch Board	Fixture	Power	Current Rating	Total per SB	Wire Rating	Breaker to SB
CKT1	B-SB1	B-CL8 B-CL10 B-CL12 B-CL1 B-CL3 B-CL5	20 20 20 20 20 20	.101 .101 .101 .101 .101 .101	.606	C1	5A
	B-SB3	B-CL18	20	.101	.101	C1	5A
CKT2	B-SB2	B-CL17 B-CL14	20 20	.101 .101	.202	C1	5A


B_TL1
C1
B_SS1
B_SB1
C3
B_SDB
B_ESDB
C3
B_CL8
B_CL9
B_CL10
B_CL11
B_CL12
B_CL18
B_SB3
C2
C1
B_CL1
C3
B_CL2
B_CL3
C2
B_CL4
B_CL5
B_CL7
C1
B_SS2
B_SB2
C3
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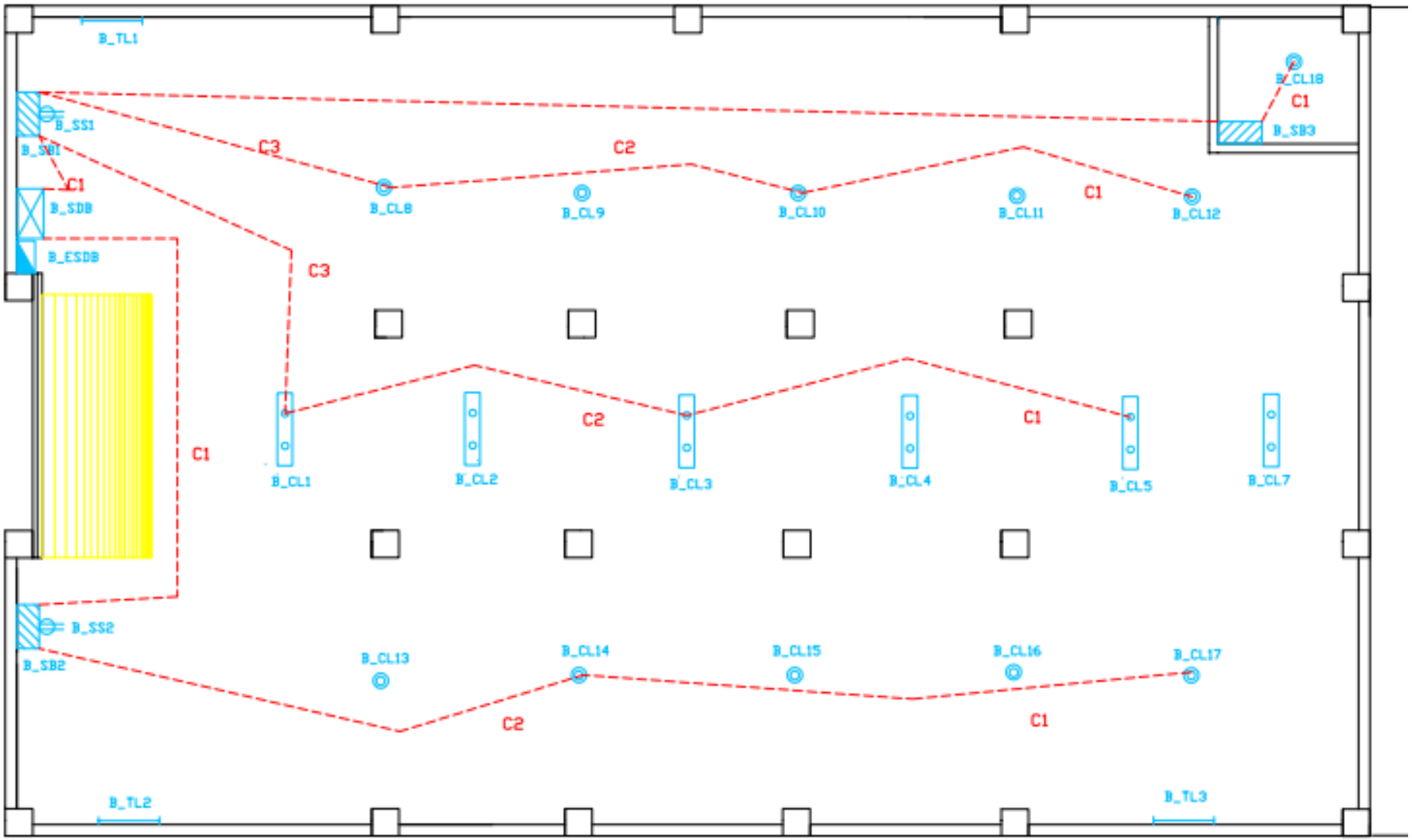
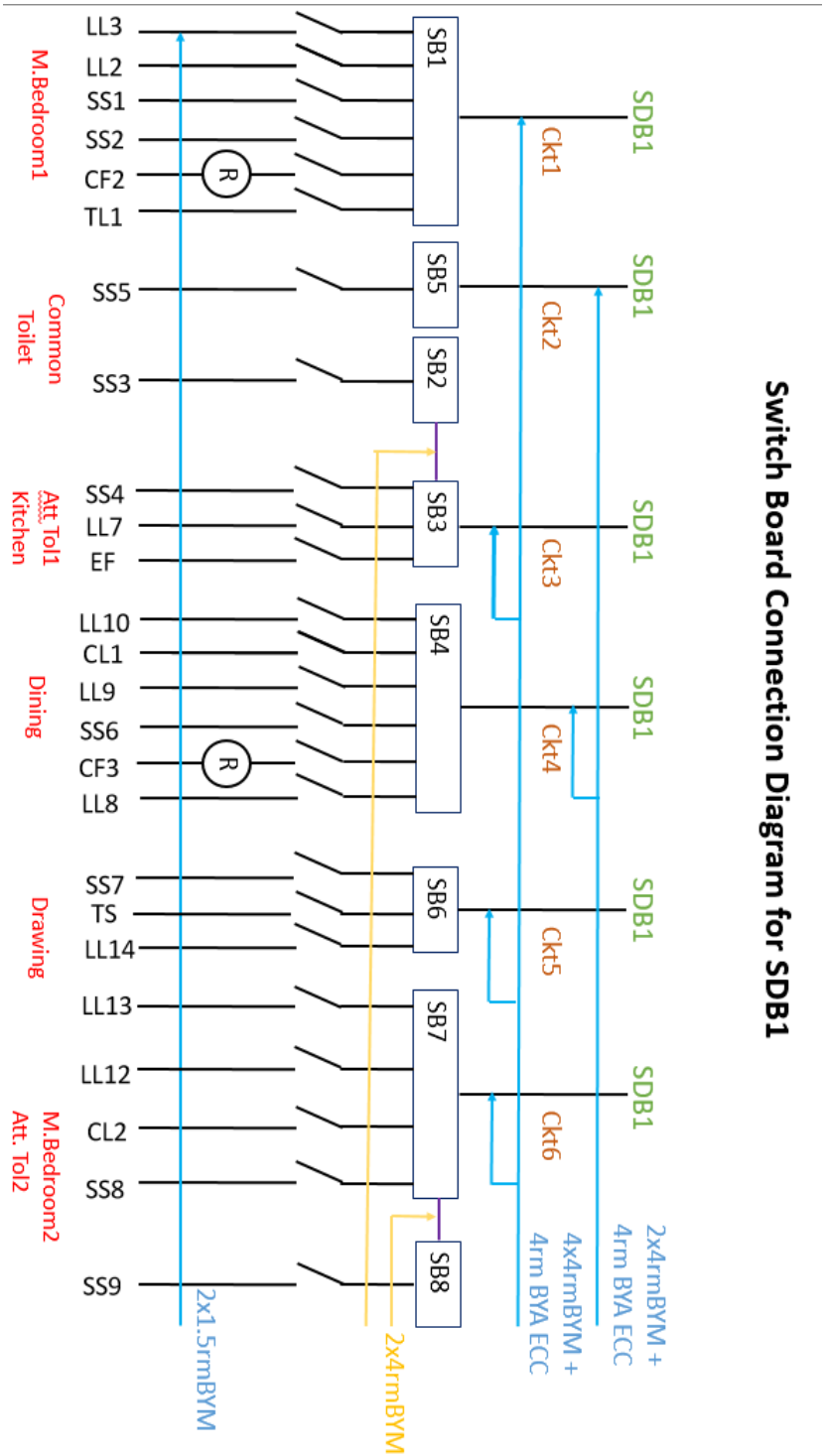
B_CL14
C2
B_CL15
B_CL16
B_CL17
C1
C1
B_TL2
B_TL3


B_TL1
B_SS1
B_SB1
B_SDB
B_ESDB
B_CL18
B_SB3
C1
C3
C2
B_CL8
B_CL9
B_CL10
B_CL11
B_CL12
B_CL1
B_CL2
B_CL3
B_CL4
B_CL5
B_CL7
B_SS2
B_SB2
B_CL13
B_CL14
B_CL15
B_CL16
B_CL17
B_TL2
B_TL3

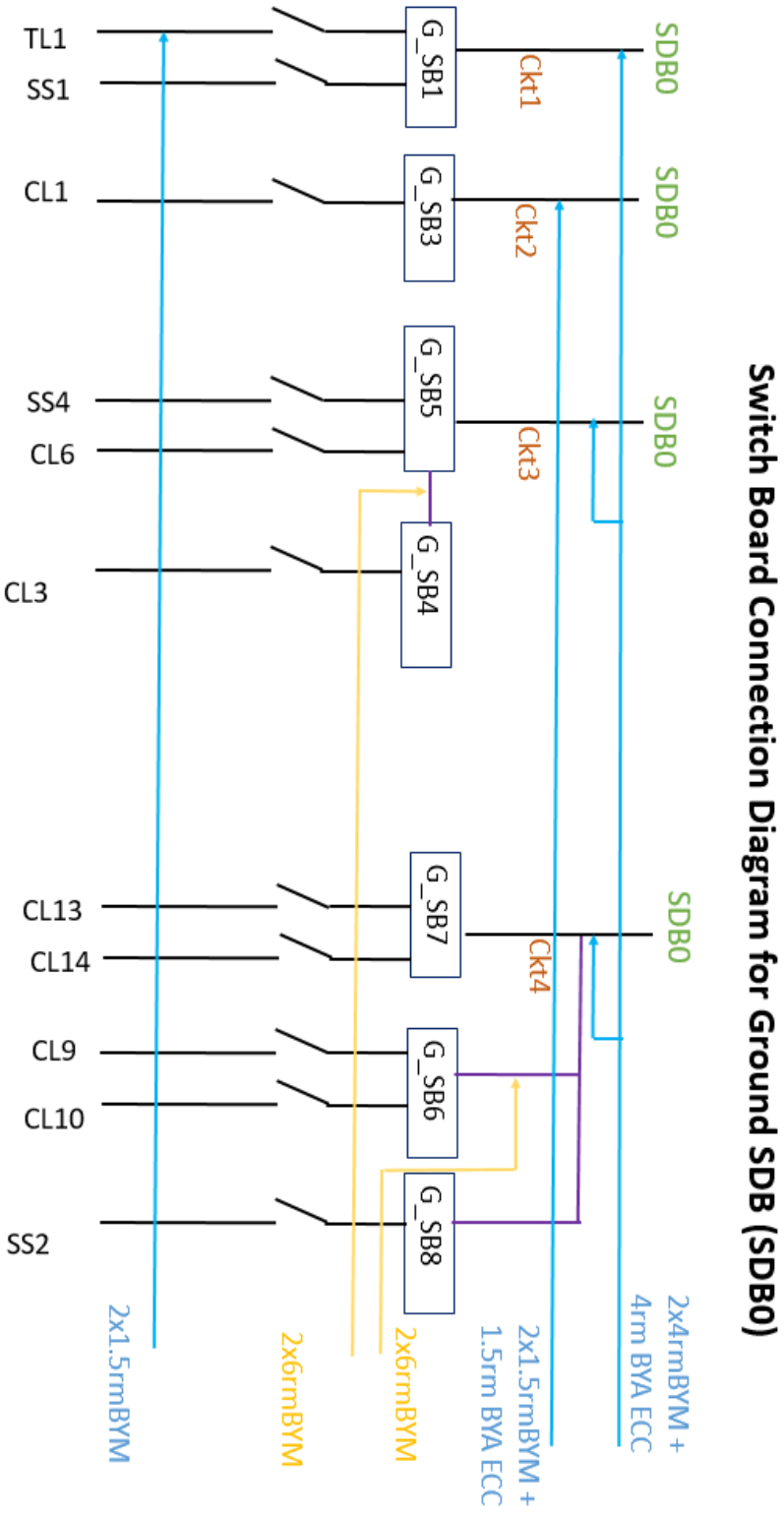
7. SDB ESDB Circuit Breaker Calculation

(i) Fittings to SDB

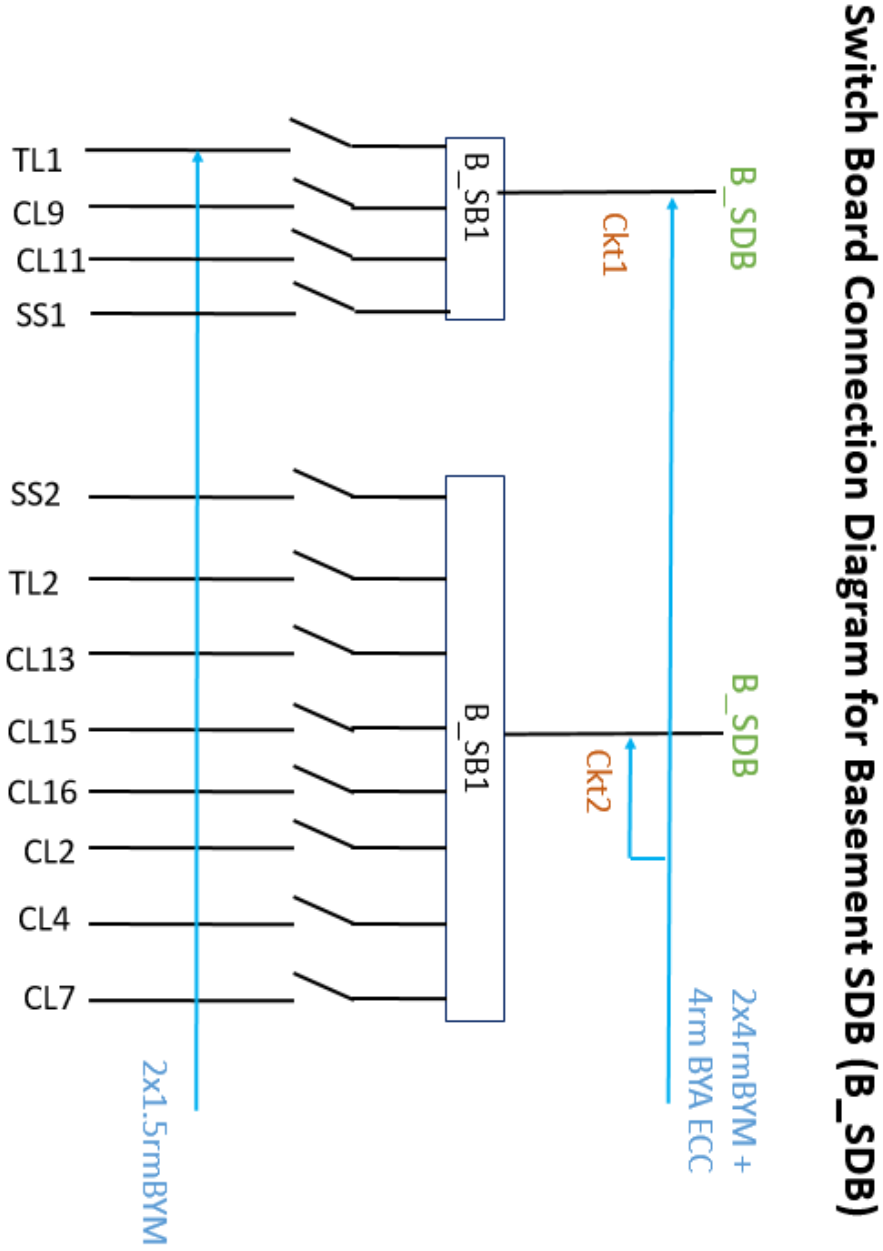
Main Floorplan:



Ground Floorplan:

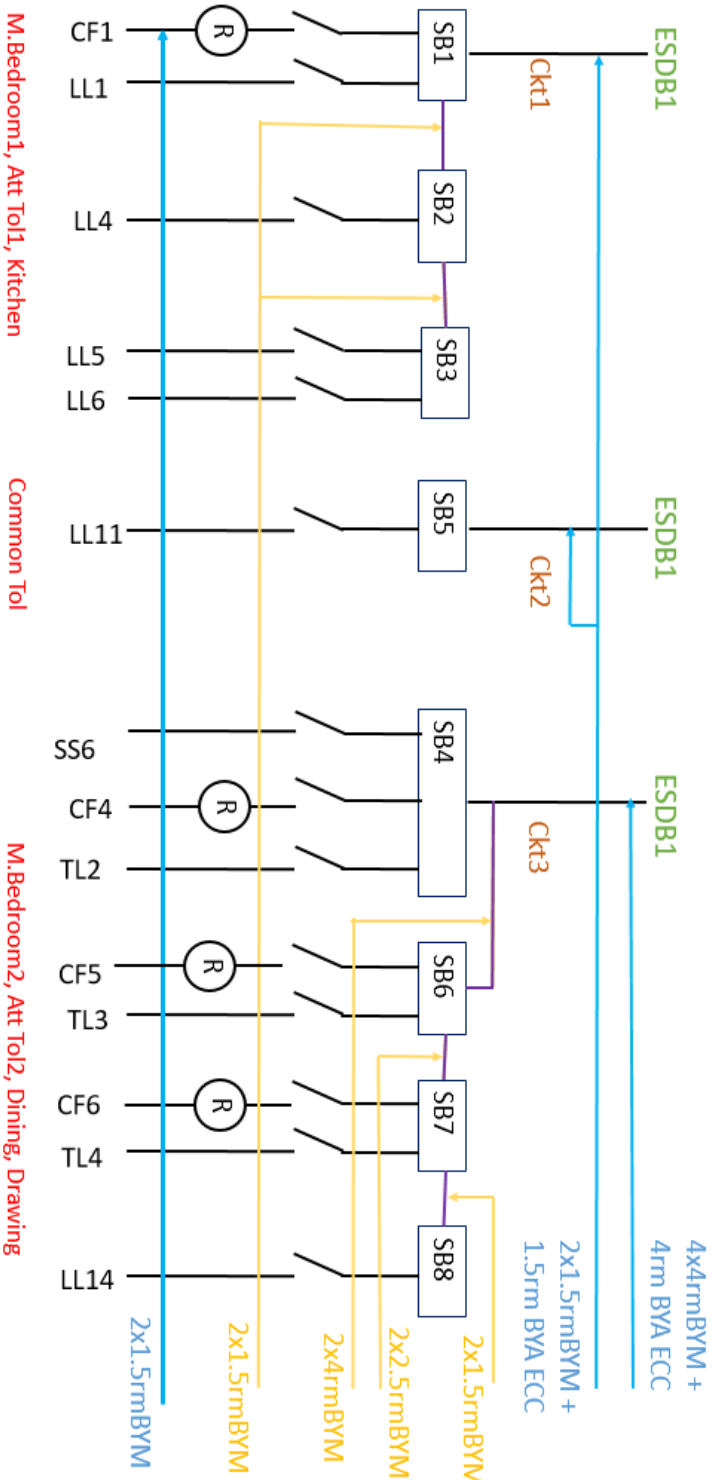


Basement:

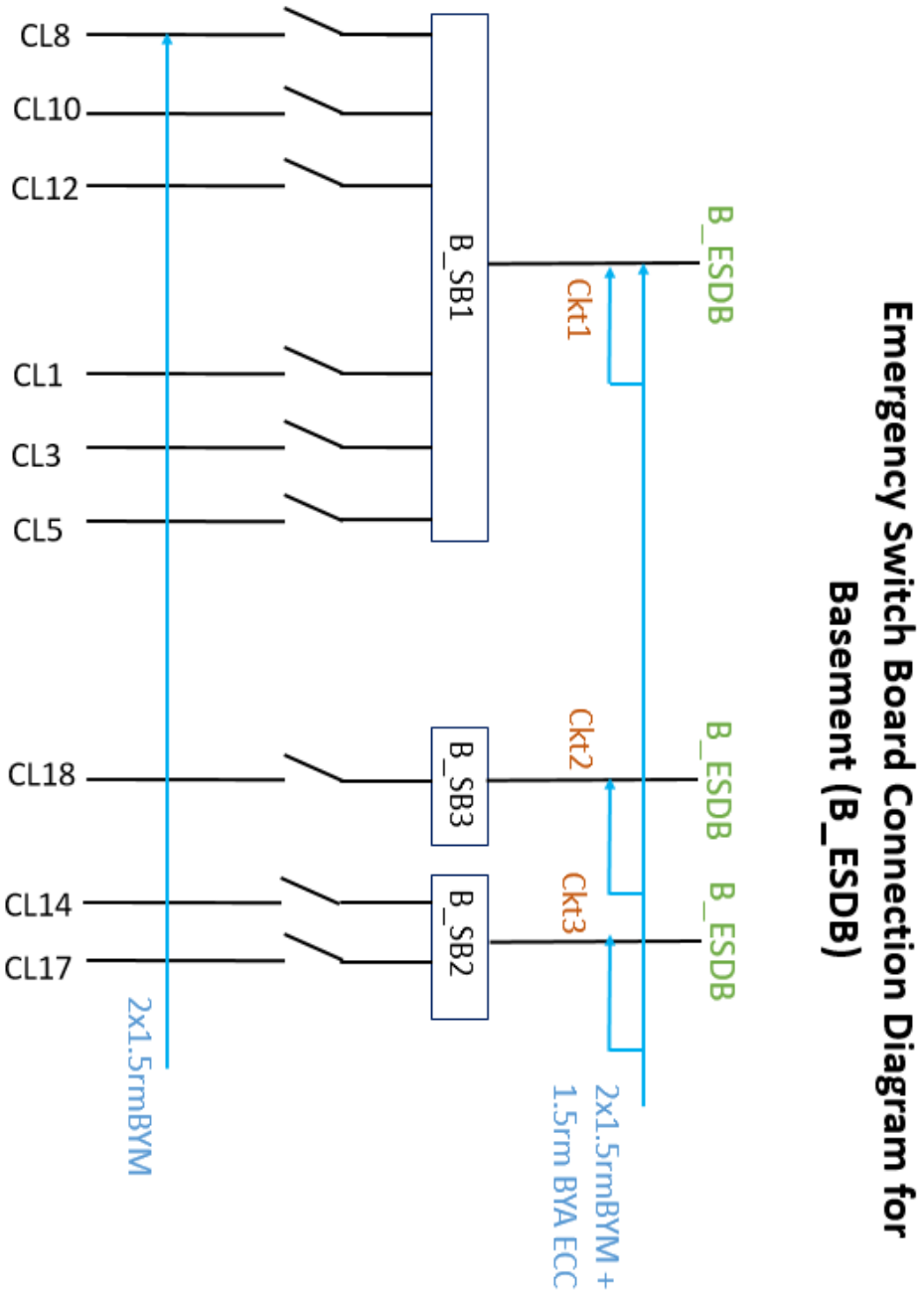

Switch Board Connection Diagram for Basement SDB (B_SDB)
TL1
CL9
CL11
SS1
B_SB1
Ckt1
B_SDB
SS2
TL2
CL13
CL15
CL16
CL2
CL4
CL7
B_SB1
Ckt2
B_SDB
2x4rmBYM +
4rm BYA ECC
2x1.5rmBYM

(ii) Fittings to ESDB

Main Floorplan:

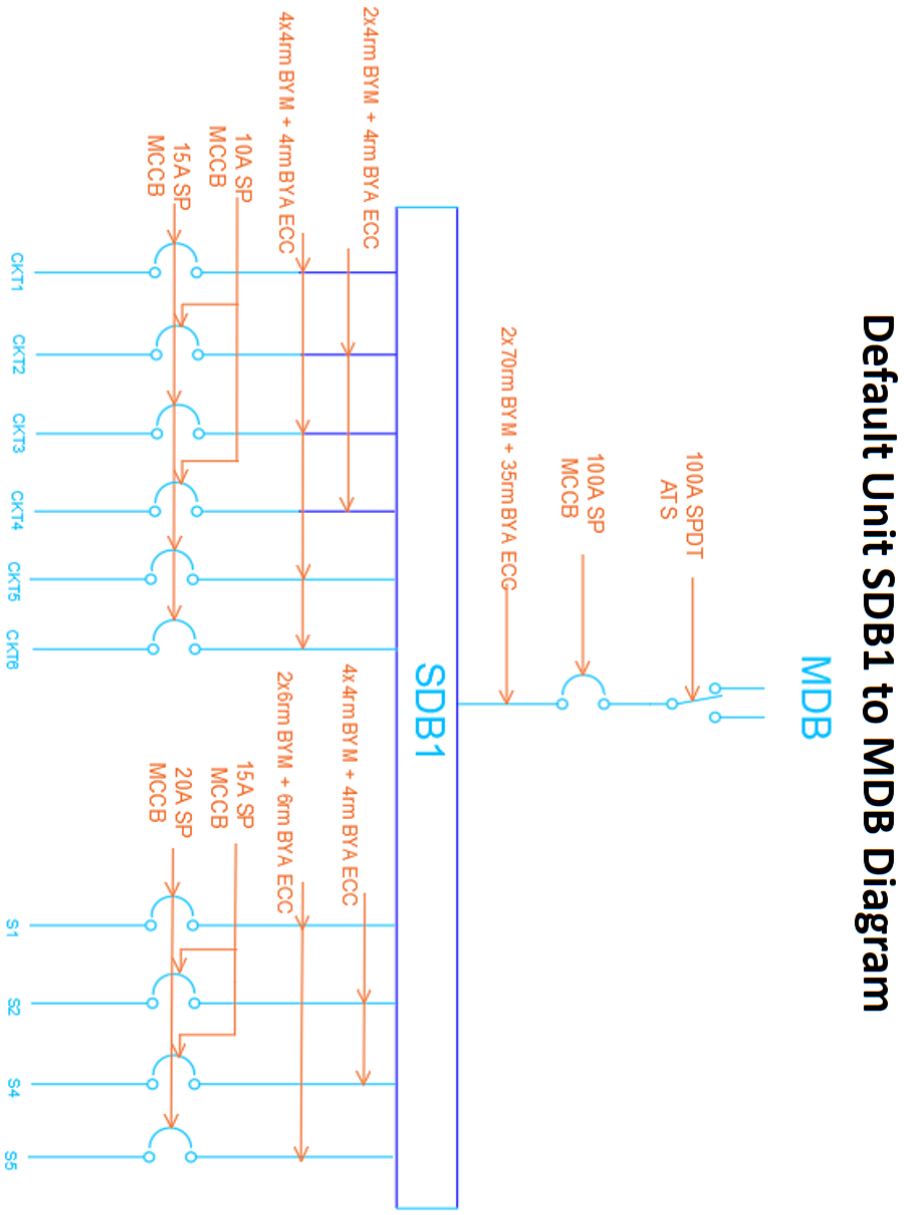


Basement:

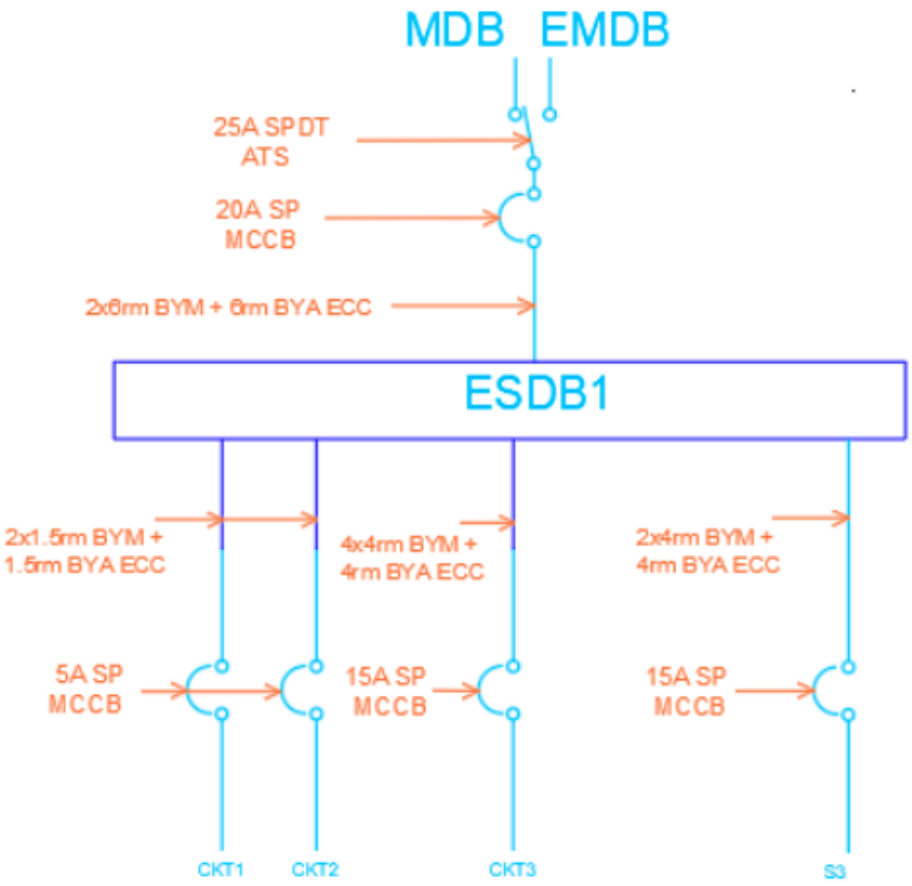

Emergency Switch Board Connection Diagram for Basement (B_ESDB)
CL8
CL10
CL12
CL1
CL3
CL5
CL18
CL14
CL17
2x1.5rmBYM
B_SB1
B_SB3
B_SB2
Ckt1
Ckt2
Ckt3
B_ESDB
B_ESDB
B_ESDB
2x1.5rmBYM +
1.5rm BYA ECC

8. MDB EMDB Circuit Breaker Calculation)

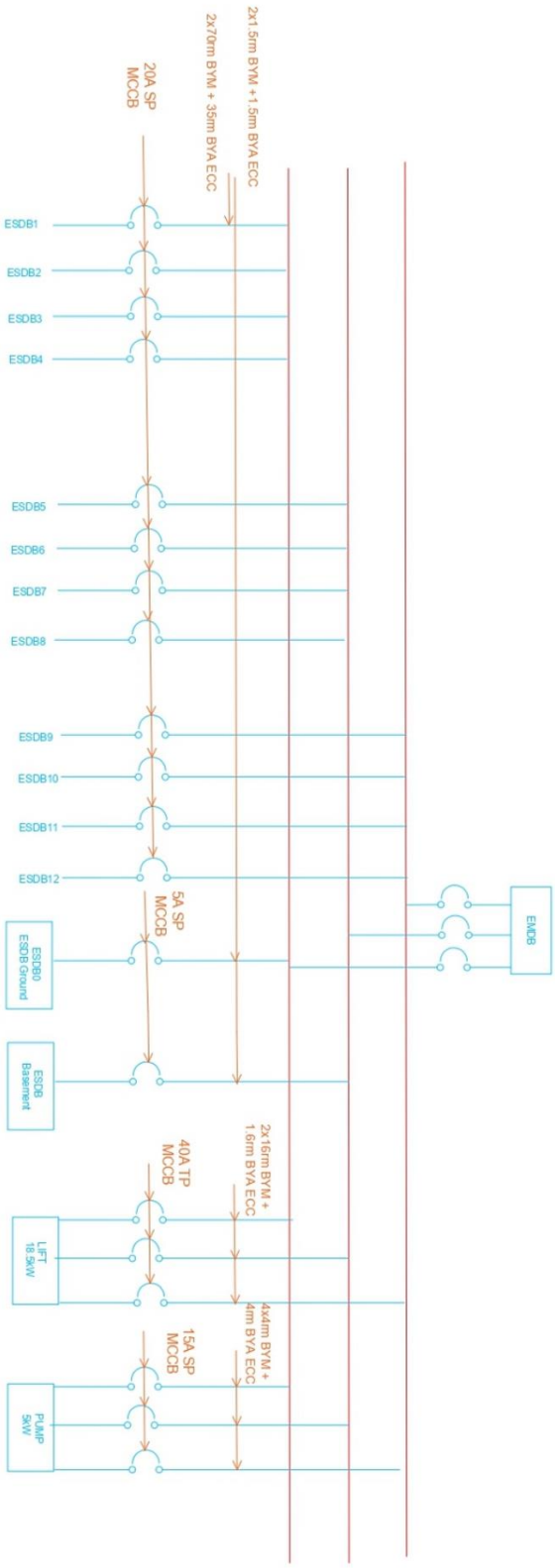
(i) SDB to MDB Connection: This is shown for 1 Unit only. All unit SDB follow the same to connect to MDB.



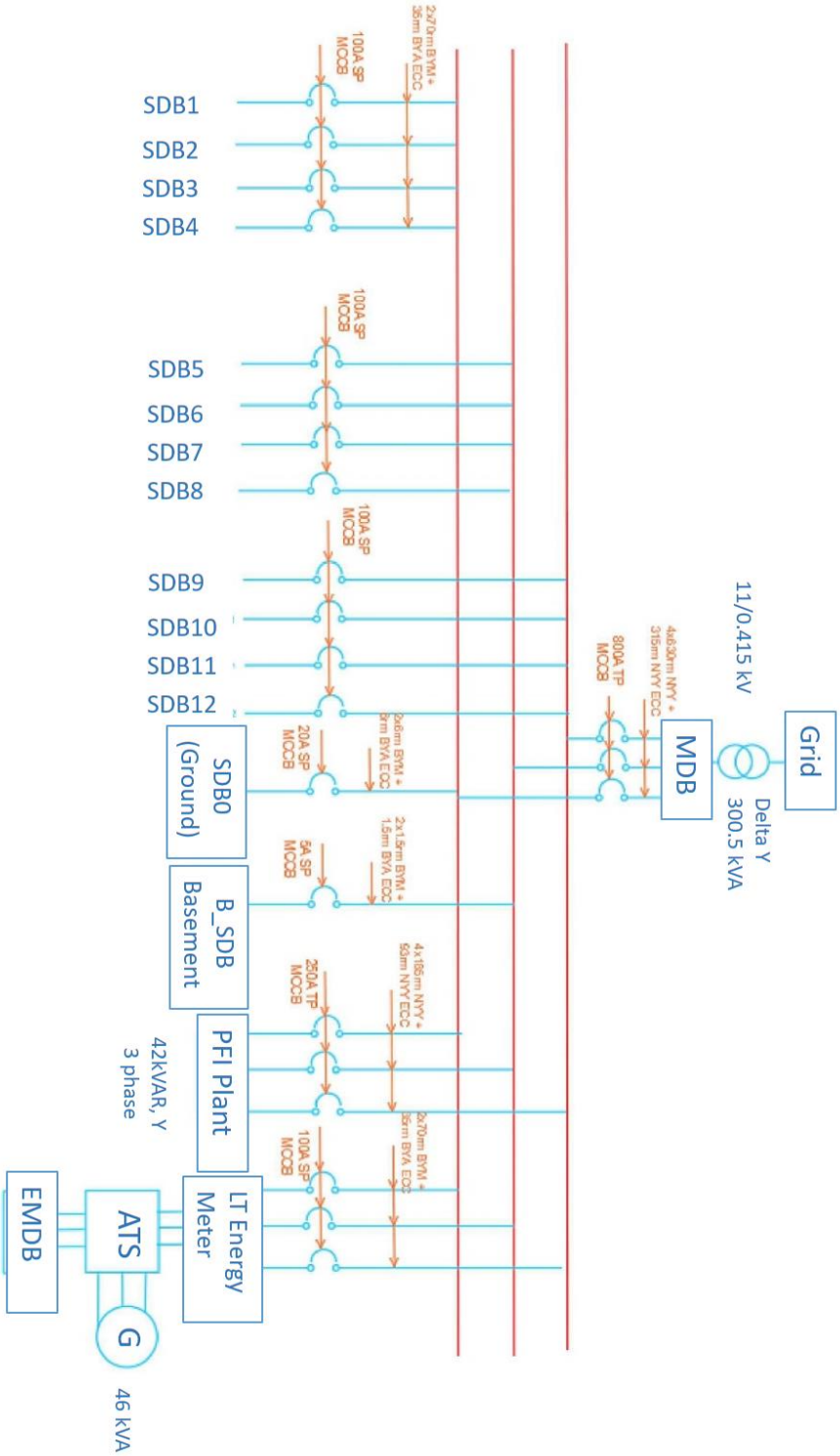
(ii) ESDB to EMDB Connection: This is shown for 1 Unit only. All unit ESDB follow the same to connect to EMDB.



(iii) EMDB Circuit: ESDB from all 12 unit, ESDB from ground and Basement, Lift and Pump are connected at EMDB for emergency supply.



(iv) MDB Circuit



9. SDB ESDB Current and Wire rating Calculation

(1) Sub distribution board (SDB)-1

Total current rating for SDB/ESDB to MDB (Ampere) Calculation:

Sub distribution board (SDB)-1 = 90% x Fixtures Current Rating + 50% x Power Circuits Current raitng

= 0.9 x 52.1716 + 0.5 x 70 = 81.9544 A

so, 100A is considred.

Breaker rating:

So, SDB to MDB breaker rating = 100A SP MCCB

Wire rating:

So, SDB to MDB wire rating = 2 x 70rm BYA + 35rm BYA ECC

(2) Sub distribution board (SDB)-0

Total current rating for SDB/ESDB to MDB (Ampere) Calculation:

Sub distribution board (SDB)-1 = 90% x Fixtures Current Rating + 50% x Power Circuits Current raitng

= 0.9 x 15.808 = 14.227 A

so, 20A is considred.

Breaker rating:

So, SDB to MDB breaker rating = 20A SP MCCB

Wire rating:

So, SDB to MDB wire rating = 2 x 6rm BYA + 6rm BYA ECC

(3) Emergency Sub distribution board (ESDB)-1

Total current rating for SDB/ESDB to MDB (Ampere) Calculation:

Sub distribution board (SDB)-1 = 90% x Fixtures Current Rating + 50% x Power Circuits Current raitng

= 0.9 x 7.4606 + 0.5 x 15 = 14.2145 A

so, 20A is considred.

Breaker rating:

So, ESDB to EMDB breaker rating = 20A SP MCCB

Wire rating:

So, ESDB to EMDB wire rating = 2 x 6rm BYA + 6rm BYA ECC

(4) Emergency Sub distribution board (ESDB)-0

Total current rating for SDB/ESDB to MDB (Ampere) Calculation:

Sub distribution board (SDB)-1 = 90% x Fixtures Current Rating + 50% x Power Circuits Current raitng

$$= 0.9 \times 4.444 = 3.999 \text{ A}$$

so, 5A is considred.

Breaker rating:

So, SDB to MDB breaker rating = 5A SP MCCB

Wire rating:

So, SDB to MDB wire rating = 2 x 1.5rm BYA + 1.5rm BYA ECC

Main and Emergency Distribution Board Calculations

Main Bus Bar

Sub Distribution Board	
Total number of sub-distribution boards	14
Total Current rating for SDB-1 to MDB	81.9544 A
Sub-distribution boards per phase of MDB bus-bar	5
Total maximum current rating for phase R/Y/B from Main lines	70% x (5 x 81.9544) = 409.772 A

Emergency Sub Distribution Board	
Total number of Emergency-sub-distribution boards	14
Total Current rating for ESDB-1 to EMDB	14.2145 A
Sub-distribution boards per phase of MDB bus-bar	5
Total maximum current rating for phase R/Y/B from Generator lines	5 x 14.2145 = 71.0725 A
Lift Breaker Rating	$I = \frac{Lift\ Load}{3 * V} = \frac{18.5\ kW}{0.9 * 3 * 220} \approx 40$ A
Pump Breaker Rating	15 A
Total maximum current rating for phase R/Y/B from Generator lines (including Lift and Pump)	70% x (71.0725 + 40 + 15) = 88.25075A
Total	
Total current from main bus bar to phase	409.772 +88.25075 = 498.022 A
Thus, triple phase breaker rating for transformer to main bus bar	800A TP MCCB
Line rating from transformer to main bus bar	4x630rm NYY + 315rm NYY ECC

Power meter line

Current supply to SDB1	81.9544 A
Current supply to ESDB1	14.2145 A
Total current for each standard unit	= (81.9544 + 14.2145) A = 96.1689 A
Breaker Rating	100 A SP MCCB
Wire rating from power meter to bus bar	2 x 70rm BYA + 35 rm BYA ECC

Generator Bus Bar

Total number of sub-distribution boards	14
Sub-distribution boards per phase of MDB bus-bar	5
Lift Breaker Rating	$I = \frac{Lift\ Load}{3 * V} = \frac{18.5\ kW}{0.9 * 3 * 220} \approx 40$ A
Pump Breaker Rating	15 A
Total maximum current rating for phase R/Y/B from Generator lines (including Lift and Pump)	88.25075A
Total maximum current rating for phase R/Y/B from Generator lines	70A TP MCCB
Line rating from transformer to Main bus bar	4 x 70rm NYY + 1 x 35rm NYY ECC

Transformer, PFI Plant and Generator Calculations

Transformer

Total current from main bus bar to phase	409.772 A
Worst case power factor	0.9
KVA rating of DPDC to main bus bar 3-phase transformer	

Transformer Rating $= \frac{3 * \text{phase voltage} * \text{line current}}{0.9}$	$= \frac{3 * 220\ V * 409.772\ \text{A}}{0.9}$ $= 300.5\ \text{kVA}$
Conclusion	
Since, transformer rating (300.5 kVA) > 200 kVA, separate substation is needed	

PFI Plant

(For improving PFI from worst case 0.9 to best case 0.95)	
Total apparent power draw, S	$= 3.V.I. = 3 * 220\ \text{V} * 409.772\text{A}$ $= 270.449\ \text{kVA}$
Worst case reactive power for 0.9 pf, Q_{worst}	$Q_{worst} = S\sqrt{\left(\frac{1}{0.9}\right)^2 - 1}$ $= 130.9844\ \text{kVAR}$
Best case reactive power for 0.95 pf, Q_{best}	$Q_{best} = S\sqrt{\left(\frac{1}{0.95}\right)^2 - 1}$ $= 88.89\ \text{kVAR}$
PFI plant rating = $Q_{worst} - Q_{best}$	$= (130.9844 - 88.89)\ \text{kVAR} =$ $42.0944\ \text{kVAR} \approx 42\ \text{kVAR}$
For PF Improvement current value	$I = \frac{Q}{3 * V * \sin\theta}$ $= \frac{42\ \text{kVAR}}{3 * 220\ \text{V} * \sin(18.19)}$ $= 203.85\ \text{A}$
PFI breaker rating	250A TP MCCB

PFI Line rating	4x185 rm NYY + 93rm NYY ECC

Generator

Total current to generator bus bar per phase	71.0725 A
Worst case power factor	0.9
KVA rating of 3-phase generator	$Generator\ Rating = \frac{3 * phase\ voltage * line\ current}{pf} = \frac{3 * 220 * 61.6}{0.9} = 45.173 \approx 46\ \text{kVA}$

Lightning Protection System (LPS)

Risk Assessment

Index	Parameter	Class	Value
A	Use of Structure	Houses and similar buildings	2
B	Type of Construction	Brick, plain concrete or masonry with nonmetal roof	4
C	Contents of Consequential Effects	Ordinary domestic of office building, factories and workshops not containing valuable materials	2
D	Degree of Isolation	Structure Located in an area with a few other structures or trees of similar height	5
E	Type of Terrain	Flat terrain at any level	2
F	Height of Structure	18-24m	8
G	Lightning Prevalence	19-21	20
Total			43

- Our residential building is 6 storied building.
- By letting each floor height about 10' out building height is approximately 18.288 m
- **Recommendation:** Risk assessment factor > 40 and so, lightning protection system is mandatory.

LPS Design Parameters

Lightning Arrestor

Rod Height = 24 inch
Roof's length is 75'
Roof's width is 45' 8" approximately 46'
Roof perimeter = 2 x (75' + 46') = 242'
We place arrestors 25' apart, requiring about 10 arrestors along the roof perimeter. But we used 7 arrestors to minimize cost here

Down conductor

Total Area = 75' * 46' = 3450 sq ft = 320.51 sq m
Number of Down conductors is 1 conductor for first 80 sq m:
For rest of the area (320.51 -80)/100 = 3 extra conductors
Thus, we use total of 4 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.

Conclusion

Through our project work, we gained insight on how to design conduit and determine optimum number of electrical equipment for a specified home area. Also, we designed circuit diagrams to connect switchboards, sub distribution boards, main distribution board and finally to grid in a consecutive manner. We tabulated all the breaker and wire rating values along with each room's RI, UF, Number of light and fans so that we can change the formulas for all at any time without manually changing each of them. Moreover, the project also introduced us to Emergency Supply calculation, Lightning Arrester theory etc. which are important design aspects too. Since the floorplan was already designed and taken from a resource and so, in some calculations there were abrupt values which did not correspond to optimal design characteristics. In such cases we adjusted them and understood that electrical designs should initiate along with the initiation of architectural design of the home units. Finally, the designs were carried out in *AutoCAD 2007* which proved very useful due to its graphical interface and numerous functions to illustrate the whole design efficiently.

Appendix:

Formulas Used

Table 02: Formulas

Symbol	Formula
Number of lights required, (N)	$N = \frac{E * L(meter) * W(meter)}{F * UF * MF}$
Number of fans required, (M)	$M = \frac{L(ft) * W(ft)}{100}$
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$* F$)	$\mathrm{N} * \mathrm{F} = \frac{E * L(meter) * W(meter)}{UF * MF}$

Luminance Values for Each Room

Table: Luminance values for each room

Floor Type	Room Type	E (lux)
Typical Floor	Dining	150
	Drawing Room	70
	Kitchen	200
	Master Bedroom	100
	Guest Bedroom	100
	Veranda	70
	Exercise Room	150
	Store Room	50
	Home Office	300
	Entrance Hall	150
Garage	Store Room	50
	Meter Room	50
	Generator Room	50
	Toilet	100

	Garage	100
	Guard Room	70
	Drivers Waiting Room	70
Stairs	Stairs	100
Basement	Basement	100
Rooftop	Rooftop	100
Lift	Lift	70

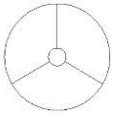
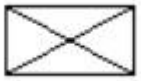
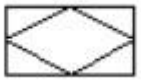
Abbreviations

Table 01: 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)

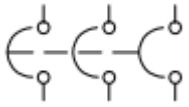
Fittings and Fixtures

Fittings and Fixtures

Description	Height	Caption	Symbol
Wall Mounted Light	Lintel	LL	
Ceiling Light	Ceiling	CL	
Wall Mounted Tube Light	Lintel	TL	
Suspended LED Light	Ceiling	SL	
Fan (56” diameter)	Ceiling	CF	
Switch Board	Mid wall	SB	
Sub Distribution Board	Mid wall	SDB	
Main Distribution Board	Mid wall	MDB	
Emergency Sub Distribution Board	Mid wall	ESDB	

Exhaust Fan (8” diameter)	Lintel	EF	
2 Pin Socket	Mid wall	SS	
2 Pin TV Socket	Lower	TS	
3 Pin Socket 20A	Lintel	S	

SDB MDB Circuit Diagram Notations

Description	Symbol
Switch	
Fan Regulator	
Single Pole Circuit Breaker (SP MCCB)	
Triple Pole Circuit Breaker (TP MCCB)	
Delta to Wye Transformer	

Generator	G

Utilization Factor Table

Utilization factor											
Room Reflectance			Room Index								
Ceiling	Wall	Floor	0.75	1	1.25	1.5	2	2.5	3	4	5
0.7	0.5	0.2	0.43	0.49	0.55	0.6	0.66	0.71	0.75	0.8	0.83
0.7	0.3	0.2	0.35	0.41	0.47	0.52	0.59	0.65	0.69	0.75	0.78
0.7	0.1	0.2	0.29	0.35	0.41	0.46	0.53	0.59	0.63	0.7	0.74
0.5	0.5	0.2	0.38	0.44	0.49	0.53	0.59	0.63	0.66	0.7	0.73
0.5	0.3	0.2	0.31	0.37	0.42	0.46	0.53	0.58	0.61	0.66	0.7
0.5	0.1	0.2	0.27	0.32	0.37	0.41	0.48	0.53	0.57	0.62	0.66
0.3	0.5	0.2	0.3	0.37	0.41	0.45	0.52	0.57	0.6	0.65	0.69
0.3	0.3	0.2	0.28	0.33	0.38	0.41	0.47	0.51	0.54	0.59	0.62
0.3	0.1	0.2	0.24	0.29	0.34	0.37	0.43	0.48	0.51	0.56	0.59
0	0	0	0.19	0.23	0.27	0.3	0.35	0.39	0.42	0.46	0.48

Light Bulb Wattage and Lumen Chart

Incandescent Flood Light Lamps (Luminous Flux lm)		
Type	**Wattage (220-230 V)**	**Luminous Flux (lm)**
120 E	**100 W**	**1050**
123 E	**250 W**	**3250**
126 G	**500 W**	**8000**
6036 G	**1000 W**	**19000**
7083 U	**100 W**	**2250**
162 G	**500 W**	**12600**

TABLE 12

Flourscent lamps(220 V), Standard (Construction)

Wattage (W)	Lenth of lamps (mm)	Lumlmous flux (lm)
8	288	350
16	720	950
20	590	1250
40	1200	3200