Bangladesh University of Engineering and Technology

EEE 414- Electrical Services Design

Project Report

Group Number: 04

Section: A2

Group Members:

Student ID	Name
1906054	Md. Fahadul Islam
1906055	Tasmin Khan
1906056	Bokhtiar Foysol Himon
1906057	Tawsif Arefin
1906058	Mohammad Ismail Chowdhury
1906059	Md. Hasib Ur Rashid

Submitted to-

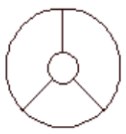
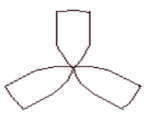
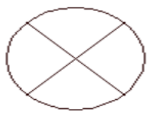
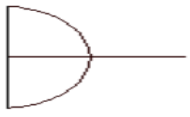
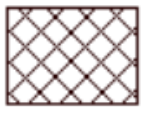
1. Yeasir Arafat, Associate Professor, Department of EEE, BUET
2. Saif Ahmed, Lecturer (PT), Department of EEE, BUET

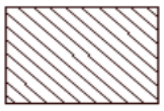
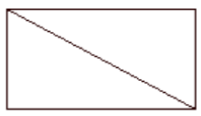
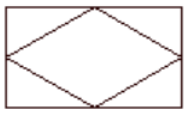
Project Name: Electrical service design of a nine-storeyed residential building with garage, basement and substation

Names of designers:

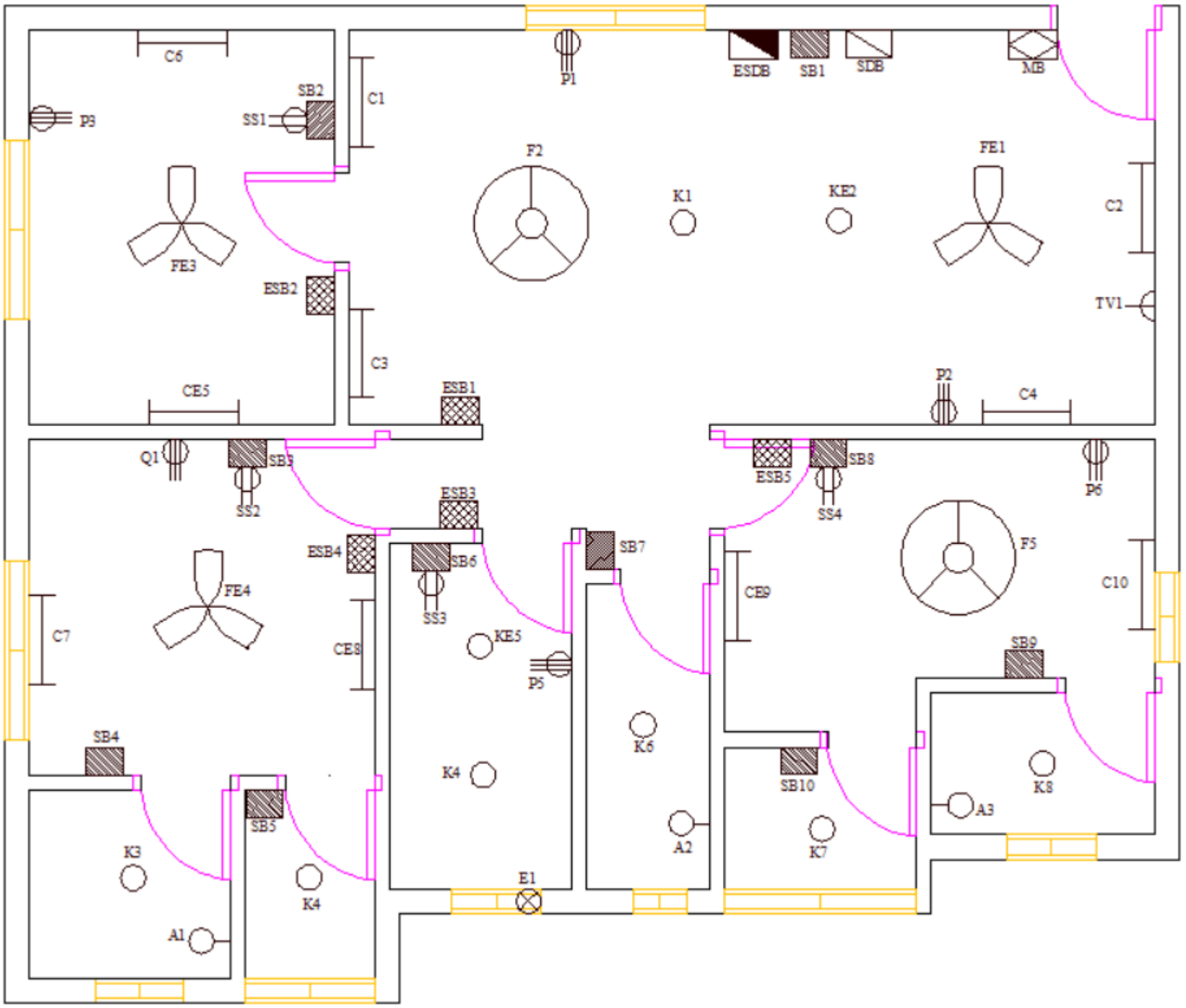
1.Md Hasib Ur Rashid
2.Tasmin Khan
3.Tawsif Arefin
4.Bokhtiar Foysol Himon
5.Mohammad Ismail Chowdhury
6.Md. Fahadul Islam

Symbols and Legends:

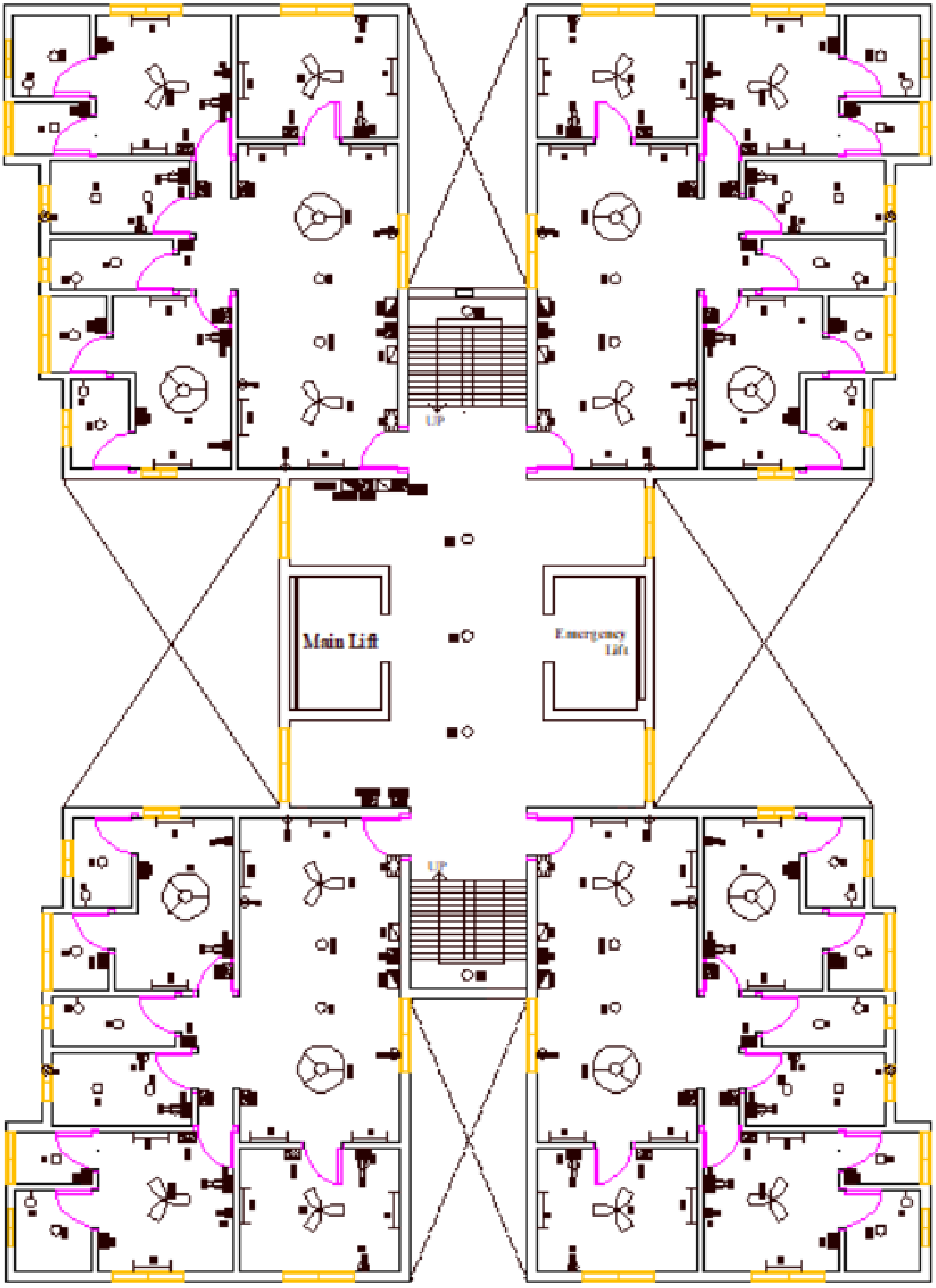
Fitting and Fixtures Symbol	Symbol Legend	Symbol Description	Power Rating
	SS	2 pin 5A socket at SB level	100W
	P / Q	3 pin 5A/20A socket	3000/4000W
	F	3 Blade Fan	100W
	FE	3 Blade Fan (Emergency)	100W
	C / CE	Fluorescent Light	20W
	K / KE	Ceil Mounted Light Bulb	20W
	A	Wall Bracket Light at Lintel Level	10W
	E	Exhaust Fan	40W
	TV	TV Socket	300W
	ESB	Emergency Switch Board	-

	SB	Switch Board	-
	ESDB	Sub-Distribution Board (Emergency)	-
	SDB	Sub-Distribution Board	-
	MB	Meter Board	-
	MDB	Main Distribution Board	-

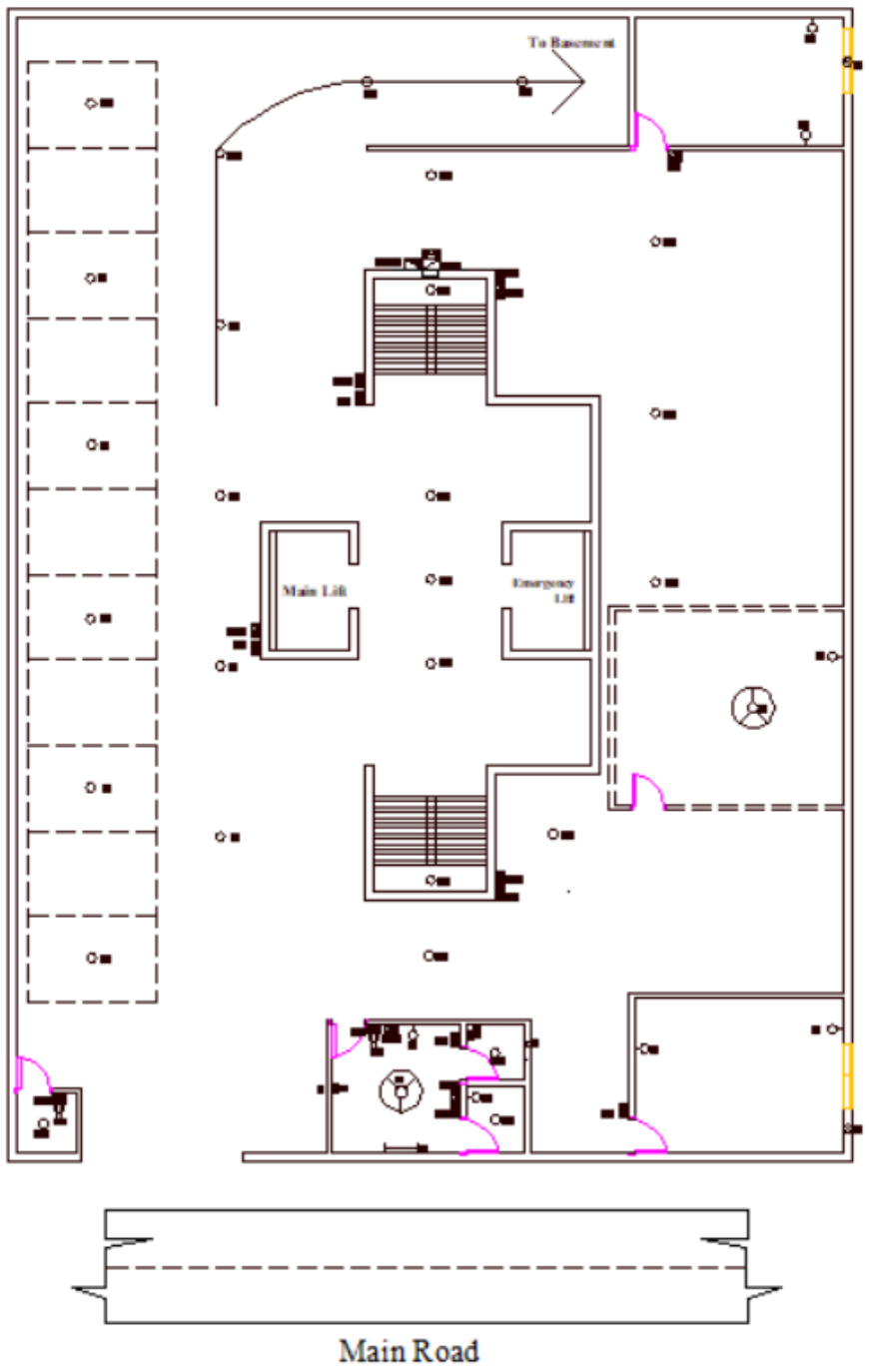
Electrical fittings and fixtures layout diagram (Single Unit):



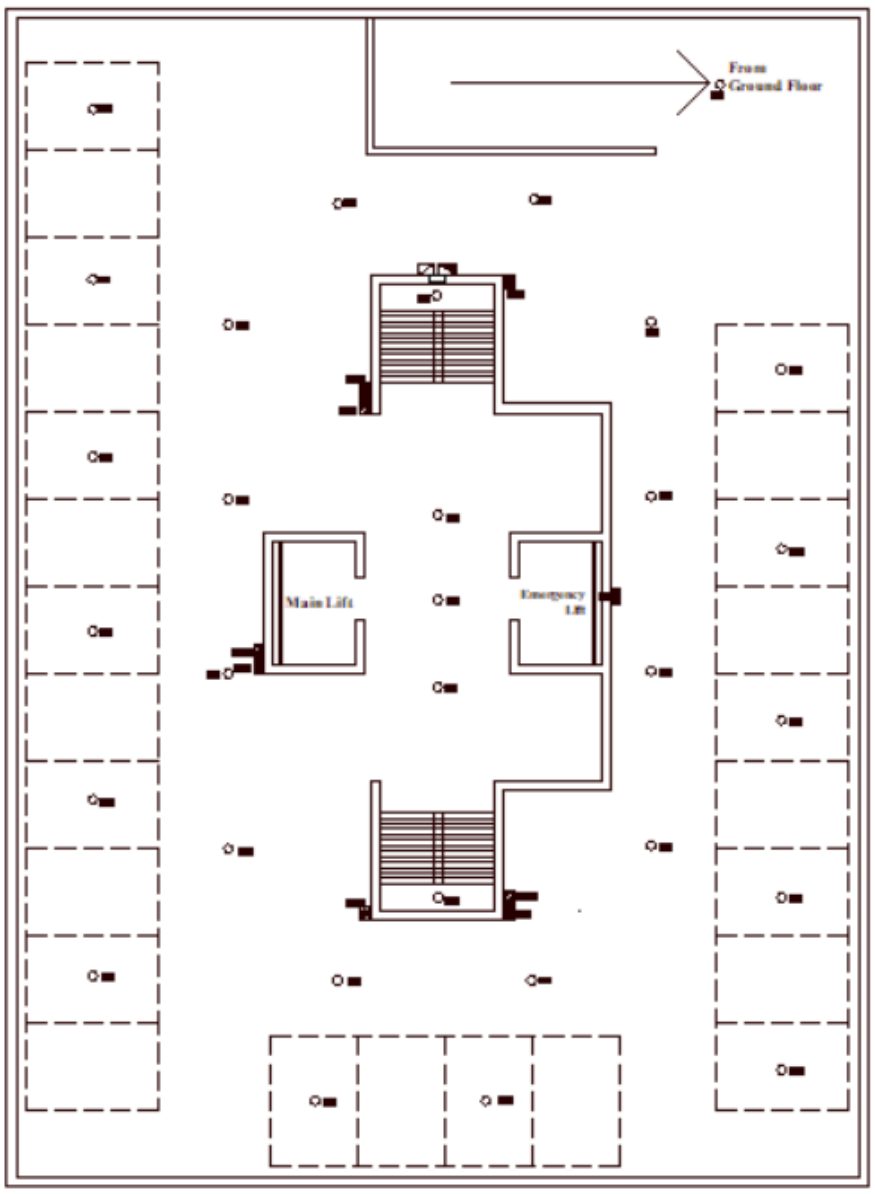
Electrical fittings and fixtures layout diagram (Entire Floor):



Electrical fittings and fixtures layout diagram (Ground Floor):



Electrical fittings and fixtures layout diagram (Basement):

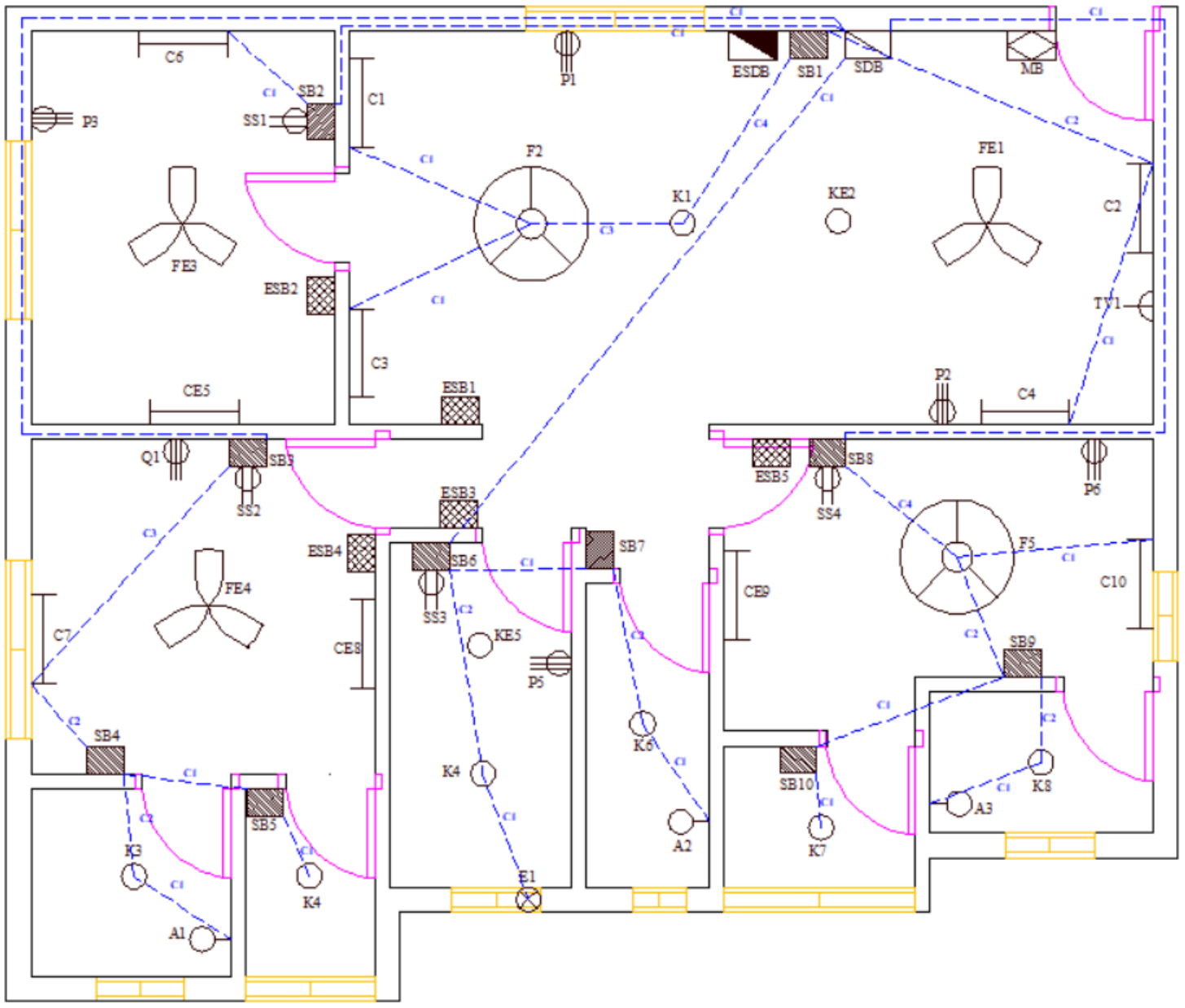


Schedule of Conduits:

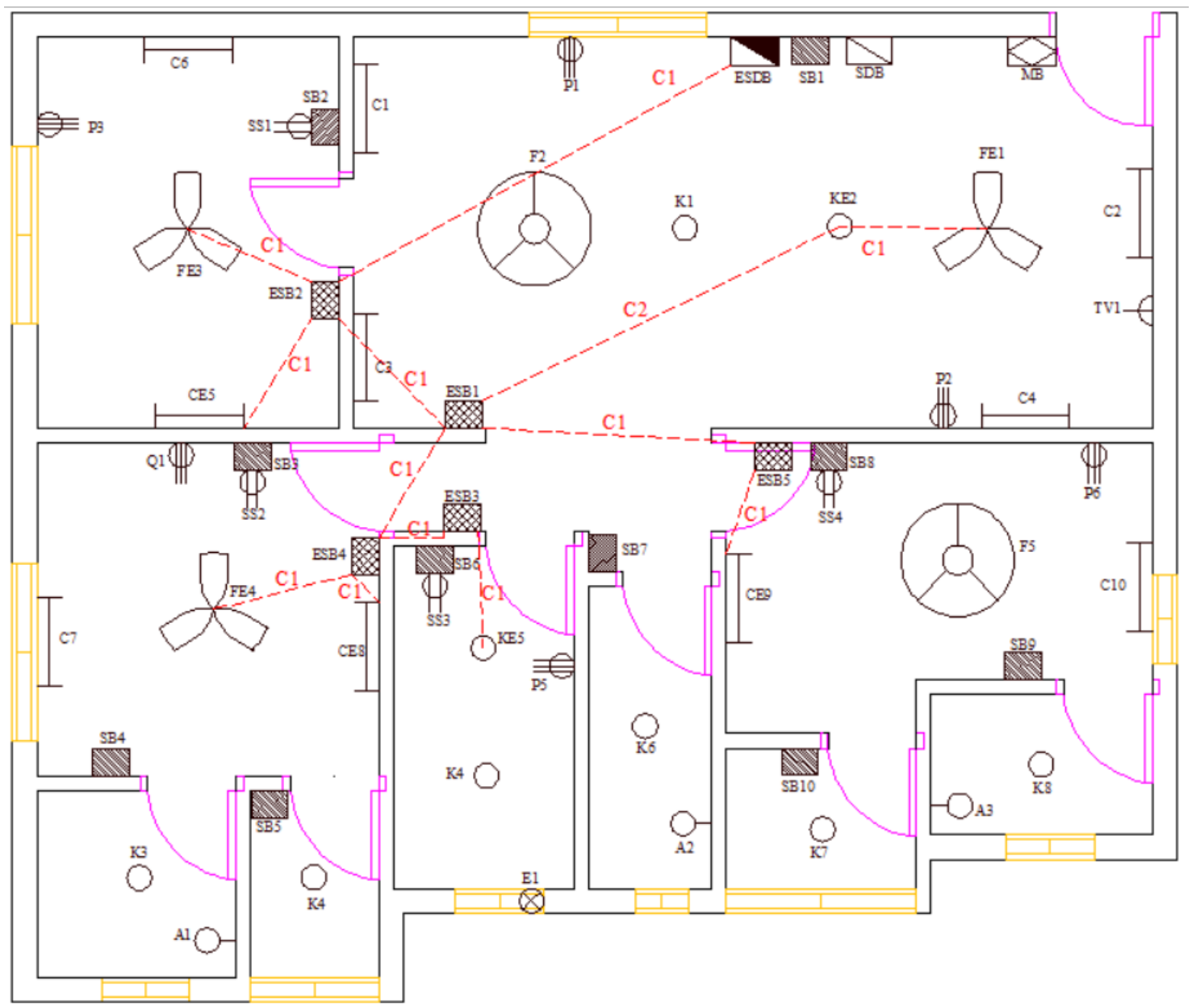
Symbol	Containing Power Cable	CB Rating
C1	2*1.5 rm BYM + 1.5 rm BYA ECC	5A
C2	4*1.5 rm BYM + 2*1.5 rm BYA ECC	5A
C3	6*1.5 rm BYM + 3*1.5 rm BYA ECC	5A
C4	8*1.5 rm BYM + 4*1.5 rm BYA ECC	5A
C5	10*1.5 rm BYM + 5*1.5 rm BYA ECC	5A
C6	2*2.5 rm BYM + 2.5 rm BYA ECC	10A
C7	4*2.5 rm BYM + 2*2.5 rm BYA ECC	10A
C8	2*4 rm BYM + 4 rm BYA ECC	15A
C9	4*4 rm BYM + 2*4 rm BYA ECC	15A
C10	2*6 rm BYM + 6 rm BYA ECC	20A
C11	2*10 rm BYM + 10 rm BYA ECC	30A
C12	2*25 rm BYM + 16 rm BYA ECC	50A

Electrical Conduit Diagram (Single Unit):

Main Conduit:

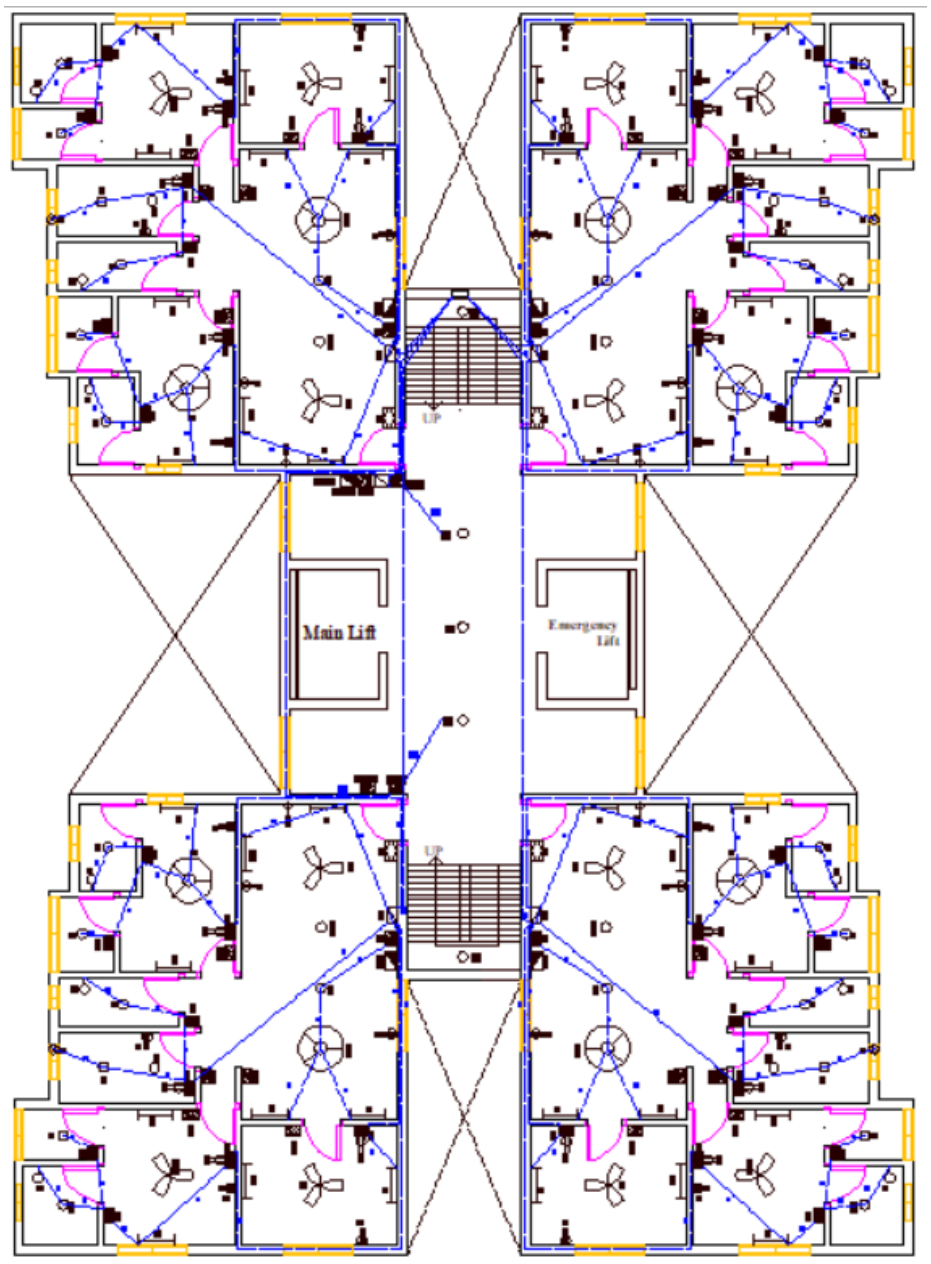


Emergency Conduit:

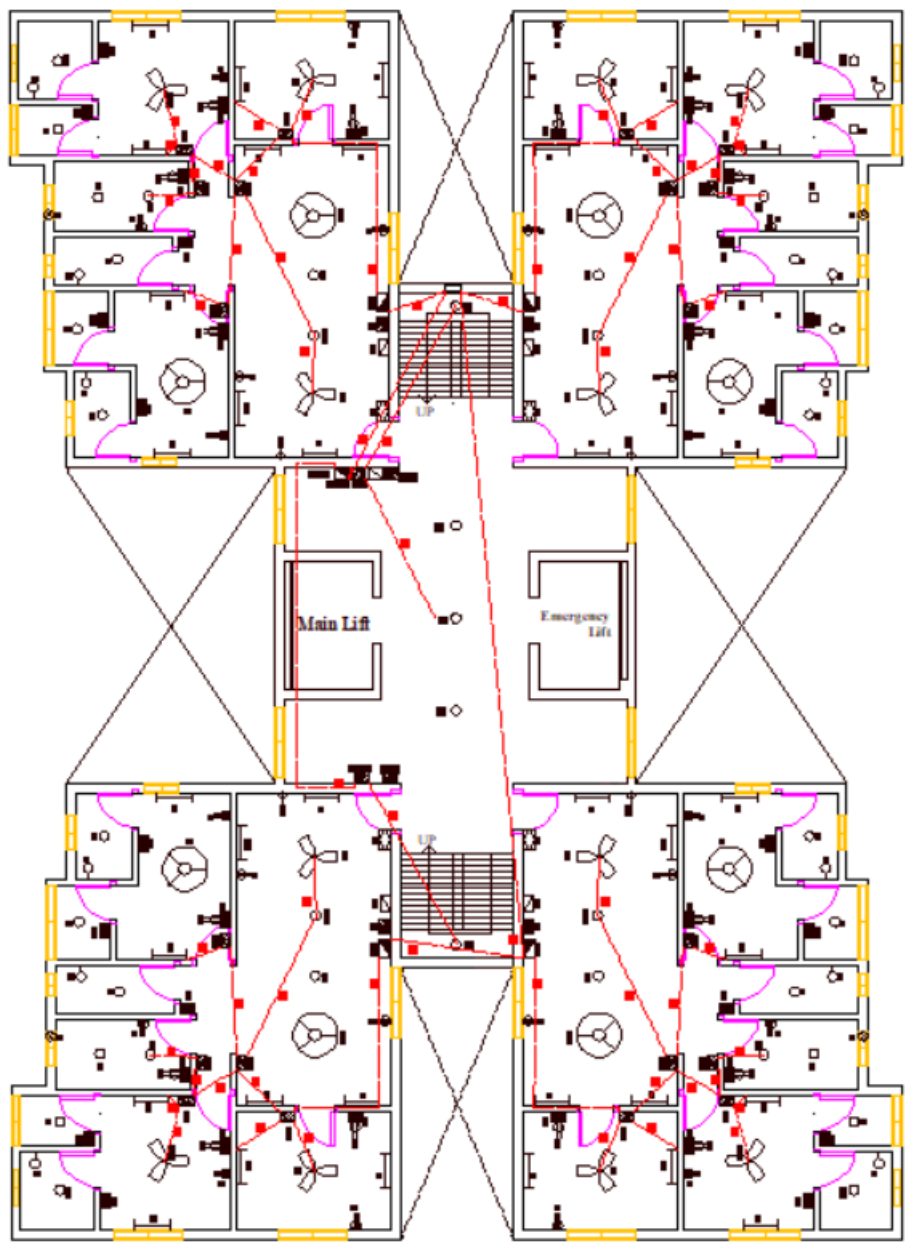


Electrical Conduit Diagram (Entire Floor):

Main Conduit:

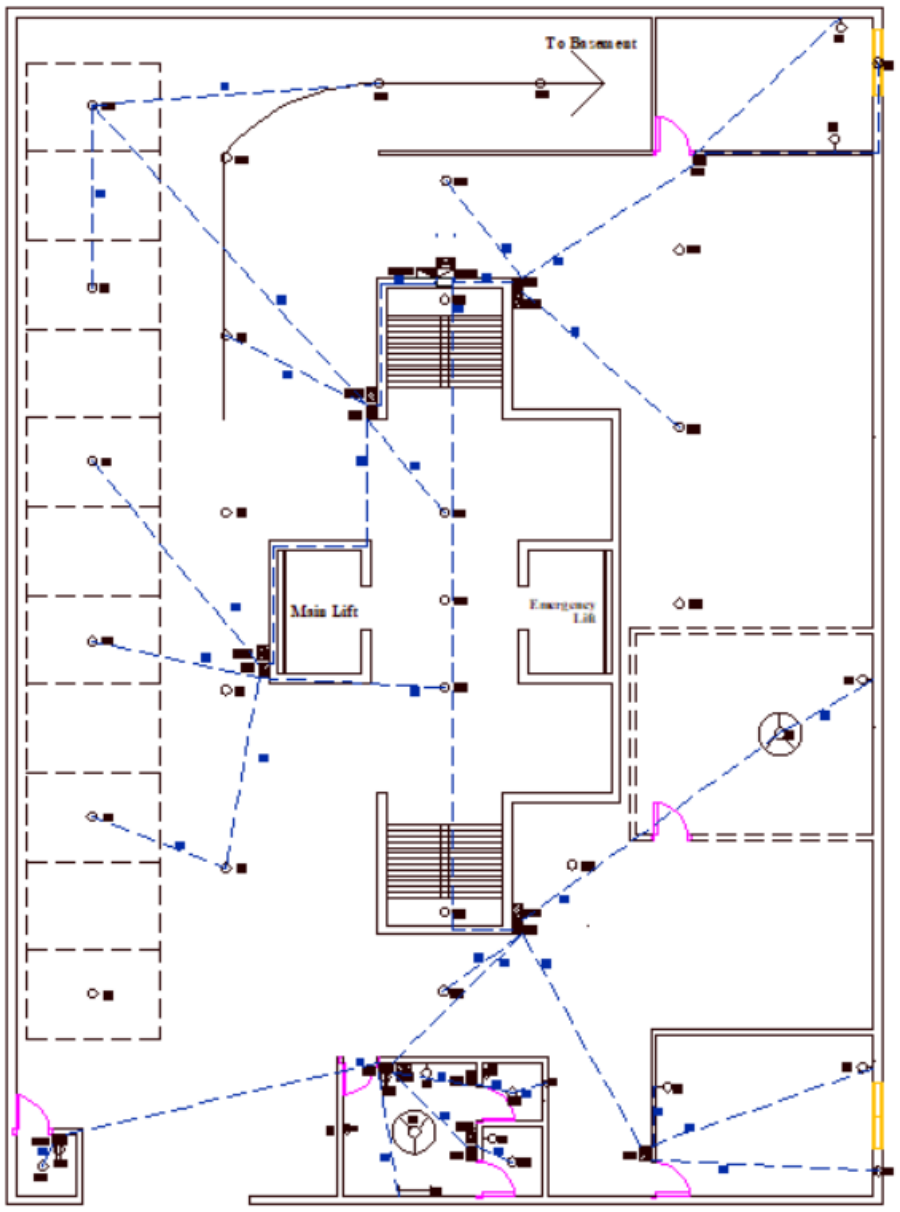


Emergency Conduit:

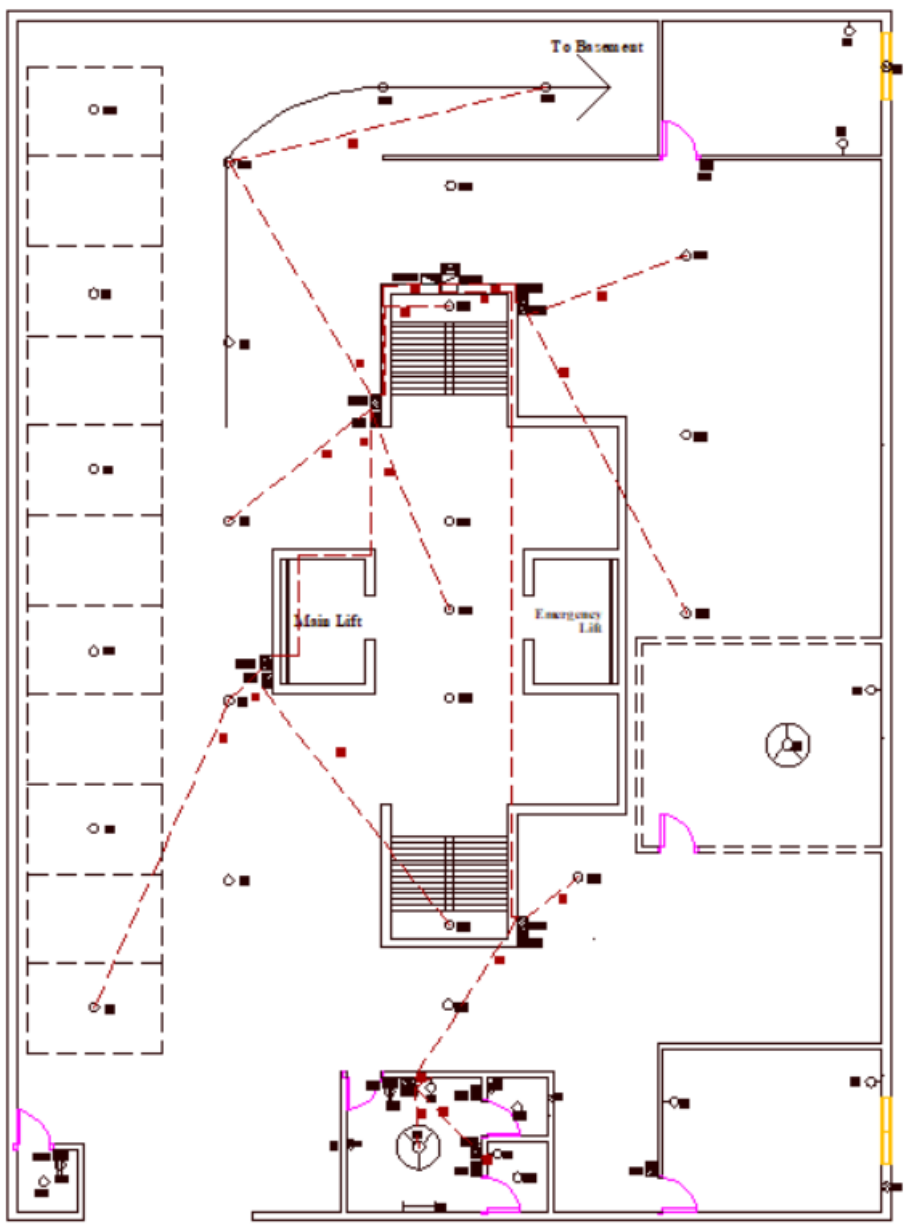


Electrical Conduit Diagram (Ground Floor):

Main Conduit:

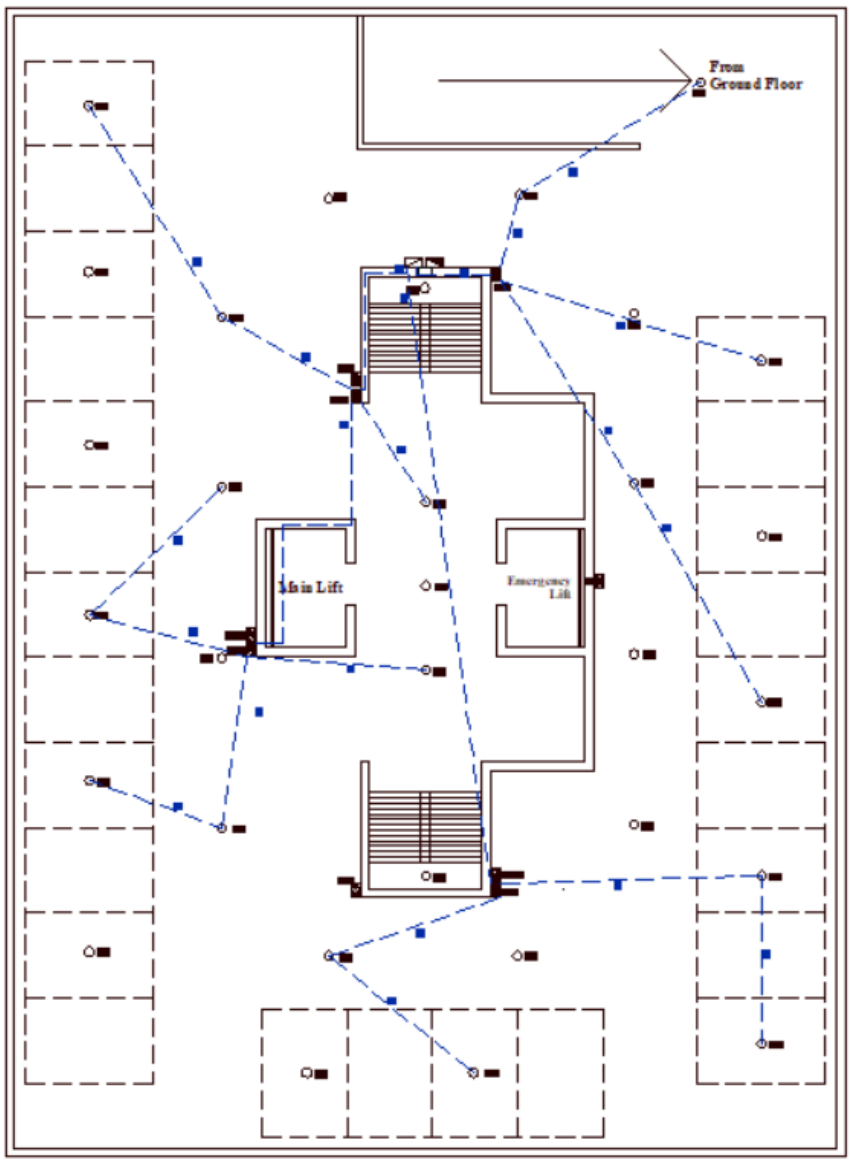


Emergency Conduit:

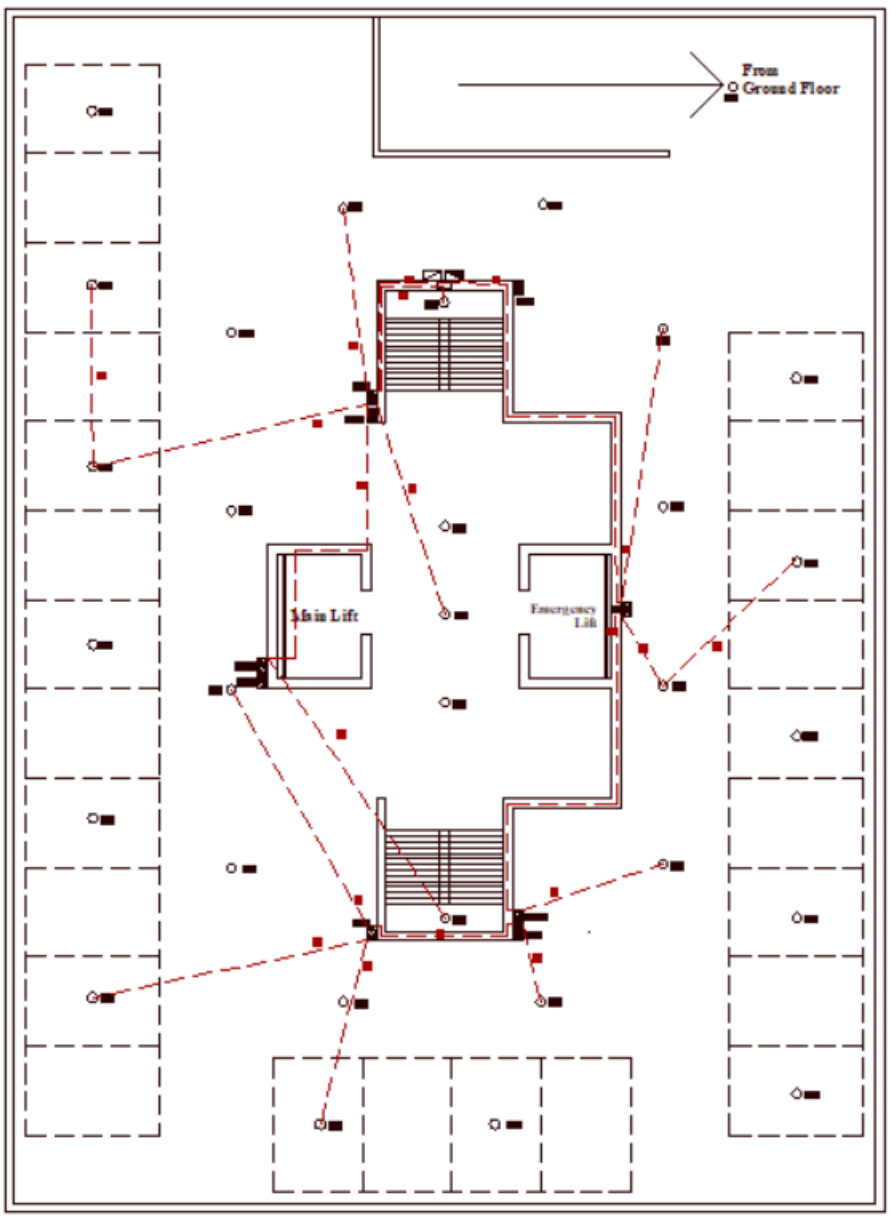


Electrical Conduit Diagram (Basement):

Main Conduit:

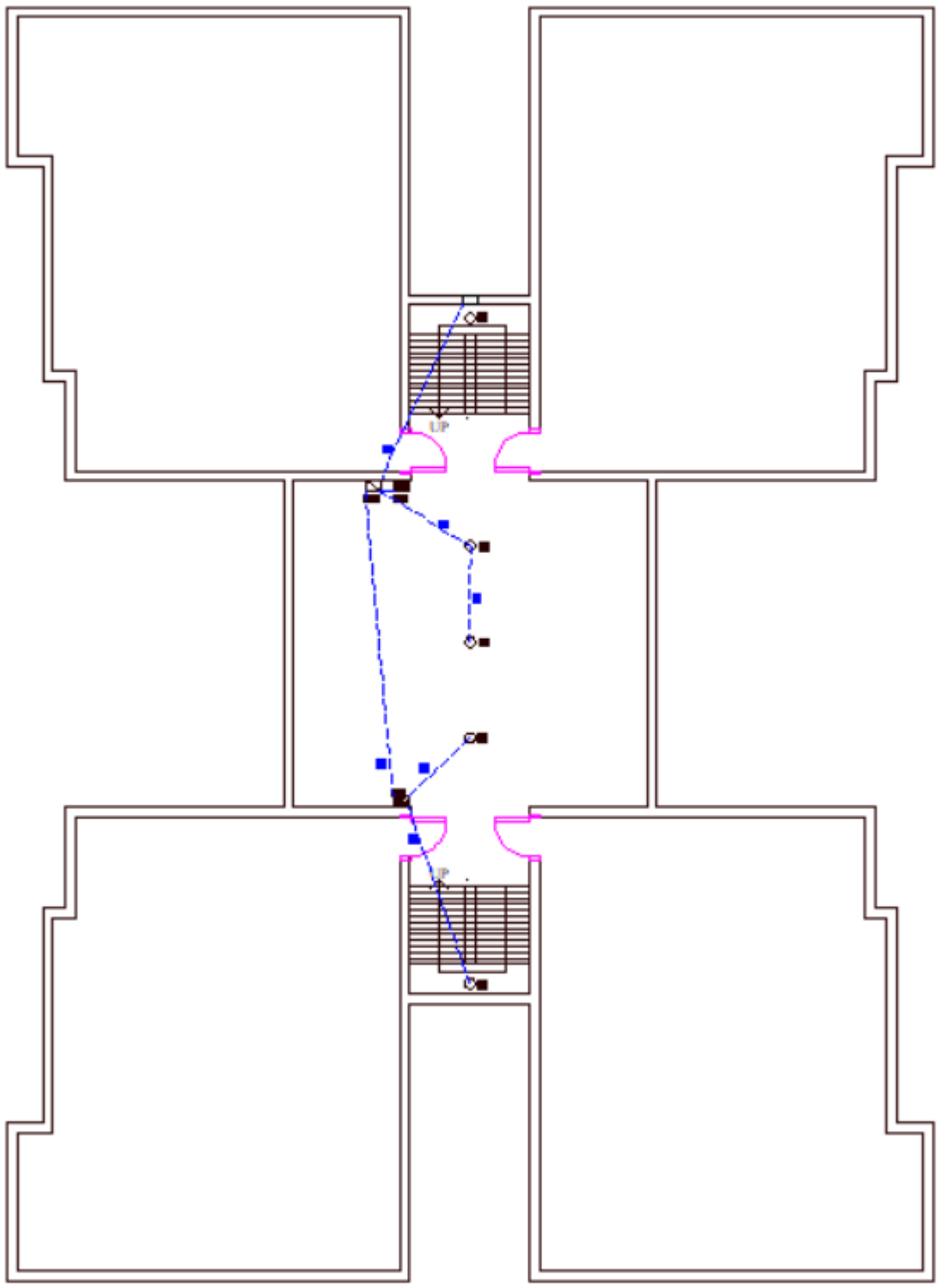


Emergency Conduit:

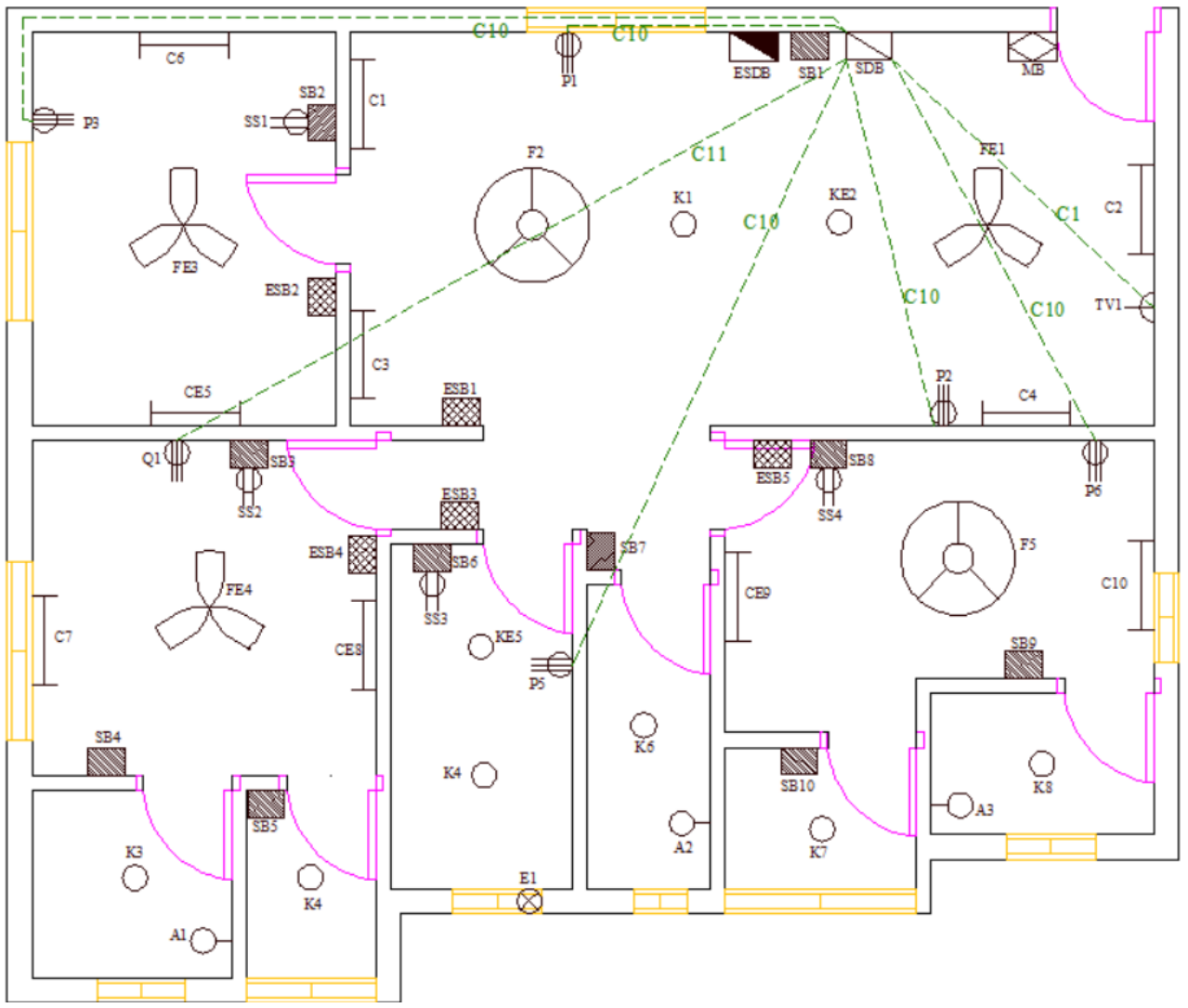


Electrical Conduit Diagram (Roof Lobby):

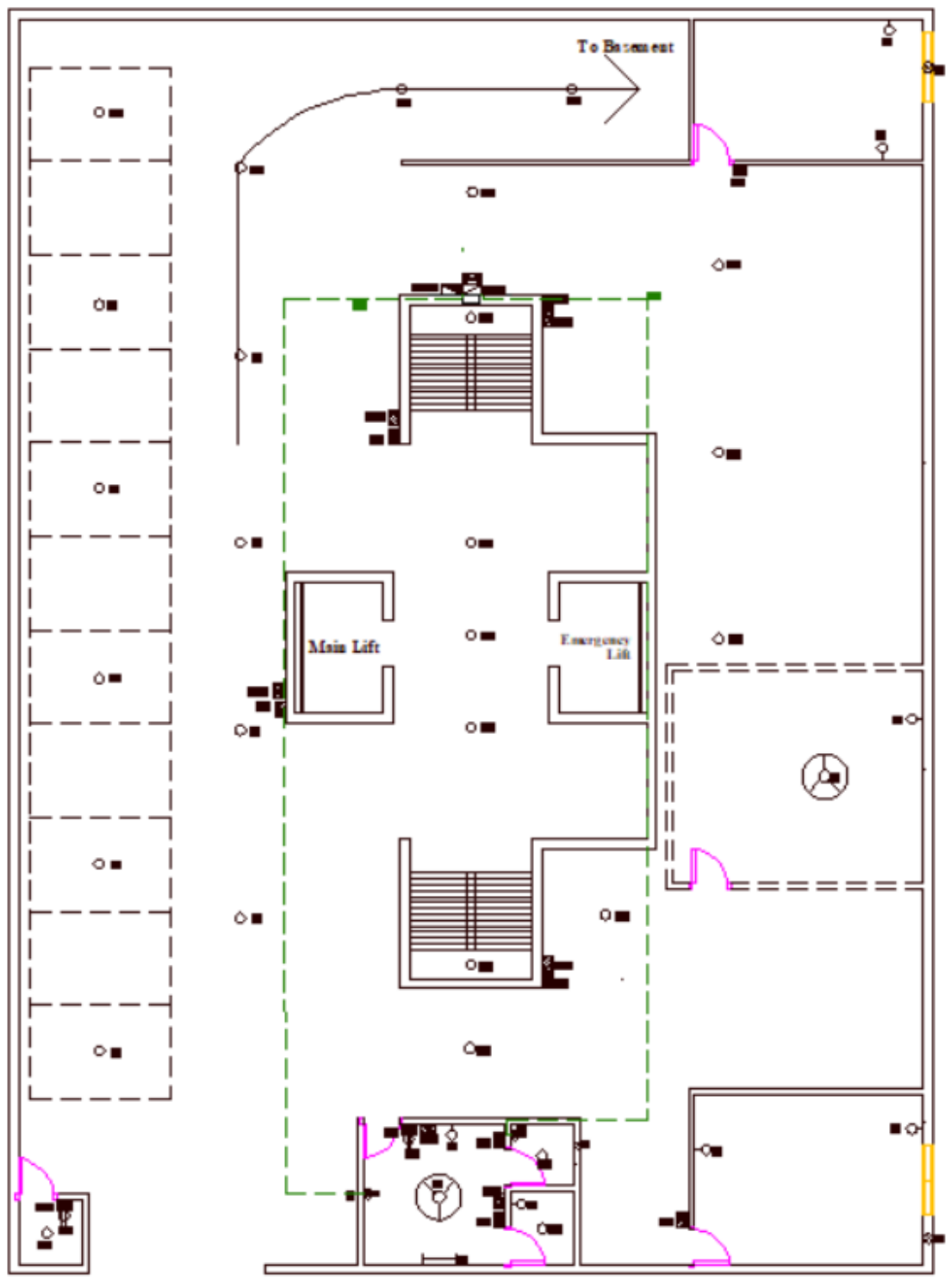
Main Conduit:



Electrical Conduit for Power Sockets (Single Unit):

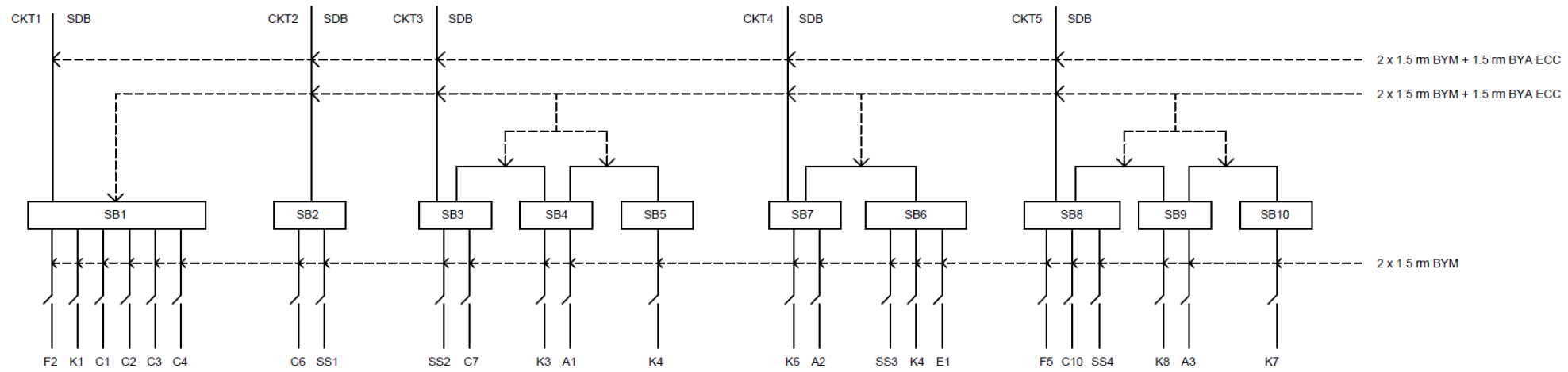


Electrical Conduit for Power Sockets (Ground Floor):

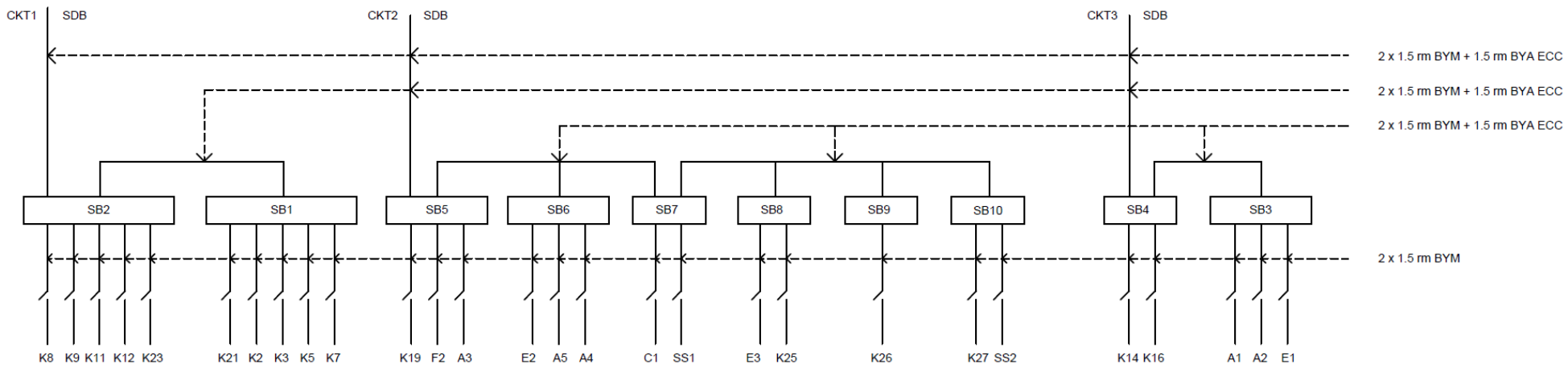


Switchboard Diagrams:

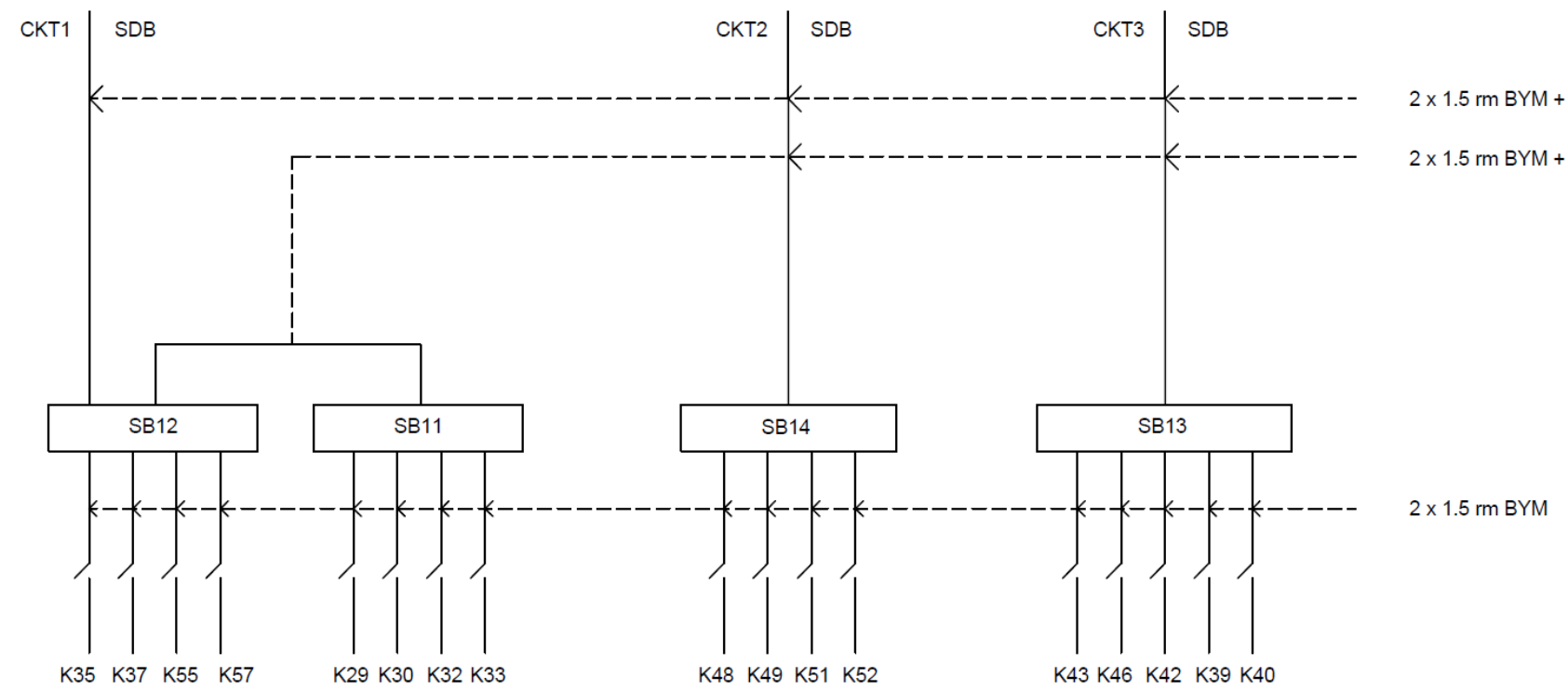
Switchboard Diagram (Each Unit):



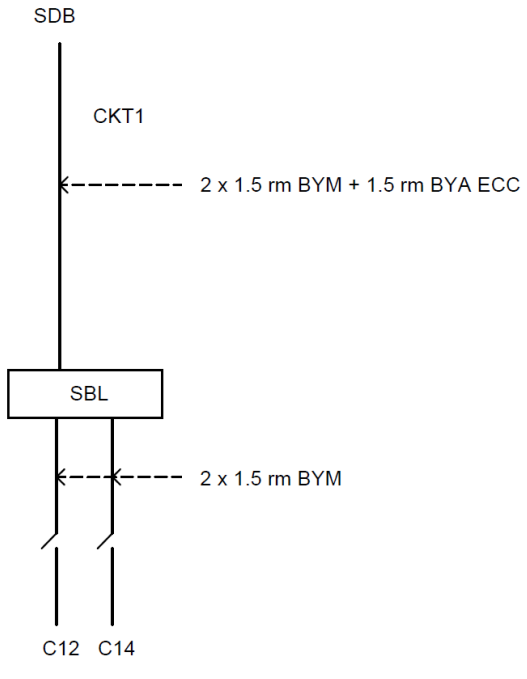
Switchboard Diagram (Ground Floor):



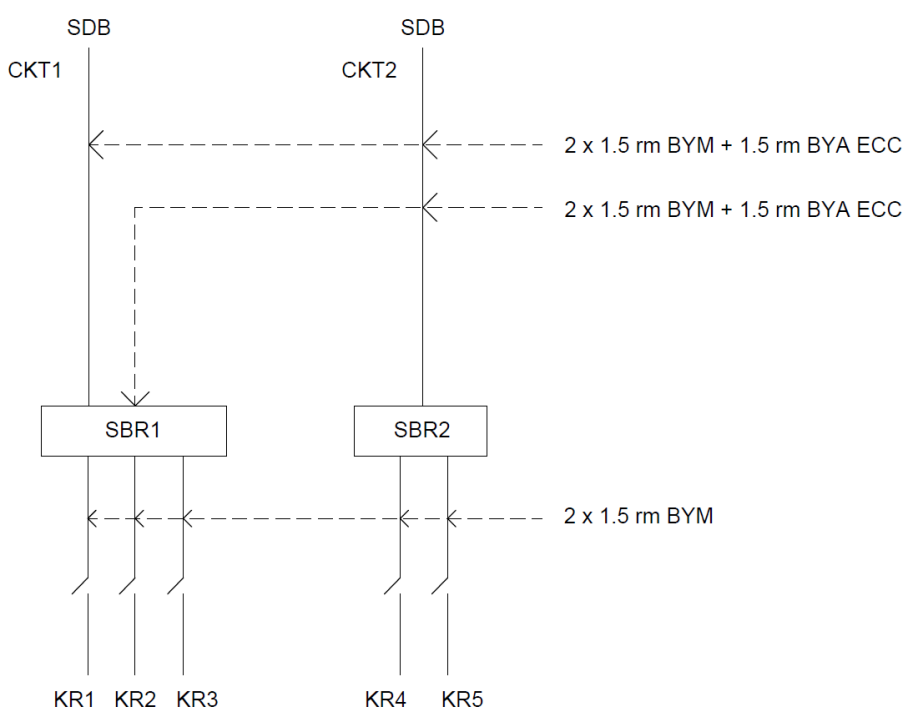
Switchboard Diagram (Basement):



Switchboard Diagram (Lobby):

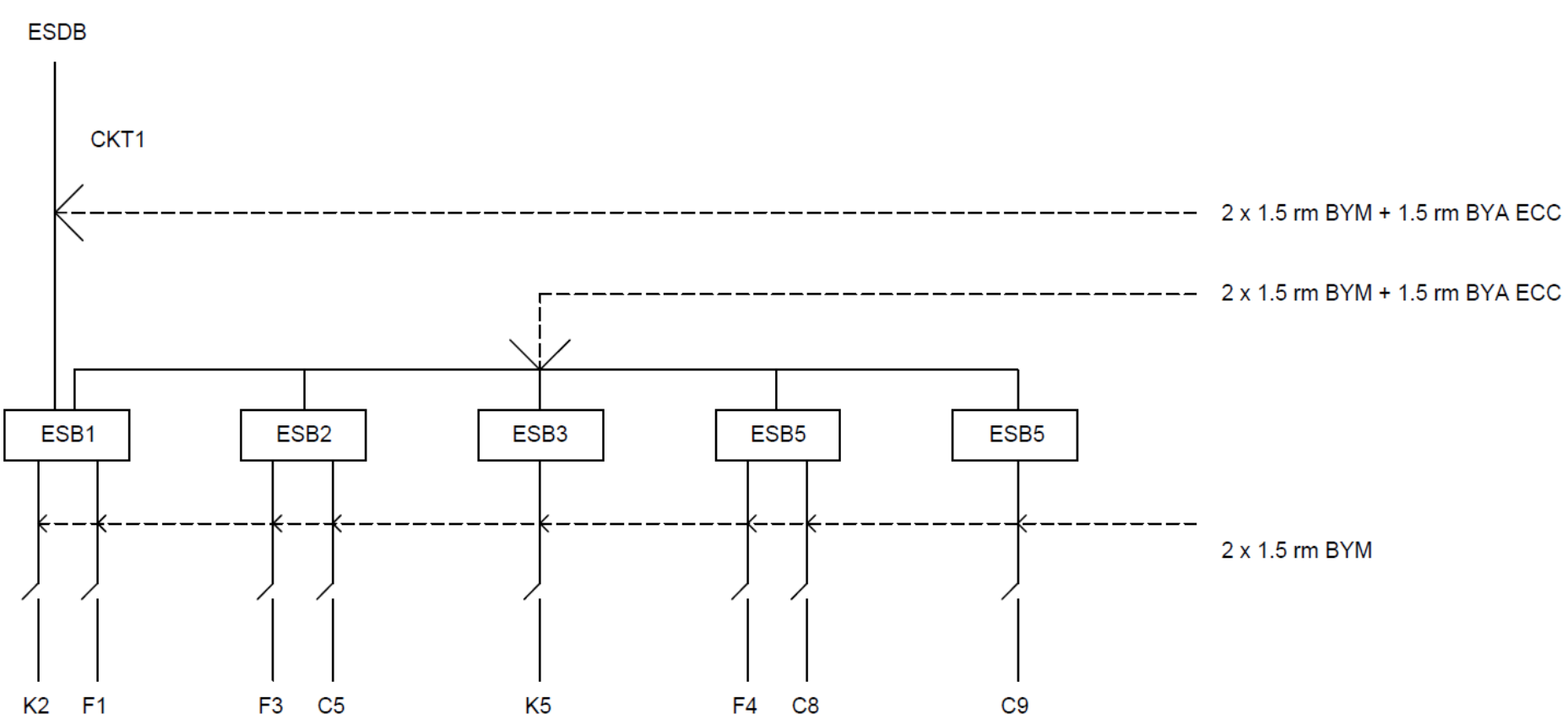


Switchboard Diagram (Roof Lobby):

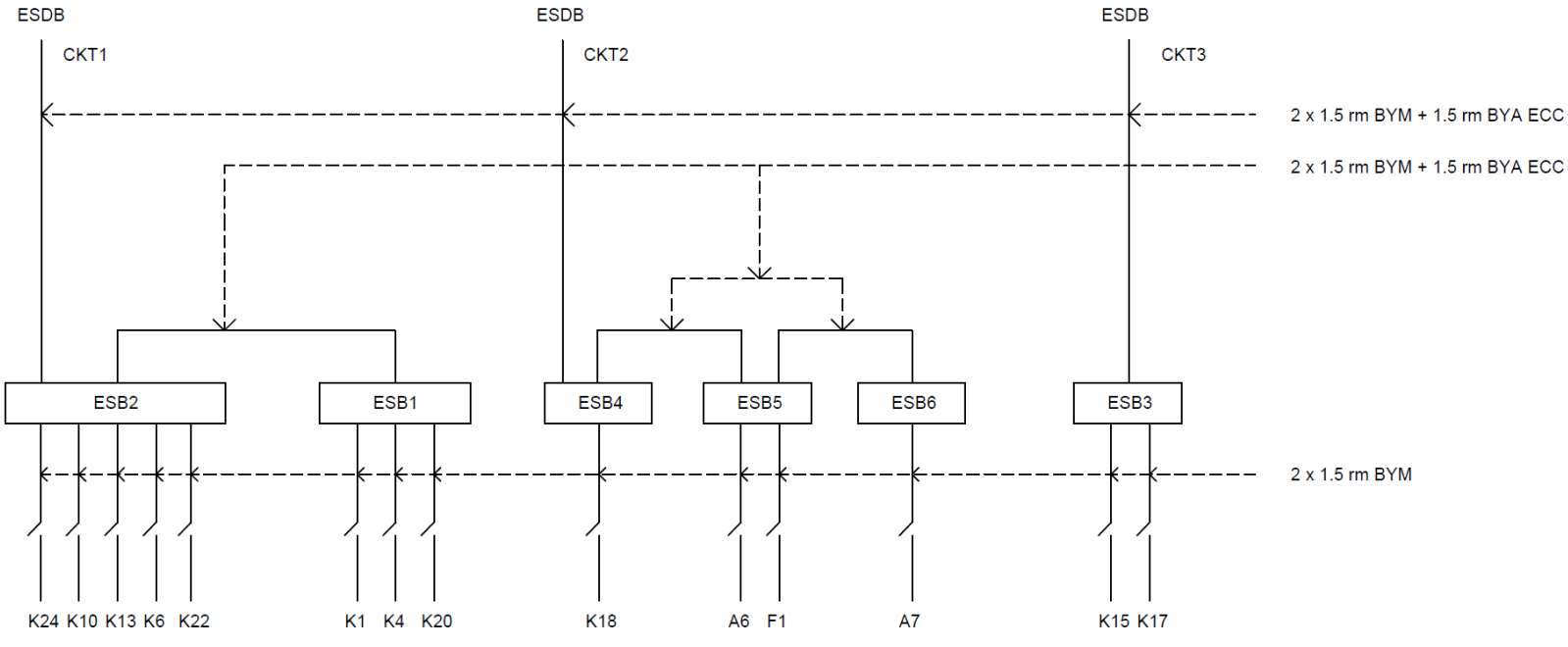


Emergency Switchboard Diagrams:

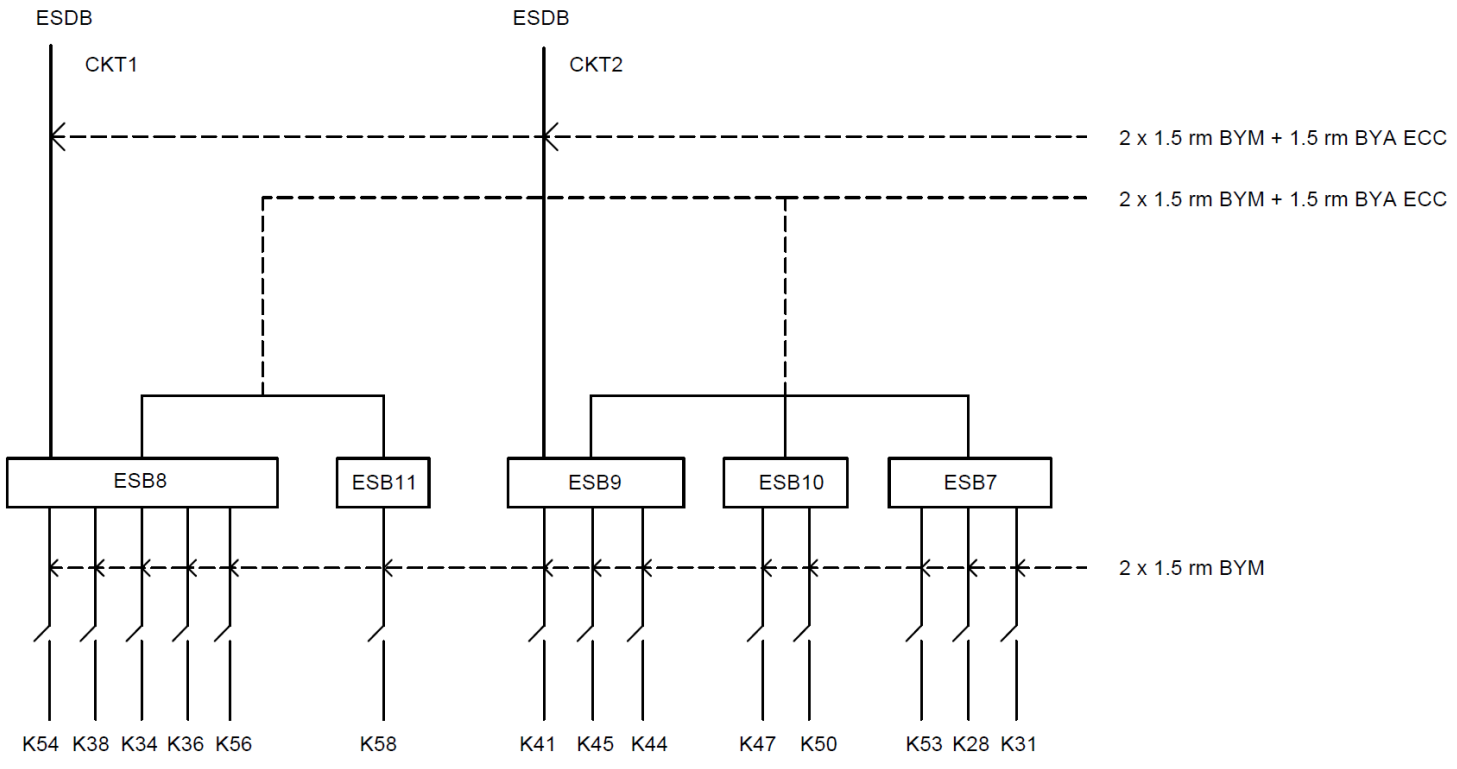
ESB Diagram (Each Unit):



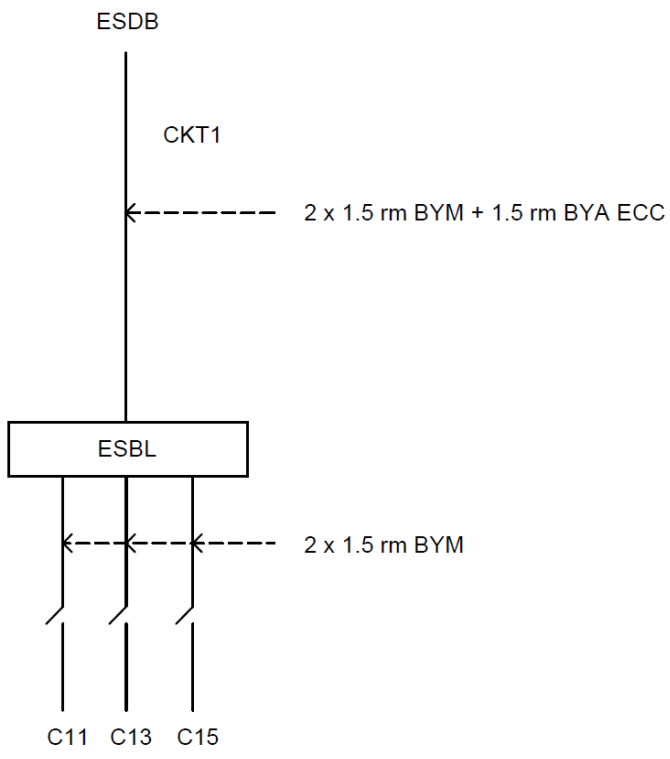
ESB Diagram (Ground Floor):



ESB Diagram (Basement):

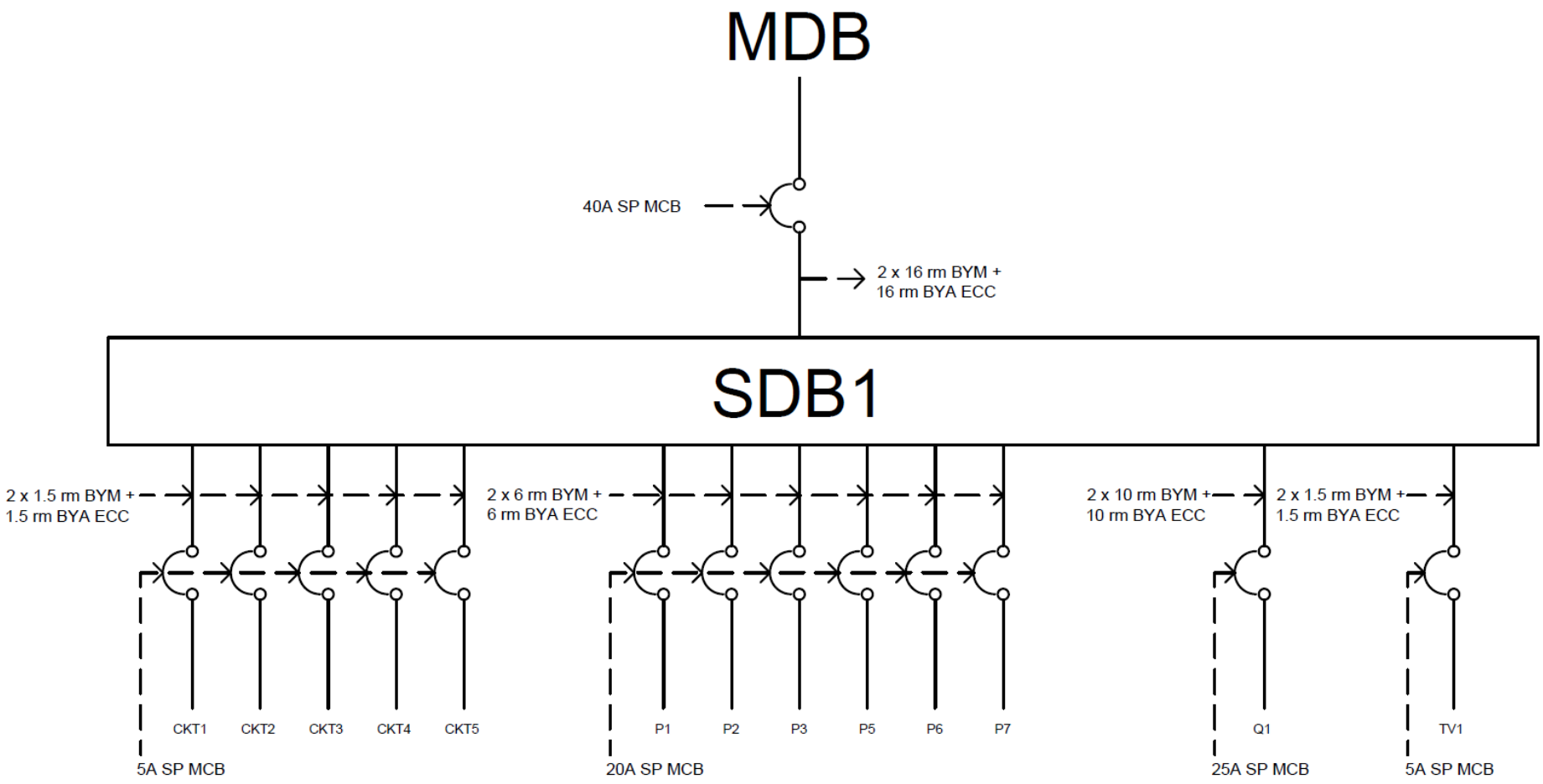


ESB Diagram (Lobby):

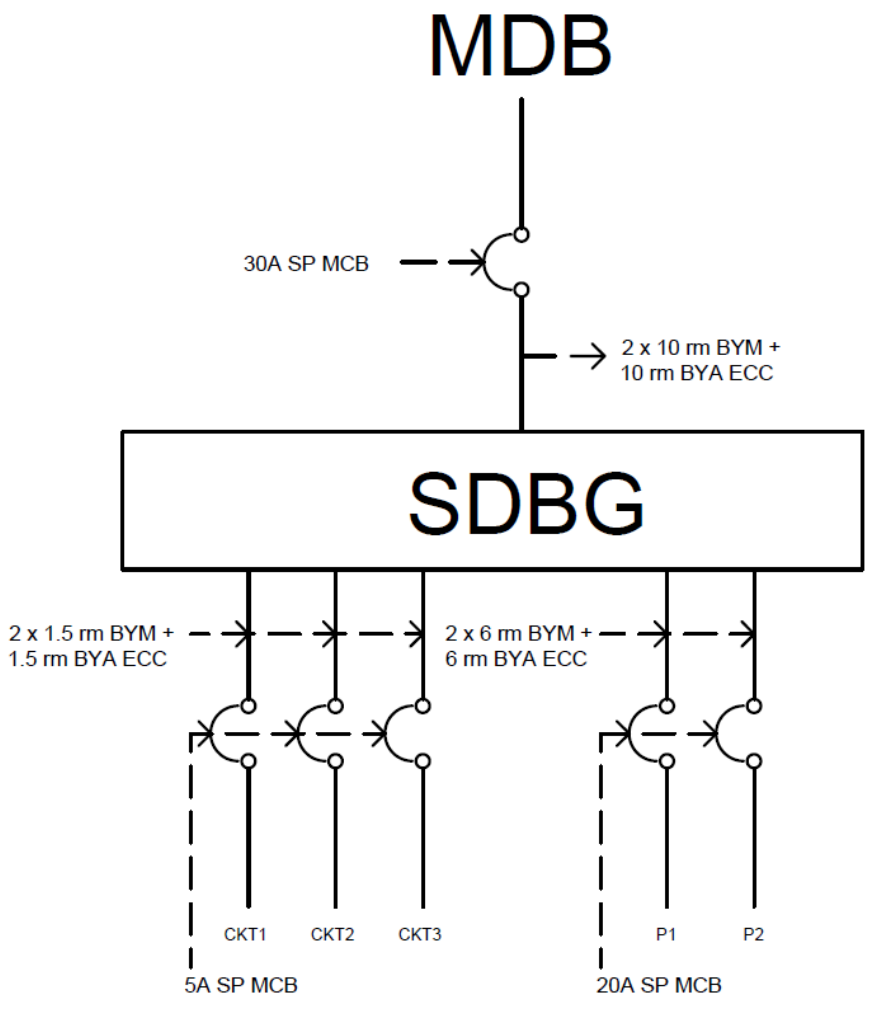


SDB Diagrams:

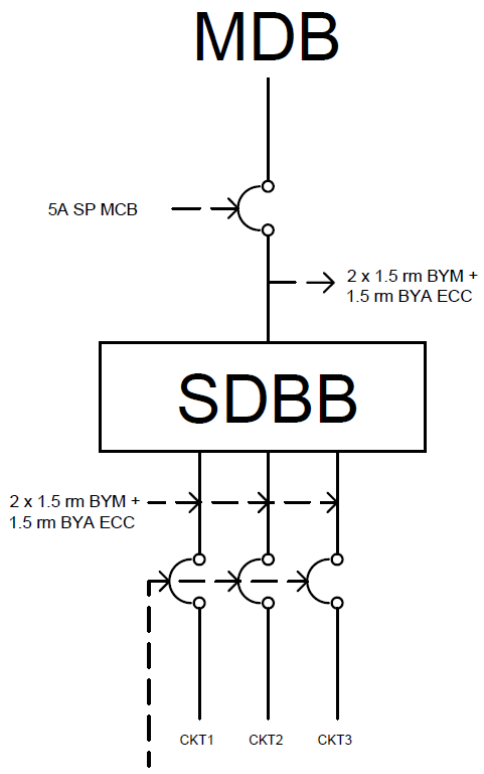
SDB Diagram (Each Unit):



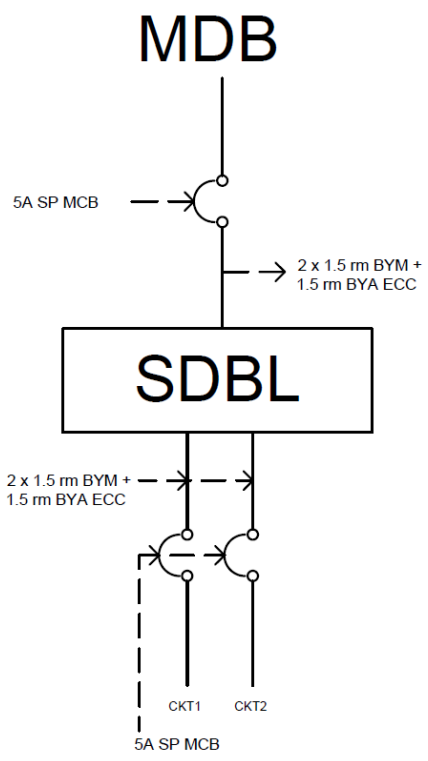
SDB Diagram (Ground Floor):



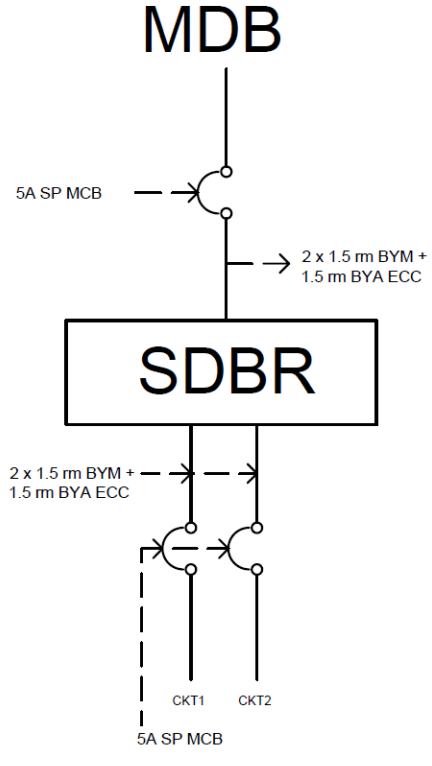
SDB Diagram (Basement):



SDB Diagram (Lobby):

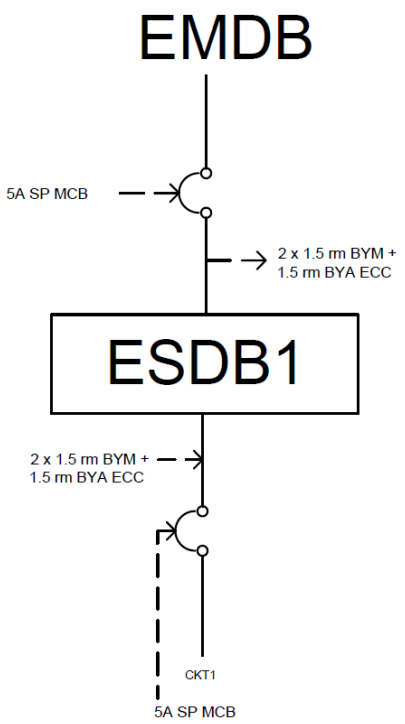


SDB Diagram (Roof Lobby):

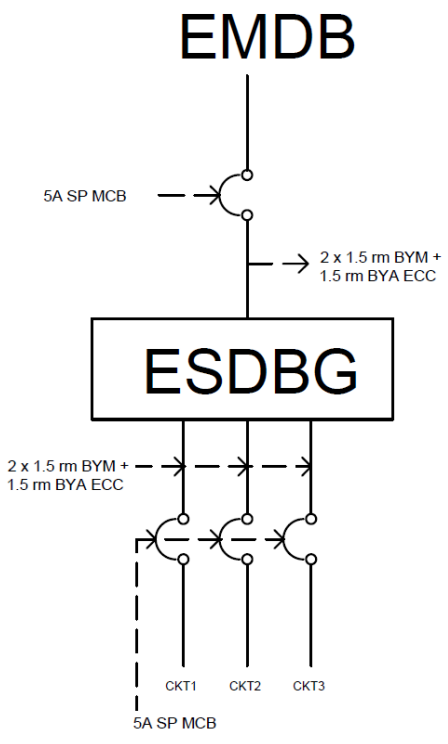


ESDB Diagrams:

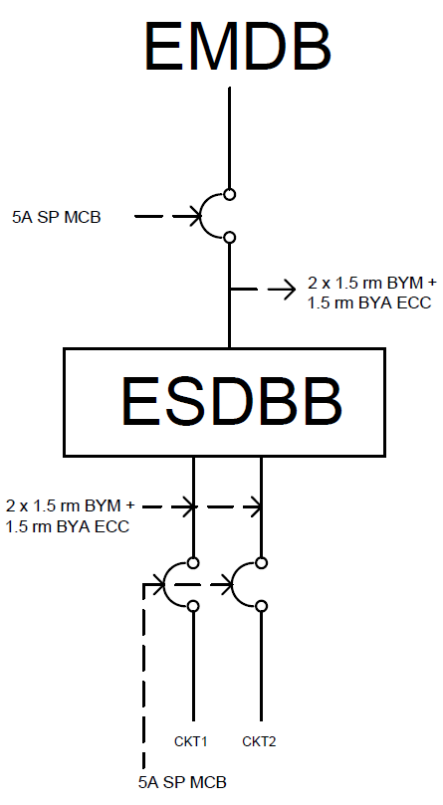
ESDB Diagram (Each Unit):



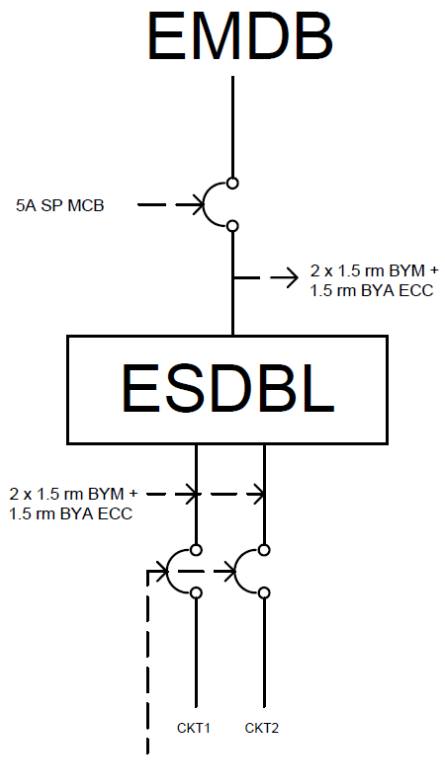
ESDB Diagram (Ground Floor):



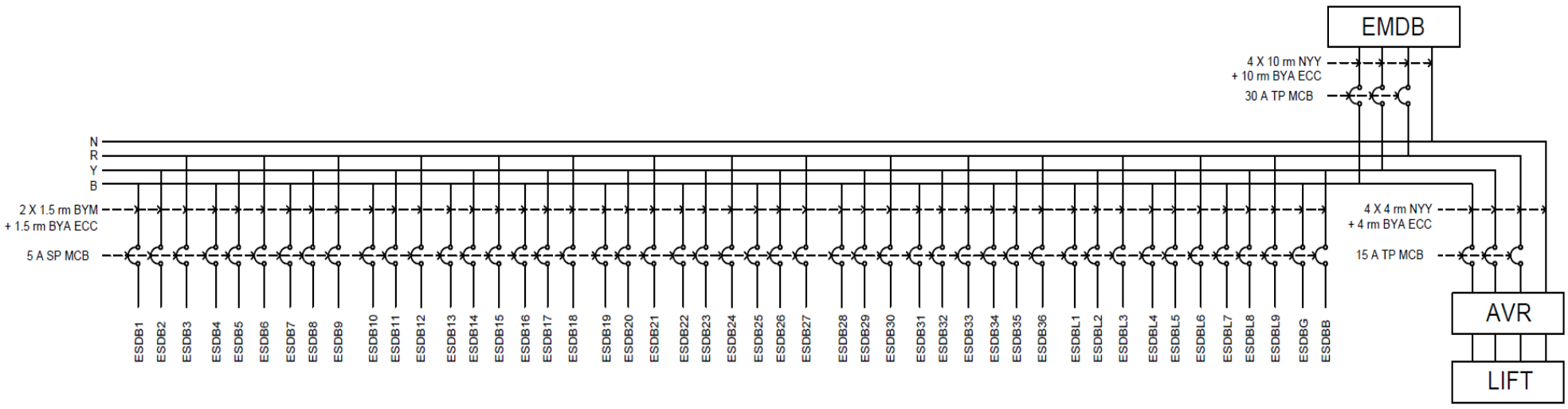
ESDB Diagram (Basement):



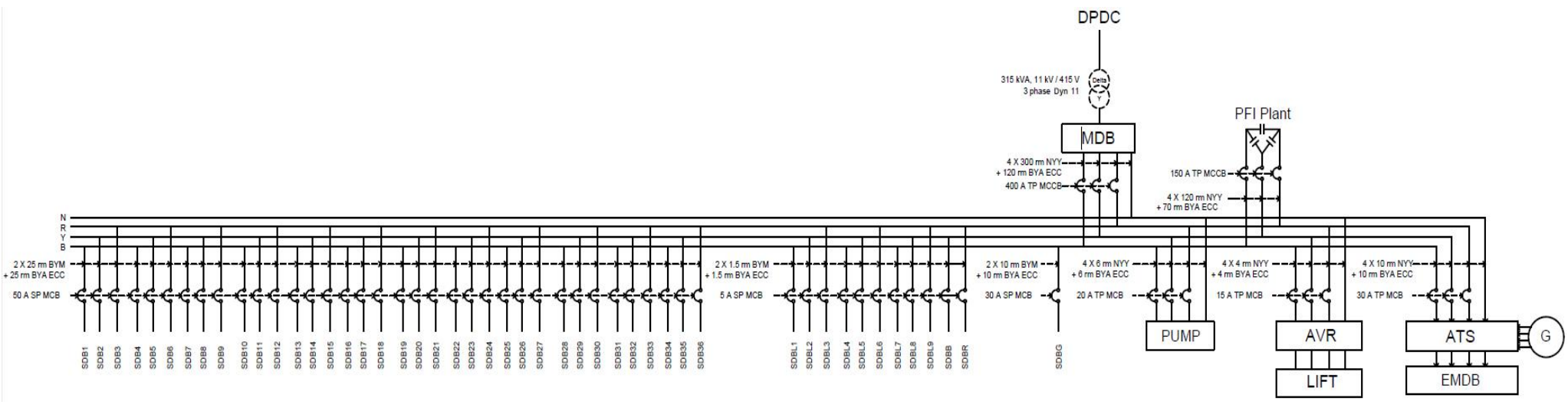
ESDB Diagram (Lobby):



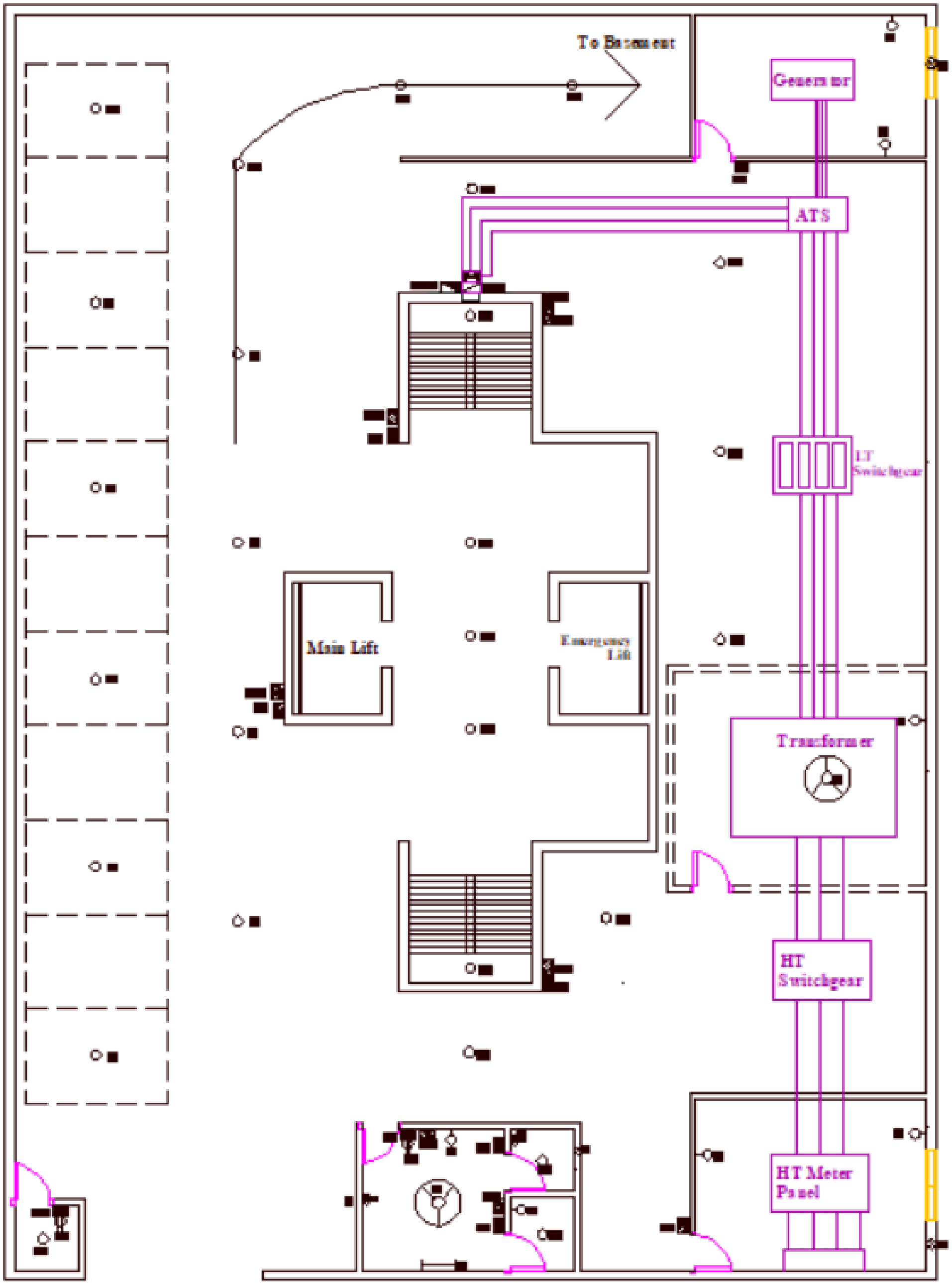
EMDB Diagram:



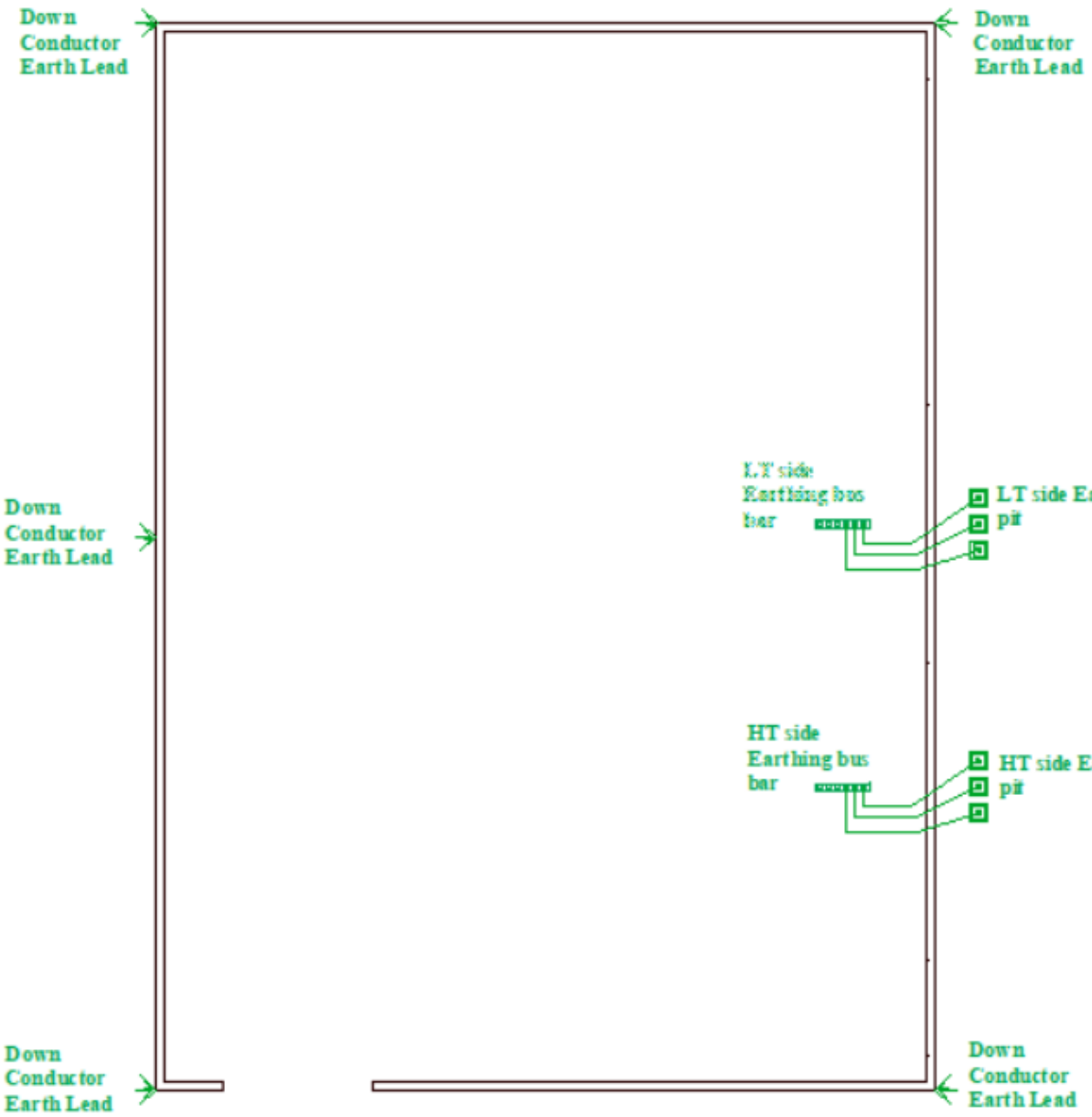
MDB Diagram:

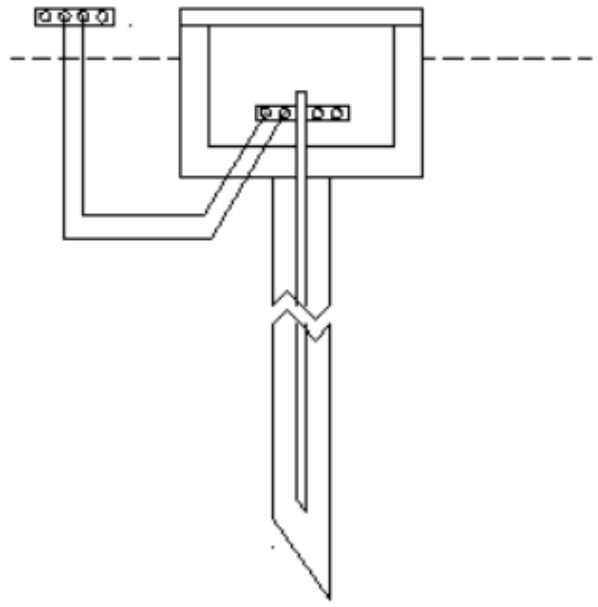


Substation Design, Layout (Power Flow) Diagram and SLD:

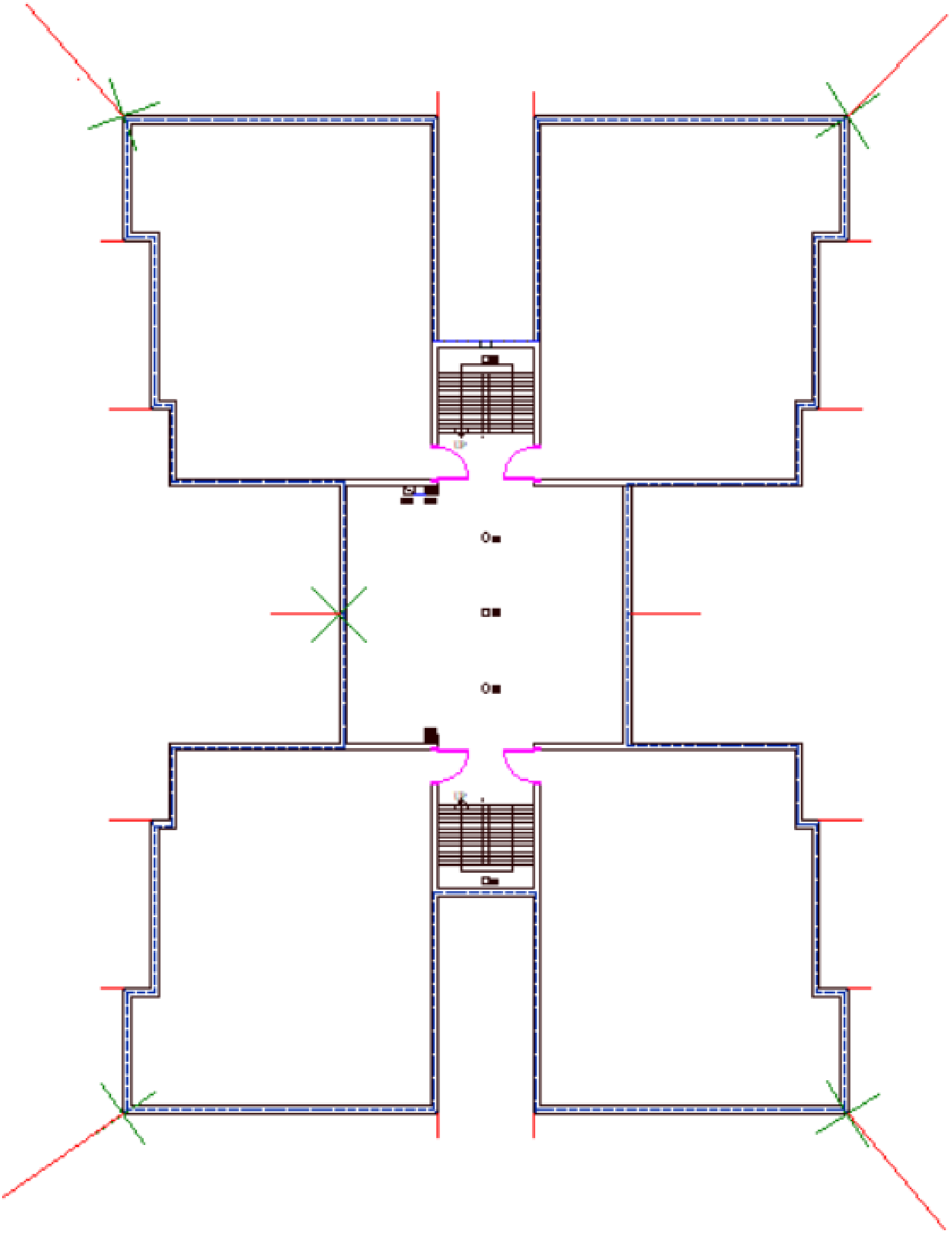


Earthing System Design:





Lightning Protection System Design:



Relevant Calculations:

Calculation For EMDB

EMDB load= Total ESDB Load * 0.7 + Emergency Lift Load * 0.7

Total ESDB Load=9*4*ESDB_Each Unit+ ESDB_Ground + ESDB_Basement + 9* ESDB_Lobby

EMDB Current= $\frac{EMDB\ Load}{\sqrt{3}*Line\ Voltage*pf}$

Phase Voltage = 230 V

Line Voltage = $\sqrt{3}$* 230 = 398.37 V

Power Factor, pf = 0.8

Total ESDB Load = 9*4*280+238+196+9*42 = 10892 W = **10.892 kW**

Emergency Lift Load = 7 kW

EMDB Load= 0.7* (10.892+7) = 12.5244 kW

EMDB Current= $\frac{12.5244*1000}{\sqrt{3}*398.37*0.8}$ **= 22.68 A**

So, 20 A TP MCB is needed from EMDB to MDB.

Wire is 4x6 rm NYY + 6 rm BYA ECC (Cable is used same as the 20A CB rating Cable)

Generator Sizing

EMDB LOAD =12.5244 KW, Assumed pf = 0.8

Generator size= EMDB LOAD/pf = 12.5244 kW/ 0.8

= 15.66 KVA

[Reference 2]

Calculation for MDB

MDB Load = Total SDB Load * 0.7 + (EMDB Load + Pump Load) * 0.7 + 0.7* Main Lift Load

Total SDB Load = 9*4*SDB_Each Unit + 9* SDB_Lobby + SDB_Ground + SDB_Basement + SDB_Roof

= (9*4*7397 + 9*28 + 4893 + 238+70) W

= 271745 W = 271.745 KW

Pump Load = 10000 W

Main Lift Load = 7 kW = 7000 W

MDB Load = 271745 * 0.7 + (12524.4 +10000) * 0.7 +0.7* 7000 = 210888.58 W = 210.89 kW

MDB Current= $\frac{MDB\ Load}{\sqrt{3}*Line\ Voltage*pf}$ **=** $\frac{210888.58}{\sqrt{3}*398.37*0.8}$ **= 382.05 A**

So**, 400 A TP MCCB** is needed from **MDB to Main Line**.

Wire: 4x 300 rm NYY +120 rm BYA ECC

Pump Current Calculation

Pump power = 10000 W 3 phase; assumed pf= 0.8

Pump Current= $\frac{10000}{\sqrt{3}*398.37*0.8}$ **= 18.12 A**

CB: 15 A TP MCB

Wire: 4x 6 rm NYY +6 rm BYA ECC (**Cable is used same as the 20A CB rating Cable**)

Calculation for Transformer

Apparent Power, S= $\sqrt{3}$ * V * I = 3* 230 * 382.05 **= 263614.5 VA = 263.61 kVA**

Taking an overload factor of 0.9

required Transformer = 263.61 KVA/ 0.9 = 292.91 KVA

So, **11/0.415 kV, 50 Hz, 315 kVA**, Dyn 11, Oil Immersed Transformer with 4-6% Impedance is needed. [Reference 3]

Lift Sizing

Main/Emergency Lift Load =7 KW, Assumed pf = 0.8

Line Current for = $\frac{7000}{\sqrt{3}*398.37*0.8}$ **= 12.68 A**

CB: 10 A TP MCB

Wire: 4x 4 rm NYY +4 rm BYA ECC (**Cable is used same as the 15A CB rating Cable**)

Calculation for PFI Plant:

Q_{req}=60% of the Transformer Rating = 189 KVAR

Current supplied by PFI,

I=$\frac{189*1000}{3*230*1}$ = **273.91 A**

CB: 250 TP MCCB

Wire: 4 x 240 rm NYY + 120 rm BYA ECC (**Cable is used same as the 300A CB rating Cable**)

Sample calculation of each unit, ground floor and basement:

SB Calculation For Each Unit						
Circuit No.	Switch Board No.	Fixture	Power (W)	Current (A)	Wire	Breaker
CKT1	SB1	F2	100	0.5434783	2x1.5 rm BYM	
		K1	20	0.1086957	2x1.5 rm BYM	
		C1	20	0.1086957	2x1.5 rm BYM	
		C2	20	0.1086957	2x1.5 rm BYM	
		C3	20	0.1086957	2x1.5 rm BYM	
		C4	20	0.1086957	2x1.5 rm BYM	
		Total	**200**	**1.0869565**	**2x1.5 rm BYM + 1.5 rm BYA ECC**	**5A SP MCB**
CKT2	SB2	C6	20	0.1086957	2x1.5 rm BYM	
		SS1	100	0.5434783	2x1.5 rm BYM	
		Total	**120**	**0.6521739**	**2x1.5 rm BYM + 1.5 rm BYA ECC**	**5A SP MCB**
CKT3	SB3	SS2	100	0.5434783	2x1.5 rm BYM	
		C7	20	0.1086957	2x1.5 rm BYM	
	SB4	K3	20	0.1086957	2x1.5 rm BYM	
		A1	10	0.0543478	2x1.5 rm BYM	
	SB5	K4	20	0.1086957	2x1.5 rm BYM	
		Total	**170**	**0.923913**	**2x1.5 rm BYM + 1.5 rm BYA ECC**	**5A SP MCB**
CKT4	SB7	K6	20	0.1086957	2x1.5 rm BYM	
		A2	10	0.0543478	2x1.5 rm BYM	
	SB6	SS3	100	0.5434783	2x1.5 rm BYM	
		K4	20	0.1086957	2x1.5 rm BYM	
		E1	100	0.5434783	2x1.5 rm BYM	
		Total	**250**	**1.3586957**	**2x1.5 rm BYM + 1.5 rm BYA ECC**	**5A SP MCB**
CKT5	SB8	F5	100	0.5434783	2x1.5 rm BYM	
		C10	20	0.1086957	2x1.5 rm BYM	
		SS4	100	0.5434783	2x1.5 rm BYM	
	SB9	K8	20	0.1086957	2x1.5 rm BYM	
		A3	10	0.0543478	2x1.5 rm BYM	
	SB10	K7	20	0.1086957	2x1.5 rm BYM	
		Total	**270**	**1.4673913**	**2x1.5 rm BYM + 1.5 rm BYA ECC**	**5A SP MCB**

SDB Calculation(For each Unit)

SDB	Load Type	Circuits &	Power(W)	SDB Load(W)	SDB Current(A)	Wire to MDB	Breaker of MDB
SDB	SB	CKT1	200				
		CKT2	120				
		CKT3	170				
		CKT4	250				
		CKT5	270				
		Total	1010				
	P Socket	P1	3000				
		P2	3000				
		P3	3000				
		P5	3000				
		P6	3000				
		P7	3000				
		Total	18000				
	Q Socket	Q1	4000				
		Total	4000				
	TV Socket	TV1	300				
		Total	300				
		Total(all)		7397	40.20108696	**2*16 rm BYM + 16 rm BYA ECC**	**40 A SP MCB**

SB Calculation For Ground Floor

Circuit No.	Switch Board No.	Fixture	Power (W	Current (A	Wire	Breaker
Ckt 1	SB2	K8	20	0.1087	2x1.5 rm BYM	
		K9	20	0.1087	2x1.5 rm BYM	
		K11	20	0.1087	2x1.5 rm BYM	
		K12	20	0.1087	2x1.5 rm BYM	
		K23	20	0.1087	2x1.5 rm BYM	
	SB1	K21	20	0.1087	2x1.5 rm BYM	
		K2	20	0.1087	2x1.5 rm BYM	
		K3	20	0.1087	2x1.5 rm BYM	
		K5	20	0.1087	2x1.5 rm BYM	
		K7	20	0.1087	2x1.5 rm BYM	
		Total	200	1.08696	**2x1.5 rm BYM + 1.5 rm BYA EC(**	**5A SP MCB**
Ckt 2	SB5	K19	20	0.1087	2x1.5 rm BYM	
		F2	100	0.54348	2x1.5 rm BYM	
		A3	10	0.05435	2x1.5 rm BYM	
	SB6	A4	10	0.05435	2x1.5 rm BYM	
		A5	10	0.05435	2x1.5 rm BYM	
		E2	100	0.54348	2x1.5 rm BYM	
	SB7	C1	20	0.1087	2x1.5 rm BYM	
		SS1	100	0.54348	2x1.5 rm BYM	
	SB9	K26	20	0.1087	2x1.5 rm BYM	
	SB8	K25	20	0.1087	2x1.5 rm BYM	
		E3	100	0.54348	2x1.5 rm BYM	
	SB10	K27	20	0.1087	2x1.5 rm BYM	
		SS2	100	0.54348	2x1.5 rm BYM	
		Total	630	3.42391	**2x1.5 rm BYM + 1.5 rm BYA EC(**	**5A SP MCB**
Ckt 3	SB4	K14	20	0.1087		
		K16	20	0.1087		
	SB3	A1	10	0.05435		
		A2	10	0.05435		
		E1	100	0.54348		
		Total	160	0.86957	**2x1.5 rm BYM + 1.5 rm BYA EC(**	**5A SP MCB**

SB Calculation For Basement

Circuit No.	Switch Board No.	Fixture	Power (W	Current (A	Wire	Breaker
Ckt 1	SB12	K35	20	0.1087	2x1.5 rm BYM	
		K37	20	0.1087	2x1.5 rm BYM	
		K55	20	0.1087	2x1.5 rm BYM	
		K57	20	0.1087	2x1.5 rm BYM	
	SB11	K29	20	0.1087	2x1.5 rm BYM	
		K30	20	0.1087	2x1.5 rm BYM	
		K32	20	0.1087	2x1.5 rm BYM	
		K33	20	0.1087	2x1.5 rm BYM	
		Total	160	0.86957	**2x1.5 rm BYM + 1.5 rm BYA EC(**	**5A SP MCB**
Ckt 2	SB14	K48	20	0.1087		
		K49	20	0.1087		
		K51	20	0.1087		
		K52	20	0.1087		
		Total	80	0.43478	**2x1.5 rm BYM + 1.5 rm BYA EC(**	**5A SP MCB**
Ckt 3	SB13	K43	20	0.1087		
		K46	20	0.1087		
		K42	20	0.1087		
		K39	20	0.1087		
		K40	20	0.1087		
		Total	100	0.54348	**2x1.5 rm BYM + 1.5 rm BYA EC(**	**5A SP MCB**

SDB Calculation(For Ground Floor)							
SDB	Load Type	Circuits & Socket	Power(W	SDB Load(W)	SDB Current(A)	Wire to MDB	Breaker of MDB
SDB	SB	Ckt1	200				
		Ckt2	630				
		Ckt3	160				
		Total	990				
	P Socket	P1	3000				
		P2	3000				
		Total	6000				
		Total		4893	26.5923913	2*10 rm BYM +10 rm BYA ECC	30A SP MCB

SDB Calculation(For Basement)							
SDB	Load Type	Circuits & Socket	Power(W	SDB Load(W)	SDB Current(A)	Wire to MDB	Breaker of MDB
SDB	SB	Ckt1	160				
		Ckt2	80				
		Ckt3	100				
		Total		238	1.2935	2x1.5 rm BYM + 1.5 rm BYA ECC	5A SP MCB

Lightning Risk Assessment:

Assessment of the risk is based on a set of indices for the various factors involved, as mention in BNBC-

1. **Use of Structure (2-10):** It denotes the specific use of the structure to be assessed
2. **Type of Construction (1-10):** It denotes the type of the structure along with the type of roof it uses
3. **Contents of Consequential Effects (2-10):** It denotes the specifications of the buildings which might have consequential effects in making it lightning-prone
4. **Degree of Isolation (2-10):** The relative exposure of a particular building will be an element in determining whether the expense of lightning protection is warranted. In closely built-up towns and cities, the hazard is not as great as in the open country.
5. **Height of Structure (2-30):** Height of the structure is an important factor for the purpose of lightning protection. Taller structures are subject to greater hazards than smaller structures and, therefore, lightning protection is more desirable for tall structures. Structure taller than 53 metres require protection in all cases.
6. **Lightning Prevalence (2-21):** The number of thunderstorm days in a year varies in different parts of a country. However, the severity of lightning storms, as distinguished from their frequency of occurrence, is usually much greater in some locations than others. Hence, the need for protection varies from place to place, although not necessarily in direct proportion to the thunderstorm frequency.

Risk Index:

Risk index is the sum of all the factors mentioned above. A risk index above 40 means that lightning protection is compulsory.

Calculation for Project Building:

Our designed building is a ten-storied structure which contains many residential apartments, transformer with significant number of electrical loads, two lifts and a generator of 12.5 kW. The roof of the building also has the scope for multiple solar panels to be procured in future as well.

Lightning Risk Assessment for Project Building:

Index A: Use of structure

Index A: Use of Structure	Index
Houses and similar buildings	2
Houses and similar buildings with outside aerial	4
Small and medium size factories, workshops and laboratories	6

Big Industrial plants, telephone exchanges, office blocks, hotels, blocks of flats	7
Places of assembly, for example, places of workshop, theatres, museums, exhibitions, department stores, post offices, stations, airports, stadiums	8
Schools, Hospitals, Children's homes and other such structures	10

Since Project building is primarily a residential building covering a big area with a spacious premise, it falls under **Houses and similar buildings with outside aerial**

Index for use of structure: 4

Index-B: Type of Construction

Index B: Type of Construction	**Index**
Steel framed encased with nonmetal roof	1
Reinforced concrete with nonmetal roof	2
Brick, plain concrete, or masonry with nonmetal roof	4
Steel framed encased or reinforced concrete with metal roof	5
Timber formed or clad with any roof other than metal or thatch	7
Any building with a thatched roof	10

Project building is a ten-storied massive structure, covering a huge area and built to accommodate various utilities along with huge number of people. Its structure has been made to be very resilient and durable. Reinforced concrete has been used along with normal concrete and brick for its construction. Its roof does not contain major metallic constructions. So, it falls under the category **Reinforced concrete with nonmetal roof.**

Index for Type of Construction: 2

Index-C: Contents of Consequential Effects

Index C: Contents or Consequential Effects	**Index**
Ordinary domestic or office building, factories and workshops not containing valuable materials	2
Industrial and agricultural buildings with especially susceptible contents	5
Power stations, gas works, telephone exchanges, radio stations	6
Industrial key plants, ancient monuments, historic buildings, museums, art galleries	8
Schools, hospitals, children's and other homes, places of assembly	10

Since our Project building is primarily a residential building, it falls under the first category i.e., **Ordinary domestic or office building, factories and workshops not containing valuable materials**

Index for Contents of Consequential Effects: 2

Index-D: Degree of Isolation

Index D: Degree of Isolation	Index
Structure located in a large area having structures or trees of similar or greater height, e.g. a large town or forest	2
Structure located in an area with a few other structures or trees of similar height	5
Structure completely isolated or exceeding at least twice the height of surrounding structures or trees	10

Structure located in an area with a few other structures or trees of similar height.

Index for Degree of Isolation: 5

Index-E: Type of Terrain

Index E: Type of Terrain	Index
Flat terrain at any level	2
Hilly Terrain	6
Mountainous terrain 300m or above	8

Project building is to be situated in Dhaka City, which is a flat terrain. There are no slopy areas anywhere near, so it falls under the category- **Flat terrain at any level**

Index for Type of Terrain: 2

Index-F: Height of Structure

Index F: Height of Structure	Index
Up to 9 m	2
9-15 m	4
15-18 m	5
18-24 m	8
24-30 m	11
30-38 m	16
38-46 m	22
46-53 m	30

Structures higher than 53 m require protection in all cases

Each floor of project building is estimated to be 10 ft in height and for 10 floors, the total height is $10 \times 10 = 100\ ft$. If plinth height is taken as 5 ft, the total height= $(100 + 5) ft = 105\ ft$= 32.004 m, which is in between 30-38 metres.

Therefore, the risk index for Height of Structure= 16

Index G: Lightning Prevalence

Index G: Lightning Prevalence	**Index**
Number of thunderstorm days per year:	
Up to 3	2
4-6	5
7-9	8
10-12	11
13-15	14
16-18	17
19-21	20
Over 21	21

From Karmakar Et al. [5], the thunderstorm days for each month were determined and averaged for the entire year.

Average thunderstorm days= $\frac{0.9+3.4+10.1+20.8+29.4+24.5+18.9+16.2+22.2+11.2+1+0.4}{12} = 11.2\ days/year$

Therefore, it falls in the category **10-12** thunderstorm days per year.

Index for lightning prevalence= 11

<u>Risk Index Calculation for Project Building:</u>

Parameter	**Index**
A: Use of Structure	4
B: Type of Construction	2
C: Contents or Consequential Effects	2
D: Degree of Isolation	5
E: Type of Terrain	2
F: Height of Structure	16
G: Lightning Prevalence	11
Total	42

Therefore, total index figure= $4 + 2 + 2 + 5 + 2 + 16 + 11 = 42$

Since index figure is above 40, protection is necessary for the construction.

Lightning Protection Calculation:

For lightning protection, rolling sphere method has been used. For rolling sphere, the distance between two air terminals is-

$$d = 2\sqrt{2hR - h^2}$$

Here, R has been considered as 45 metres.

h= Height of Air Terminal

d= Distance between two air terminals

For our design, the distance between two air terminals were fixed by placing them at suitable locations (corners of buildings and other vulnerable points). Hence, the only variable in this equation is the height of the air terminal. Since the distance between two consecutive air terminals aren't the same in our design, the height of air terminals also varies from each other.

According to calculation, the length of the air terminals in a counter-clockwise direction starting from the top right corner are- 1.1782 m, 0.103 m, 0.103 m, 1.1782 m, 0.1823 m, 0.332 m, 0.55 m, 0.332 m, 0.1823 m, 1.1752 m, 0.103 m, 0.103 m, 1.1782 m, 0.1823 m, 0.332 m, 0.55 m, 0.332 m, 0.1823 m respectively.

In the diagram for lightning protection, the air terminals have been expanded 2.5 times for visual clarity.

Down Conductor Calculation:

Area of roof= Area of each unit x 4 + Area of lobby + Area of Staircase x2

= 991.24 x 4+ 151.25x2+ 704.09

= 4971.55 sq ft = 461.8721 m^2

There shall be one down conductor for the first 80 m^2 and 1 for each 100 m^2 of the rest.

Total number of down conductors = $ceil\left(\frac{461.8721-80}{100}\right) + 1 = 4 + 1 = 5$

Earthing System:

For earthing, GI pipe earth electrode system was used. Earthing pits were designed for both LT and HT sides of the transformer. Three earthing pits were constructed for safety in case one of the connection fails.

Earth electrodes for lightning protection were directly connected into the earth mass without any earthing pit. Each down conductor had its own earth electrode and so 5 earth electrodes for lightning protection were used in total.

References:

1. Bangladesh National Building Code (BNBC). 2020. Volume-3
2. PWD Website : **https://ss.pwd.gov.bd/sor/sordownload/2**: FROM PWD RATE SCHEDULE (Subhead-2.2 Generator & Related works)- 20 KVA with ATS is available (Item No. 2.2.1.2.2)
3. PWD RATE SCHEDULE 2.1.4.6
4. https://www.se.com/my/en/product/LV433934/circuit-breaker-compact-nsx400- 3p-36ka-micrologic-4-3-vigi-400a/
5. Karmakar, Samarendra. (2008). Climate Feature of the Thunderstorm Days and Thunderstorm Frequency in Bangladesh. Proceedings of SAARC Seminar on Application of Weather and Climate forecasts in the Socio-economic Development and Disaster mitigation, 05-07 August 2007, Dhaka, Bangladesh. Published by SMRC in 2008.