BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 414 (January 2024)
Electrical Services Design Laboratory

Final Project Report

Section: A1 Group: 04

Electrical Services Design for a 7 Storied, 2 Unit Apartment Building

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Course Instructors:

Mrinmoy Kundu, Lecturer
Md. Nure- Alam-Dipu, Adjunct Lecturer

Signature of Instructor: ____

Academic Honesty Statement:

IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. Type the student ID and name, and put your signature. ***You will not receive credit for this project experiment unless this statement is signed in the presence of your lab instructor.***

"In signing this statement, we hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), and cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, we will each receive a score of ZERO for this project and be subject to failure of this course."

Submitted By:

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Project Objective:

This project aims to achieve the following objectives:

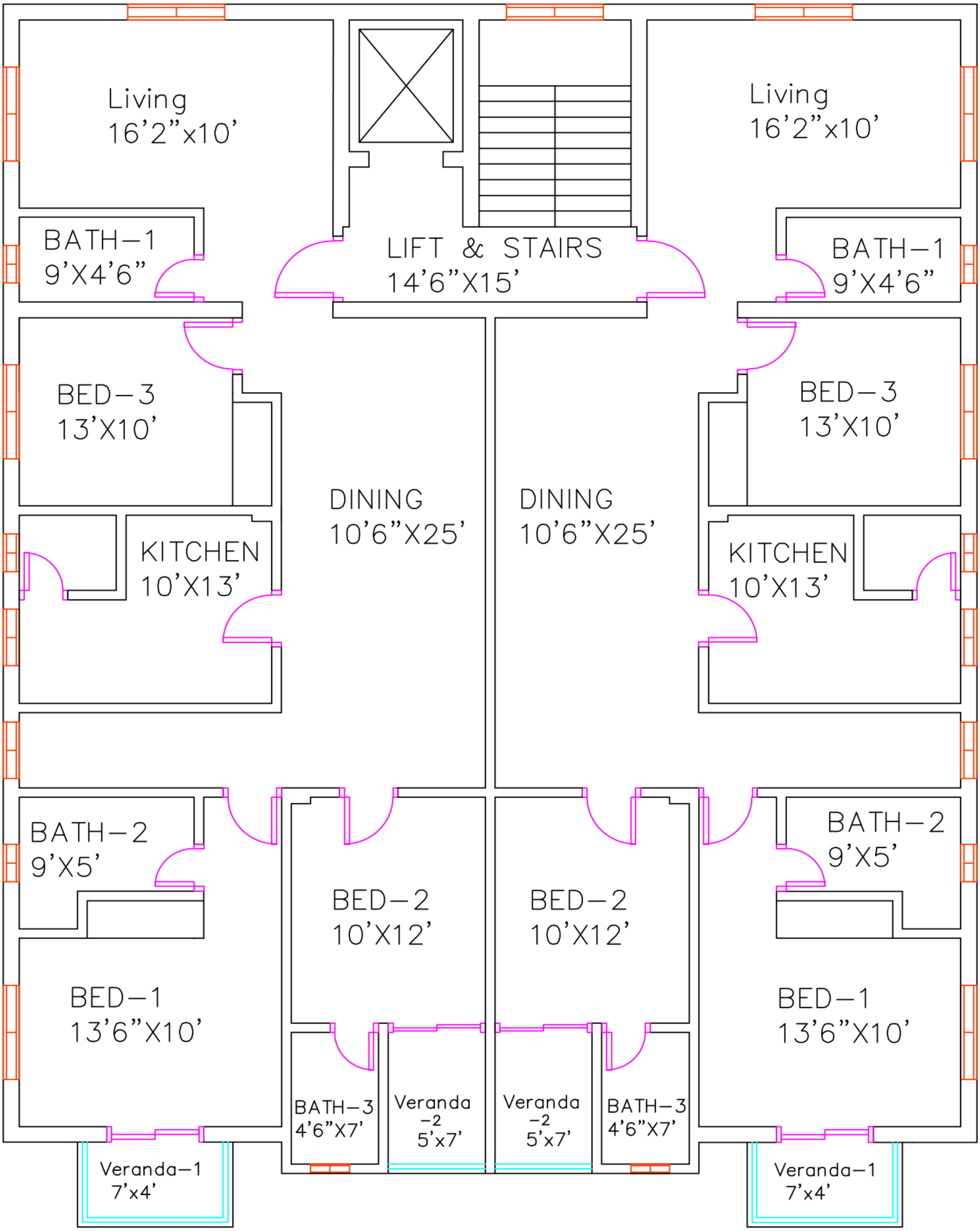
- Gain a comprehensive understanding of floor planning for multi-story residential buildings.
- Explore the selection and installation of various fittings and fixtures for different areas.
- Develop the skills to design and draft conduit layouts for the entire building.
- Learn the process of switchboard connections and implement emergency provisions.
- Calculate and position components like circuit breakers, transformers, and generators based on specific ratings in switchboard diagrams.
- Master the electrical design process for a lightning protection system.

Design Steps:

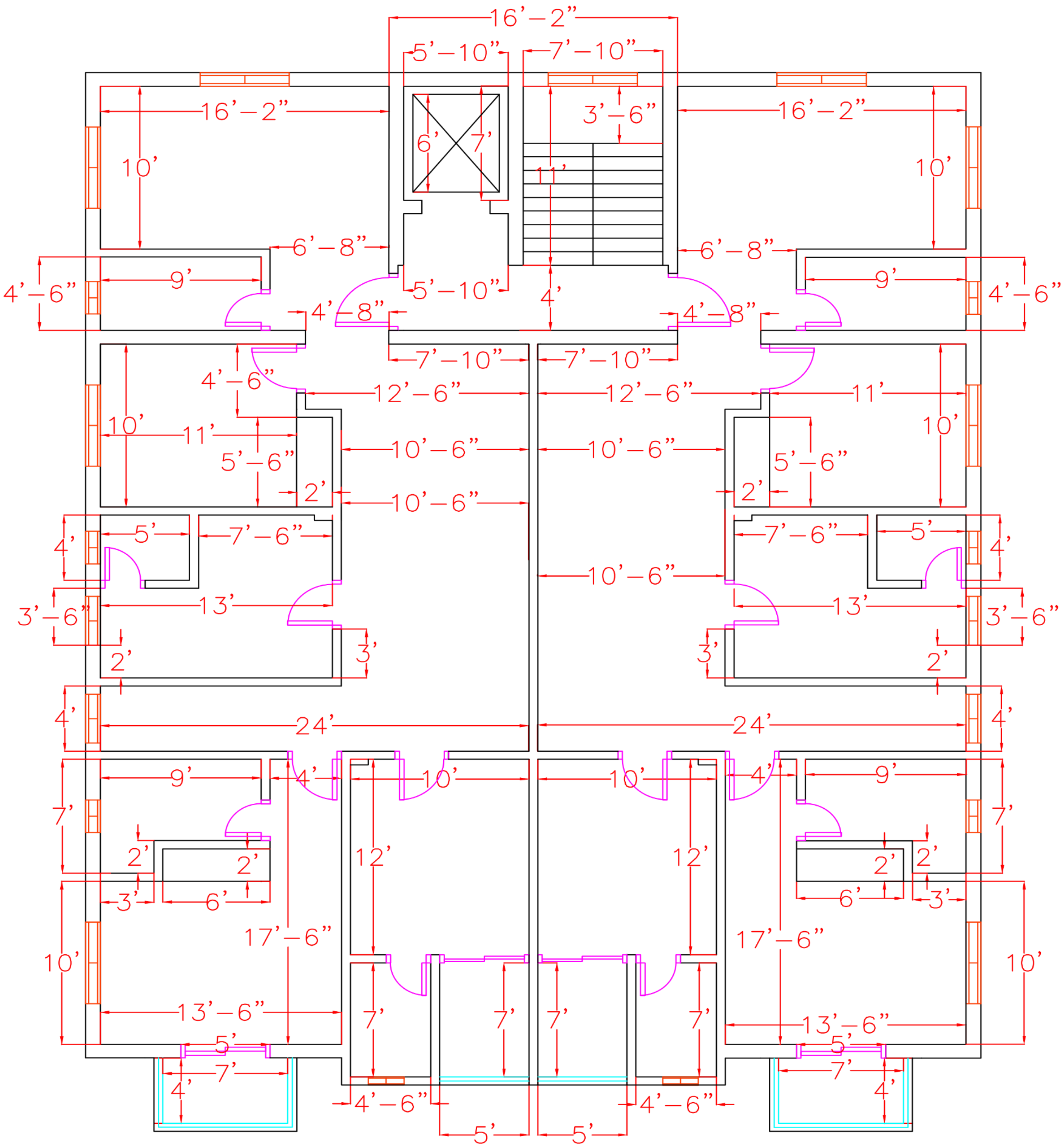
The project was completed through these key steps:

- ✓ Developed floor plans for the **typical floors**, **ground floor**, **basement**, and **rooftop** of a 7-story, 2-unit building.
- ✓ Designed and calculated the placement of **fittings and fixtures** for each floor.
- ✓ Planned the **main and emergency conduit layouts** for all floors.
- ✓ Created **switchboard and distribution board diagrams**.
- ✓ Designed the **substation and transformer** layout.
- ✓ Developed the design for the **lightning protection system (LPS)**.

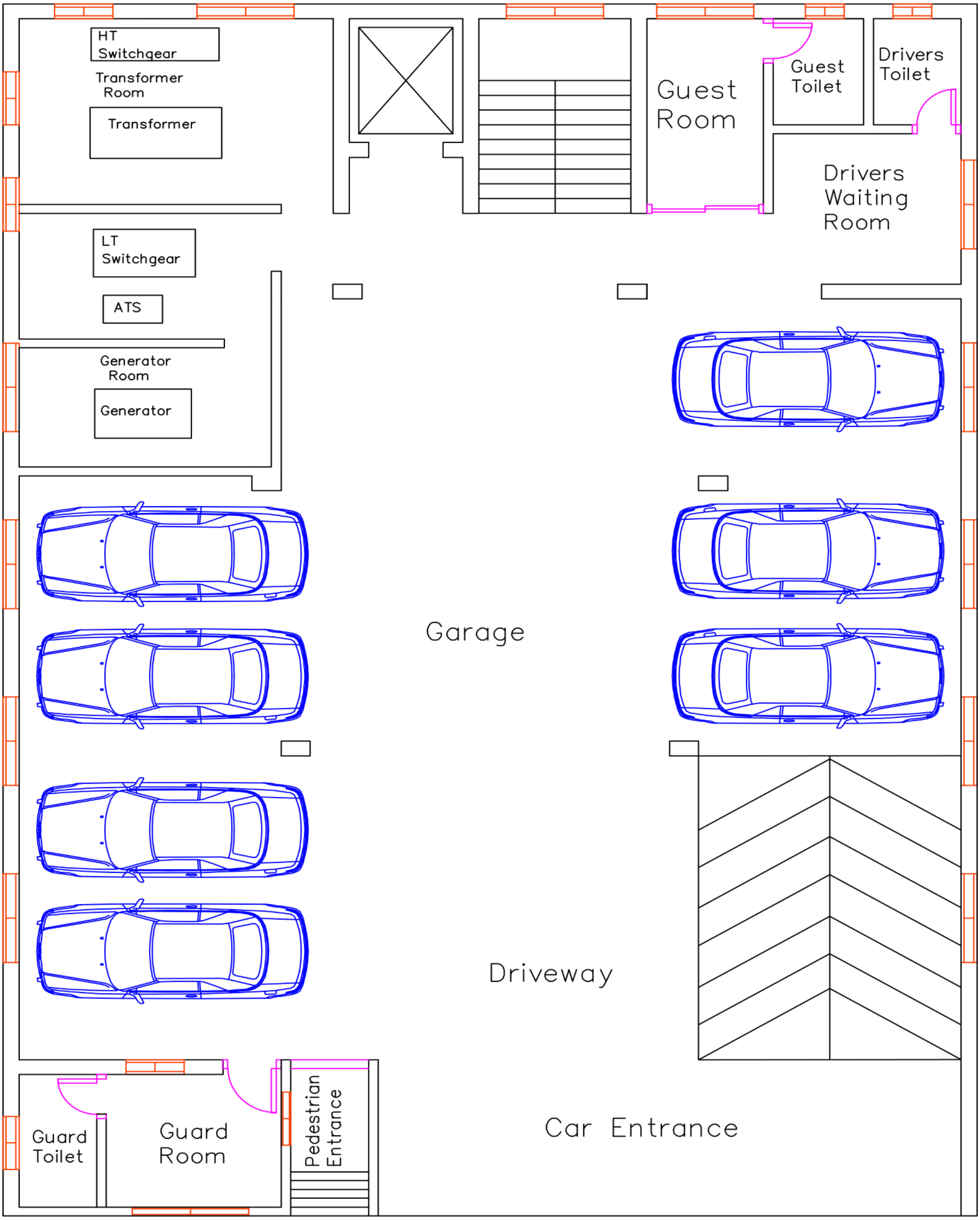
Floor Plan (Typical Floor)



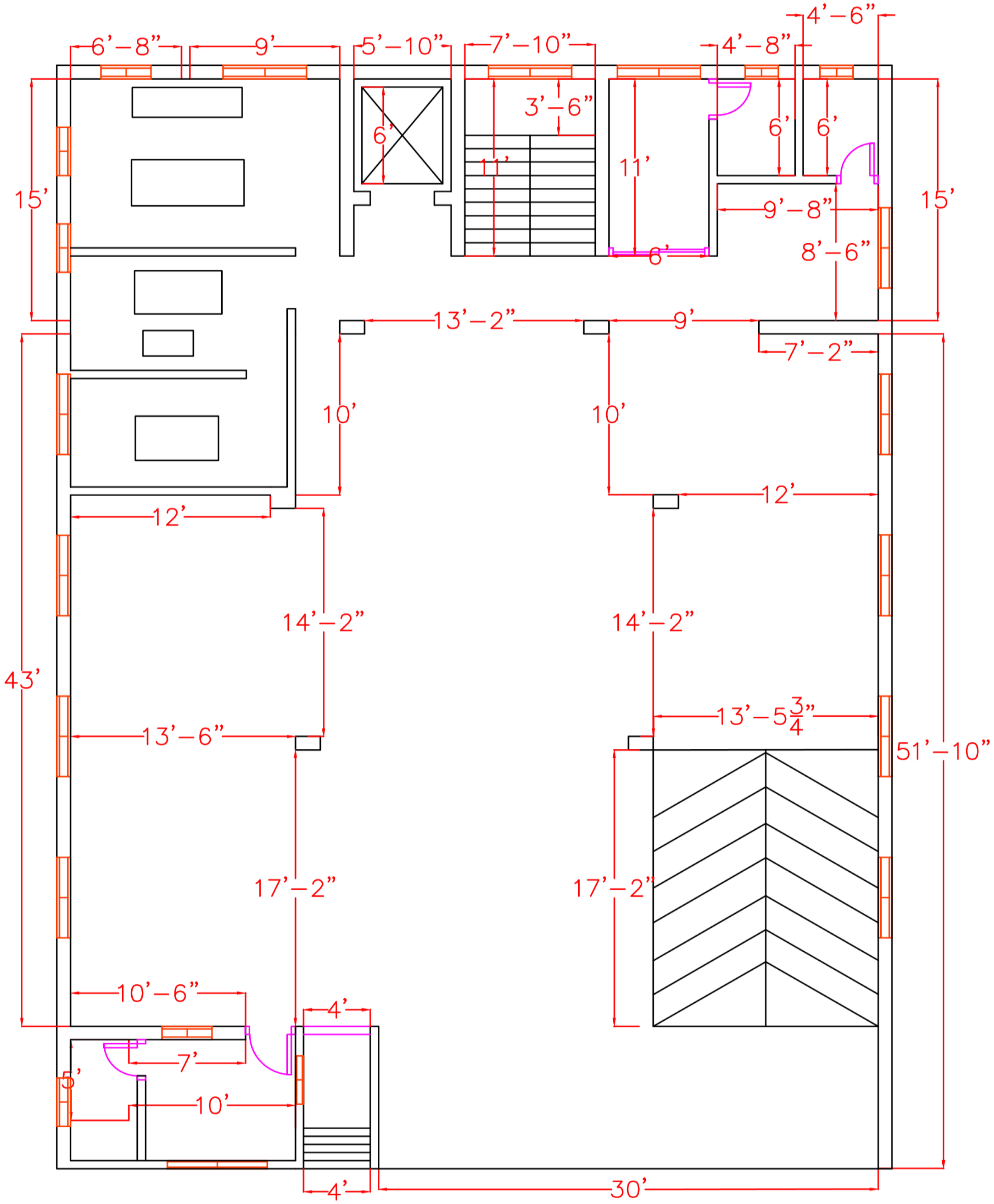
Floor Plan with Dimensions (Typical Floor)



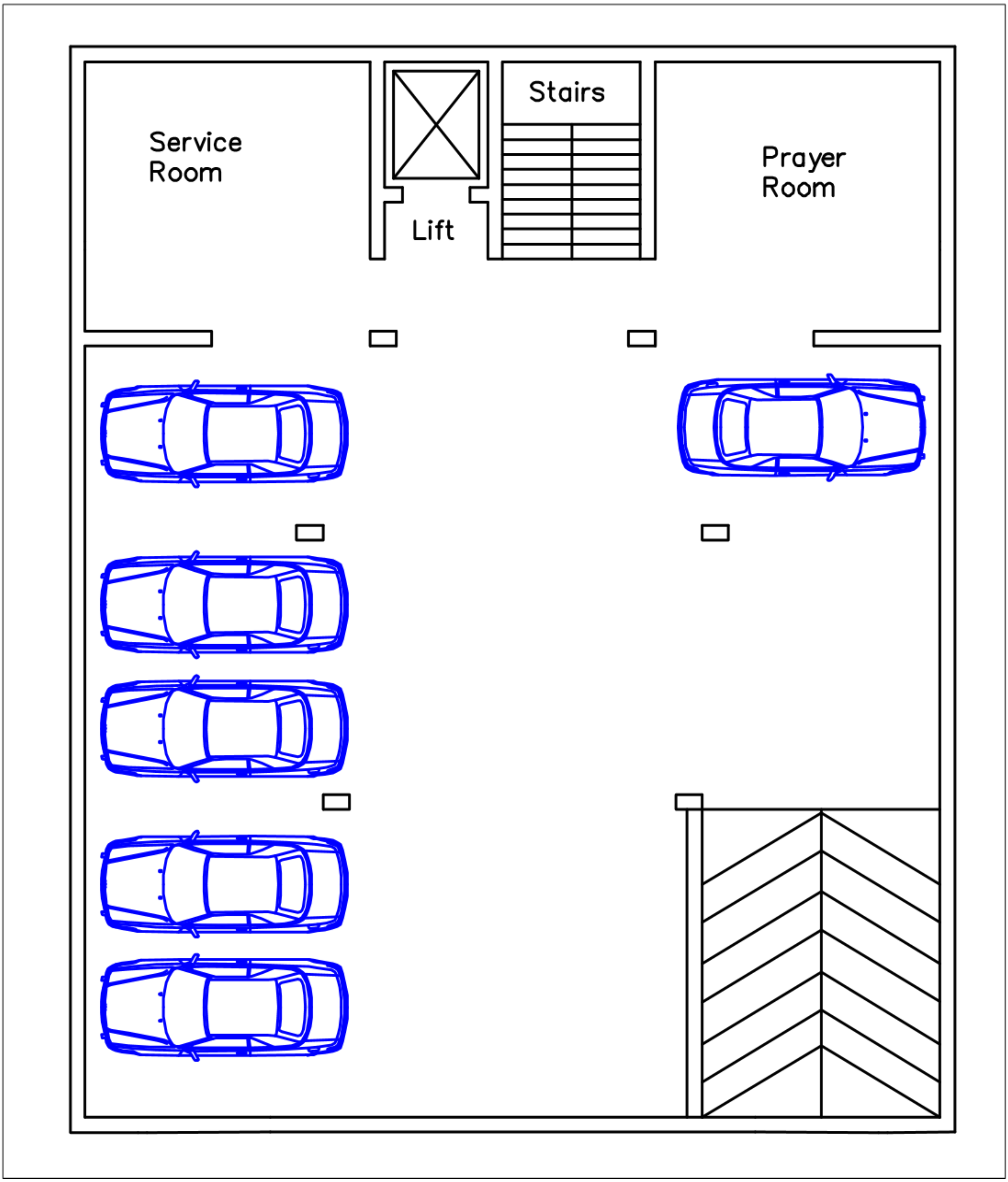
Floor Plan (Ground Floor)



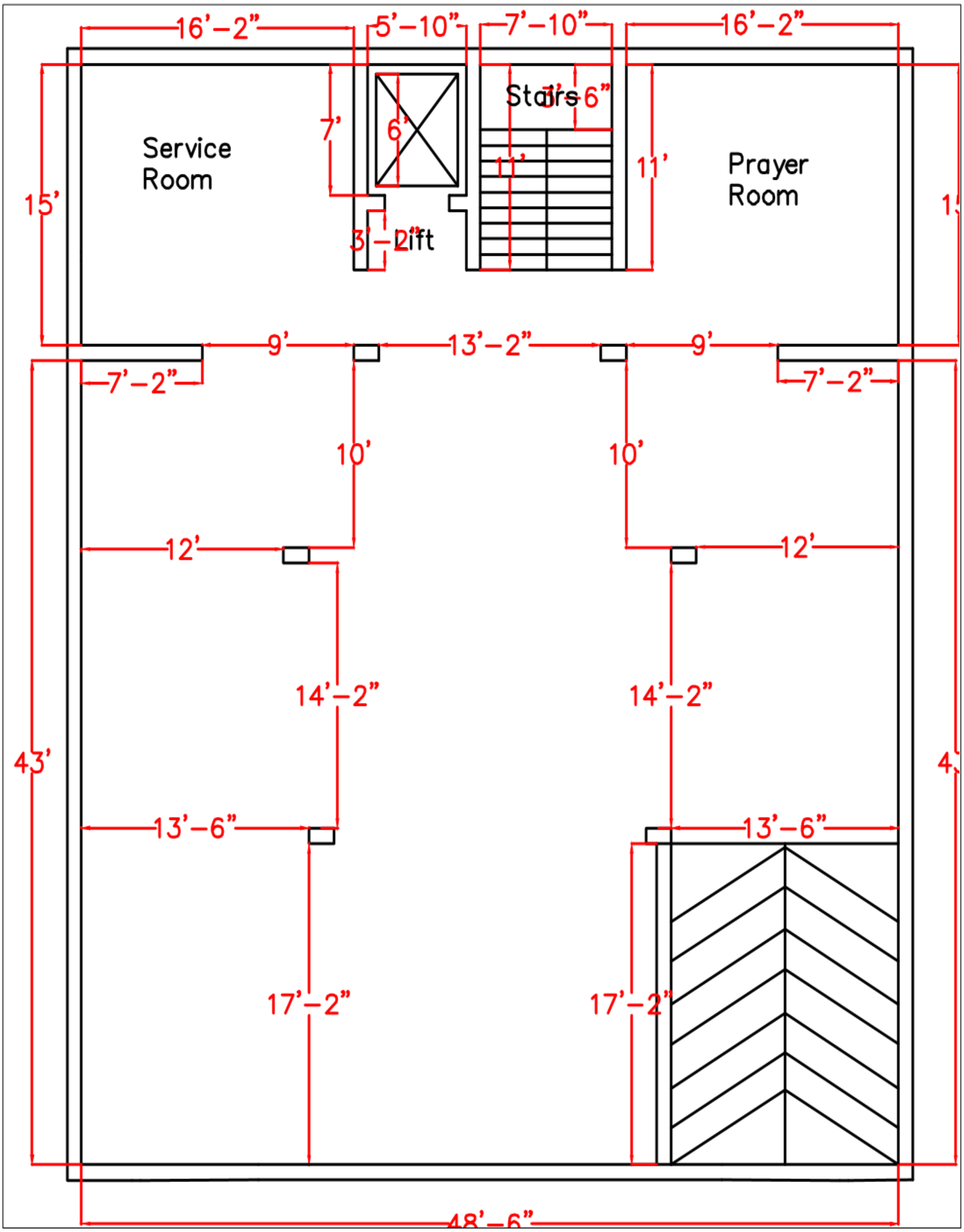
Floor Plan with Dimension (Ground Floor)



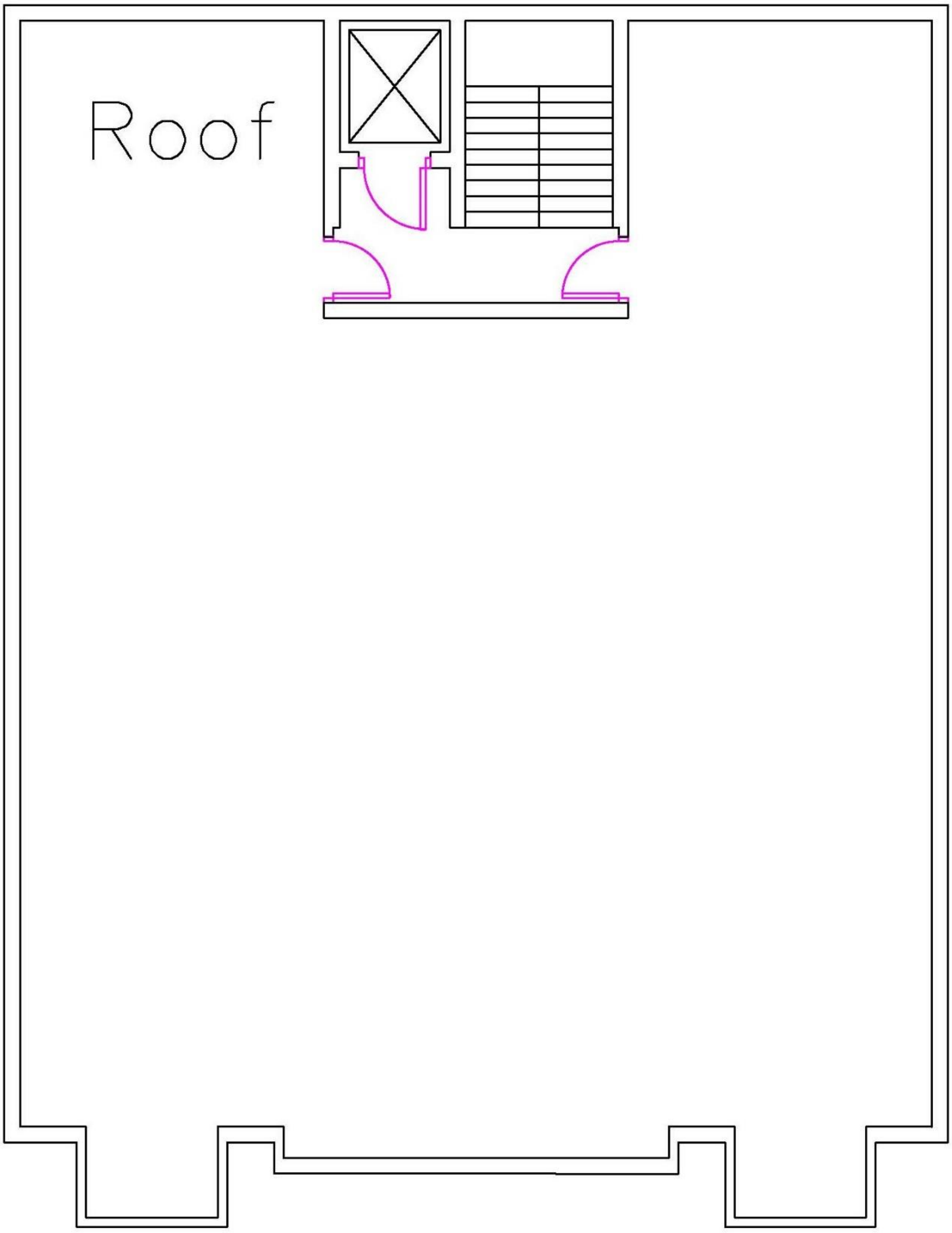
Floor Plan (Basement Floor)



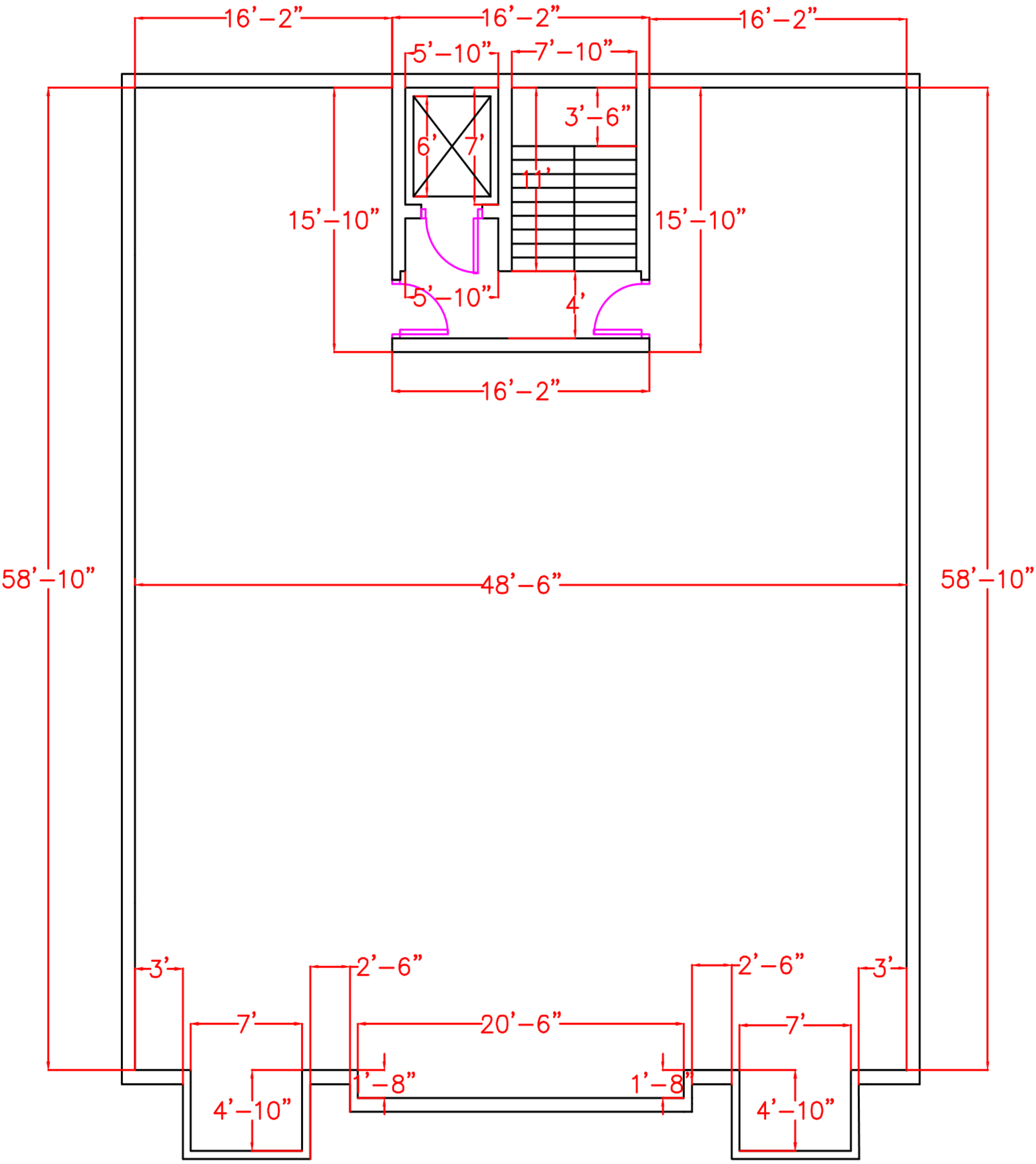
Floor Plan with Dimension (Basement Floor)



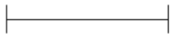
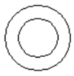
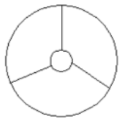
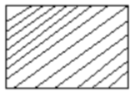
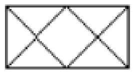
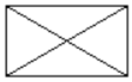
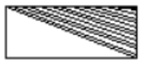
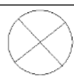
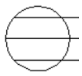
Floor Plan (Roof)



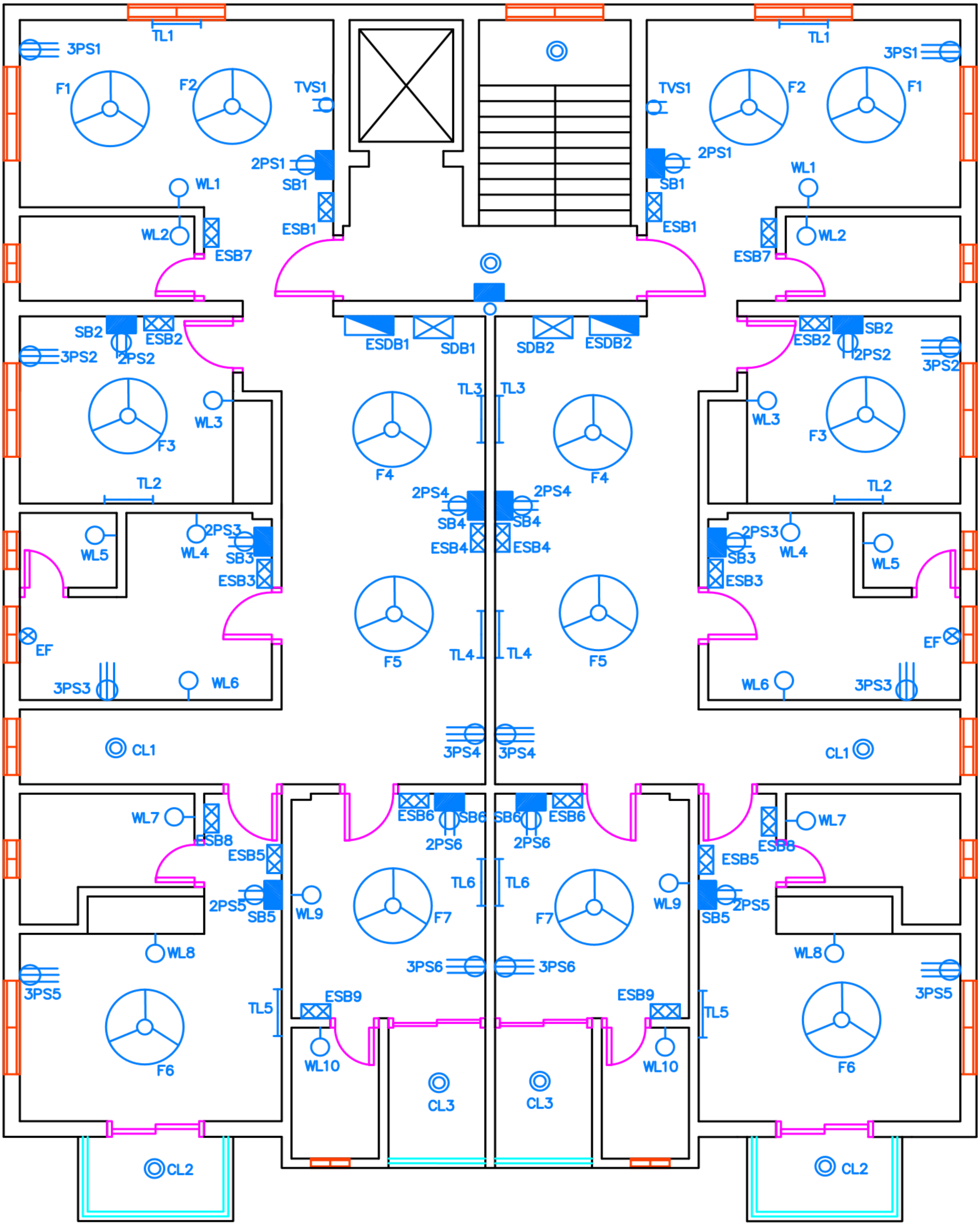
Floor Plan with Dimension (Roof)



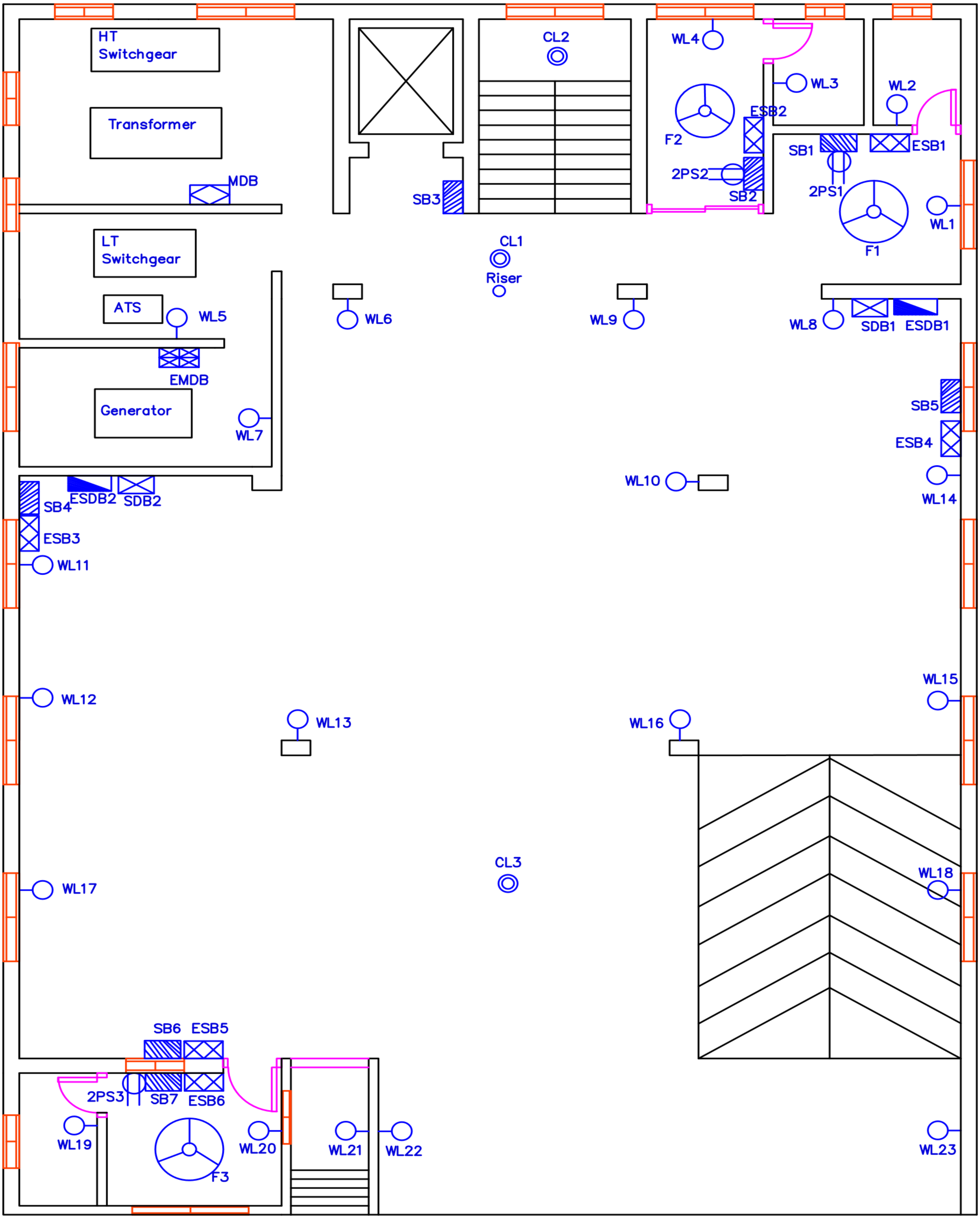
Fittings and Fixtures Legend

Legends			
Description	Height	Caption	Symbol
40W Wall Mounted Fluorescent Tube Light	Lintel	TL	
20W Fluorescent Light Bulb	Lintel	WL	
20W Fluorescent Ceiling Light	Ceiling	CL	
48’’ 70W Sweep Fan	Ceiling	F	
Switch Board	Mid Wall	SB	
Emergency Switch Board	Mid Wall	ESB	
Sub Distribution Board	Lintel	SDB	
Emergency Sub Distribution Board	Lintel	ESDB	
Exhaust Fan	Lintel	EF	
2 Pin Socket	Mid Wall	2PS	
3 Pin Socket for AC, Heater etc.	Lower Wall	3PS	

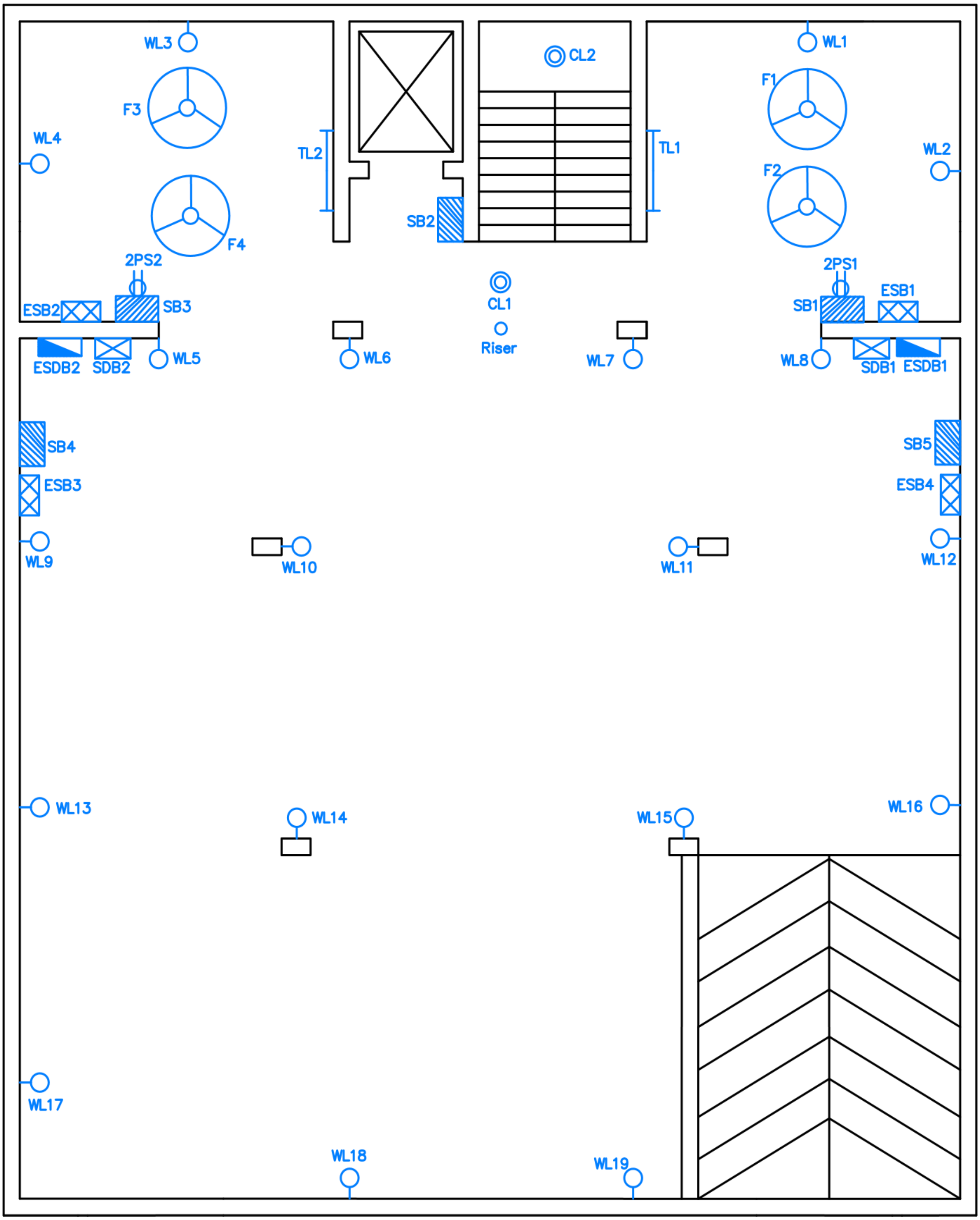
Fittings and Fixtures Plan (Typical Floor)



Fittings and Fixtures Plan (Ground Floor)



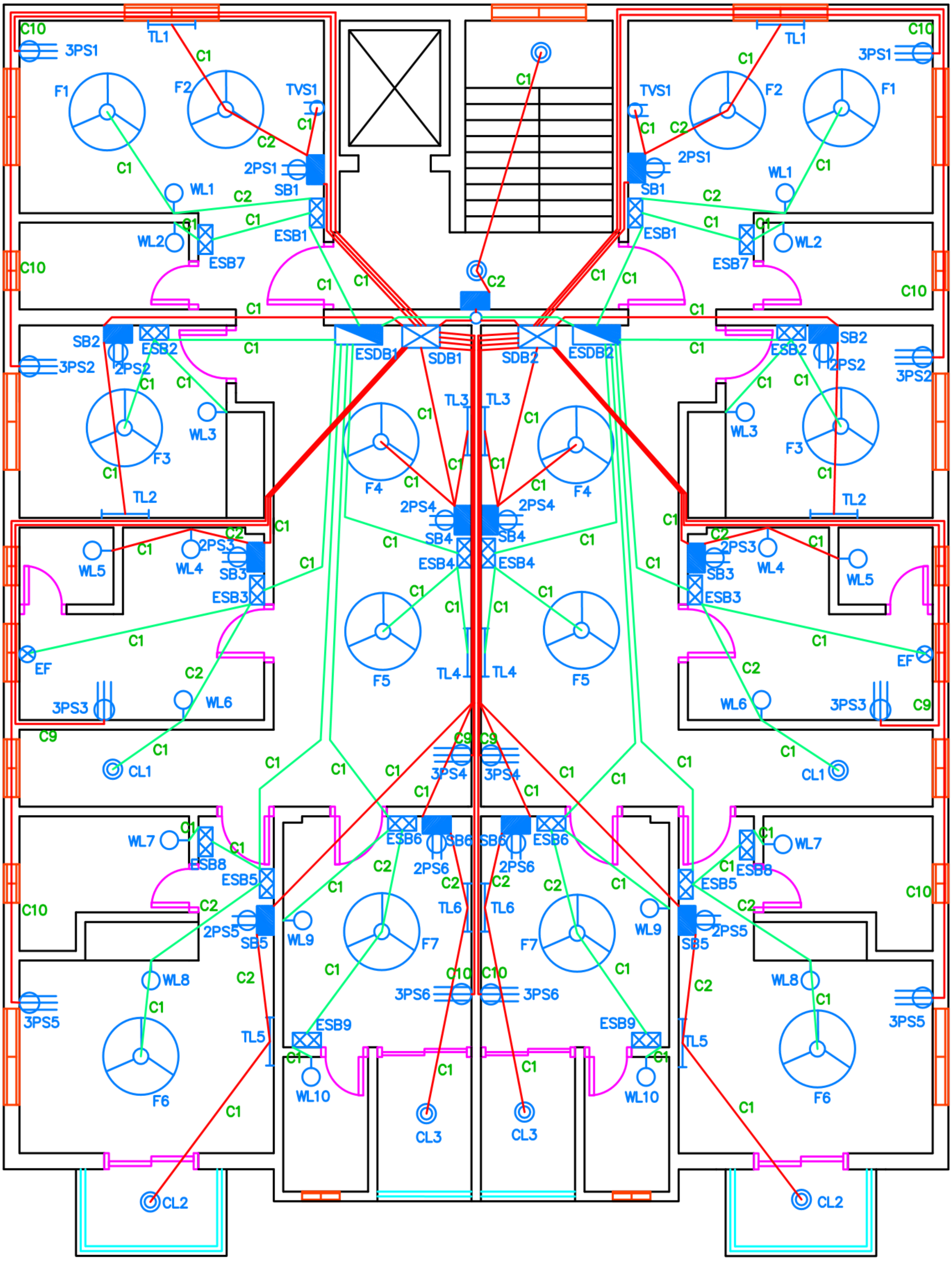
Fittings and Fixtures Plan (Basement Floor)



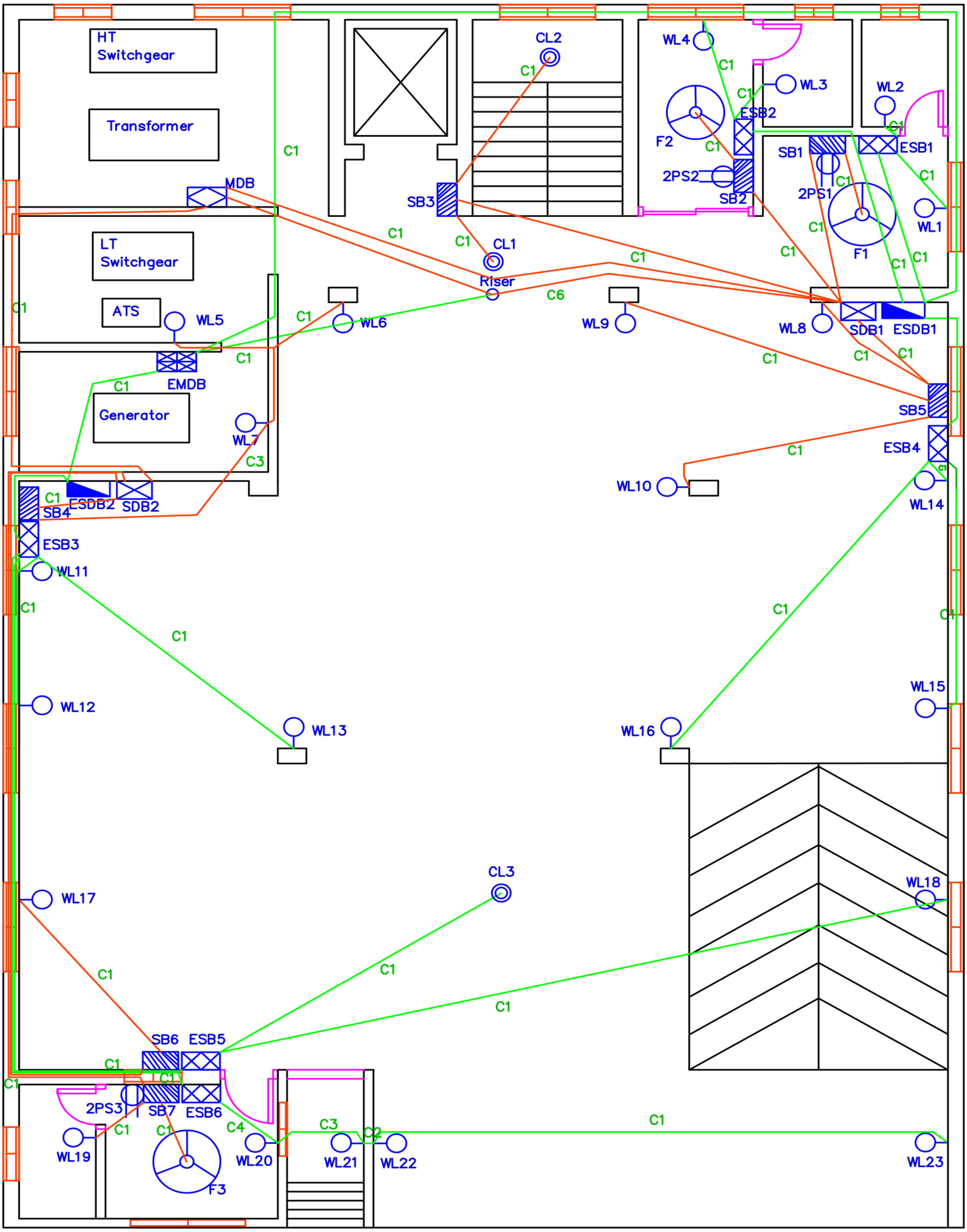
Conduit Legend

Conduit Name	Wire Rating	Conduit Size (GI Pipe Diameter (inch)
C1	2x1.5 rm	¾
C2	4x1.5 rm	¾
C3	6x1.5 rm	¾
C4	8x1.5 rm	¾
C5	10x1.5 rm	¾
C6	12x1.5 rm	1
C7	14x1.5 rm	1
C8	2x2.5 rm	1
C9	2x4 rm + 4 rm BYA ECC	1
C8,9	2x2.5 rm and 2x4 rm	1.25
C10	2x6 rm BYM + 6 rm BYA ECC	1.25
C11	2x10 rm BYM + 10 rm BYA ECC	1.5

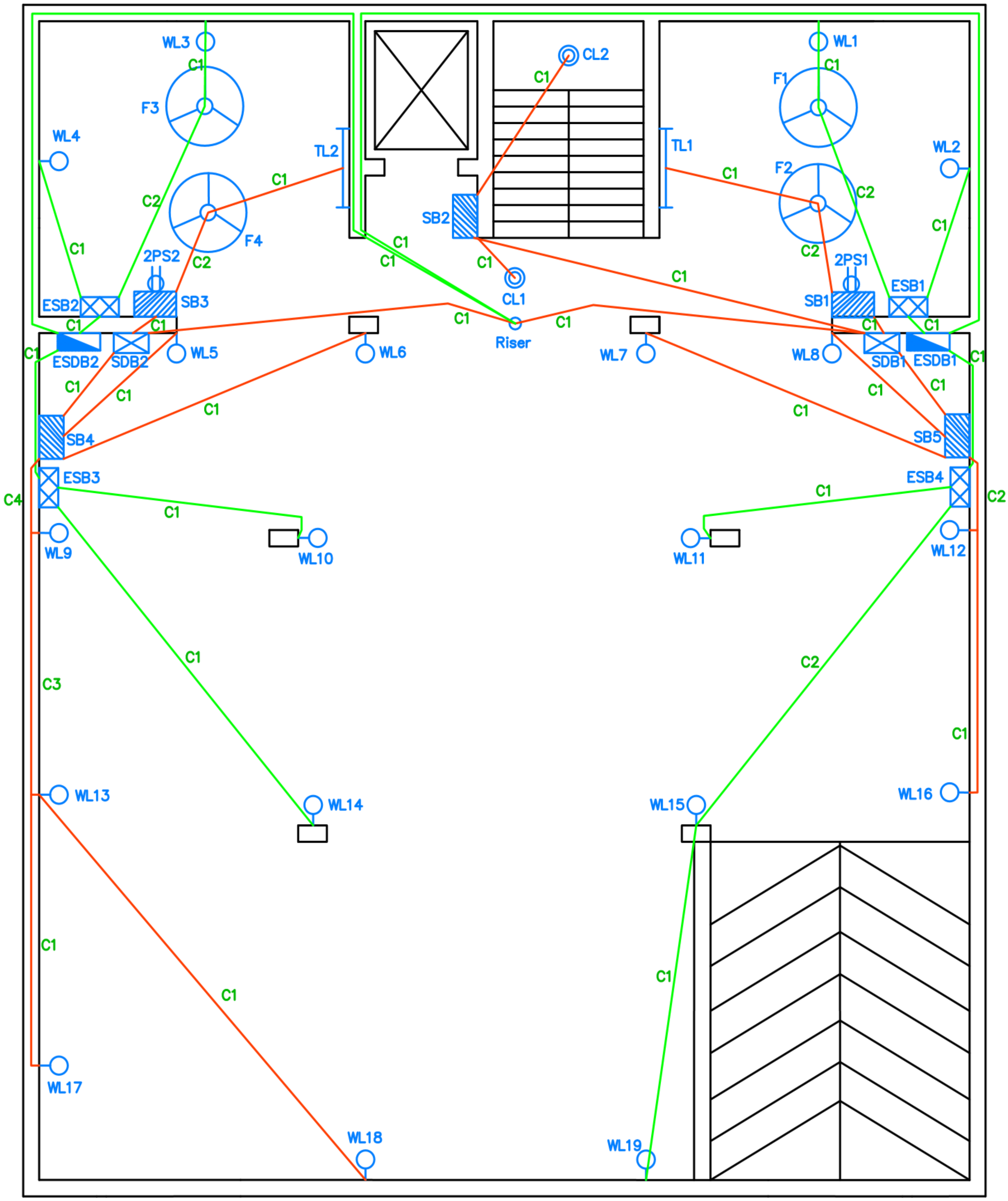
Conduit Plan (Typical Floor)



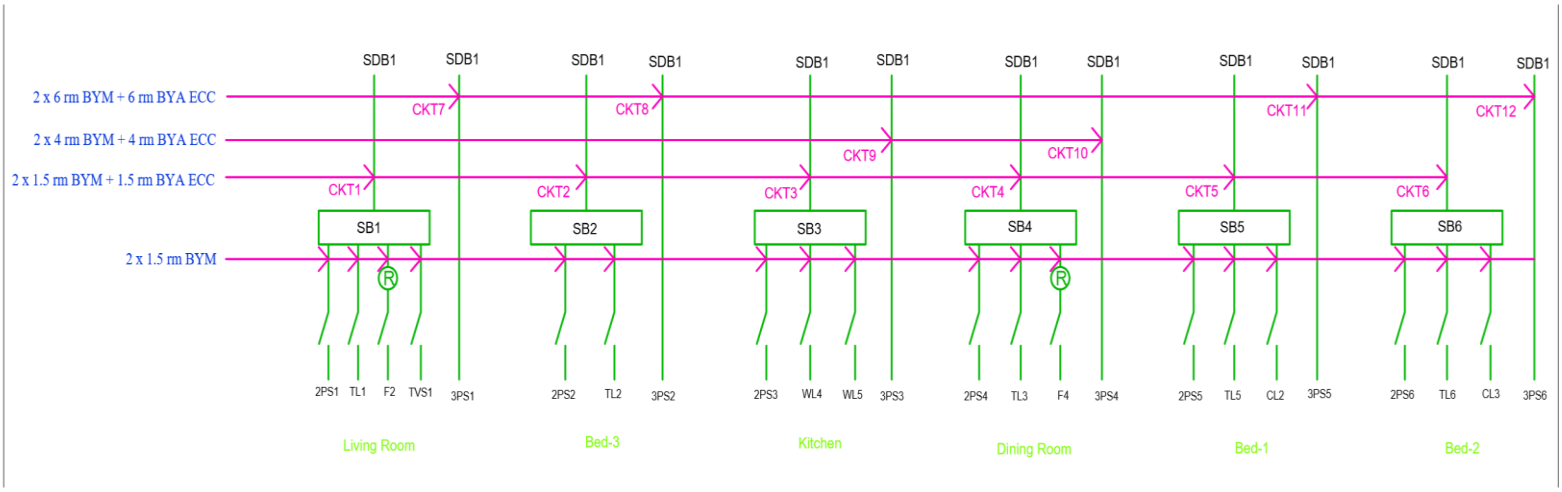
Conduit Plan (Ground Floor)



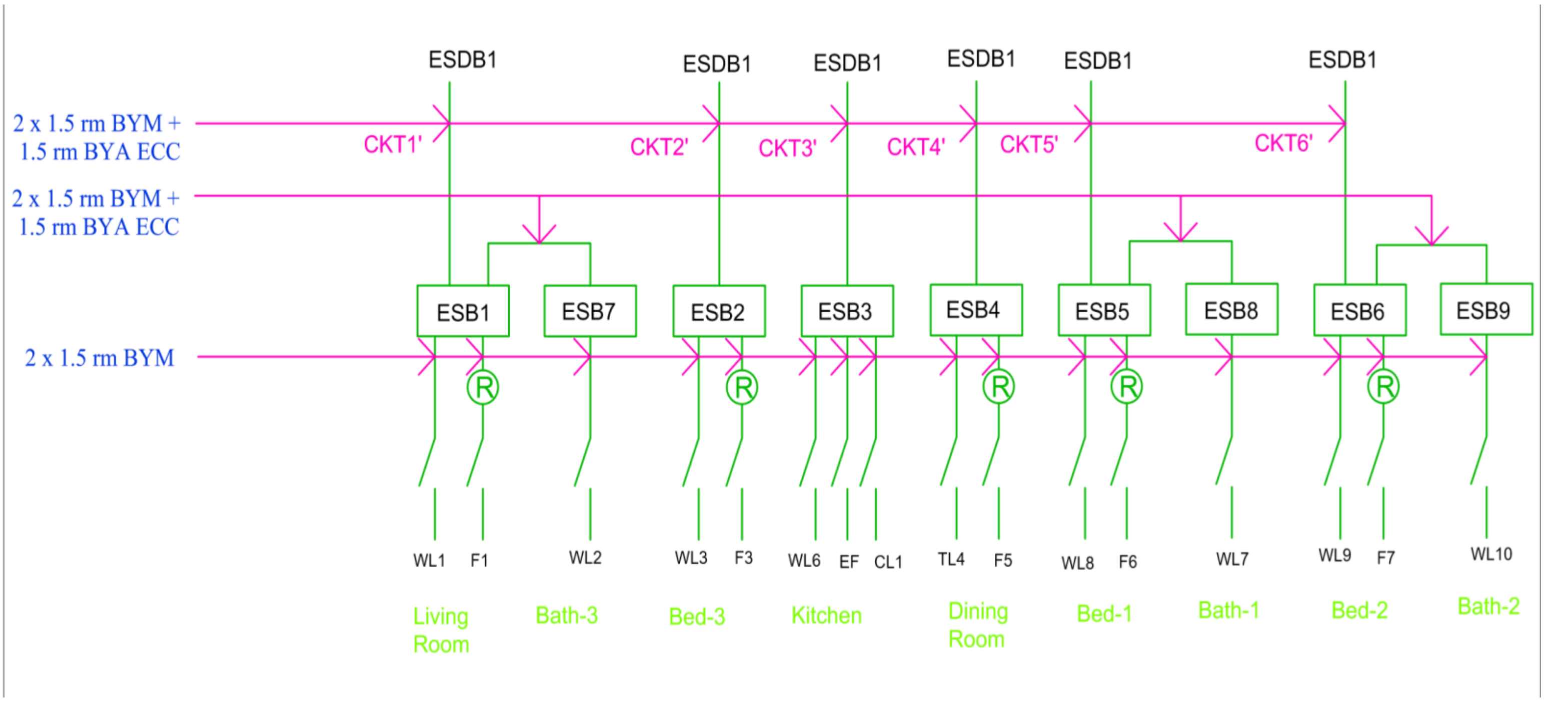
Conduit Plan (Basement Floor)



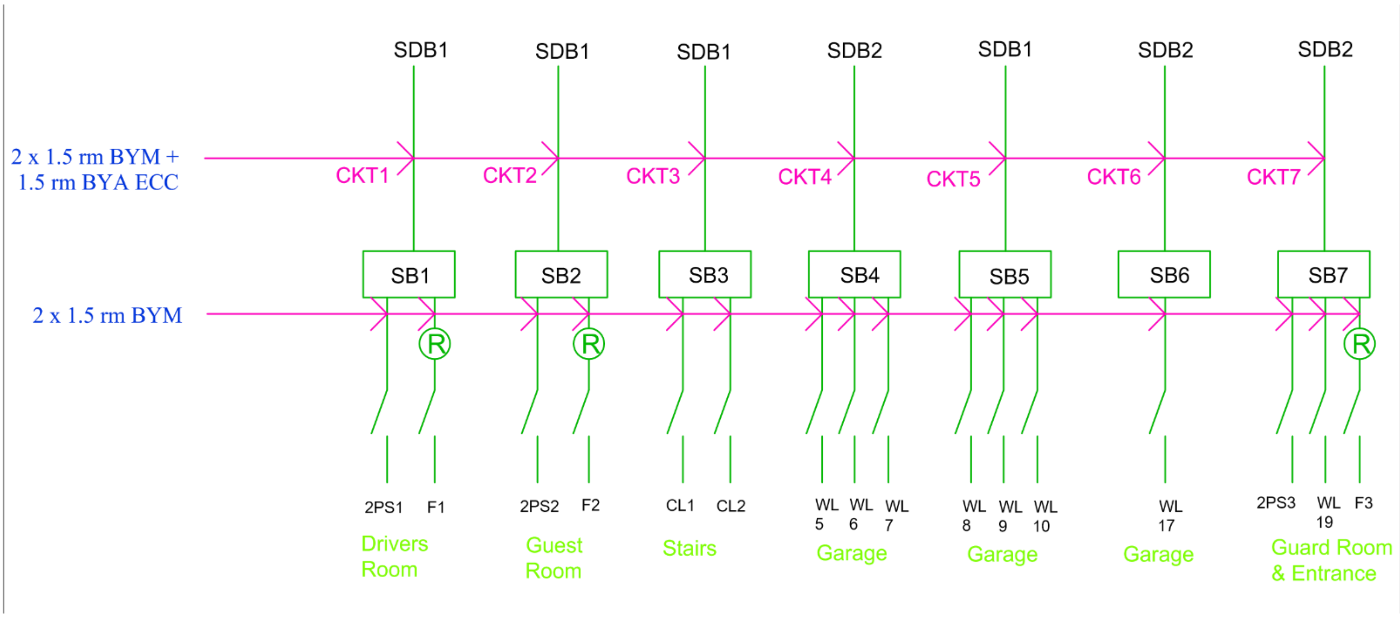
Switchboard Connection Diagram for Default Unit (Typical Floor)



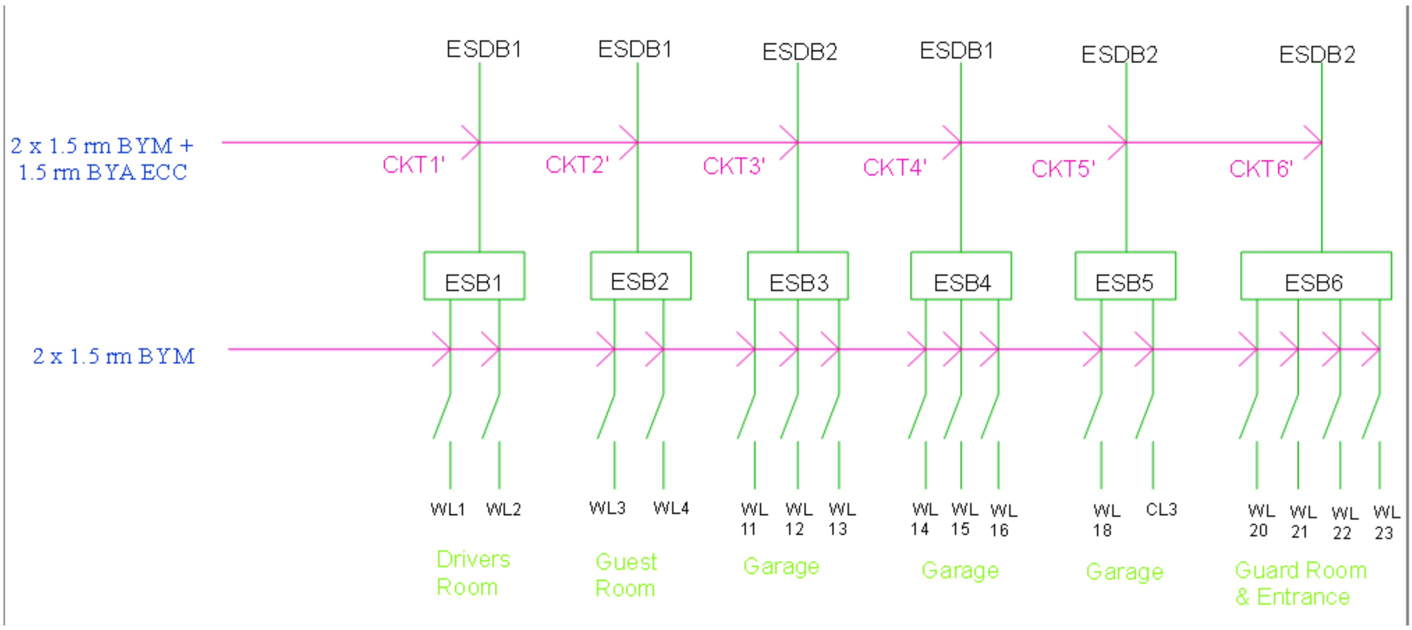
Emergency Switchboard Connection Diagram for Default Unit (Typical Floor)



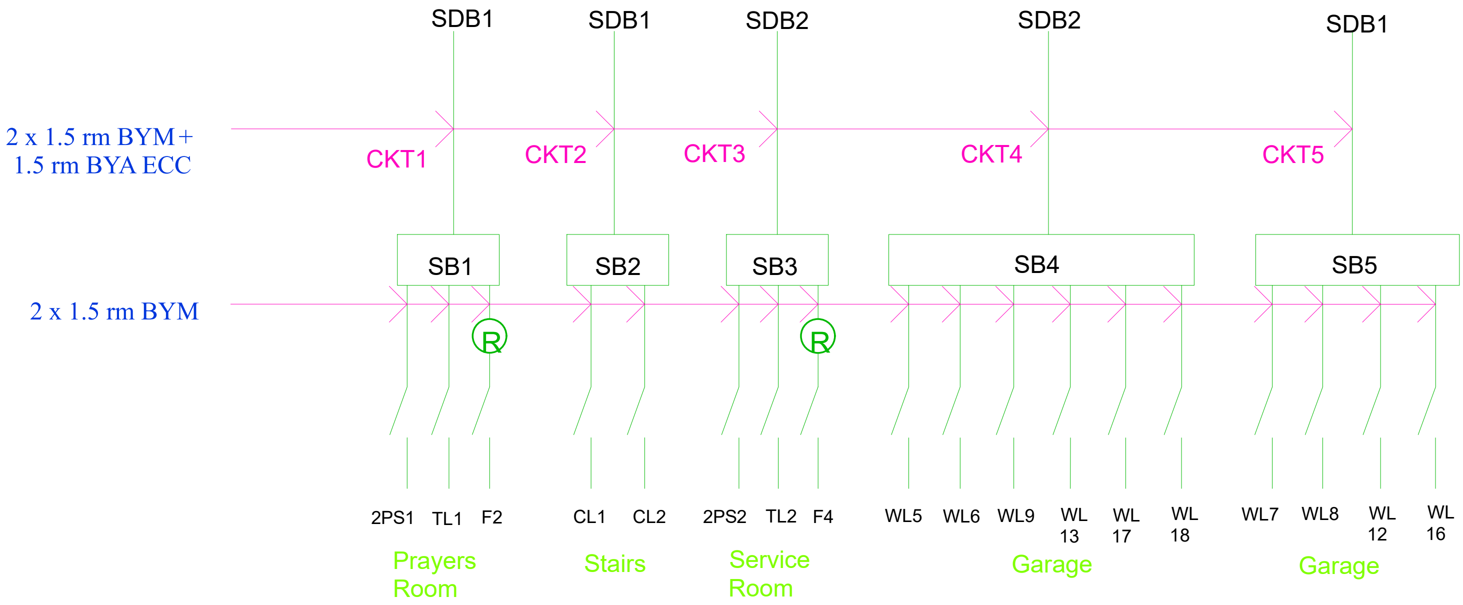
Switchboard Connection Diagram (Ground Floor)



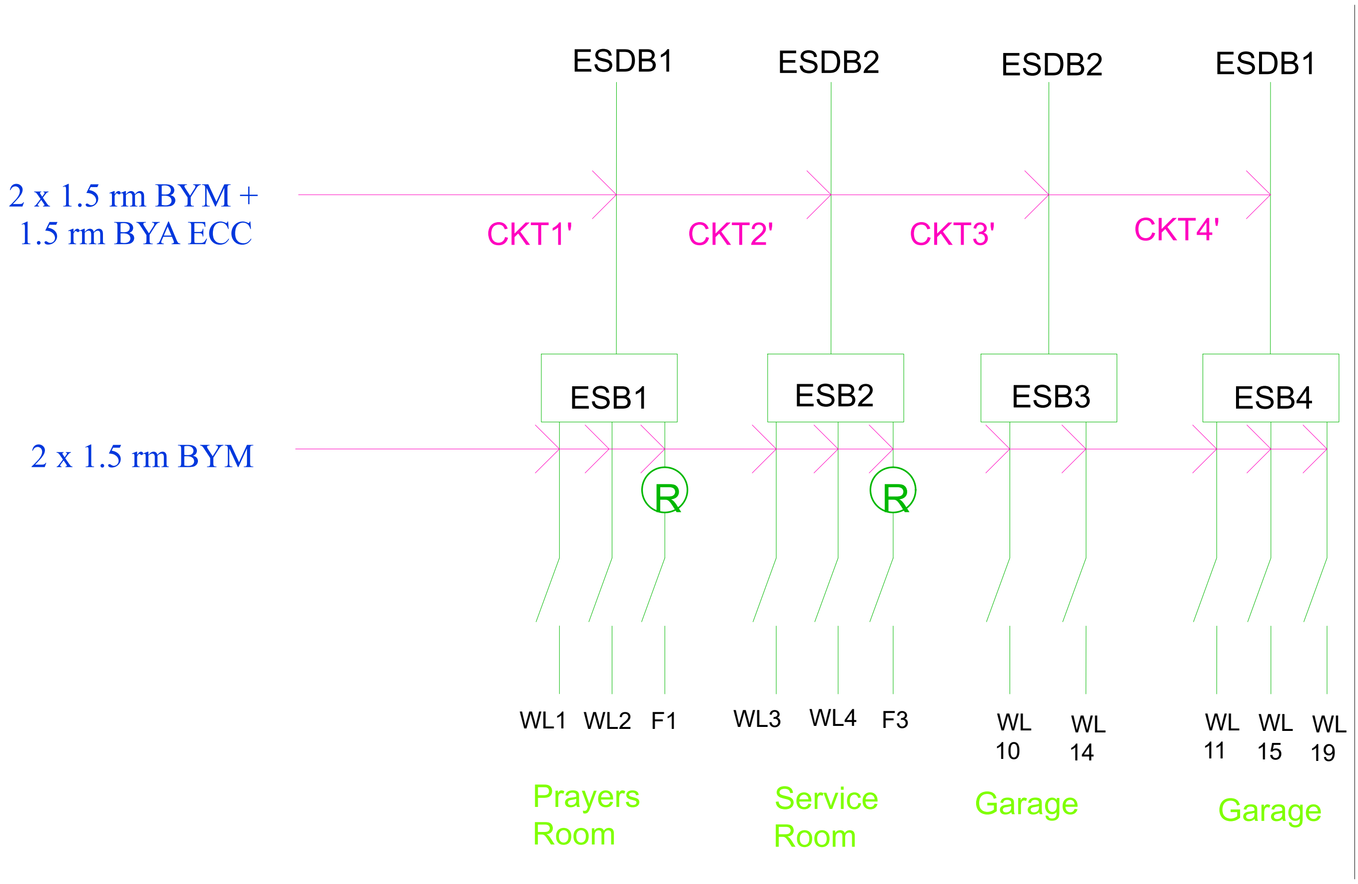
Emergency Switchboard Connection Diagram (Ground Floor)



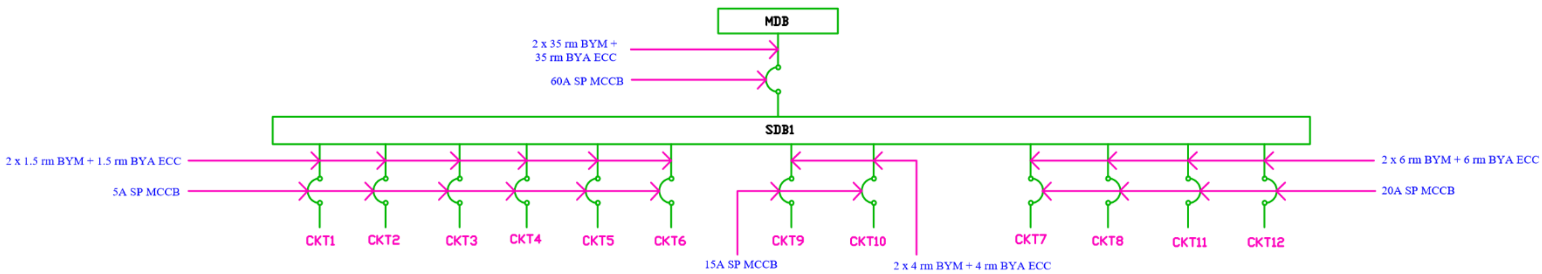
Switchboard Connection Diagram (Basement Floor)



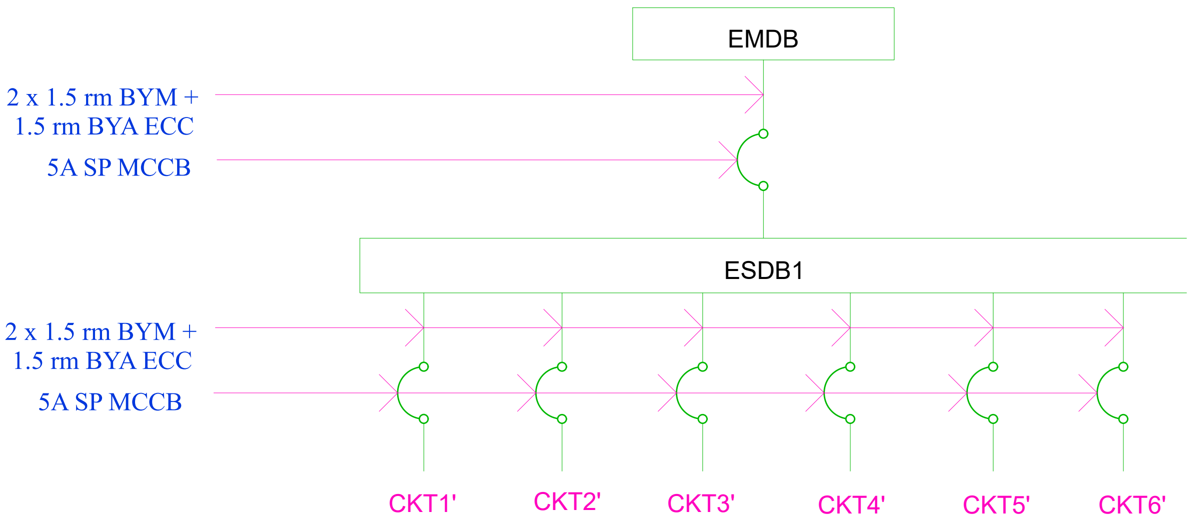
Emergency Switchboard Connection Diagram (Basement Floor)



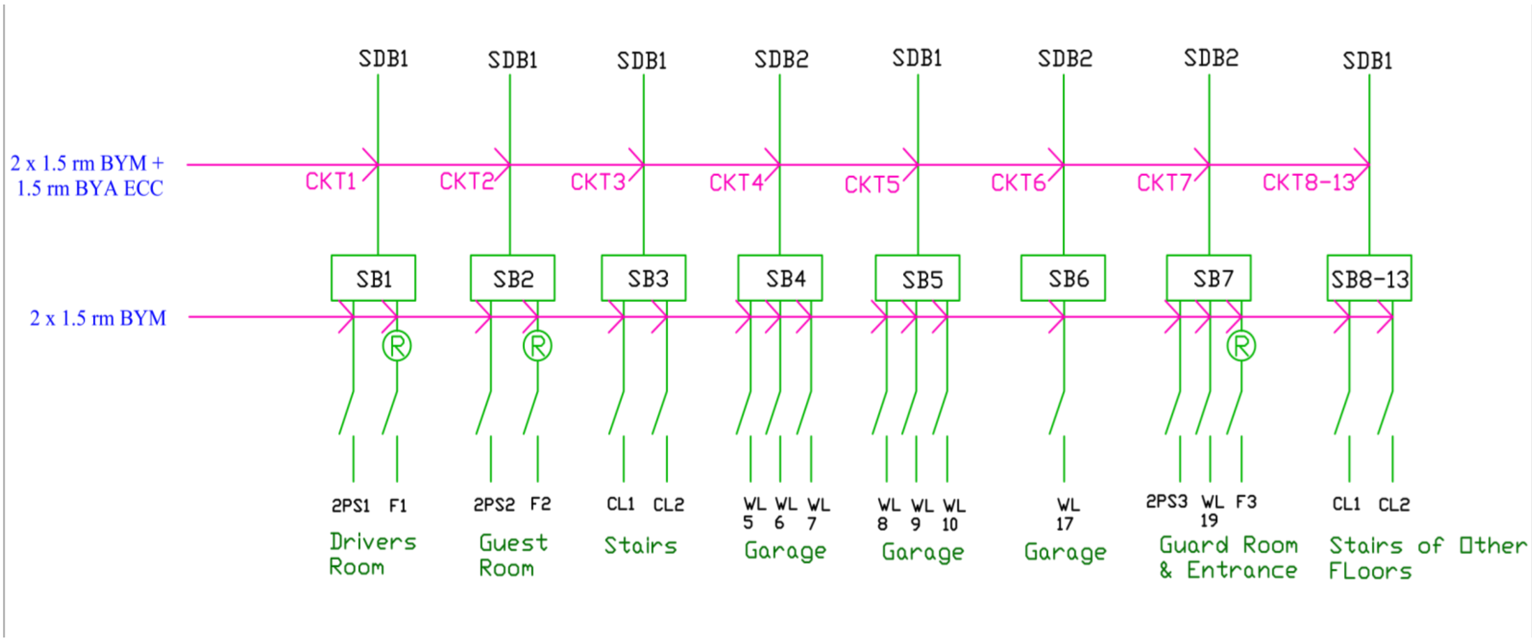
Sub Distribution Board Diagram for Default Unit (Typical Floor)



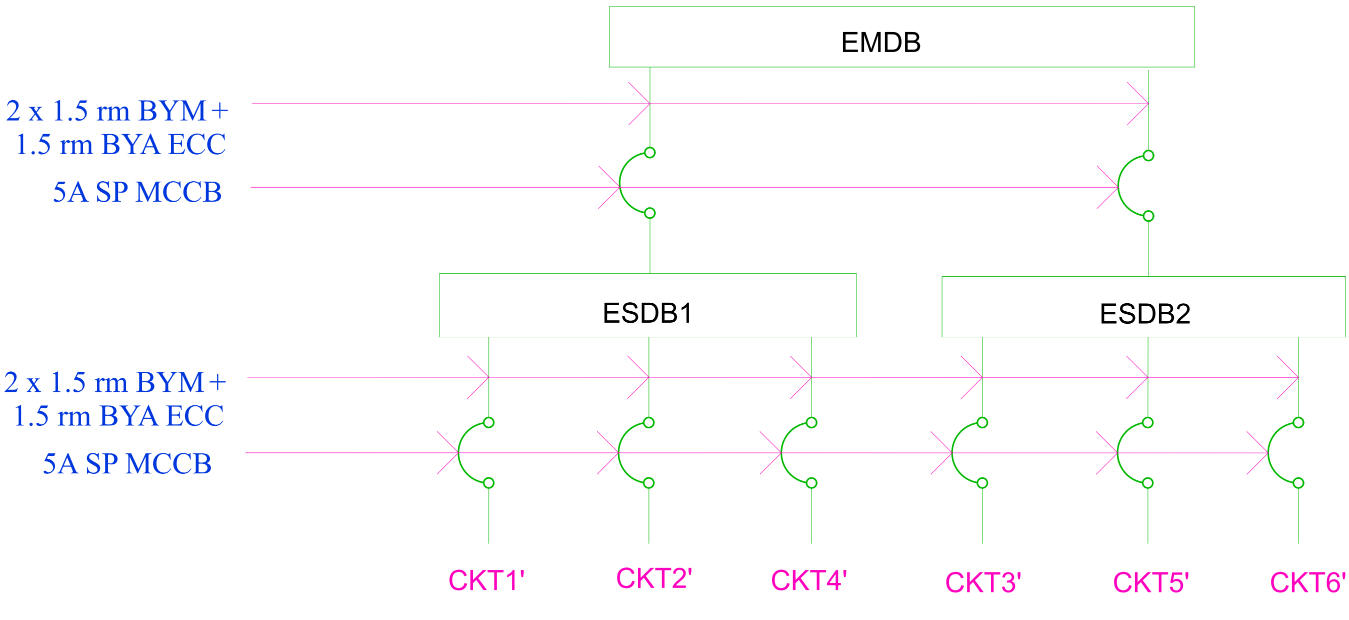
Emergency Sub Distribution Board Diagram for Default Unit (Typical Floor)



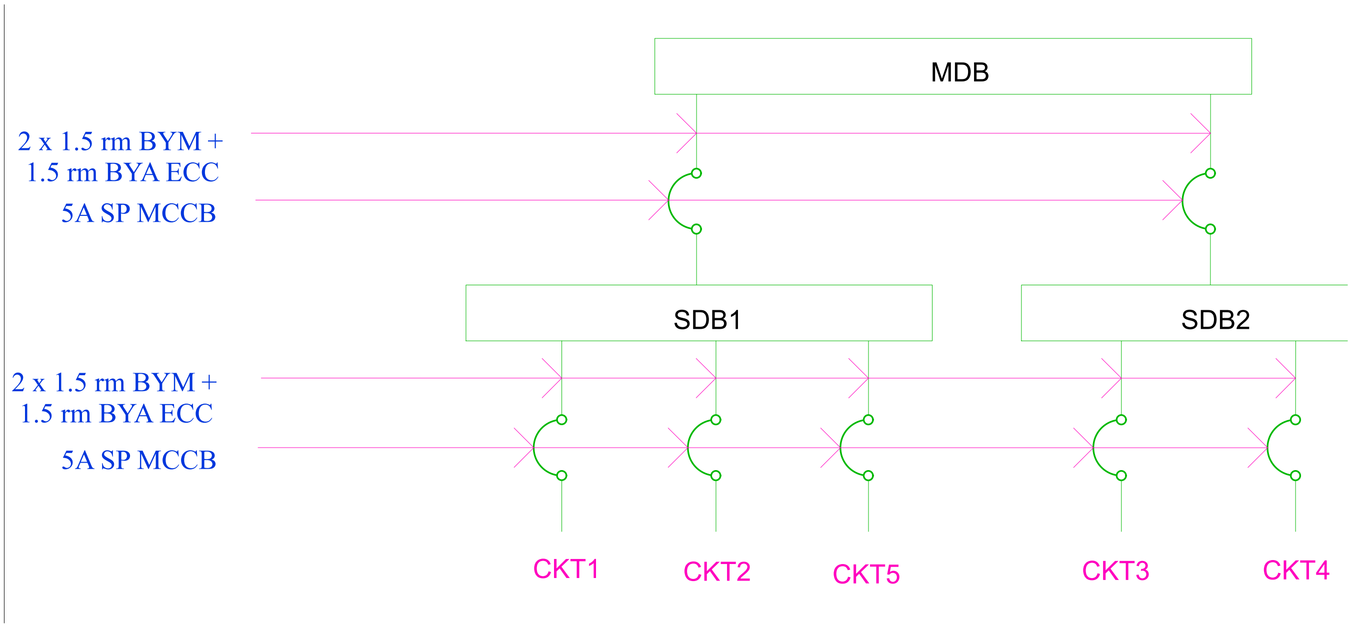
Sub Distribution Board Diagram (Ground Floor)



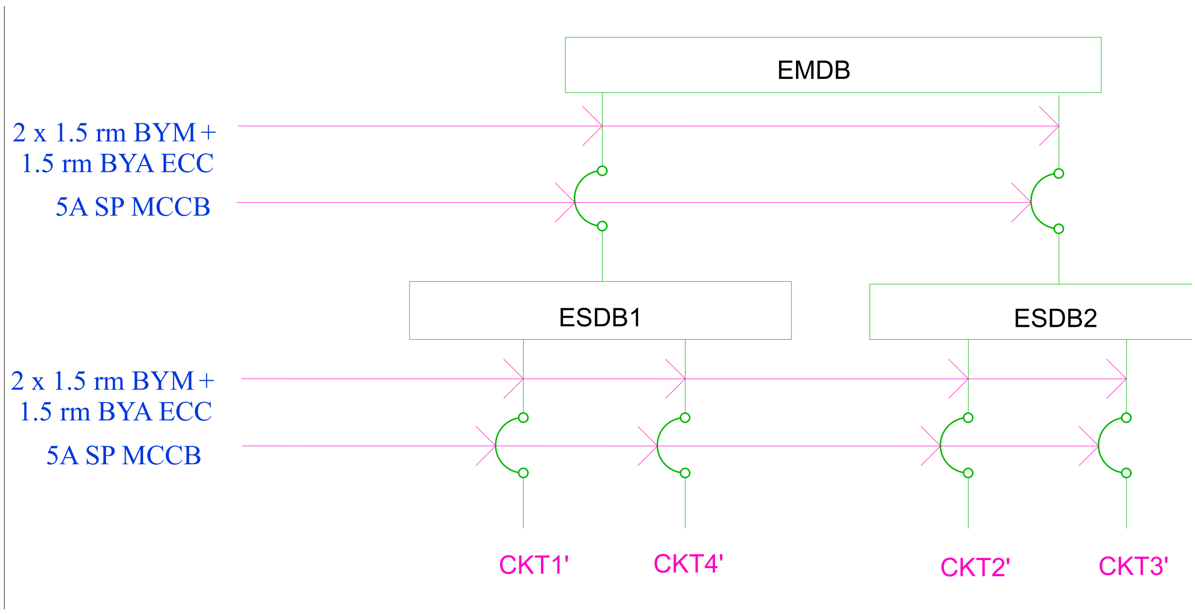
Emergency Sub Distribution Board Diagram (Ground Floor)



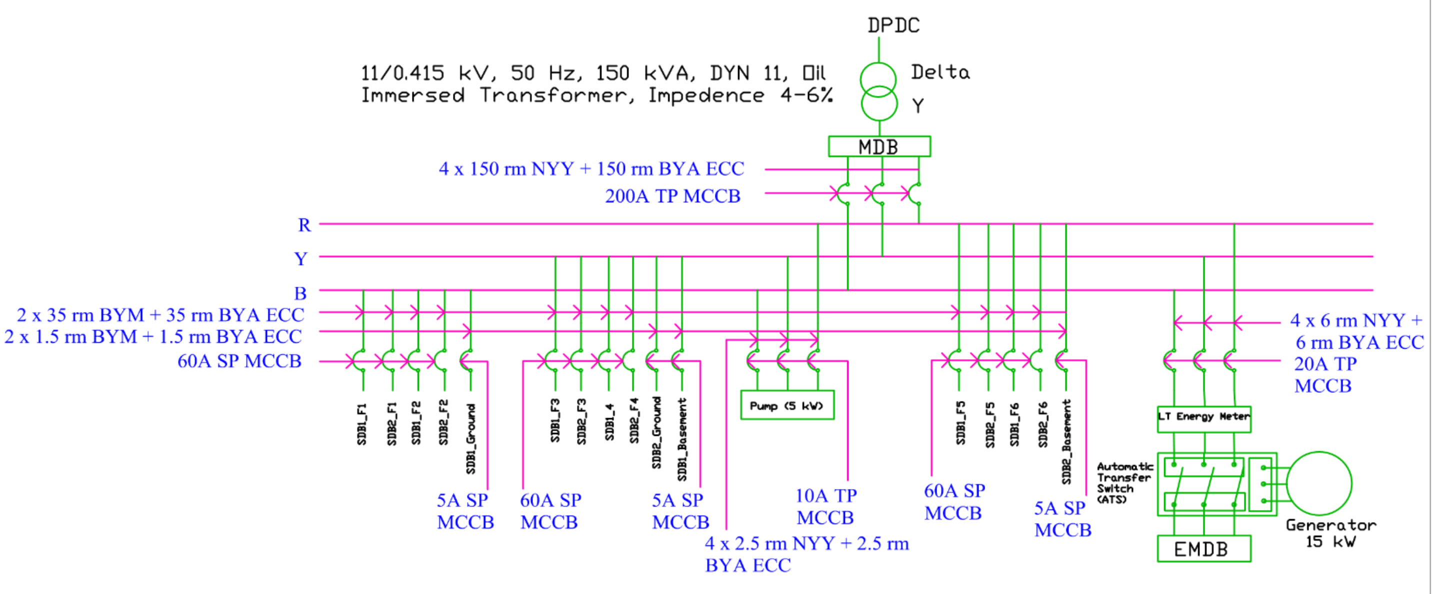
Sub Distribution Board Diagram (Basement Floor)



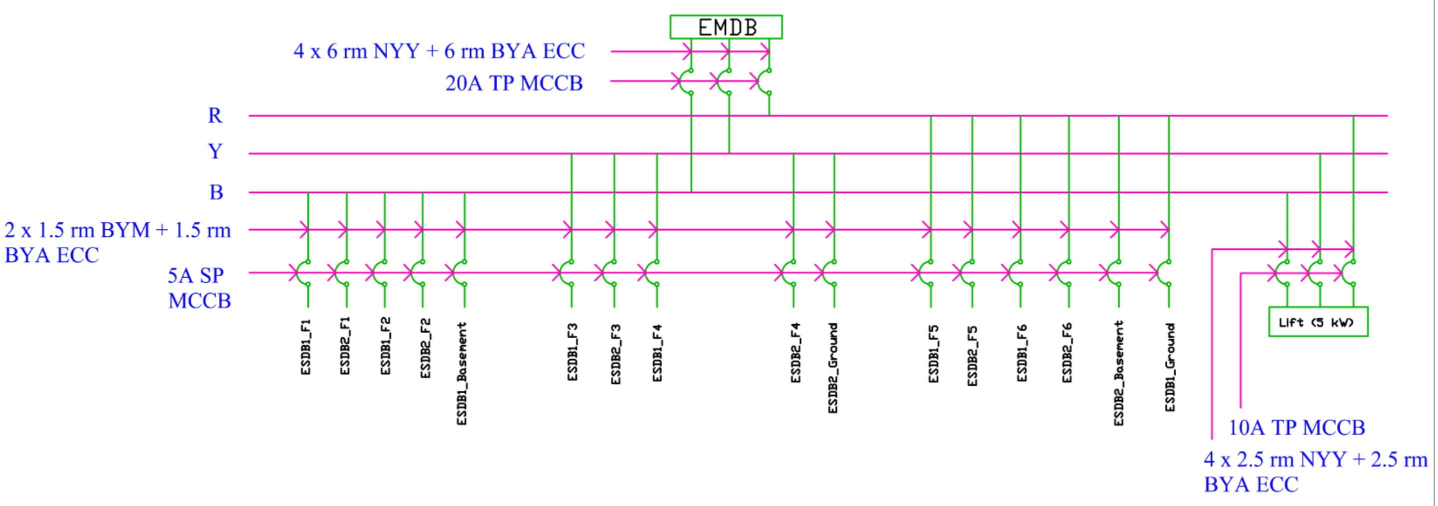
Emergency Sub Distribution Board Diagram (Basement Floor)



Main Distribution Board Diagram (MDB)



Emergency Main Distribution Board Diagram (EMDB)



Typical Floor Light Fan Calculation

Light Options:

40 W Fluorescent Tube Light 2200 Lumen

40 W Energy Saving Wall Light 2000 Lumen

20 W Energy Saving Wall Light 1200 Lumen

15 W Energy Saving Wall Light 900 Lumen

20W LED Ceiling Light 1600 Lumen

10W LED Ceiling Light 800 Lumen

Living Room:

Area = 16’2” x 10’ + 6’8” * 5’ = 195.02 ft^2 = 18.13 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 18.13}{0.6}$ = 3021.2 Lumen

So, one 40 W Tube Light and one 20 W Wall Light are selected whose combined luminous flux is (2200+1200) = 3400 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{195.02}{100}$ = 1.9502 ≈ 2

So, 2 fans are required.

Dining Space:

Area = 10’6’’ x 25’ + 2’ x 4’ + 13’6’’ x 4’ = 324.5 ft^2 = 30.147036 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 30.147036}{0.6}$ = 5024.506 Lumen

So, two 40 W Tube Light and one 20 W Ceiling Light are selected whose combined luminous flux is (2*2200+1600) = 6000 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{324.5}{100}$ = 3.245 ≈ 3

So, 3 fans are required.
But we used 2 fans in Dining Space for convenience.

Bed Room – 1:

Area = 13’6’’ x 10’ + 4’ x 7’677 = 165 ft^2 = 15.329 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 15.329}{0.6}$ = 2554.833 Lumen

So, one 40 W Tube Light and one 20 W Wall Light are selected whose combined luminous flux is (2200+1200) = 3400 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{165}{100}$ = 1.65 ≈ 1

So, 1 fan is required.

Bed Room – 2:

Area = 10’ x 12’ = 120 ft^2 = 11.1484 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 11.1484}{0.6}$ = 1858.067 Lumen

So, one 40 W Tube Light and one 20 W Wall Light are selected whose combined luminous flux is (2200+1200) = 3400 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{120}{100}$ = 1.2 ≈ 1

So, 1 fan is required.

Bed Room – 3:

Area = 11' x 10' + 2' x 5'6'' = 121 ft^2 = 11.2413 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 11.2413}{0.6}$ = 1873.55 Lumen

So, one 40 W Tube Light and one 20 W Wall Light are selected whose combined luminous flux is (2200+1200) = 3400 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{121}{100}$ = 1.21 ≈ 1

So, 1 fan is required.

Kitchen:

Area = 10' x 13' = 130 ft^2 = 12.0774 m^2

Illuminance, E = 200 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{200 * 12.0774}{0.6}$ = 4025.8 Lumen

So, two 40 W Wall Light and one 15 W Wall Light are selected whose combined luminous flux is (2*2000+1650) = 5650 Lumen

Number of Fans = 0

Bath Room - 1:

Area = 9' x 4'6'' = 40.5 ft^2 = 3.7625 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 3.7625}{0.6}$ = 627.08 Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen

Number of Fans = 0

Bath Room – 2:

Area = 9' x 5' + 3' x 2' = 51 ft^2 = 4.73806 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 4.73806}{0.6}$ = 789.677Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen
Number of Fans = 0

Bath Room – 3:

Area = 4'6'' x 7' = 31.5 ft^2 = 2.926446 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 2.926446}{0.6}$ = 487.741 Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen
Number of Fans = 0

Veranda – 1:

Area = 7' x 4' = 28 ft^2 = 2.60129 m^2

Illuminance, E = 50 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 2.60129}{0.6}$ = 216.7741 Lumen

So, one 10 W Ceiling Light is selected whose luminous flux is 800 Lumen
Number of Fans = 0

Veranda – 2:

Area = 5' x 7' = 35 ft^2 = 3.25161 m^2

Illuminance, E = 50 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 3.25161}{0.6}$ = 270.9675 Lumen

So, one 10 W Ceiling Light is selected whose luminous flux is 800 Lumen

Number of Fans = 0

Lift & Stairs:

Area = 14’6’’ x 15’ – (5’10” x 6’10”) = 171.85 ft^2 = 15.97 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 15.97}{0.6}$ = 2662.28 Lumen

So, two 20 W Ceiling Light are selected whose combined luminous flux is (2*1600) = 3200 Lumen

Number of Fans = 0

Ground Floor Light Fan Calculation

Guard Room:

Area = 9’ x 7’6’’ = 67.5 ft^2 = 6.271 m^2

Illuminance, E = 70 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{70 * 6.271}{0.6}$ = 731.6167 Lumen

So, one 20 W Wall Light is selected whose luminous flux is 1200 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{67.5}{100}$ = 0.675 ≈ 1

So, 1 fan is required.

Guard Bathroom:

Area = 4’ x 7’6’’ = 30 ft^2 = 2.7871 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 2.7871}{0.6}$ = 461.5152 Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen

Number of Fans = 0

Pedestrian Entrance:

Area = 4’ x 8’10’’ = 35.332 ft^2 = 3.2826 m^2

Illuminance, E = 50 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{50 * 3.2826}{0.6}$ = 273.55 Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen

Number of Fans = 0

Car Entrance:

Area = 30' x 8'10'' = 264.9 ft^2 = 21.62 m^2

Illuminance, E = 50 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{50 * 24.62}{0.6}$ = 2051.67 Lumen

So, two 20 W Wall Light are selected whose combined luminous flux is (2*1200) = 2400 Lumen

Number of Fans = 0

Garage:

Area = 45'6'' x 43' - 13'6" x 15'8" = 1744.96 ft^2 = 142.195 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 142.195}{0.6}$ = 23699.17 Lumen

So, four 40 W Wall Light, one 40 W Ceiling Light and ten 30 W Wall Light are selected whose combined luminous flux is (4*2000+2500+10*1500) = 25500 Lumen

Number of Fans = 0

Guest Room:

Area = 6' x 11' = 66 ft^2 = 6.1316 m^2

Illuminance, E = 70 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{70 * 6.1316}{0.6}$ = 715.3533 Lumen

So, one 20 W Wall Light is selected whose luminous flux is 1200 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{66}{100}$= 0.66 ≈ 1

Guest Toilet:

Area = 4'8'' x 6' = 28 ft^2 = 2.6013 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 2.6013}{0.6}$ = 433.55 Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen

Number of Fans = 0

Driver's Waiting Room:

Area = 9'8'' x 8'6'' =86.16695 ft^2 = 7.6335 m^2

Illuminance, E = 70 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{70 * 7.6335}{0.6}$ = 890.575 Lumen

So, one 20 W Wall Light is selected whose luminous flux is 1200 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$ = $\frac{86.16695}{100}$= 0.86 ≈ 1

Driver's Toilet:

Area = 4'8'' x 6' = 27 ft^2 = 2.50838 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 * 2.50838}{0.6}$ = 418.0633 Lumen

So, one 15 W Wall Light is selected whose luminous flux is 900 Lumen

Number of Fans = 0

Basement Floor Light Fan Calculation

Service Room:

Area = 16’2” x 15’= 242.50 ft^2 = 22.53 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$= $\frac{100 * 22.53}{0.6}$= 3754.71 Lumen

So, one 40 W Tube Light and two 20 W Wall Light are selected whose combined luminous flux is (2200+2*1200) = 4600 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$=$\frac{242.50}{100}$= 2.425 ≈ 2

So, 2 fans are required.

Prayer Room:

Area = 16’2” x 15’= 242.50 ft^2 = 22.53 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$= $\frac{100 * 22.53}{0.6}$= 3754.71 Lumen

So, one 40 W Tube Light and two 20 W Wall Light are selected whose combined luminous flux is (2200+2*1200) = 4600 Lumen

Number of Fans = $\frac{Area\ (ft2)}{100}$=$\frac{242.50}{100}$= 2.425 ≈ 2

So, 2 fans are required.

Garage:

Area = 43’ x 48’6’’ – (13’6” x 17’2”) = 1853.84 ft^2 = 172.31m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$= $\frac{100 * 193.75}{0.6}$= 26719.26 Lumen

So, seven 40 W Wall Light and eight 30 W Wall Light are selected whose combined luminous flux is (7*2000+8*1600) = 26800 Lumen

Number of Fans = 0

Lift & Stairs:

Area = 14’6’’ x 15’ – (5’10” x 6’10”) = 171.85 ft^2 = 15.97 m^2

Illuminance, E = 100 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.6

Total required luminous flux = $\frac{E * Area\ (m2)}{LLF * UF}$ = $\frac{100 *15.97}{0.6}$ = 2662.28 Lumen

So, two 20 W Ceiling Light are selected whose combined luminous flux is (2*1600) = 3200 Lumen

Number of Fans = 0

Conduit and Wire Calculation (Typical Floor)

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

Pf = 0.85

Wall Light = 15W, 20W, 30W, 40W

Tube light = 40W

Ceiling Light = 10W, 20W

Ceiling Fan = 80W

Exhaust Fan = 80W

All internal wires are below 5A rating, so 2 x 1.5 rm BYM is used in all internal wiring.

<u>To SDB1 of Default Unit (Typical Floor)</u>

CKT1 Rating (SB1)

I = $\frac{100(2PS1) + 40(TL1) + 200(TVS1) + 80(F2)}{220 *0.85}$ (A) = 2.246 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT2 Rating (SB2)

I = $\frac{40(TL2) + 100(2PS2)}{220 *0.85}$ (A) = 0.7487 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT3 Rating (SB3)

I = $\frac{40(WL4) + 15(WL5) + 100(2PS3)}{220 *0.85}$ (A) = 0.8289 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT4 Rating (SB4)

I = $\frac{40(TL3) + 15(F4) + 100(2PS4)}{220 *0.85}$ (A) = 1.1765 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT5 Rating (SB5)

I = $\frac{40(TL5) + 100(2PS5) + 10(CL2)}{220 * 0.85}$ (A) = 0.8021 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT6 Rating (SB6)

I = $\frac{40(TL6) + 100(2PS6) + 10(CL3)}{220 * 0.85}$ (A) = 0.8021 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT7 Rating

I = $\frac{3500(3PS1)}{220 * 0.85}$ (A) = 18.7166 A

So, 2 x 6 rm BYM + 6 rm BYA ECC is used.

CKT8 Rating

I = $\frac{3500(3PS2)}{220 * 0.85}$ (A) = 18.7166 A

So, 2 x 6 rm BYM + 6 rm BYA ECC is used.

CKT9 Rating

I = $\frac{2000(3PS3)}{220 * 0.85}$ (A) = 10.6952 A

So, 2 x 4 rm BYM + 4 rm BYA ECC is used.

CKT10 Rating

I = $\frac{2000(3PS4)}{220 * 0.85}$ (A) = 10.6952 A

So, 2 x 4 rm BYM + 4 rm BYA ECC is used.

CKT11 Rating

I = $\frac{3500(3PS5)}{220 * 0.85}$ (A) = 18.7166 A

So, 2 x 6 rm BYM + 6 rm BYA ECC is used.

CKT12 Rating

I = $\frac{3500(3PS6)}{220 * 0.85}$ (A) = 18.7166 A

So, 2 x 6 rm BYM + 6 rm BYA ECC is used.

Emergency:

<u>To ESDB1 of Default Unit (Typical Floor)</u>

CKT1' Rating (ESB1, ESB7)

I = $\frac{20(WL1) + 80(F1) + 15(WL2)}{220 * 0.85}$ (A) = 0.615 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT2' Rating (ESB2)

I = $\frac{20(WL3) + 80(F3)}{220 * 0.85}$ (A) = 0.5348 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT3' Rating (ESB3)

I = $\frac{80(EF) + 40(WL6) + 20(CL1)}{220 * 0.85}$ (A) = 0.7487 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT4' Rating (ESB4)

I = $\frac{40(TL4) + 80(F5)}{220 * 0.85}$ (A) = 0.6417 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT5' Rating (ESB5, ESB8)

I = $\frac{20(WL8)+80(F6)+WL7(15)}{220 * 0.85}$ (A) = 0.615 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT6' Rating (ESB6, ESB9)

I = $\frac{20(WL9)+80(F7)+WL10(15)}{220 * 0.85}$ (A) = 0.615 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

Conduit and Wire Calculation (Ground Floor)

To SDB1 (Ground Floor)

CKT1 Rating (SB1)

I = $\frac{100(2PS1)+ 80(F1)}{220 *0.85}$ (A) = 0.9626 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT2 Rating (SB2)

I = $\frac{80(F2) + 100(2PS2)}{220 *0.85}$ (A) = 0.9626 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT3 Rating (SB3)

I = $\frac{20(CL1)+20(CL2)}{220 *0.85}$ (A) = 0.2139 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT5 Rating (SB5)

I = $\frac{30(WL8)+30(WL9)+30(WL10)}{220 *0.85}$ (A) = 0.4813 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

To SDB2 (Ground Floor)

CKT4 Rating (SB4)

I = $\frac{30(WL5)+30(WL6)+30(WL7)}{220 *0.85}$ (A) = 0.4813 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT6 Rating (SB6)

I = $\frac{30(WL17)}{220 *0.85}$ (A) = 0.1604 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT7 Rating (SB7)

I = $\frac{100(2PS3)+15(WL19)+80(F3)}{220 * 0.85}$ (A) = 1.0427 A

So, 2 x1.5 rm BYM + 1.5 rm BYA ECC is used.

Emergency:

<u>To ESDB1 Ground Floor)</u>

CKT1' Rating (ESB1)

I = $\frac{20(WL1) + 15(WL2)}{220 * 0.85}$ (A) = 0.1872 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT2' Rating (ESB2)

I = $\frac{15(WL3) + 20(WL4)}{220 * 0.85}$ (A) = 0.1872 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT4' Rating (ESB4)

I = $\frac{40(WL14)+30(WL15)+40(WL16)}{220 * 0.85}$ (A) = 0.588 A

So, 2 x1.5 rm BYM + 1.5 rm BYA ECC are used.

<u>To ESDB2 (Ground Floor)</u>

CKT3' Rating (ESB3)

I = $\frac{40(WL11)+30(WL12)+40(WL13)}{220 * 0.85}$ (A) = 0.588 A

So, 2 x1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT5' Rating (ESB5)

I = $\frac{30(WL18)+40(CL3)}{220 * 0.85}$ (A) = 0.3743 A

So, 2 x1.5 rm BYM + 1.5 rm BYA ECC are used.

CKT6' Rating (ESB6)

I = $\frac{20(WL20)+15(WL21)+20(WL22)+20(WL23)}{220 *0.85}$ (A) = 0.4011 A

So, 2 x1.5 rm BYM + 1.5 rm BYA ECC is used.

Conduit and Wire Calculation (Basement Floor)

<u>To SDB1 (Basement Floor)</u>

CKT1 Rating (SB1)

I =$\frac{100(2PS1) + 40(TL1) + 80(F2)}{220 *0.85}$ (A) = 1.1765 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT2 Rating (SB2)

I =$\frac{20(CL1) +20(CL2)}{220 *0.85}$ (A) =0.2139 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT5 Rating (SB5)

I =$\frac{40(WL7) + 30(WL8) + 30(WL12) + 30(WL16)}{220 *0.85}$ (A) =0.6952 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

<u>To SDB2 (Basement Floor)</u>

CKT3 Rating (SB3)

I =$\frac{100(2PS2) + 40(TL2) + 80(F4)}{220 *0.85}$ (A) = 1.1765 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT4 Rating (SB4)

I = $\frac{30(WL5)+40(WL6)+30(WL9)+30(WL13)+30(WL17)+40(WL18)}{220*0.85}$ (A) =1.0695 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

Emergency:

<u>To ESDB1 (Basement Floor)</u>

CKT1' Rating (ESB1, ESB7)

I = $\frac{20(WL1)+20(WL2)+80(F1)}{220*0.85}$ (A) =0.6417 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT4' Rating (ESB4)

I = $\frac{40(WL11)+40(WL15)+30(WL19)}{220*0.85}$ (A) = 0.5882 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

<u>To ESDB2 (Basement Floor)</u>

CKT2' Rating (ESB2)

I = $\frac{20(WL3)+20(WL4)+80(F3)}{220*0.85}$ (A) =0.6417 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT3' Rating (ESB3)

I = $\frac{40(WL10)+40(WL14)}{220*0.85}$ (A) = 0.4278 A

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

Calculation for SDB and ESDB (Typical Floor)

<u>SDB1 To MDB</u>

CKT1 load = 420 W

CKT2 load = 140 W

CKT3 load = 155 W

CKT4 load = 220 W

CKT5 load = 150 W

CKT6 load = 150 W

Total = 1235 W

Power CKT Load

CKT7 load = 3500 W

CKT8 load = 3500 W

CKT9 load = 2000 W

CKT10 load = 2000 W

CKT11 load = 3500 W

CKT12 load = 3500 W

Total = 18000 W

Activity Factor of Power CKT = 0.5

Pf = 0.85

SDB1 (Typical Floor) Total Load = 1235 + 18000 x 0.5 = 10235 W

I $=\frac{10235}{220 * 0.85}$ (A) = 54.73 A

So, 60 A SP MCCB is needed from SDB1 to MDB

And 2 x 35 rm BYM + 35 rm BYA ECC is used.

Emergency:

ESDB1 To EMDB

CKT1’ load = 115 W

CKT2’ load = 100 W

CKT3’ load = 140 W

CKT4’ load = 120 W

CKT5’ load = 115 W

CKT6’ load = 115 W

Total = 705 W

Pf = 0.85

ESDB1 (Typical Floor) Total Load = 705 W

I = $\frac{705}{220 * 0.85}$ (A) = 3.77 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

Calculation for SDB and ESDB (Ground Floor)

SDB1 To MDB

CKT1 load = 180 W

CKT2 load = 180 W

CKT3 load = 40 W

CKT5 load = 90 W

CKT8 load = 40 W (1st Floor Stairs Switchboard)

CKT9 load = 40 W (2nd Floor Stairs Switchboard)

CKT10 load = 40 W (3rd Floor Stairs Switchboard)

CKT11 load = 40 W (4th Floor Stairs Switchboard)

CKT12 load = 40 W (5th Floor Stairs Switchboard)

CKT13 load = 40 W (6th Floor Stairs Switchboard)

Total = 730 W

Pf = 0.85

SDB1 (Ground Floor) Total Load = 730 W

I =$\frac{730}{220 * 0.85}$ (A) = 3.90 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

<u>SDB2 To MDB</u>

CKT4 load = 90 W

CKT6 load = 30 W

CKT7 load = 195 W

Total = 315 W

Pf = 0.85

SDB2 (Ground Floor) Total Load = 315 W

I =$\frac{315}{220 * 0.85}$ (A) = 1.68 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

Emergency:

<u>ESDB1 To MDB</u>

CKT1’ load = 35 W

CKT2’ load = 35 W

CKT4’ load = 110 W

Total = 180 W

Pf = 0.85

ESDB1 (Ground Floor) Total Load = 180 W

I = $\frac{180}{220 * 0.85}$ (A) = 0.962 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

ESDB2 To MDB

CKT3’ load = 110 W

CKT5’ load = 70 W

CKT6’ load = 75 W

Total = 255 W

Pf = 0.85

ESDB2 (Ground Floor) Total Load = 255 W

I = $\frac{255}{220 * 0.85}$ (A) = 1.36 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

Calculation for SDB and ESDB (Basement Floor)

SDB1 To MDB

CKT1 load = 220 W

CKT2 load = 40 W

CKT5 load = 130 W

Total = 390 W

Pf = 0.85

SDB1 (Basement Floor) Total Load = 390 W

I = $\frac{390}{220 * 0.85}$ (A) = 2.09 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

<u>SDB2 To MDB</u>

CKT3 load = 220 W

CKT4 load = 200 W

Total = 420 W

Pf = 0.85

SDB2 (Basement Floor) Total Load = 420 W

I =$\frac{420}{220 * 0.85}$ (A) = 2.25 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

Emergency:

<u>ESDB1 To MDB</u>

CKT1 load = 120 W

CKT4 load = 110 W

Total = 230 W

Pf = 0.85

ESDB1 (Basement Floor) Total Load = 230 W

I =$\frac{230}{220 * 0.85}$ (A) =1.23 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

ESDB2 To MDB

CKT2 load = 115 W

CKT3 load = 80 W

Total = 195 W

Pf = 0.85

ESDB2 (Basement Floor) Total Load = 195 W

I = $\frac{195}{220 * 0.85}$ (A) = 1.04 A

So, 5 A SP MCCB is needed from SDB1 to MDB

And 2 x 1.5 rm BYM + 1.5 rm BYA ECC is used.

Calculation for Emergency Main Distribution Board (EMDB)

Activity Factor = 0.7

EMDB load = Total ESDB load × Activity Factor + Lift Load x Activity Factor

Total ESDB load = $(ESDB1+ESDB2)_{\text{Ground floor}} + (ESDB1+ESDB2)_{\text{Basement floor}} +$ Number of Typical Floors x Unit x $ESDB1_{\text{Typical Floor}}$

= (180 + 255) + (230 + 195) + 6 x 2 x 705

= 9320 W

Lift Load = 5000 W

Phase voltage = 220 V

Line voltage = √3 ×Pphase voltage = 381.05 V

EMDB load = 9320 × 0.7 + 5000 x 0.7 = 10024 W = 10.024 kW

EMDB Current = $\frac{EMDB\ Load}{\sqrt{3} \times Line\ voltage \times power\ factor} = \frac{10024}{\sqrt{3} \times 381.05 \times 0.85}$ = 17.87 A

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

A 15 kW Generator is used to supply the EMDB Load through an ATS.

Calculation for Main Distribution Board (MDB)

Activity Factor = 0.7

MDB load = Total SDB load × Activity Factor + (EMDB Load + Pump Load) x Activity Factor

Total SDB load = (SDB1+SDB2) $_{\text{Ground floor}}$ + (SDB1+SDB2) $_{\text{Basement floor}}$ + Number of Typical Floors x Unit x SDB1$_{\text{Typical Floor}}$

= (730 + 315) + (390 + 420) + 6 x 2 x 10235

= 124675 W

= 124. 675 kW

Pump Load = 5000 W

Phase voltage = 220 V

Line voltage = √3 ×Pphase voltage = 381.05 V

MDB load = 124675 × 0.7 + (10024 + 5000) x 0.7 = 97789.3 W = 97.79 kW

MDB Current = $\frac{MDB\ Load}{\sqrt{3}\times Line\ voltage \times power\ factor} = \frac{97789.3}{\sqrt{3}\times 381.05 \times 0.85}$ = 174.31 A

So, 200 A TP MCCB is needed from MDB to Transformer. And 4 x 150 rm + 150 rm BYA ECC wire is used.

Calculation for Transformer

S = 3VI = 3 * 220 * 200 = 132 KVA

So, 11kV/0.415 kV, 50 Hz, 150 kVA, DYN 11, Oil Immersed Transformer with 4-6% Impedance is needed.

Transformer room area 12 m^2 and Total Substation Area 45 m^2

Lightning Protection System

Risk factor calculation:

Index	**Parameter**	**Description**	**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 or Consequential Effects	Ordinary domestic or office building, factories and workshops not containing valuable materials	2
D	Degree of Isolation	Structure located in a large area having structures or trees of similar or greater height, e.g. a large town or forest	2
E	Type of Terrain	Flat terrain at any level	2
F	Height of Structure	18-24m	8
G	Lightning Prevalence	Number of thunderstorm days per year= over 21	21
		Total	41

Recommendation: Risk assessment factor > 40, lightning protection system is mandatory for safety.

<u>LPS Design</u>

<u>Lightning Arrestor</u>

Rod Height = 2m

Roof perimeter = 2 x (58’10” + 48’6”) = 214’8” = 215’

We place arrestors 25’ apart, requiring (215/25=8.6) or 9 arrestors, 3 arrestors along the length of the roof perimeter, 3 arrestors along the width, and 2 on the corners of the stair-room.

<u>Down conductor:</u>

Total Area = 2853.4 sq ft = 265.089 sq m

1 down conductor for first 80 sq m

Number of down conductor for rest of the areas = (265.089-80)/100 = 1.85 or 2

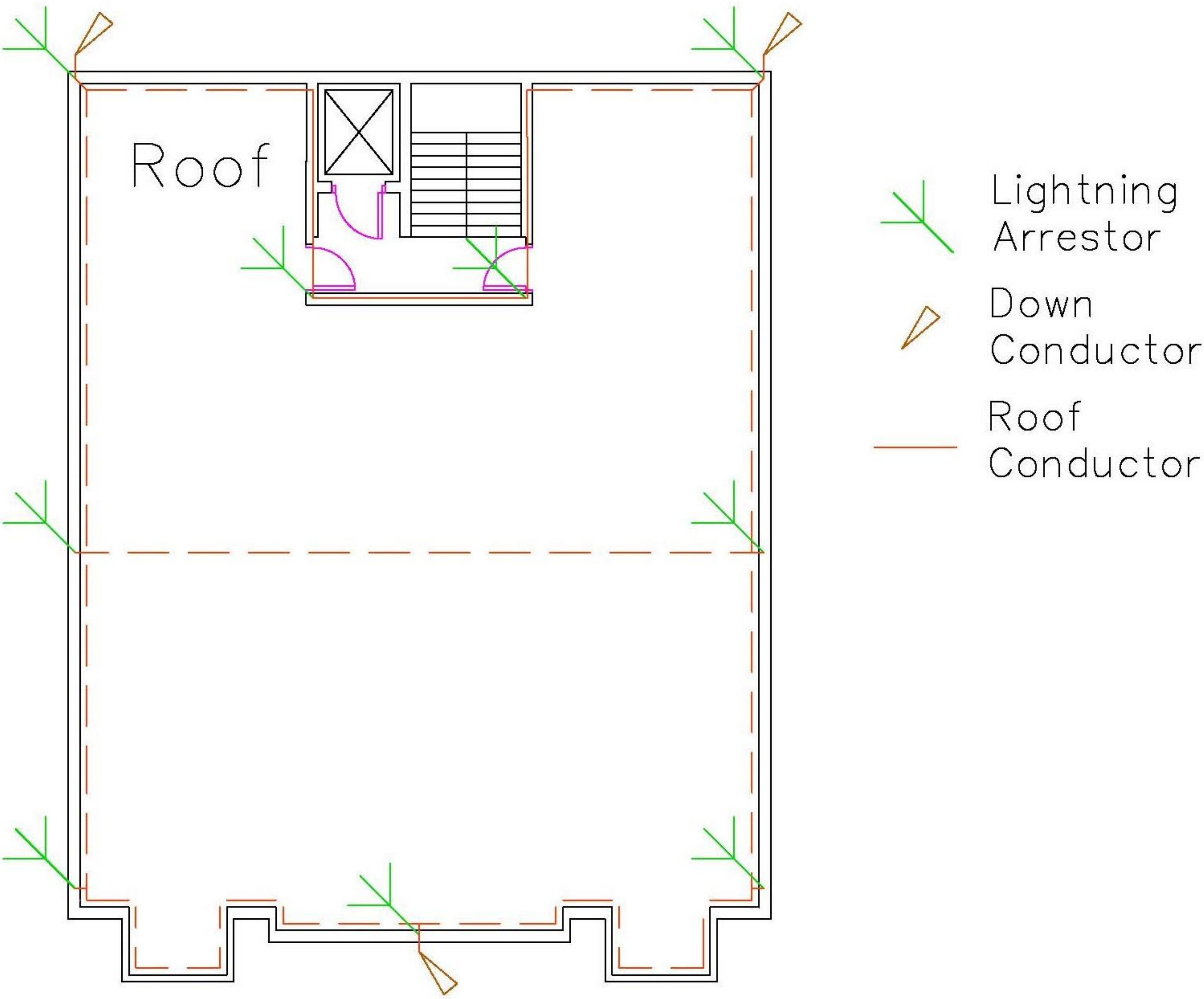
Total number of down conductors = 1+2 = 3

Thus, we 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.



Individual Contribution:

1906006: Kazi Ahmed Akbar Munim

1. Typical floor plan drawing
2. Typical floor Switchboard diagram drawing
3. Ground floor fittings plan drawing
4. Substation, Transformer and Generator design
5. MDB Diagram
6. Report Writing

1906007: Md. Abu Obaida Ma-az

1. Basement floor plan drawing
2. Basement Floor Switchboard diagram drawing
3. Basement Floor SDB and ESDB Diagram
4. Report Writing
5. Presentation Slide Making

1906017: Md. Rifat Ulla

1. Typical floor fittings plan drawing
2. Typical floor conduit plan drawing
3. Substation, Transformer and Generator design
4. EMDB Diagram
5. Basement Floor SDB and ESDB Load Calculation
6. Report Writing

1906023: Khandakar Humyra Oyshi

1. Light Fan Calculation of all floors
2. Ground Floor Switchboard Calculation
3. Ground Floor SDB and ESDB Load Calculation
4. Ground Floor SDB and ESDB Diagram drawing
5. Report Writing

1906032: Sabir Mahmud

1. Ground Floor plan drawing
2. Ground Floor Switchboard Diagram drawing
3. EMDB Calculation
4. Typical Floor SDB and ESDB Load Calculation
5. Report Writing

1906033: Nafis Faisal

1. Ground Floor Conduit plan drawing
2. Basement Floor Fittings plan drawing
3. Basement Floor Conduit plan drawing
4. MDB Calculation
5. Report Writing
6. Presentation Slide Making

1806054: Most. Noor Afroz Rimu

1. Rooftop floor plan drawing
2. Lightning protection calculation
3. Lightning protection system design
4. Typical Floor SDB and ESDB Diagram
5. Report Writing

Conclusion

In this project, we successfully designed the floor plan of a seven-storied residential building, integrating detailed layouts for electrical fixtures and conduit systems. Additionally, we developed a comprehensive switchboard connection diagram, demonstrating the distribution of incoming electric power throughout the building. To ensure clarity and efficiency, wire schedules and protective devices, such as circuit breakers, were incorporated into the single-line diagrams. Recognizing the importance of safety, we also planned and implemented a lightning protection system to safeguard the building from electrical surges caused by lightning strikes.

Furthermore, this project emphasized the critical balance between functionality, safety, and sustainability in electrical design. It allowed us to apply theoretical concepts to practical scenarios, honing our skills in system optimization, adherence to regulatory standards, and ensuring energy efficiency. This hands-on experience not only enhanced our understanding of residential electrical service design but also prepared us for tackling more complex design challenges in the future.

Acknowledgments

We would like to express our heartfelt gratitude to our respected course teacher **Mrinmoy Kundu** and **Md. Nure-Alam-Dipu** for their invaluable guidance, insightful advice, and continuous support throughout the course of this project. Their expertise and encouragement have been instrumental in helping us overcome challenges and achieve our objectives. We sincerely appreciate their contributions to the successful completion of this work.

References

[1] BNBC Table 8.1.5 (Recommended Values of Illumination for Residential Buildings

[2] Table for Cables, Conduits, ECC, EL, Voltage drop and Current ratings of different specifications as per Manual of Eastern Cables, BICC cables and Tables, Electrical Conductors (International Standard Sizes etc.)

[3] BNBC Table 8.1.27 (Index Figures Associated with Lightning Protection Design)

Reference [1]

Table 8.1.5: Recommended Values of Illumination for Residential Buildings

Area or Activity	Illuminance (lux)	Area or Activity	Illuminanc e (lux)
Dwelling Houses		Hotels	
Bedrooms		Entrance halls	150
General	70	Reception and accounts	300
Bed-head, Dressing table	250	Dining rooms (tables)	150
Kitchens	200	Lounges	150
Dining rooms (tables)	150	Bedrooms	
Bathrooms		General	100
General	100	Dressing tables, bed heads, etc.	250
Shaving, make-up	300	Writing rooms (tables)	300
Stairs	100	Corridors	70
Lounges	100	Stairs	100
Garages & Porches	100	Laundries	200

Area or Activity	Illuminance (lux)	Area or Activity	Illuminanc e (lux)
Basement Car Park	100	Kitchens	
Porches, Entrances	70	Food stores	100
Sewing and darning	600	Working areas	250
Reading (casual)	150	Goods and passenger lifts	70
Home work and sustained reading	300	Cloak-rooms and toilets	100
		Bathrooms	100
		Above mirror in bathrooms	300

Reference [2]

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Table for Cables, Conduits, ECC, EL, Voltage drop and Current ratings of different specifications as per Manual of Eastern Cables, BICC cables and Tables, Electrical Conductors (International Standard Sizes) etc. :

A	B	C	D	E	F		G	H	I		J	
					a'	b'			a''	b''	a'''	b'''
3/0.029	1.5	5	16	10	6	10		27	27	22	16	20
7/0.029	2.5	10	16	10	4	7		16	36	30	22	28
7/0.036	4	15	14	10	3	5	1	10	47	39	30	37
7/0.044	6	20	14	10	2	4	1	6.8	59	50	38	47
7/0.052	10	30	10	10	1	2	1.5	4	78	68	52	63
7/0.064	16	40	10	10		1	1.5	2.6	100	94	70	85
19/0.052	25	50	6	6		1	2	1.6	130	125	91	110
19/0.064	35	60	6	6			2	1.2	155	160	112	136
19/0.072	50	70	6	6			2	0.93	185	195	136	164
19/0.083	70	100	1/0	1/0			2	0.65	225	245	173	207
37/0.072	95	120	1/0	1/0			2.5	0.48	270	300	216	253
37/0.083	120	150	1/0	1/0			2.5	0.4	310	350	244	291
37/0.093	150	200	1/0	1/0			3	0.34	350	405		333
37/0.130	185	250	3/0	3/0			3.5	0.29	390	460		381
61/0.093	240	300	3/0	3/0			4	0.24	450	555		452
61/0.103	300	425	3/0	3/0			4	0.22	515	640		526
91/0.093	400	585	3/0	3/0			6	0.2	586	770		639
91/0.103	500	685	3/0	3/0			6	0.18	680	900		752
127/0.103	630	800	3/0	3/0			6	0.17	800	1030		855

A : Single core cable construction diameter, inch …. as per Imperial Standard Size : B.S.S (old).
B : Single core cable construction area, mm^2 …. as per Metric Standard Size : VDE.
C : CB designed current rating amps.
D : ECC (Earth Continuity Conductor), SWG.
E : EL (Earthing Lead), SWG
F : No. of cables in
  a') 3/4" diameter conduit
  b') 1" diameter conduit
G : GI pipe diameter (for 4 – core cable), inch.
H : Volt drop /amp/meter, Vd in mV (For PVC insulated, non-armoured single core cable 600/1000 volts as per BICC Metric Supplement, page 20-22, September 1969).
I : Maximum Current rating (For Type : NYY to VDE 0271/3, 69)
  a") 30^0 C ambient temperature, underground, amps
  b") 35^0 C ambient temperature in air, amps
J : Maximum current carrying capacity (For Type : BYA to B.S. 6004 : 1975)
  a"') Bunched & Enclosed in conduit, two cables single phase at 35^0 C, amps
  b"') Clipped to a surface or on a cable tray bunched and un-enclosed two cables single phase at 35^0 C, amps
NYY : PVC insulated and PVC sheathed cable, rated voltage 600/1000 volts.
BYA : PVC insulated non-sheathed single core cable, rated voltage 450/750 volts.

Reference [3]

1.3.33 Lightning Protection of Buildings

Whether a building needs protection against lightning depends on the probability of a stroke and acceptable risk levels. Assessment of the risk and of the magnitude of the consequences needs to be made. As an aid to making a judgment, a set of indices is given in Table 8.1.27 below for the various factors involved.

Table 8.1.27 (a): Index Figures Associated with Lightning Protection Design

Index A: Use of Structure	Index	Index B: Type of Construction	Index
Houses and similar buildings	2	Steel framed encased with nonmetal roof[a]	1
Houses and similar buildings with outside aerial	4	Reinforced concrete with nonmetal roof	2
Small and medium size factories, workshops and laboratories	6	Brick, plain concrete, or masonry with nonmetal roof	4
Big industrial plants, telephone exchanges, office blocks, hotels, blocks of flats	7	Steel framed encased or reinforced concrete with metal roof	5
Places of assembly, for example, places of workshop, halls, theatres, museums, exhibitions, department stores, post offices, stations, airports, stadiums	8	Timber formed or clad with any roof other than metal or thatch	7
Schools, hospitals, children's homes and other such structures	10	Any building with a thatched roof	10

[a] A structure of exposed metal which is continuous down to ground level is excluded from the table as it requires no lightning protection beyond adequate earthing arrangements.

Table 8.1.27 (b): Index Figures Associated with Lightning Protection Design

Index C : Contents or Consequential Effects	Index	Index D : Degree of Isolation	Index
Ordinary domestic or office building, factories and workshops not containing valuable materials	2	Structure located in a large area having structures or trees of similar or greater height, e.g. a large town or forest	2
Industrial and agricultural buildings with specially susceptible [b] contents	5	Structure located in an area with a few other structures or trees of similar height	5
Power stations, gas works, telephone exchanges, radio stations	6	Structure completely isolated or exceeding at least twice the height of surrounding structures or trees	10
Industrial key plants, ancient monuments, historic buildings, museums, art galleries	8	**Index E : Type of Terrain**	**Index**
Schools, hospitals, children's and other homes, places of assembly	10	Flat terrain at any level	2
[b] This means specially valuable plant or materials vulnerable to fire or the results of fire.		Hilly terrain	6
		Mountainous terrain 300 m and above	8

Table 8.1.27 (c) : Index Figures Associated with Lightning Protection Design

Index F : Height of Structure	Index	Index G : Lightning Prevalence	Index
Up to 9 m	2	Number of thunderstorm days per year:	
9-15 m	4	Up to 3	2
15-18 m	5	4-6	5
18-24 m	8	7-9	8
24-30 m	11	10-12	11
30-38 m	16	13-15	14
38-46 m	22	16-18	17
46-53 m [c]	30	19-21	20
[c] Structures higher than 53 m require protection in all cases		Over 21	21