BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

EEE 414: Electrical Service Design

Project Report on

Electrical Service Design of a 9 – Storied Residential Building with Single- and Dual-unit Floorplans

Submitted to

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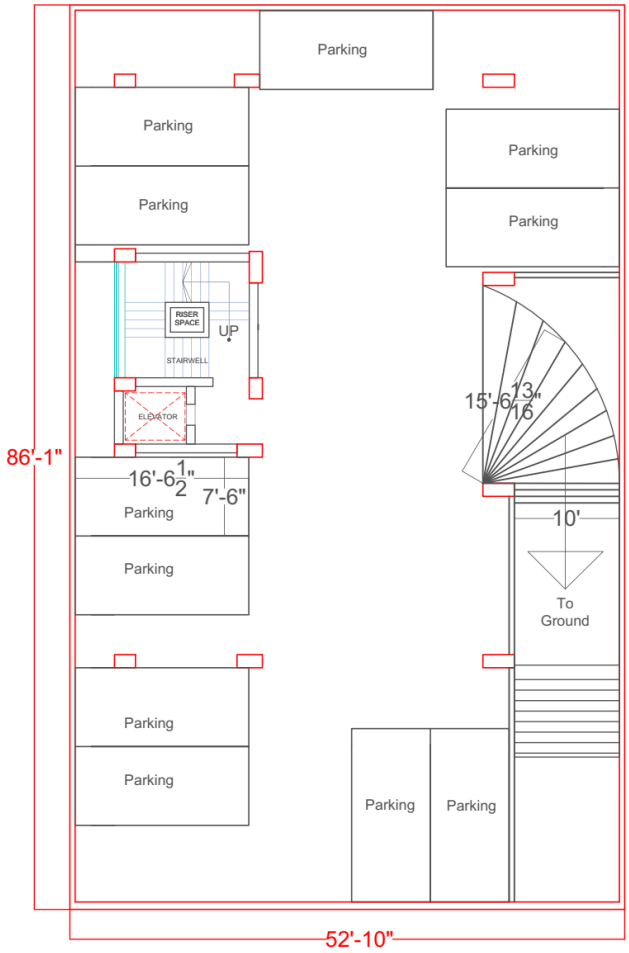
EEE 17, Section A (2)

Level 4, Term 2

Introduction

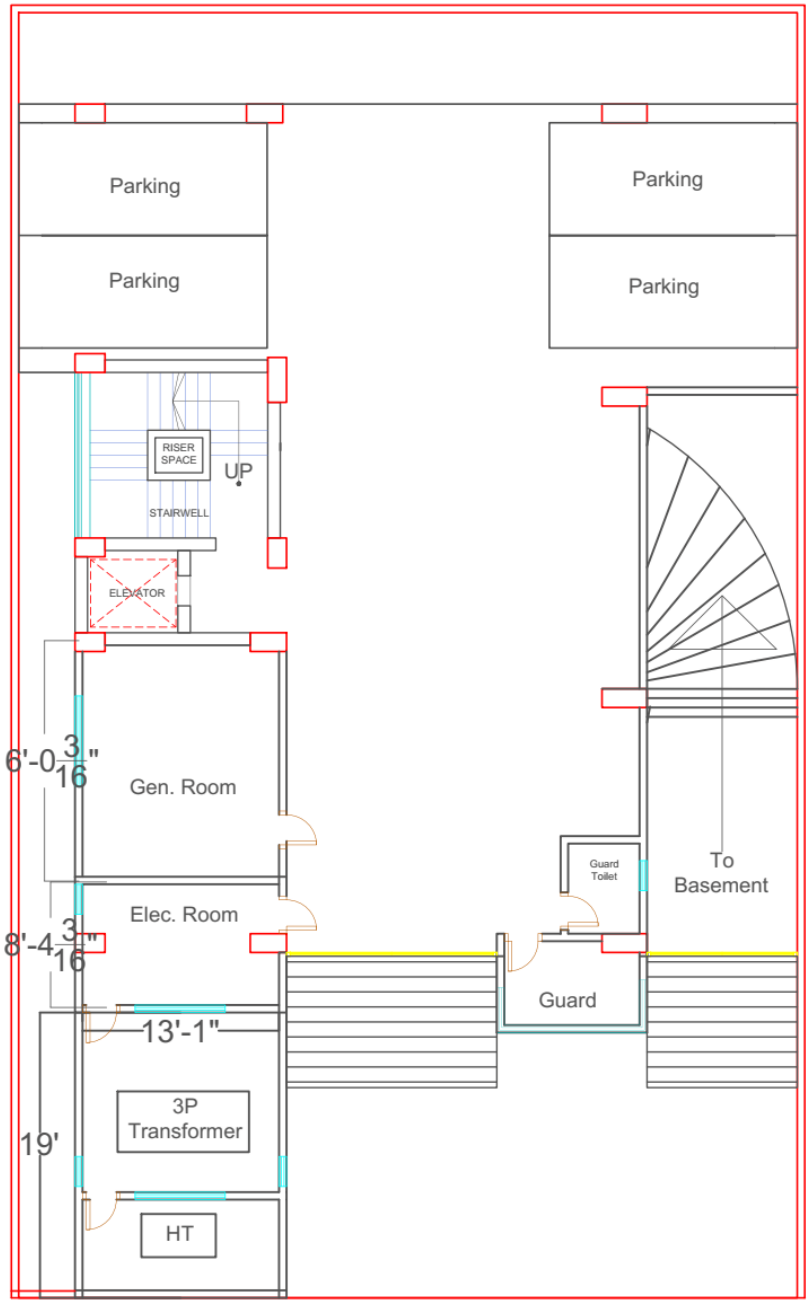
Our designed building plan has been taken from an under construction building in Baridhara residential area, with swimming pool facility on rooftop. We had to make proper adjustments to the initial plan to accommodate 9 residential stories, 6 of which are dual units and 3 single units, and had to add another basement parking area to make room for 15 cars (one for each unit) along with the necessary driving ramp for cars to move between levels. We also had to extend the plan to include substation and emergency generator room. Electric designs were then made according to the theory taught in our EEE 414 course and using practical considerations.

Layout - Basement



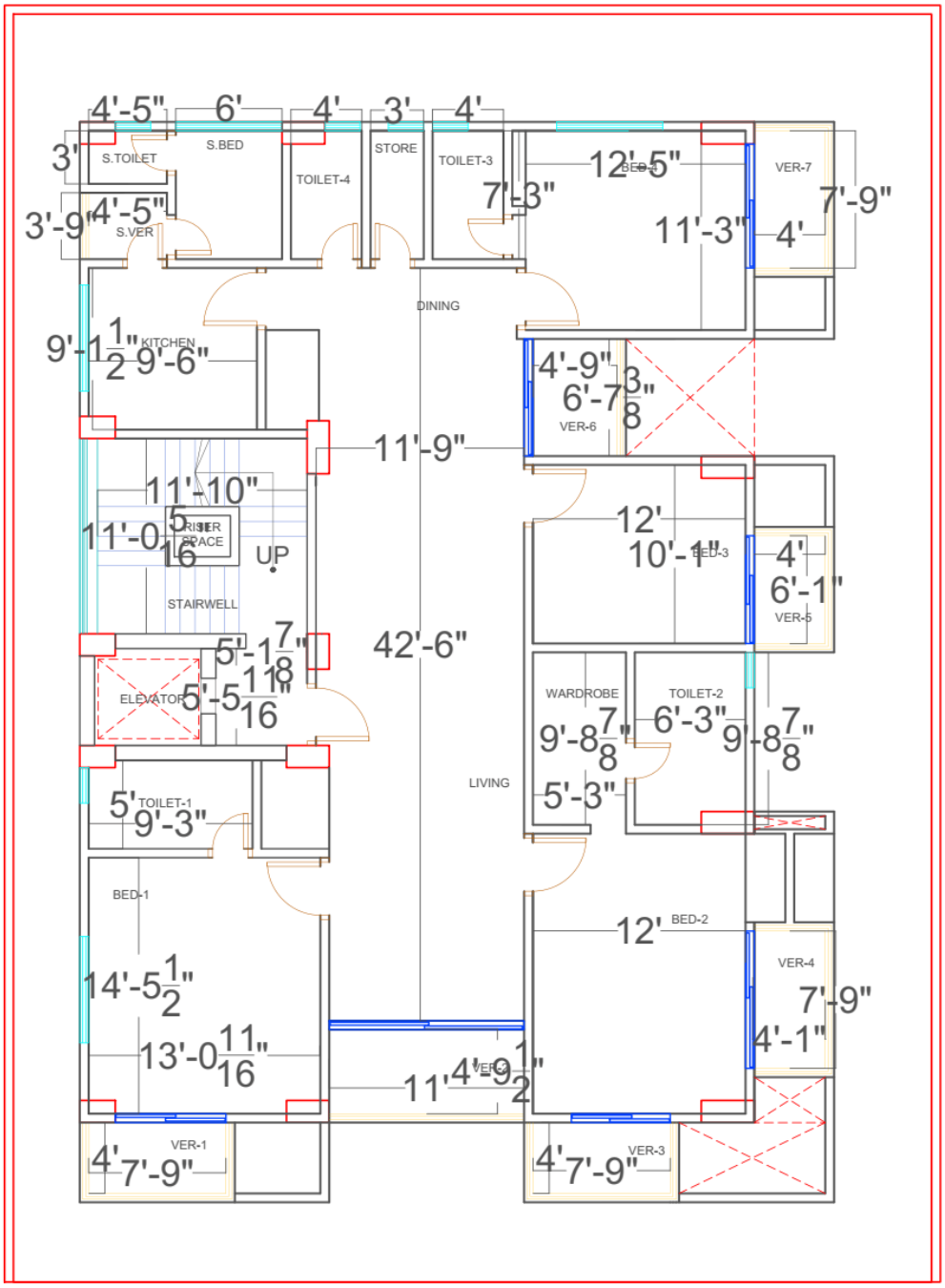
Here, we had to extend the basement and the ground and the basement to make room for the cars and the substation and generator room.

Layout - Ground Floor

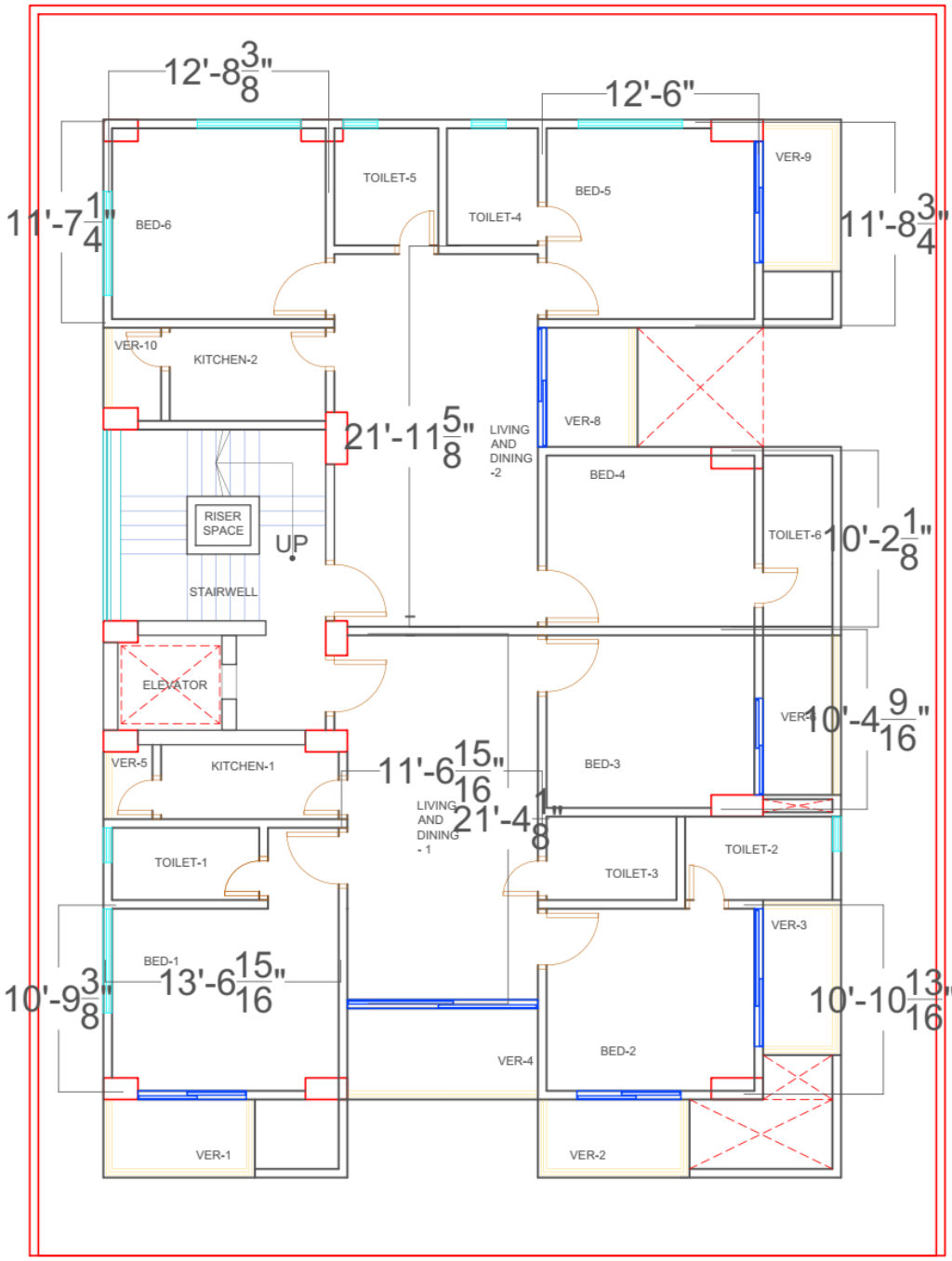


There are 4 car parking spaces in the ground floor and 11 in the basement – a total of 15 cars for the 15 units in our building. The ramp is at the right side with approximately 20% slope (The ground lies 5 ft above road height, and the ramp length is around 25 feet. Thus, 5/25 = 20%).

Layout - Typical 1 Unit

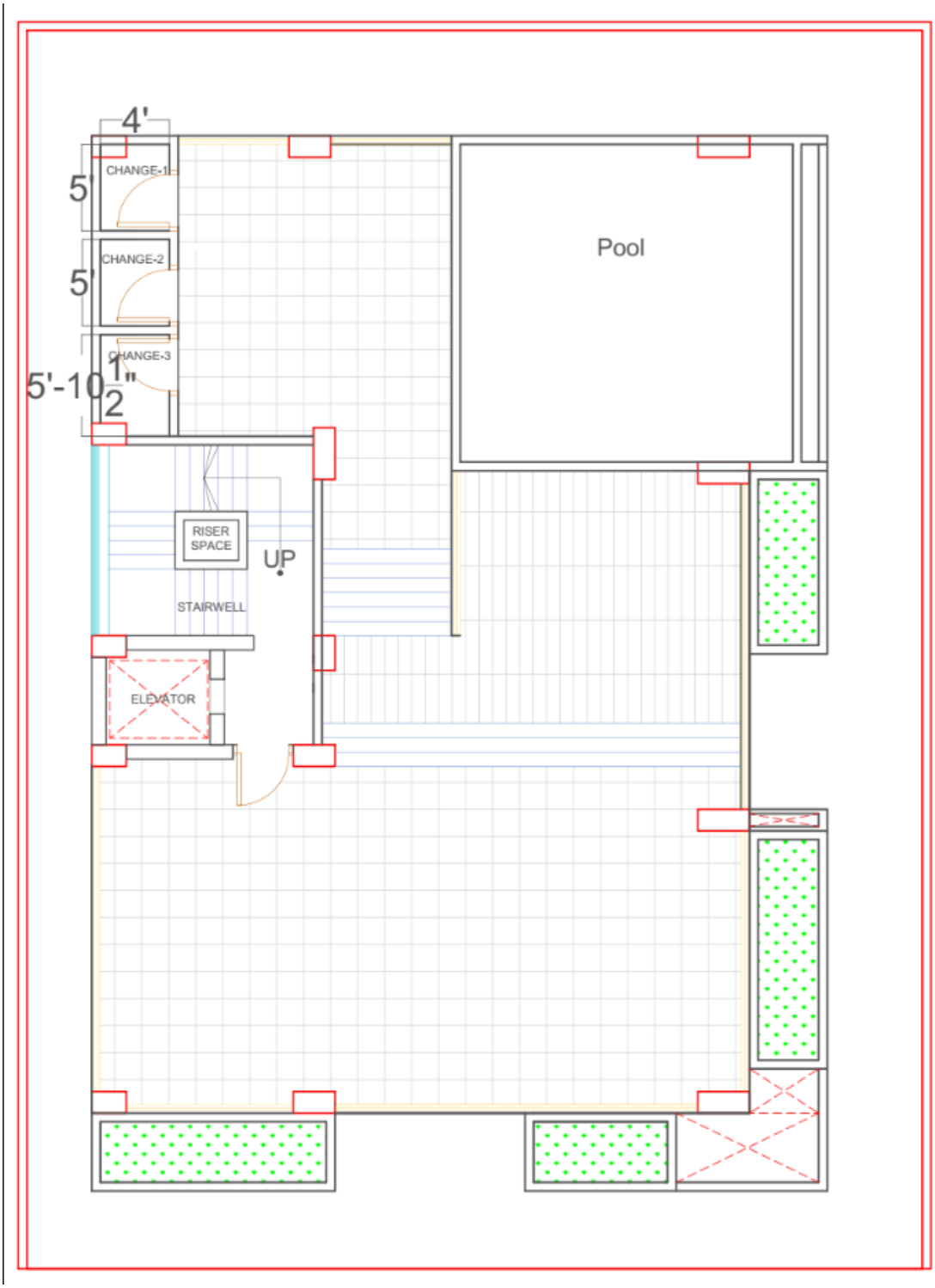


Layout - Typical 2 Unit



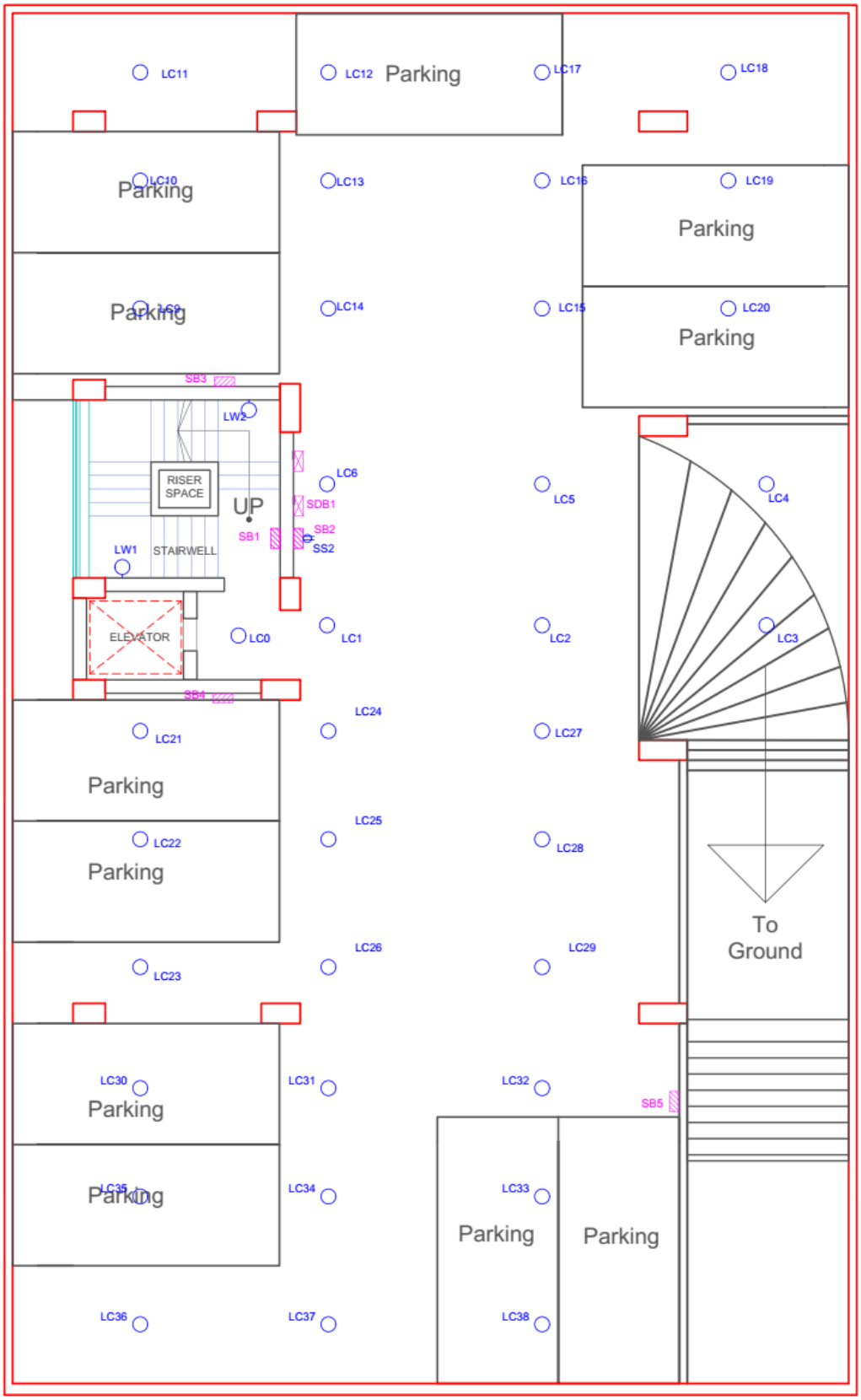
The 2 units in the plan are not symmetric. We also had to make some adjustments as the toilet area of one flat was inserted into the other unit.

Layout - Roof

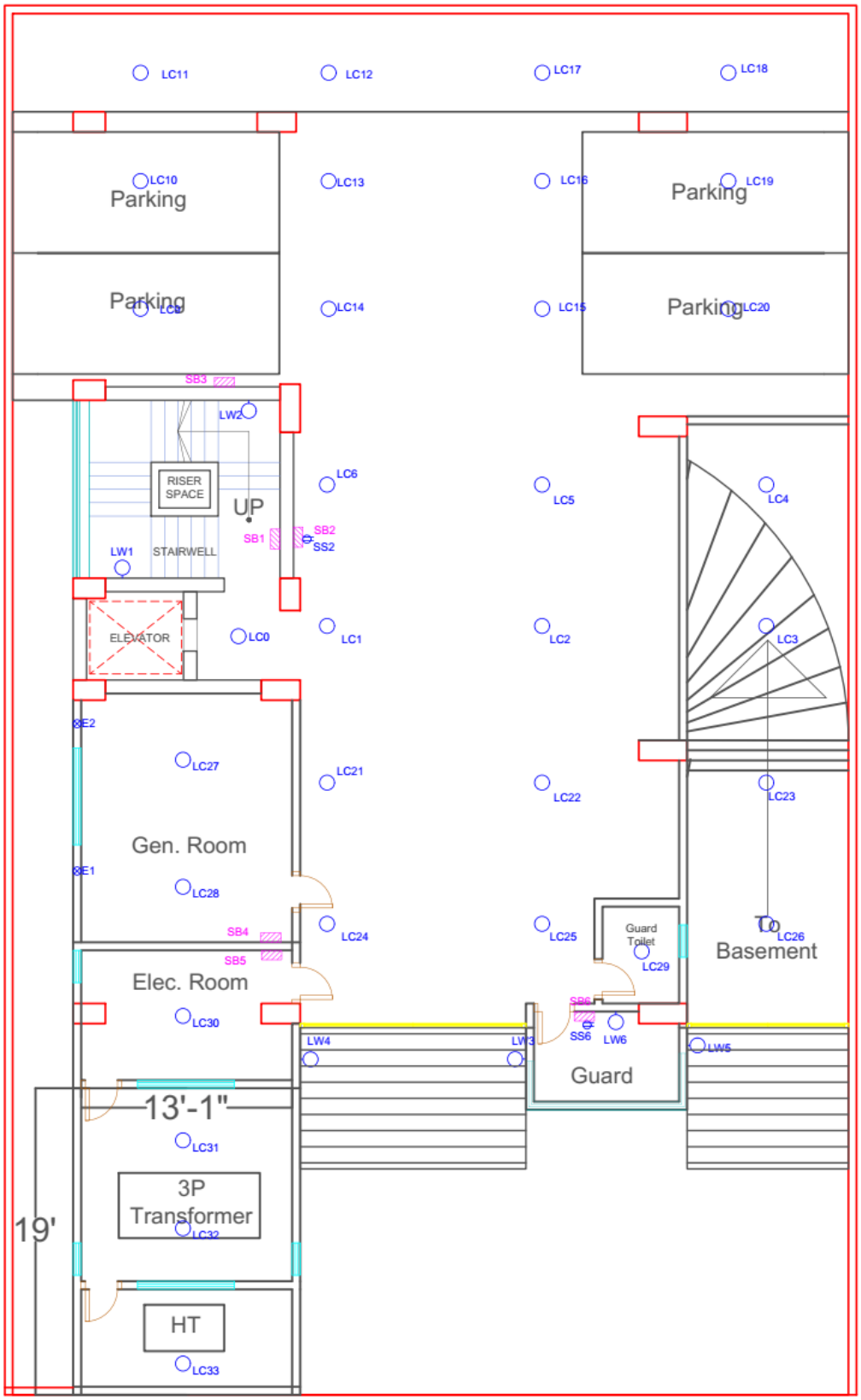


The yellow marked area on south of the swimming pool denotes a platform a little higher than the rest of the roof.

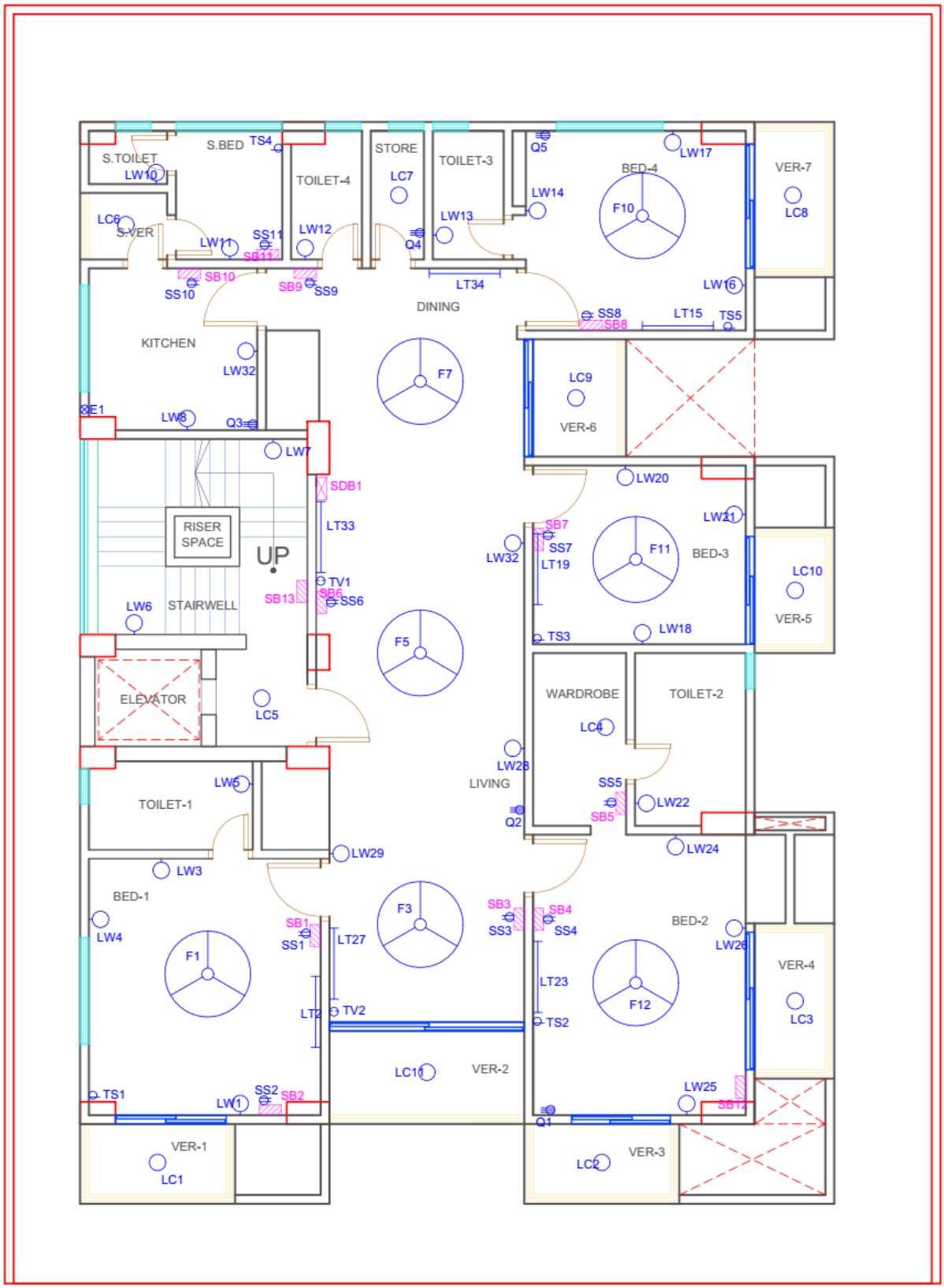
Fittings and Fixtures – Basement



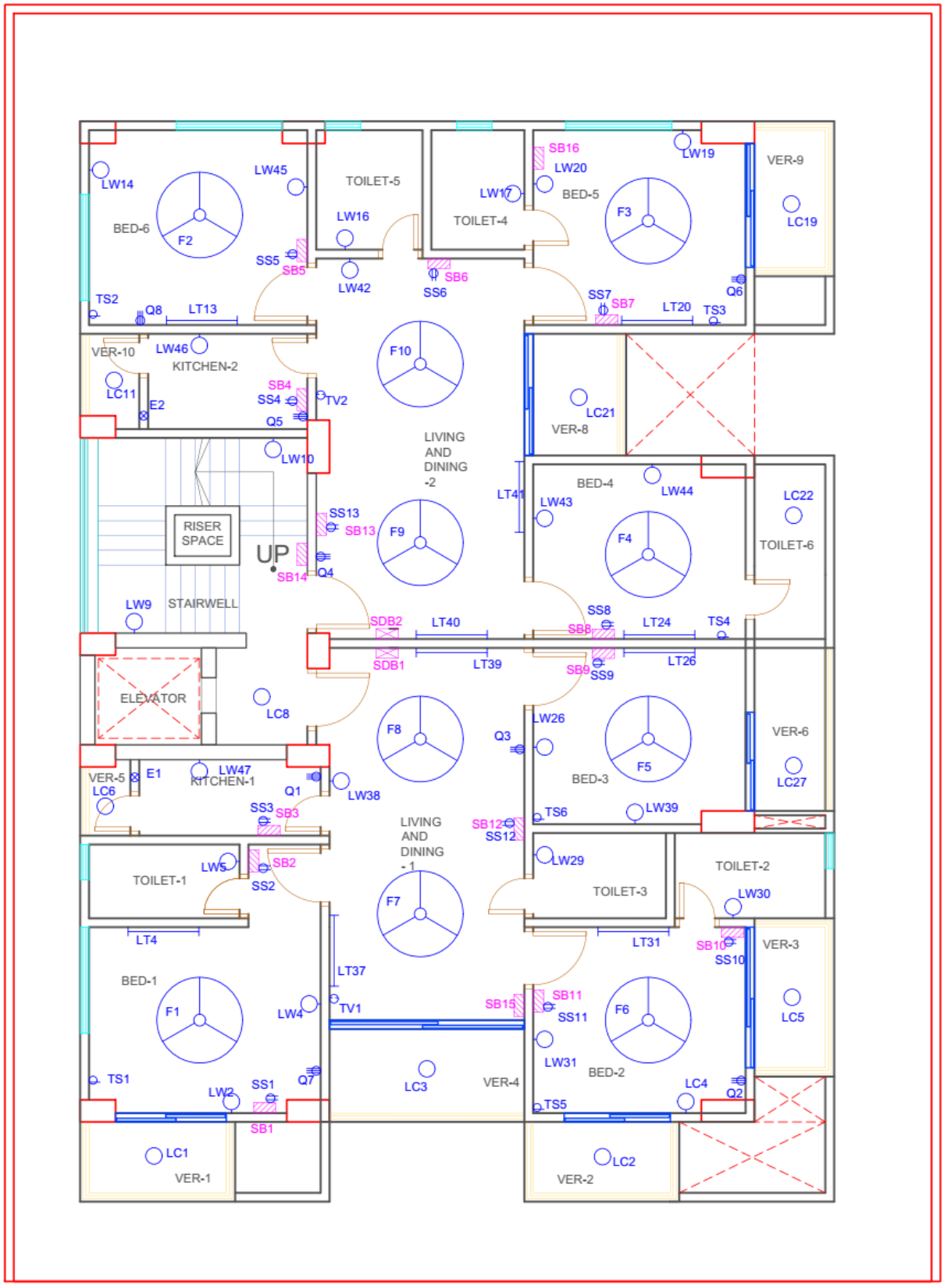
Fittings and Fixtures – Ground



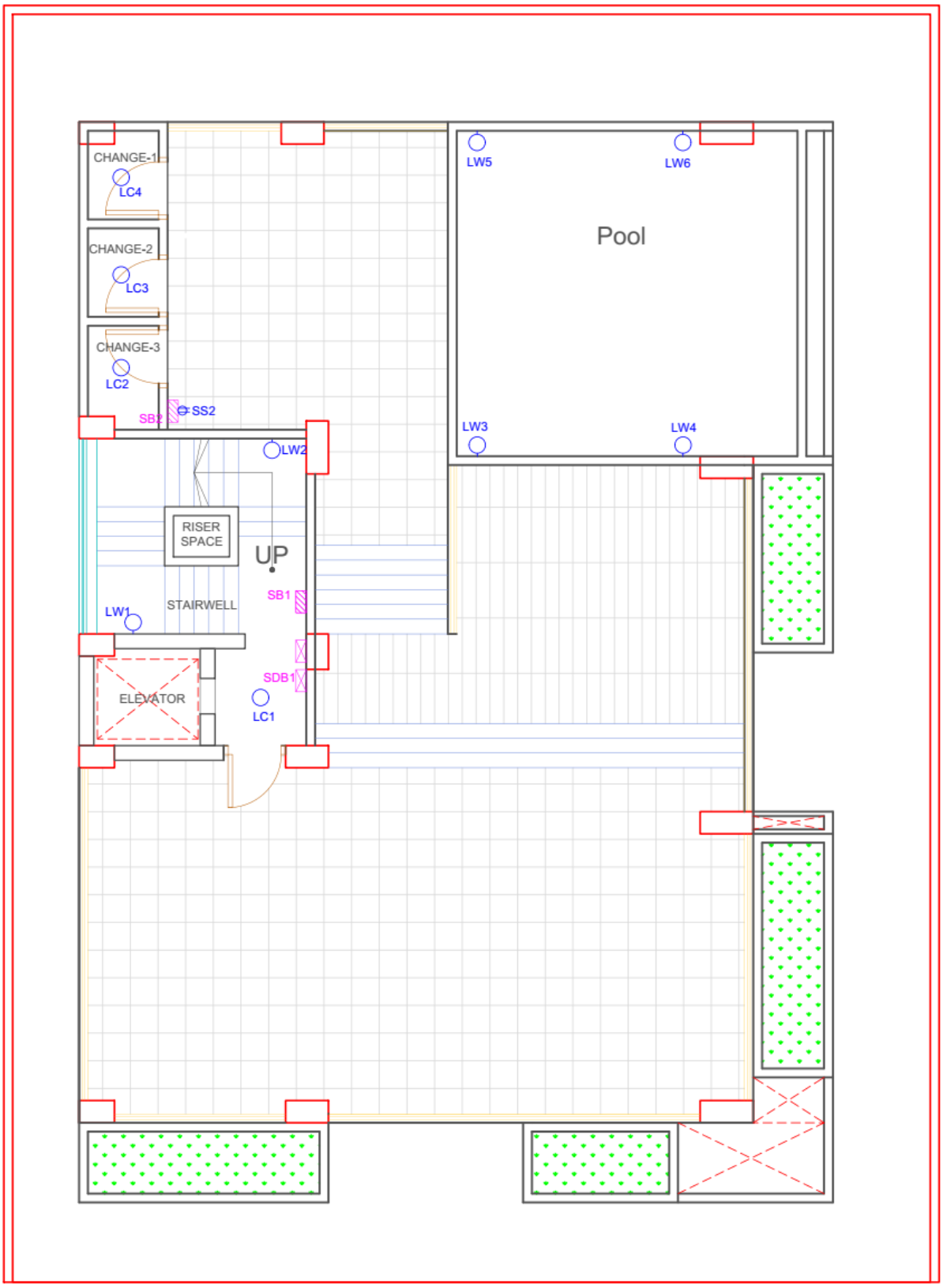
Fittings and Fixtures – Typical 1 Unit



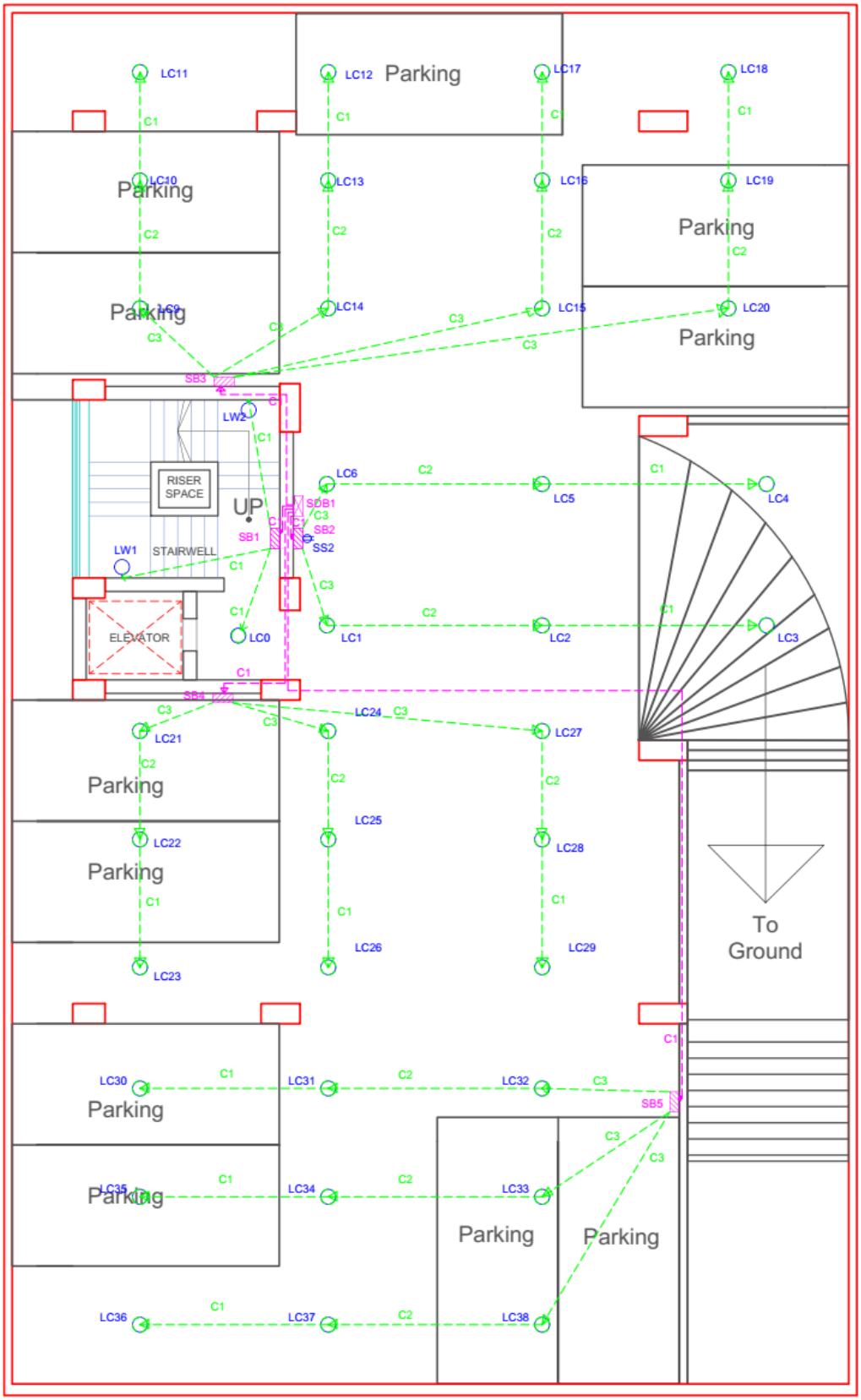
Fittings and Fixtures – Typical 2 Unit



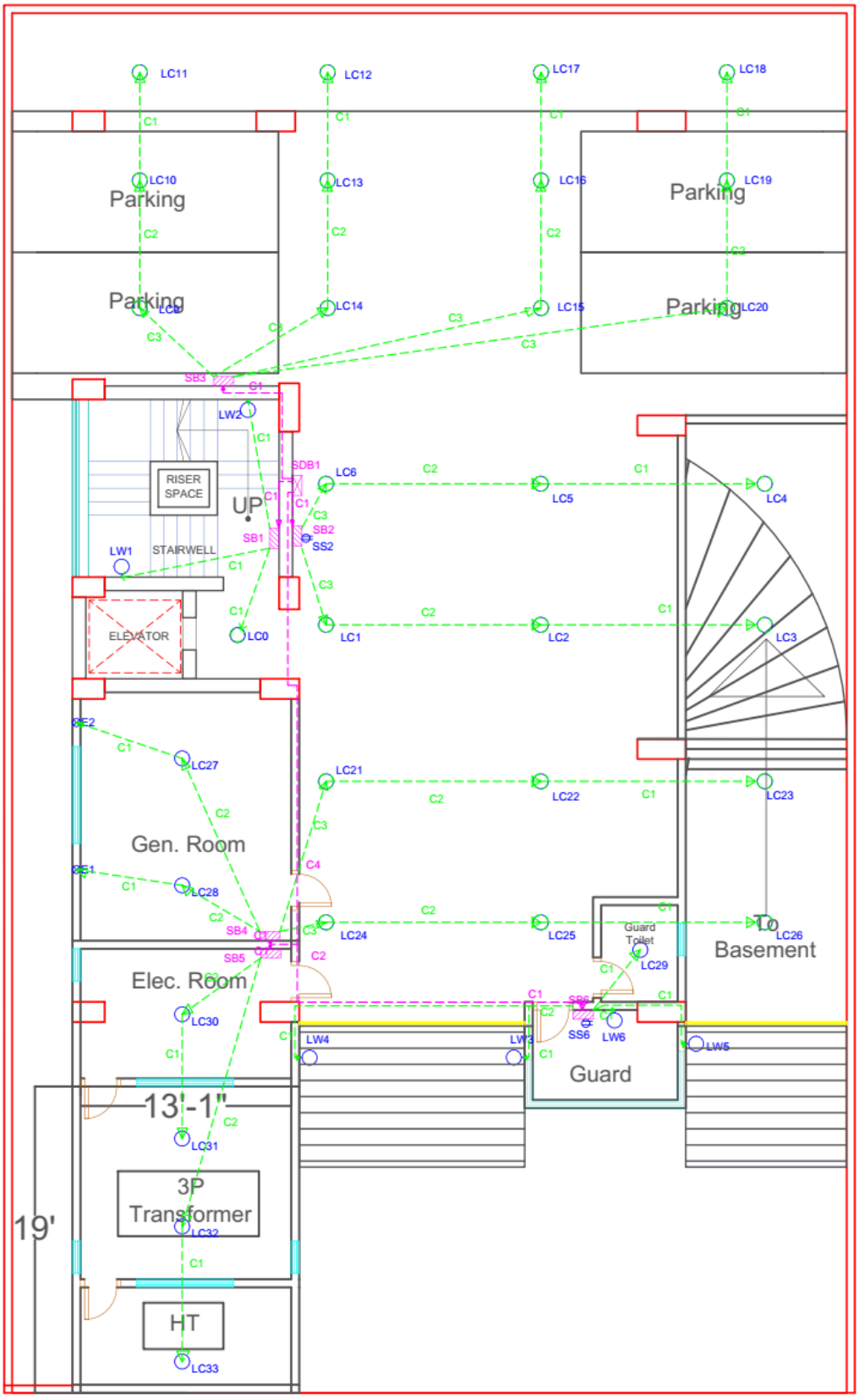
Fittings and Fixtures – roof



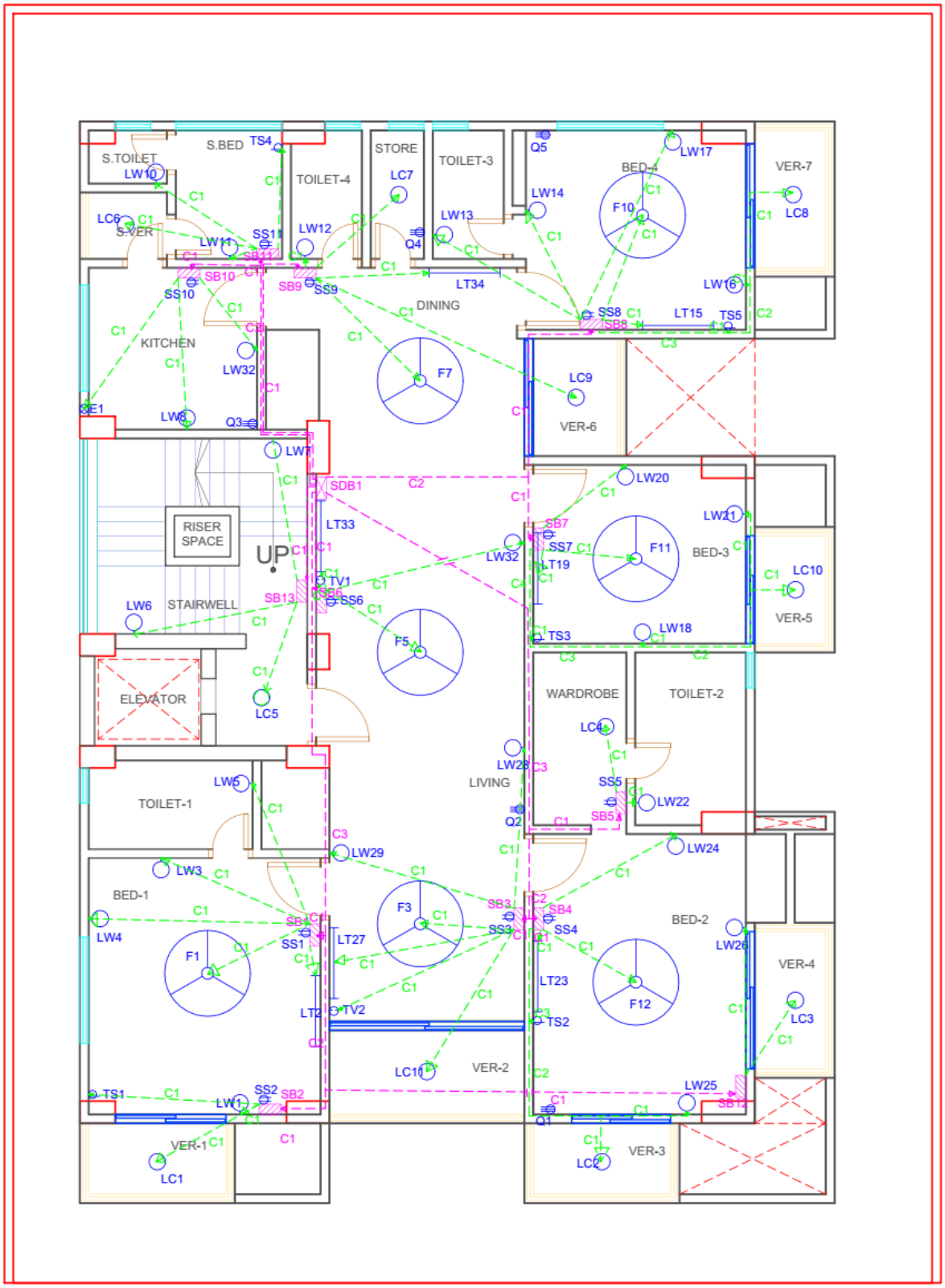
Conduit layout – Basement



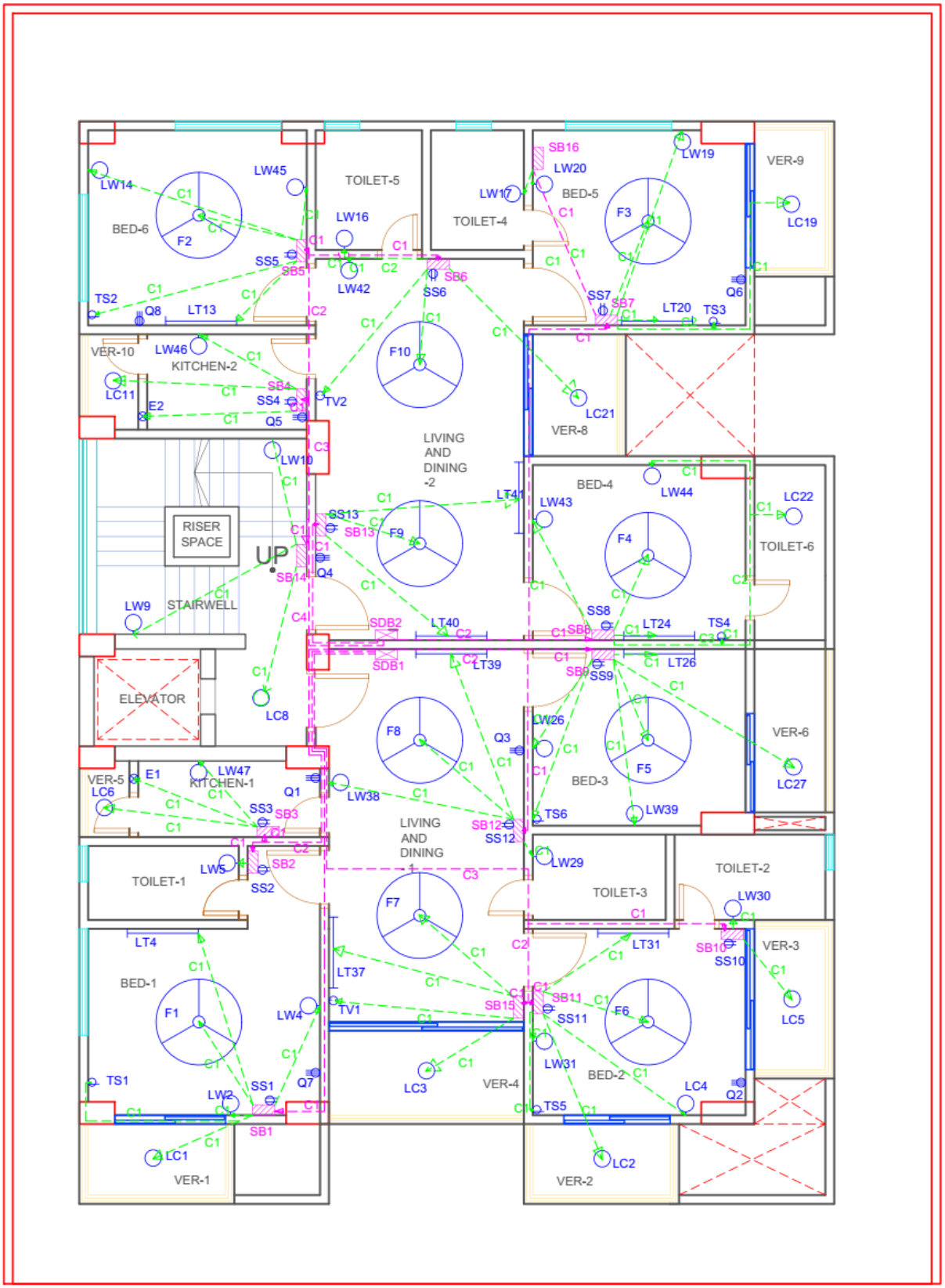
Conduit layout – Ground Floor



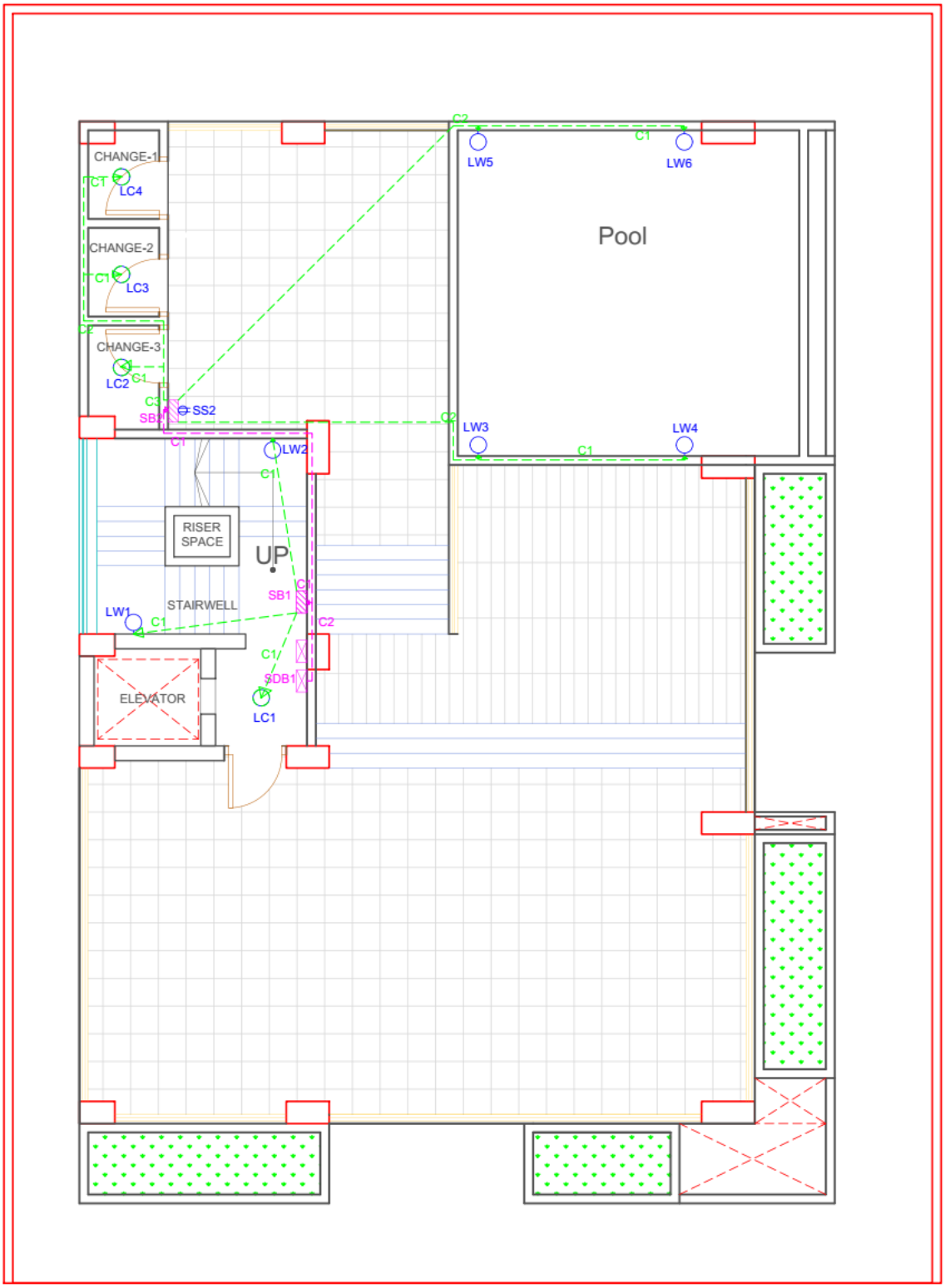
Conduit layout – Typical 1 Unit



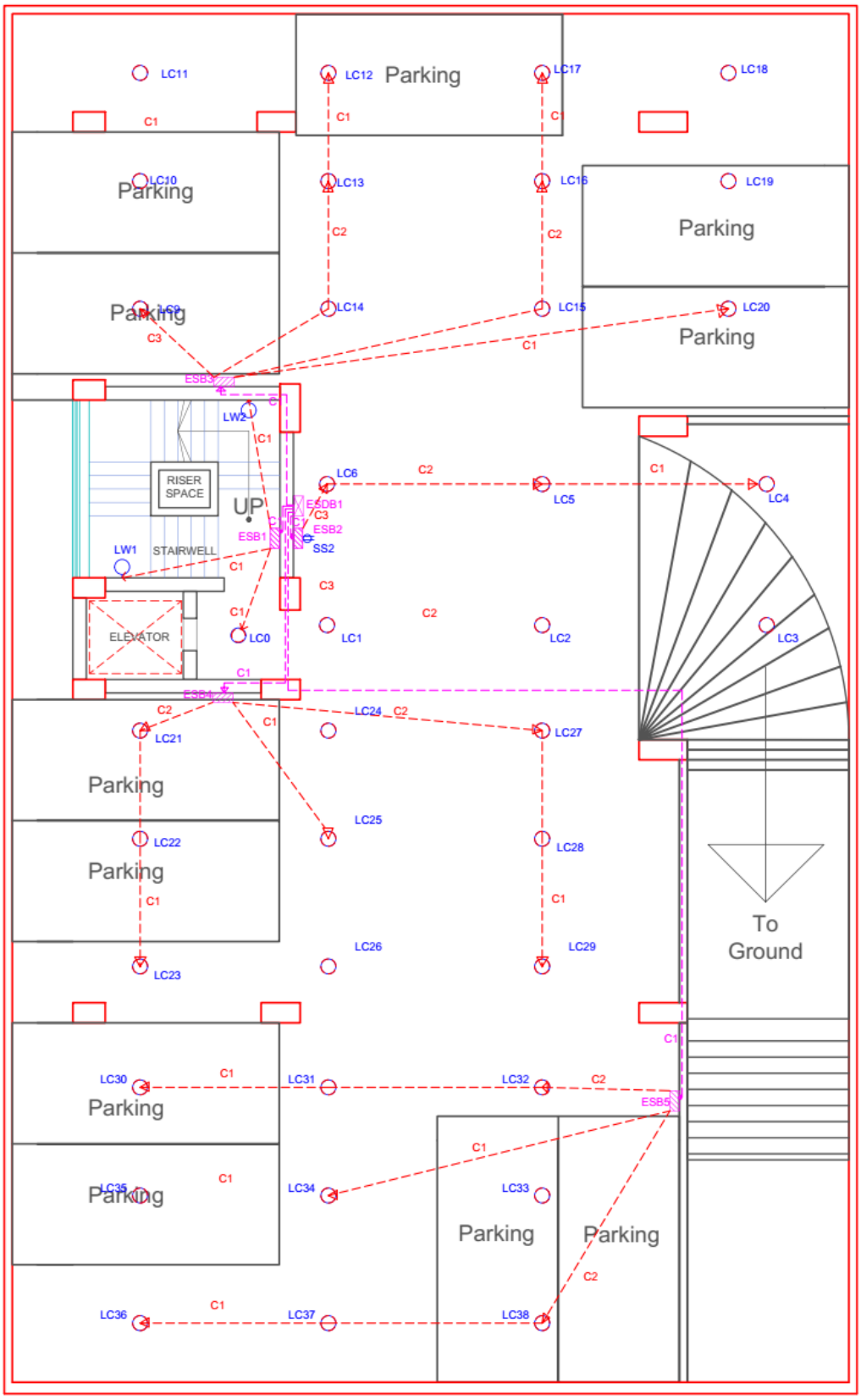
Conduit layout – Typical 2 Unit



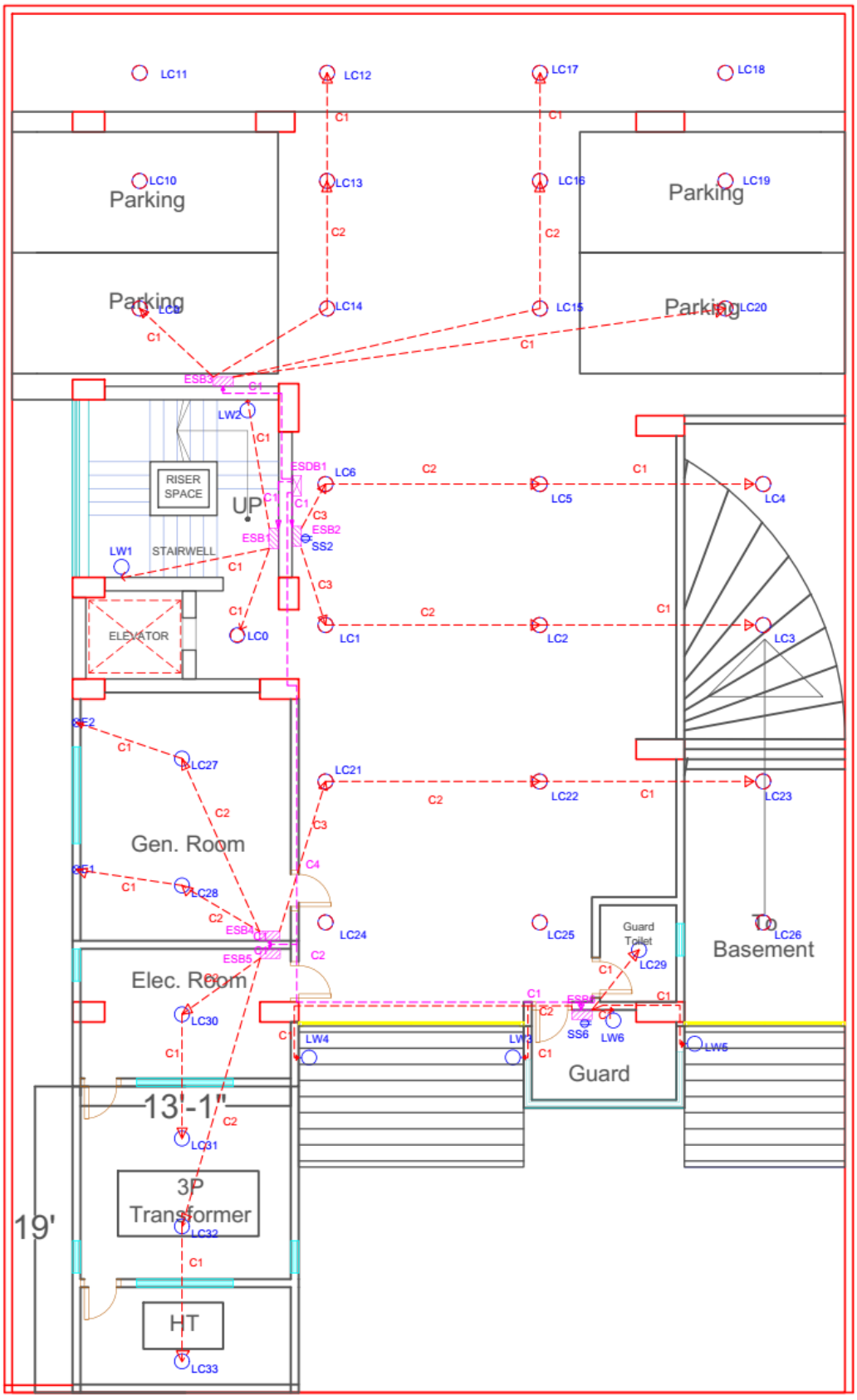
Conduit layout – Roof



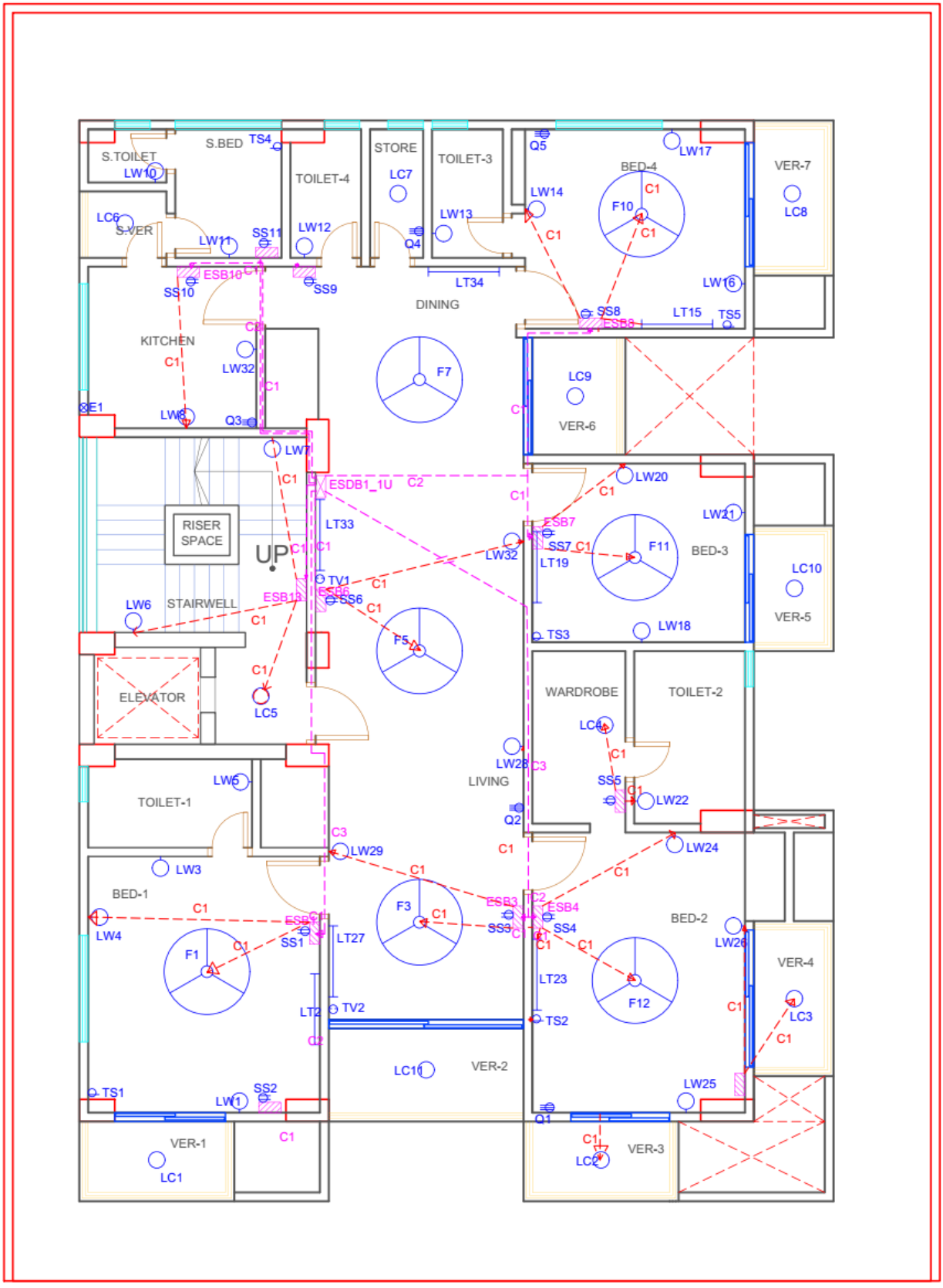
Emergency conduits – Basement



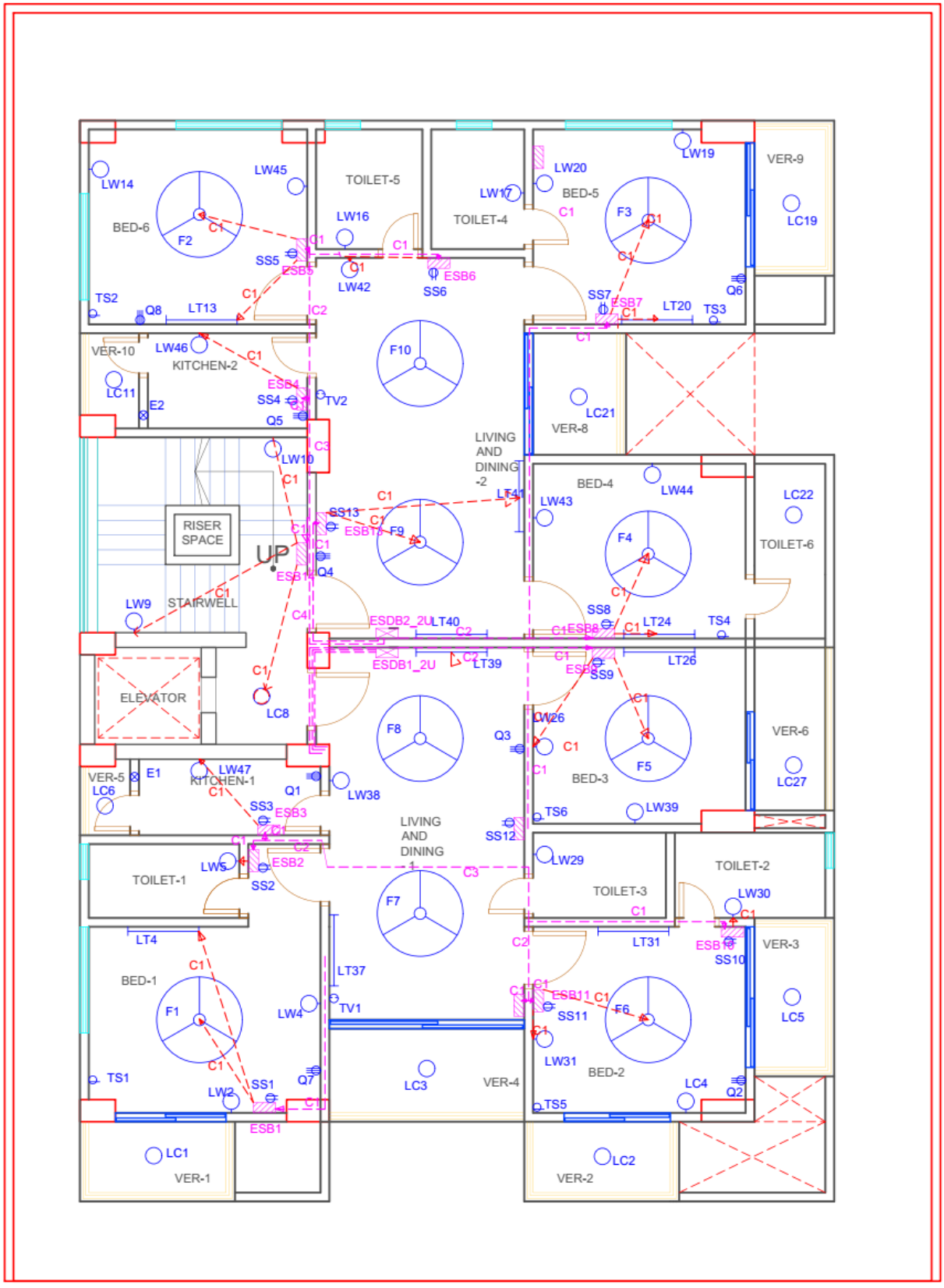
Emergency conduits – Ground



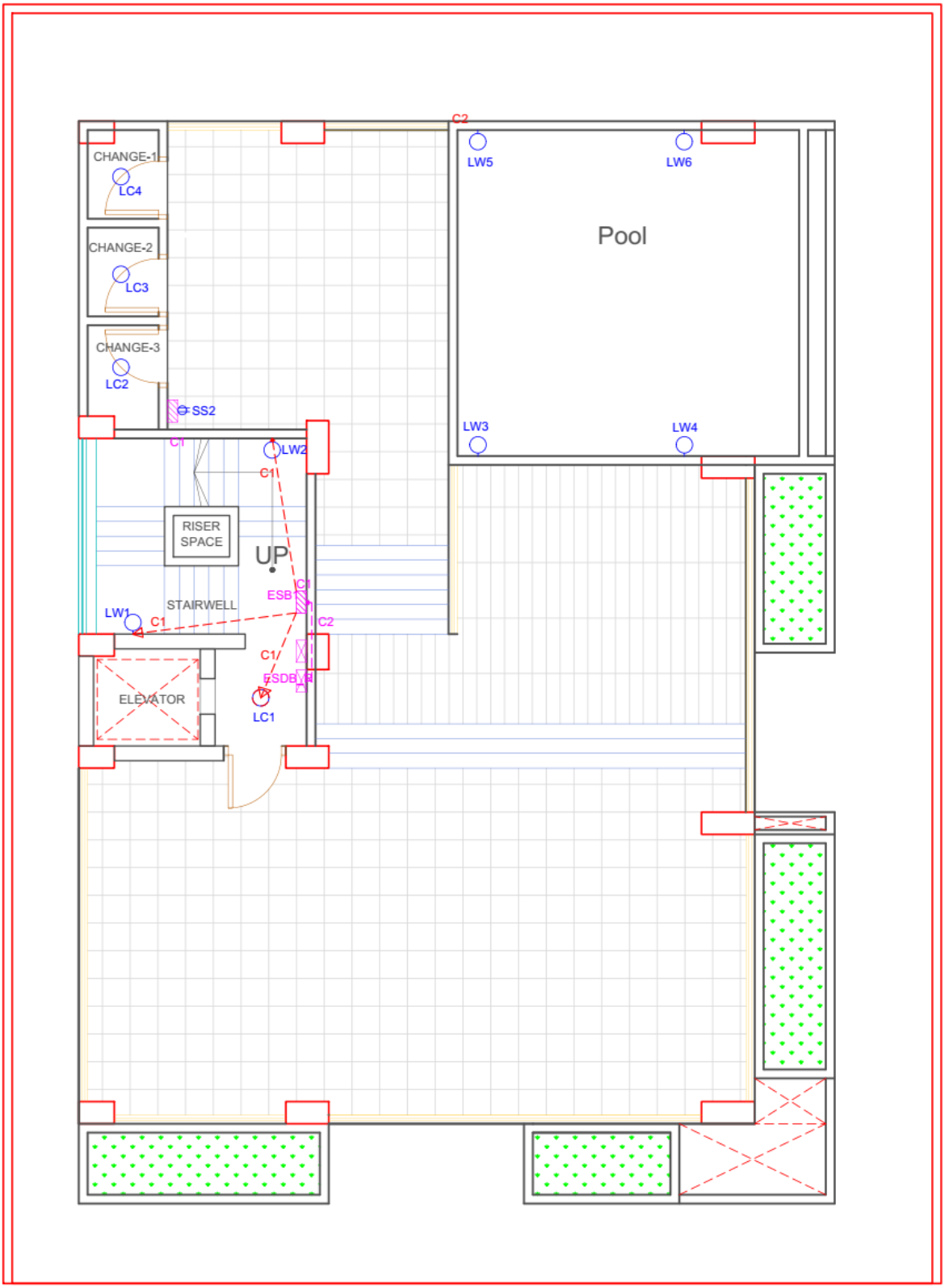
Emergency conduits – Typical 1 Unit



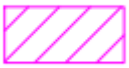
Emergency conduits – Typical 2 Unit



Emergency conduits – Roof



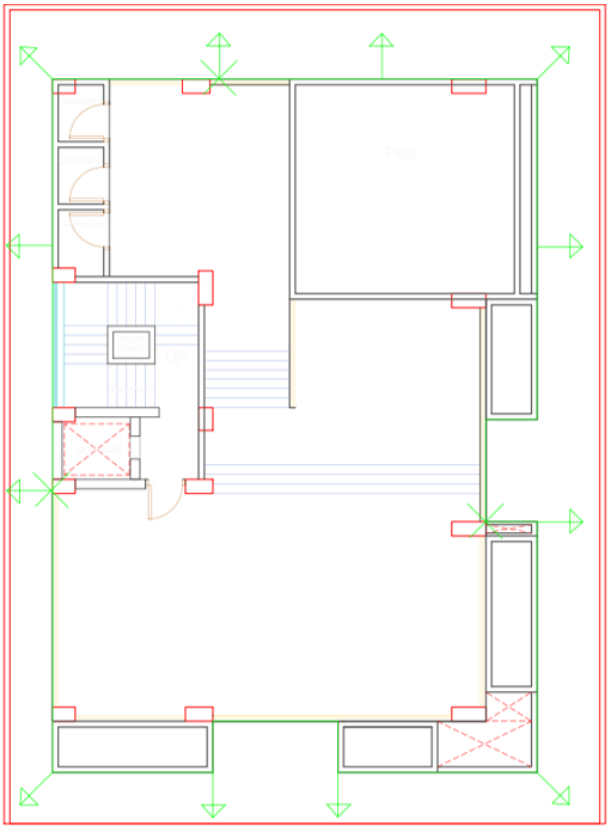
Symbol	Legend	Description	Power Rating
	LT	Tube Light	40 W
	LW	Wall Mounted Light at Lintel Level	15 W
	SS	2 Pin Socket at Switchboard Level (5A)	100 W
	TV	Television Socket	150 W
	Q	3 Pin Socket (20A)	4000 W
	ST	2 Pin Socket at Skirting Height (5A)	100 W
	F	Ceiling Fan	100 W
	E	Exhaust Fan	40 W

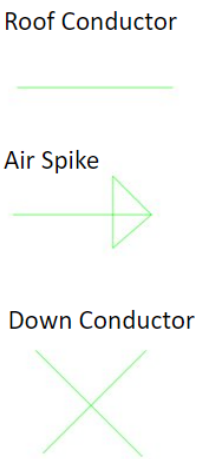
	SS/ESB	Switch Board/ Emergency Switch Board	-
	SDB	Sub Distribution Board	-
	ESDB	Emergency Sub Distribution Board	-
	MDB	Main Distribution Board	-
	EMDB	Emergency Main Distribution Board	-

Some Notes of Fitting and Fixtures and Conduits

1. We chose 20W LED bulbs and tubelights (2000 W in standard 100 lumen/W rate).
2. For power socket, 3 pin Q (20A, 4000W) were used. We tried to distribute 4 power sockets to each of the dual units and 5 to the single unit.
3. For emergency conduit, only one light and one fan per each bedroom, half of the lights in the garage, the stair lights and some few other lights were kept. Our emergency system is part of the main system and works as a partial backup, so we didn't add any separate emergency system.

Lighting Protection System:





Calculation:

Length of the Building: 72'
Width of the Building: 53'
Total Area = 3816 sq ft, 354.6 sq meters

Conductors on the Roof: (conductor height = 24", Maximum Gap between two conductors = 25')

First, 4 conductors are placed on four corners. Then it is found that two more on each of the four sides are required to maintain maximum gap. Thus, total 4 + 2x4 = 12 conductors are used.

Gap between each conductor along length = 24'

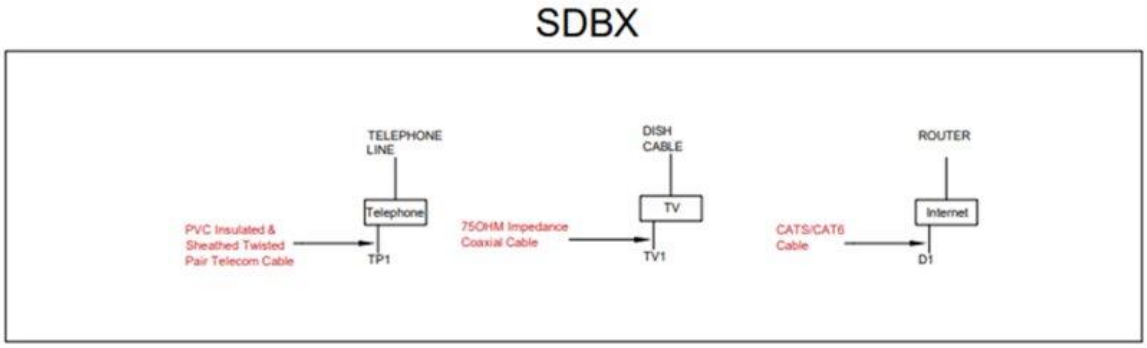
Gap between each conductor along width = 17.67'

Down Conductor:

Perimeter of the Building = 250'

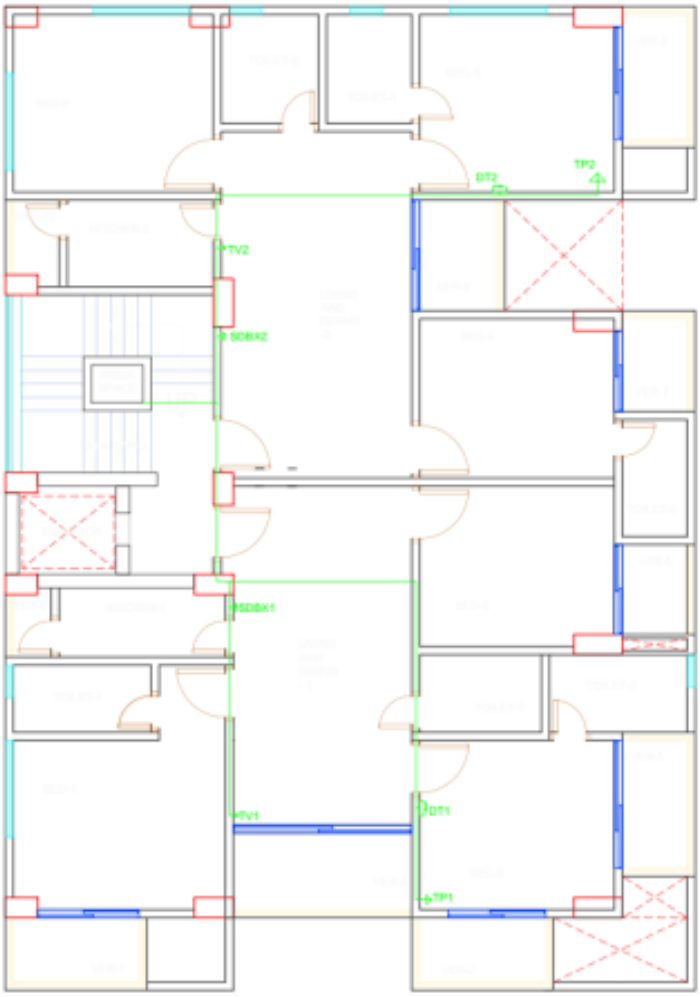
Required Down Conductor = 250/100 = 2.5 ~= 3

Conduit Layout of TV, Cable and Data Networks



Symbols	Descriptions
	TV Dish Line
	Telephone Line
	Port For Communication
	Internet Router

Conduit Layout of
TV, Cable and
Data Networks
2 Unit



Light Calculations – Typical 1 Unit

E = n*N*F*LLF*UF / A

Here, n = 1, LLF = 0.7, UF = 0.75

Room Name	LENGTH (feet) X WIDTH (feet)	AREA (in Sq.Meter)	RECOM. LUX	NO. OF LIGHTS	ACTUAL LUX
BED-1	15X14	19.5	100	4	153
BED-2	15X11	15.32	100	4	-
BED-3	11X12	12.26	100	4	-
BED-4	13X12	14.5	100	4	-
S. BED	7.5X6	4.18	100	1	188
TOILET-1	9.5X5	4.41	100	1	178
TOILET-2	6.5X10	6.03	100	1	130
TOILET-3	7.5X4	2.78	100	1	93
TOILET-4	7.5X4	2.787	100	1	93
S. TOILET	4.5X3	1.25	70	1	93
VER-1	8X4	2.97	70	1	93
VER-2	11X5	5.1	70	1	154
VER-3	8X4	2.97	70	1	93
VER-4	4X8	2.97	70	1	93
VER-5	4X6	2.22	70	1	93
VER-6	5X6.5	3.02	70	1	93
VER-7	8X4	2.97	70	1	93
S. VER	4X4.5	1.67	70	1	93
STORE	7.5X3	2.09	100	1	131
KITCHEN	9X9.5	7.94	100	2	244
DINING	12X21	23.41	150	4	161
LIVING	12X21	23.41	150	4	161
STAIRWELL	12X11	12.26	100	2	128
WARDROBE	10X5.5	5.1	100	1	154

Fan Calculations

No of Fans = Area (sq ft) / 150

Room Name	LENGTH (feet) X WIDTH (feet)	Area (sq feet)	Calculated No. of Fans
BED-1	15X14	210	2
BED-2	15X11	165	1
BED-3	11X12	132	1
BED-4	13X12	156	1
S. BED	7.5X6	45	1
DINING	12x21	252	2
LIVING	12x21	252	2

Light Calculations – Typical 2 Unit

E = n*N*F*LLF*UF / A

Here, n = 1, LLF = 0.7, UF = 0.75

Room Name	LENGTH (feet) X WIDTH (feet)	AREA (in Sq.Meter)	RECOM. LUX	NO. OF LIGHTS	ACTUAL LUX
BED-1	13X11	13.28	100	4	177
BED-2	12X11	12.26	100	4	179
BED-3	10X12	11.15	100	4	197
BED-4	10X12	11.15	100	4	197
BED-5	13X11	12.26	100	4	179
BED-6	11X12	13.28	100	4	177
TOILET-1	9X5	4.18	100	1	178
TOILET-2	8X5	3.17	100	1	130
TOILET-3	8X5	3.17	100	1	93
TOILET-4	7.5X7	4.87	100	1	93
TOILET-5	7.5X7	4.87	100	1	93
TOILET-6	10X4	3.17	100	1	93
KITCHEN-1	9X9.5	7.94	100	2	244
KITCHEN-2	9X9.5	7.94	100	2	244
DINING/LIVING-1	12X21	23.41	150	4	161
DINING/LIVING-1	12X21	23.41	150	4	161
STAIRWELL	12X11	12.26	100	2	128

Fan Calculations

No of Fans = Area (sq ft) / 150

Room Name	LENGTH (feet) X WIDTH (feet)	Area (sq feet)	Calculated No. of Fans
BED-1	13X11	143	1
BED-2	12X11	132	1
BED-3	10X12	120	1
BED-4	10X12	120	1
BED-5	13X11	143	1
BED-6	11X12	132	1
DINING/LIVING - 1	12x21	252	2
DINIG/LIVING -2	12x21	252	2

Light Calculations – Basement

Sq.Meter = Sq.Feet / 10.764

E = n*N*F*LLF*UF / A

Here, n = 1, LLF = 0.7, UF = 0.75

In Basement an Area of 20’ x 24’ has been taken as a block

In that block,

A = 44.6 sq meter

For F = 1500, E = 100

N = 5.28

Therefore 6 Ceiling Lights have been used in this space

Apart from the Stairwell the Parking space can be roughly divided up into 7 similar blocks with an equal amount of lights in each.

Light Calculations – Ground Floor

Sq.Meter = Sq.Feet / 10.764

E = n*N*F*LLF*UF / A

Here, n = 1, LLF = 0.7, UF = 0.75

In Ground Floor, an Area of 20’ x 24’ has been taken as a block

In that block,

A = 44.6 sq meter

For F = 1500, E = 100

N = 5.28

Apart from the Stairwell and Electrical Rooms, the Parking space can be roughly divided up into 4 similar blocks with an equal amount of lights in each.

Electrical Diagrams and Calculations

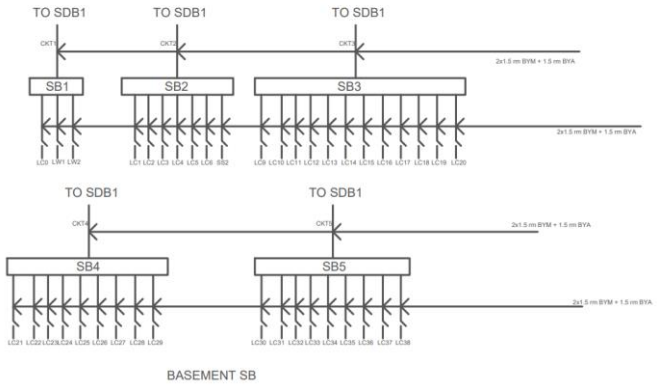
Here, for each floor and unit, we will show the switch board diagrams for main supply and emergency supply, and then show sub distribution board diagrams for main and emergency supply. The necessary calculations will be presented in tabular form.

For LED lights, we have chosen the maximum load, which is 20W, which in 100 lumen/Watt rate should give 2000 lumens of light each. This is greater than the value that we used in our lighting calculation, so there is a safe margin.

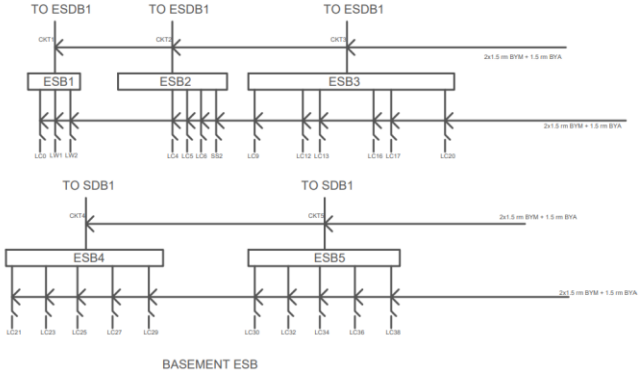
Supply line to neutral voltage has been assumed to be 220V and the power factor has been taken to be 0.9, which is reasonable for a residential building.

Basement

Switch Board Diagram and Emergency Switch Board Diagram:



BASEMENT SB



BASEMENT ESB

Calculations:

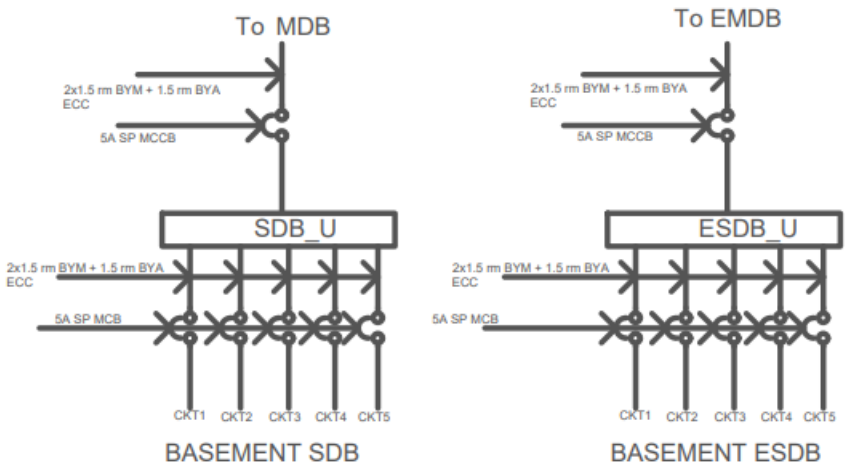
Basement - Main Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
SB1	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT1	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
SB2	1	6	0	0	0	0	220	220	0.9	1.111111111	CKT2	1.11111	2x1.5 rm BYA + 1.5 BYA (ECC)
SB3	0	12	0	0	0	0	240	220	0.9	1.212121212	CKT3	1.21212	2x1.5 rm BYA + 1.5 BYA (ECC)
SB4	0	9	0	0	0	0	180	220	0.9	0.909090909	CKT4	0.90909	2x1.5 rm BYA + 1.5 BYA (ECC)
SB5	0	9	0	0	0	0	180	220	0.9	0.909090909	CKT5	0.90909	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	880						

Basement - Emergency Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
ESB1	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT1	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB2	1	3	0	0	0	0	160	220	0.9	0.808080808	CKT2	0.80808	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB3	0	6	0	0	0	0	120	220	0.9	0.606060606	CKT3	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB4	0	5	0	0	0	0	100	220	0.9	0.505050505	CKT4	0.50505	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB5	0	5	0	0	0	0	100	220	0.9	0.505050505	CKT5	0.50505	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	540						

SDB Diagram and ESDB Diagram:



Calculation:

For SDB_U, we notice that all switchboards are below 5A rating (similarly for the emergency case, as load is even lesser). Thus, standard 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used for connecting switchboards to SDBs, along with 5A MCB breakers.

We assume utility factor for normal load to be 0.7, assuming they would be operating 70% of the time. Power Factor = 0.9

SDB_U:

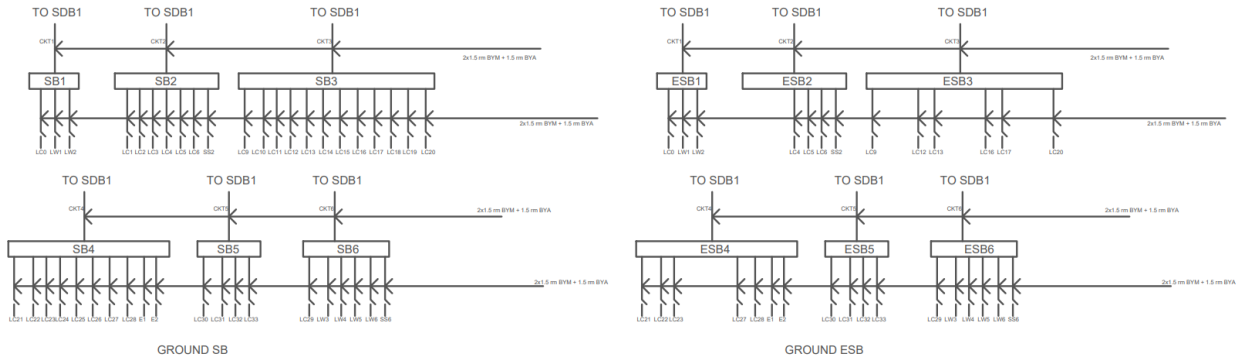
Load = 0.7 x total load = 0.7 x 880 = **616W** (No power sockets are present here)
Current = 616/(220 x 0.9) = 3.11 A
Thus, 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used, along with 5A **MCCB** breaker, to connect it to the MDB.

ESDB_U:

Load = 0.7 x total emergency load = 0.7 x 540 = **378W**
Current = 616/(220 x 0.9) = 1.9 A
Thus, 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used, along with 5A **MCCB** breaker, to connect it to the EMDB.

Ground

Switch Board Diagram and Emergency Switch Board Diagram:



Calculations:

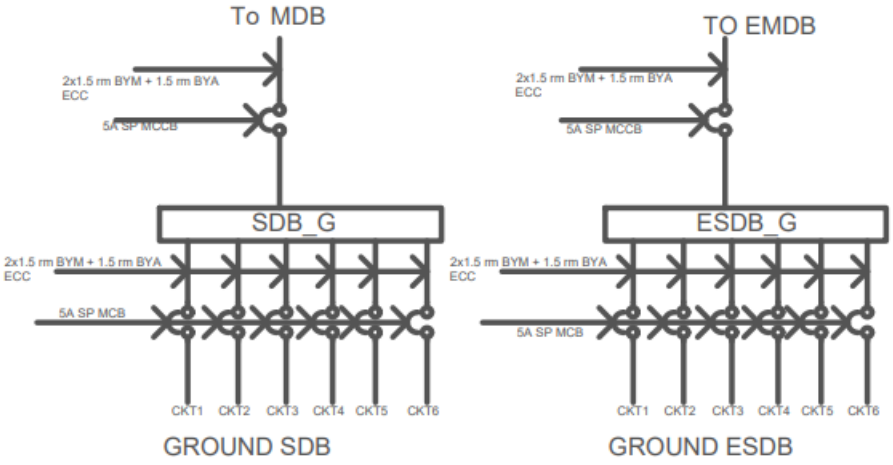
Ground - Main Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
SB1	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT1	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
SB2	1	6	0	0	0	0	220	220	0.9	1.111111111	CKT2	1.11111	2x1.5 rm BYA + 1.5 BYA (ECC)
SB3	0	12	0	0	0	0	240	220	0.9	1.212121212	CKT3	1.21212	2x1.5 rm BYA + 1.5 BYA (ECC)
SB4	0	8	0	0	2	0	240	220	0.9	1.212121212	CKT4	1.21212	2x1.5 rm BYA + 1.5 BYA (ECC)
SB5	0	4	0	0	0	0	80	220	0.9	0.404040404	CKT5	0.40404	2x1.5 rm BYA + 1.5 BYA (ECC)
SB6	1	5	0	0	0	0	200	220	0.9	1.01010101	CKT6	1.0101	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	1040						

Ground - Emergency Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
SB1	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT1	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
SB2	1	3	0	0	0	0	160	220	0.9	0.808080808	CKT2	0.80808	2x1.5 rm BYA + 1.5 BYA (ECC)
SB3	0	6	0	0	0	0	120	220	0.9	0.606060606	CKT3	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
SB4	0	5	0	0	2	0	180	220	0.9	0.909090909	CKT4	0.90909	2x1.5 rm BYA + 1.5 BYA (ECC)
SB5	0	4	0	0	0	0	80	220	0.9	0.404040404	CKT5	0.40404	2x1.5 rm BYA + 1.5 BYA (ECC)
SB6	1	5	0	0	0	0	200	220	0.9	1.01010101	CKT6	1.0101	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	800						

SDB Diagram and ESDB Diagram:



Calculation:

For SDB_G, we notice that all switchboards are below 5A rating (similarly for the emergency case, as load is even lesser). Thus, standard 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used for connecting switchboards to SDBs, along with 5A MCB breakers.

We assume utility factor for normal load to be 0.7, assuming they would be operating 70% of the time. Power Factor = 0.9

SDB_G:

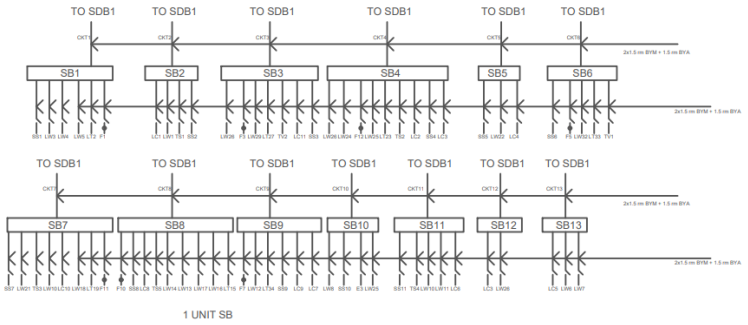
Load = 0.7 x total load = 0.7 x 1040 = **728W** (No power sockets are present here)
Current = 728/(220 x 0.9) = 3.677 A
Thus, 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used, along with 5A SP **MCCB** breaker, to connect it to the MDB.

ESDB_U:

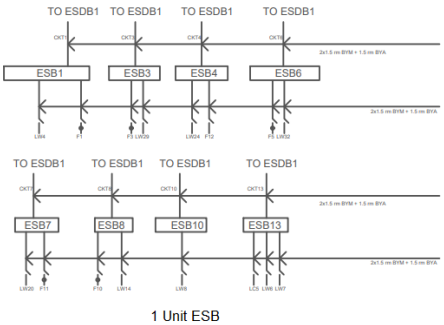
Load = 0.7 x total emergency load = 0.7 x 800 = **560W**
Current = 560/(220 x 0.9) = 2.83 A
Thus, 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used, along with 5A SP **MCCB** breaker, to connect it to the EMDB.

Single Unit Floor

Switch Board Diagram and Emergency Switch Board Diagram:



1 UNIT SB



1 Unit ESB

Calculations:

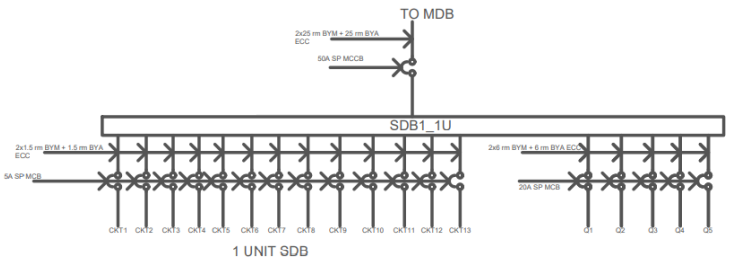
Single Unit Load Calculation - Main Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
SB1	1	4	0	0	0	1	280	220	0.9	1.414141414	CKT1	1.41414	2x1.5 rm BYA + 1.5 BYA (ECC)
SB2	1	2	1	0	0	0	240	220	0.9	1.212121212	CKT2	1.21212	2x1.5 rm BYA + 1.5 BYA (ECC)
SB3	1	4	0	1	0	1	430	220	0.9	2.171717172	CKT3	2.17172	2x1.5 rm BYA + 1.5 BYA (ECC)
SB4	1	6	1	0	0	1	420	220	0.9	2.121212121	CKT4	2.12121	2x1.5 rm BYA + 1.5 BYA (ECC)
SB5	1	2	0	0	0	0	140	220	0.9	0.707070707	CKT5	0.70707	2x1.5 rm BYA + 1.5 BYA (ECC)
SB6	1	2	0	1	0	1	390	220	0.9	1.96969697	CKT6	1.9697	2x1.5 rm BYA + 1.5 BYA (ECC)
SB7	1	5	1	0	0	1	400	220	0.9	2.02020202	CKT7	2.0202	2x1.5 rm BYA + 1.5 BYA (ECC)
SB8	1	5	1	0	0	1	400	220	0.9	2.02020202	CKT8	2.0202	2x1.5 rm BYA + 1.5 BYA (ECC)
SB9	1	4	0	0	0	1	280	220	0.9	1.414141414	VKT9	1.41414	2x1.5 rm BYA + 1.5 BYA (ECC)
SB10	1	2	0	0	1	0	180	220	0.9	0.909090909	CKT10	0.90909	2x1.5 rm BYA + 1.5 BYA (ECC)
SB11	1	3	1	0	0	0	260	220	0.9	1.313131313	CKT11	1.31313	2x1.5 rm BYA + 1.5 BYA (ECC)
SB12	0	2	0	0	0	0	40	220	0.9	0.202020202	CKT12	0.20202	2x1.5 rm BYA + 1.5 BYA (ECC)
SB13	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT13	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	**3520**						

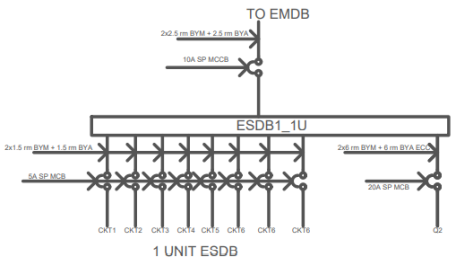
Single Unit Load Calculation - Emergency Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
ESB1	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT1	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB3	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT3	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB4	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT4	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB6	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT6	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB7	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT7	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB8	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT8	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB10	0	1	0	0	0	0	20	220	0.9	0.101010101	CKT10	0.10101	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB13	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT13	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	**800**						

SDB Diagram and ESDB Diagram:



1 UNIT SDB



1 UNIT ESDB

Calculation:

For SDB_U1, we notice that all switchboards are below 5A rating (similarly for the emergency case, as load is even lesser). Thus, standard 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used for connecting switchboards to SDBs, along with 5A MCB breakers.

Here, power sockets with rating 20A and 4000W are present. (4000V/220A = 18.18A). Thus, we have used **20A SP MCB Breakers** and 2x6 rm BYM + 6 rm BYA ECC wires.

We assume utility factor for normal load to be 0.7, assuming they would be operating 70% of the time.

For a typical AC, watt rating is 1500 Watt. As our power socket is 4000W, the ratio is then 1500/4000 = 0.375. But an AC will not run all the time. If we assume it runs 80% of the time during summer, then our utility factor should be 0.8x0.375 = 0.3. Thus for power sockets, we assume utility factor to be 30%.

Here, power factor = 0.9

SDB_U1:

Load = 0.7 x total load + 0.4 x power socket load
= 0.7 x 3520 + 0.3 x 4000 x 5 = **8464W** (5 Q sockets are present)
Current = 8464/(220 x 0.9) = 42.75 A
Thus, 2 x 25 rm BYM cables and 25 rm BYA ECC cable has been used, along with 50A SP **MCCB** breaker, to connect it to the MDB.

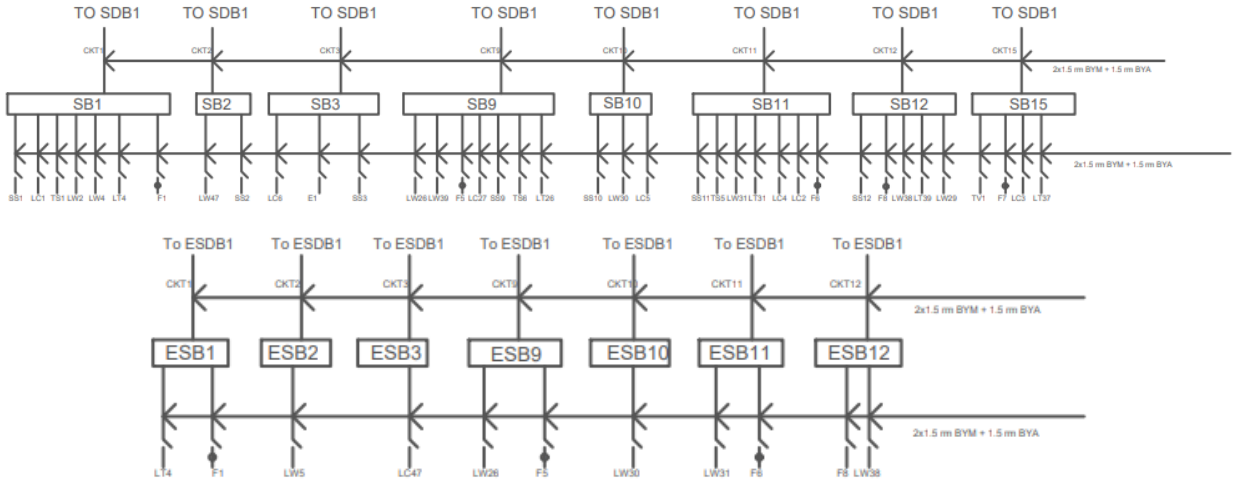
ESDB_U1:

For emergency condition, we will assume the power socket utility factor to be 0.2

Load = 0.7 x total emergency load + 0.2 x power socket load
= 0.7 x 800 + 0.2 x 4000 = **1360W** (1 Q socket is present on emergency)
Current = 1360/(220 x 0.9) = 6.87 A
Thus, 2 x 2.5 rm BYM cables and 2.5 rm BYA ECC cable has been used, along with 10A SP **MCCB** breaker, to connect it to the EMDB.

Double Unit Floor – Unit 1

Switch Board Diagram and Emergency Switch Board Diagram:



Calculations:

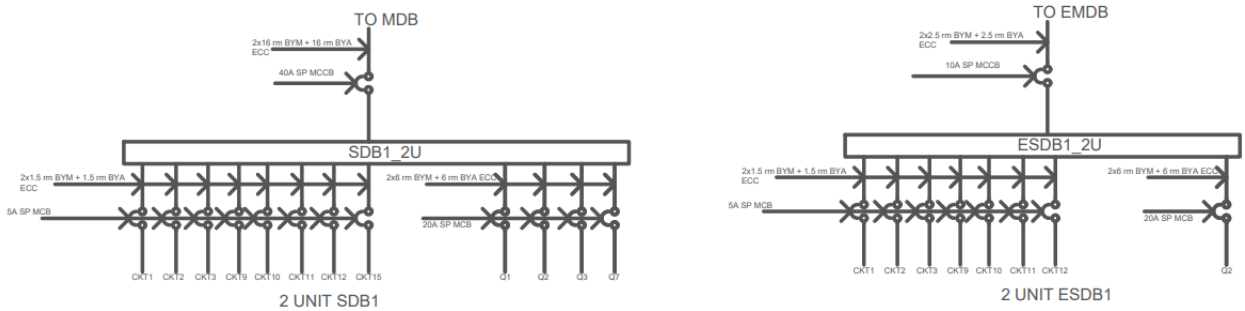
Dual Unit Load Calculation - Unit 1 - Main Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
SB1	1	4	1	0	0	1	380	220	0.9	1.919191919	CKT1	1.91919	2x1.5 rm BYA + 1.5 BYA (ECC)
SB2	1	1	0	0	0	0	120	220	0.9	0.606060606	CKT2	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
SB3	1	1	0	0	1	0	160	220	0.9	0.808080808	CKT3	0.80808	2x1.5 rm BYA + 1.5 BYA (ECC)
SB9	1	4	1	0	0	1	380	220	0.9	1.919191919	CKT9	1.91919	2x1.5 rm BYA + 1.5 BYA (ECC)
SB10	1	2	0	0	0	0	140	220	0.9	0.707070707	CKT10	0.70707	2x1.5 rm BYA + 1.5 BYA (ECC)
SB11	1	4	1	0	0	1	380	220	0.9	1.919191919	CKT11	1.91919	2x1.5 rm BYA + 1.5 BYA (ECC)
SB12	1	3	0	0	0	1	260	220	0.9	1.313131313	CKT12	1.31313	2x1.5 rm BYA + 1.5 BYA (ECC)
SB15	0	2	0	1	0	1	290	220	0.9	1.464646465	CKT15	1.46465	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	2110						

Dual Unit Load Calculation - Unit 1 - Emergency Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
ESB1	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT1	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB2	0	1	0	0	0	0	20	220	0.9	0.101010101	CKT2	0.10101	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB3	0	1	0	0	0	0	20	220	0.9	0.101010101	CKT3	0.10101	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB9	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT9	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB10	0	1	0	0	0	0	20	220	0.9	0.101010101	CKT10	0.10101	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB11	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT11	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB12	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT12	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	540						

SDB Diagram and ESDB Diagram:



Calculation:

For SDB1_U2, we notice that all switchboards are below 5A rating (similarly for the emergency case, as load is even lesser). Thus, standard 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used for connecting switchboards to SDBs, along with 5A MCB breakers.

Here, power sockets with rating 20A and 4000W are present. (4000V/220A = 18.18A). Thus, we have used **20A SP MCB Breakers** and 2x6 rm BYM + 6 rm BYA ECC wires.

We assume utility factor for normal load to be 0.7, assuming they would be operating 70% of the time. And for power sockets, we assume utility factor to be 30%.

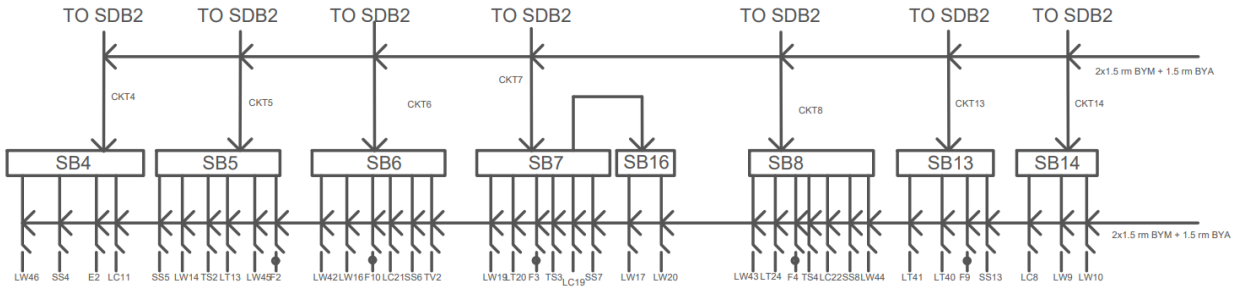
Here, power factor = 0.9

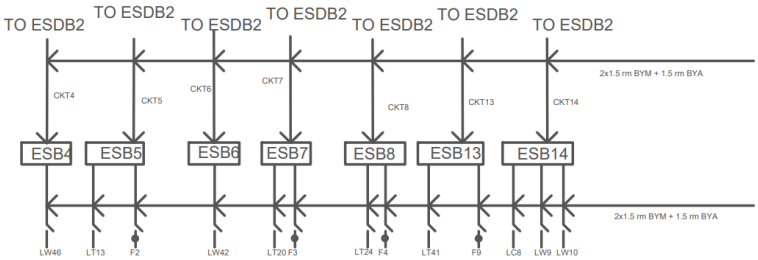
SDB1_U2:

Load = 0.7 x total load + 0.9 x power socket load
= 0.7 x 2110 + 0.3 x 4000 x 4 = **6277W** (4 Q sockets are present)
Current = 6277/(220 x 0.9) = 31.7 A
Thus, 2 x 16 rm BYM cables and 16 rm BYA ECC cable has been used, along with 40A SP **MCCB** breaker, to connect it to the MDB.

Double Unit Floor – Unit 2

Switch Board Diagram and Emergency Switch Board Diagram:





Calculations:

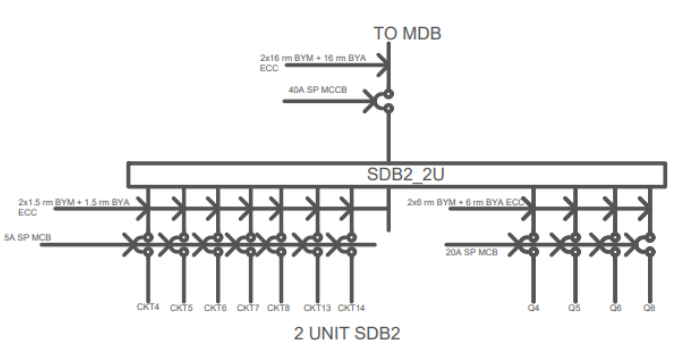
Dual Unit Load Calculation - Unit 2 - Main Supply

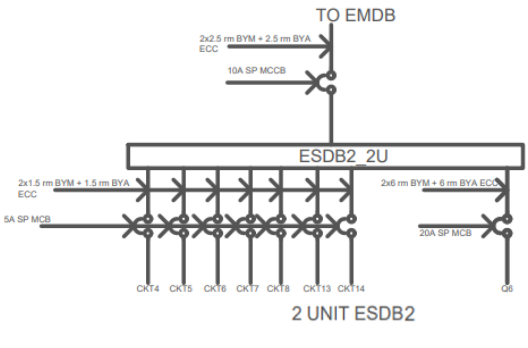
Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
SB4	1	2	0	0	1	0	180	220	0.9	0.909090909	CKT4	0.90909	2x1.5 rm BYA + 1.5 BYA (ECC)
SB5	1	3	1	0	0	1	360	220	0.9	1.818181818	CKT5	1.81818	2x1.5 rm BYA + 1.5 BYA (ECC)
SB6	1	3	0	1	0	1	410	220	0.9	2.070707071	CKT6	2.07071	2x1.5 rm BYA + 1.5 BYA (ECC)
SB7	1	3	1	0	0	1	360	220	0.9	1.818181818			
SB16	0	2	0	0	0	0	40	220	0.9	0.202020202	CKT7	2.0202	2x1.5 rm BYA + 1.5 BYA (ECC)
SB8	1	4	1	0	0	1	380	220	0.9	1.919191919	CKT8	1.91919	2x1.5 rm BYA + 1.5 BYA (ECC)
SB13	1	2	0	0	0	1	240	220	0.9	1.212121212	CKT13	1.21212	2x1.5 rm BYA + 1.5 BYA (ECC)
SB14	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT14	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	1850						

Dual Unit Load Calculation - Unit 2 - Emergency Supply

Name	SB Sockets (100W)	LED bulbs and Tubelight (20W)	TS (100W)	TV (150W)	E (40W)	F (100W)	Total Load	Voltage	pf	Current	Group Name	Group Total Current	Cable
ESB4	0	1	0	0	0	0	20	220	0.9	0.101010101	CKT4	0.10101	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB5	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT5	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB6	0	1	0	0	0	0	20	220	0.9	0.101010101	CKT6	0.10101	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB7	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT7	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB8	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT8	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB13	0	1	0	0	0	1	120	220	0.9	0.606060606	CKT13	0.60606	2x1.5 rm BYA + 1.5 BYA (ECC)
ESB14	0	3	0	0	0	0	60	220	0.9	0.303030303	CKT14	0.30303	2x1.5 rm BYA + 1.5 BYA (ECC)
						Total	560						

SDB Diagram and ESDB Diagram:





Calculation:

For SDB2_U2, we notice that all switchboards are below 5A rating (similarly for the emergency case, as load is even lesser). Thus, standard 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used for connecting switchboards to SDBs, along with **5A MCB breakers**.

Here, power sockets with rating 20A and 4000W are present. (4000V/220A = 18.18A). Thus, we have used **20A SP MCB Breakers** and 2x6 rm BYM + 6 rm BYA ECC wires.

We assume utility factor for normal load to be 0.7, assuming they would be operating 70% of the time. And for power sockets, we assume utility factor to be 40%.

Here, power factor = 0.9

SDB2_U2:

Load = 0.7 x total load + 0.9 x power socket load
= 0.7 x 1850 + 0.4 x 4000 x 4 = **6095W** (4 Q sockets are present)
Current = 7695/(220 x 0.9) = 30.78 A
Thus, 2 x 16 rm BYM cables and 16 rm BYA ECC cable has been used, along with 40A SP **MCCB** breaker, to connect it to the MDB.

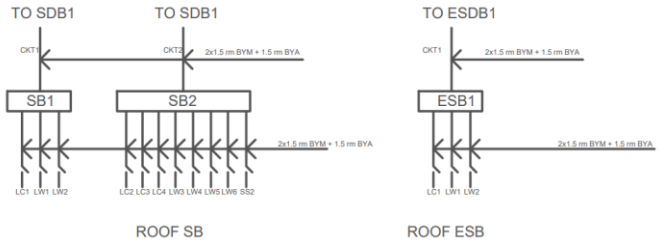
ESDB2_U2:

For emergency condition, we will assume the power socket utility factor to be 0.2

Load = 0.7 x total emergency load + 0.2 x power socket load
= 0.7 x 560 + 0.2 x 4000 = **1192W** (1 Q socket is present on emergency)
Current = 1192/(220 x 0.9) = 6.02 A
Thus, 2 x 2.5 rm BYM cables and 2.5 rm BYA ECC cable has been used, along with 10A SP **MCCB** breaker, to connect it to the EMDB.

Roof

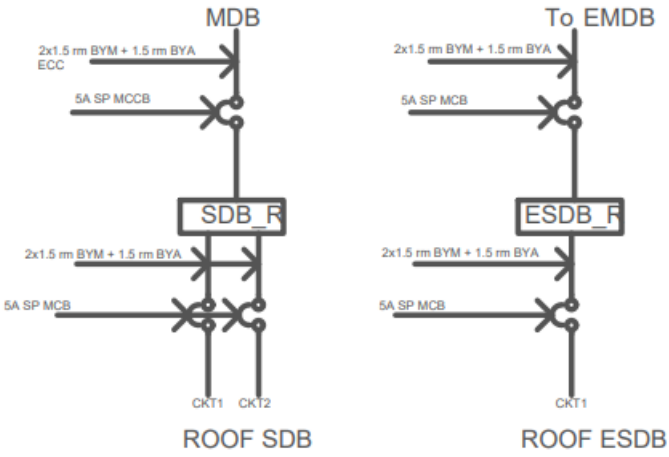
Switch Board Diagram and Emergency Switch Board Diagram:



Calculations:

SB Data (Roof)											**V=220, PF=0.9**
Board	F(100W)	LT(40W)	LW(15W)	LC(15W)	SS(100W)	P(4000W)	ST(100W)	TV(100W)	E(100W)	Total Power	Current
SB1	0	0	2	1	0	0	0	0	0	45	0.227
SB2	0	0	4	3	1	0	0	0	0	205	1.035
										250	
ESB Data (Roof)											**V=220, PF=0.9**
Board	F(100W)	LT(40W)	LW(15W)	LC(15W)	SS(100W)	P(4000W)	ST(100W)	TV(100W)	E(100W)	Total Power	Current
SB1	0	0	2	1	0	0	0	0	0	45	0.227
										45	

SDB Diagram and ESDB Diagram:



Calculation:

For SDB_R, we notice that all switchboards are below 5A rating (similarly for the emergency case, as load is even lesser). Thus, standard 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used for connecting switchboards to SDBs, along with 5A MCB breakers.

We assume utility factor for normal load to be 0.7, assuming they would be operating 70% of the time. Power Factor = 0.9

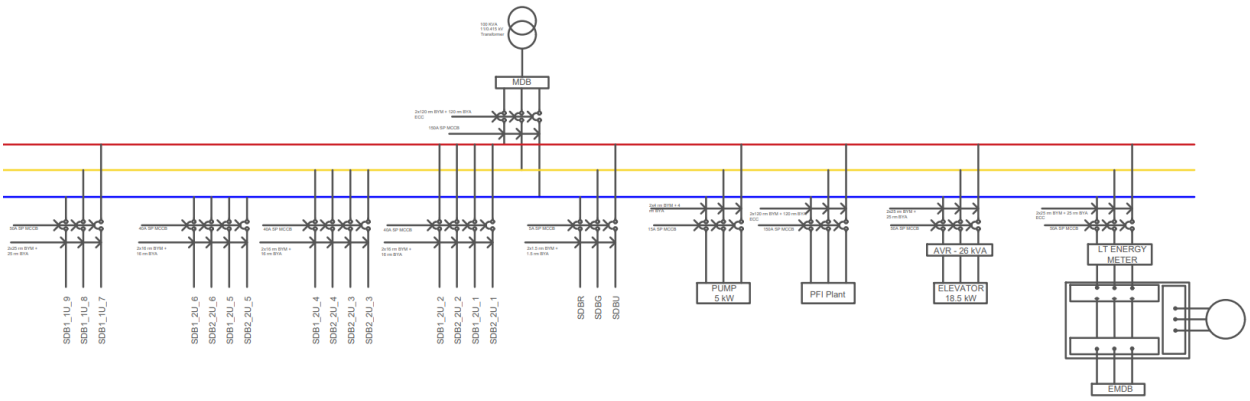
SDB_R:

Load = 0.7 x total load = 0.7 x 250 = **175W** (No power sockets are present here)
Current = 175/(220 x 0.9) = 0.88 A
Thus, 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used, along with 5A SP **MCCB** breaker, to connect it to the MDB.

ESDB_R:

Load = 0.7 x total emergency load = 0.7 x 45 = **31.5W**
Current = 31.5/(220 x 0.9) = 0.159 A
Thus, 2 x 1.5 rm BYM cables and 1.5 BYA ECC cable has been used, along with 5A SP **MCCB** breaker, to connect it to the EMDB.

Main Distribution Board Calculation



The SDB loads are listed below:
SDB_U = 616 W
SDB_G = 728 W
SDB1_1U = 8464
SDB1_2U = 6277
SDB2_2U = 6095
SDB_R = 175

Keeping in mind that 6 floors are dual units and 3 are single units, and we have installed extra Lift (18500 W) and pump (5000W), and utility factor = 0.7

Thus,

total MDB load = (SDB_U + SDB_G + SDB_R + 3x(SDB1_1U) + 6x(SDB1_2U + SDB2_2U) + Pump + Lift) x Utility Factor
= 87.250 kW

As our Emergency system is not separate from the system supplied by the main, we don't include EMDB loads in our MDB calculation, as it is already included.

Now,

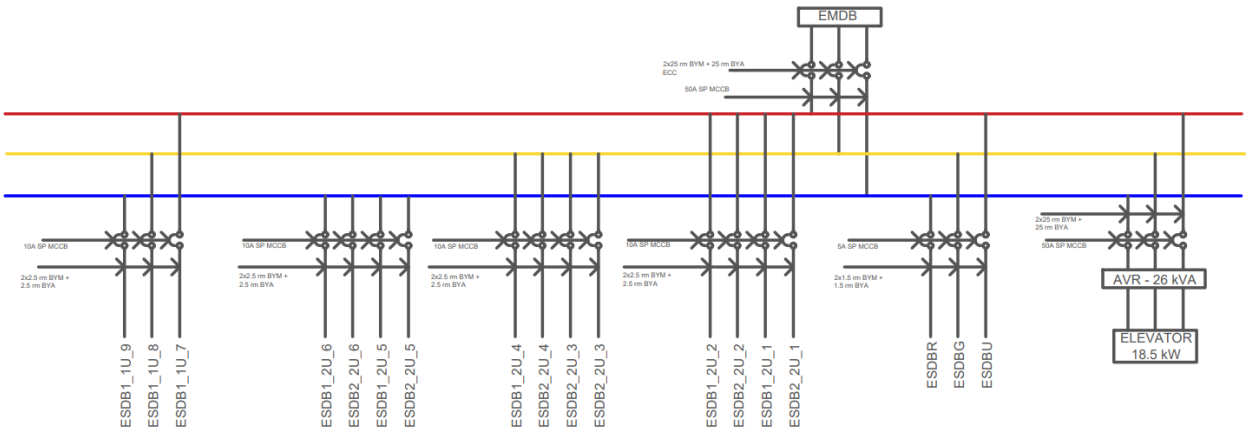
I = P/3*V*PF = **146.89 A** (V=220 V, pf = 0.9)

Thus, we will need **2x120 rm NYY + 120 rm BYA ECC** wire and a **150 A SP MCCB** Breaker.

S = P/pf = 96.944 kVA

We will need a **100kVA transformer substation**.

Emergency Main Distribution Board Calculation



The ESDB loads are listed below:

ESDB_U = 378 W
ESDB_G = 560 W
ESDB1_1U = 1360
ESDB1_2U = 1178
ESDB2_2U = 1192
ESDB_R = 31.5

total EMDB load = (ESDB_U + ESDB_G + ESDB_R + 3x(ESDB1_1U) + 6x(ESDB1_2U + ESDB2_2U) + Lift) x Utility Factor
= 26.438 kW

I = P/3*V*PF = **44.51 A** (V=220 V, pf = 0.9)

Thus, we will need **2x25 rm NYY + 25 rm BYA ECC** wire and a **50 A SP MCCB** Breaker.

S = P/pf = 29.38 kVA

Thus, a **40 kVA Generator** is to be used.

PFI Plant

Here, Q = Ptan($\cos^{-1}$(pf)) = 87.250 tan($\cos^{-1}$(0.9)) = 42.257 KVAR

The PFI plant needs to deliver this much capacitive reactive power to bring the power factor close to unity.

Thus, current = Q/3*V*sin($\cos^{-1}$(pf)) = 146.88 A

We need to use 2x120 rm NYY + 120 BYA ECC wires along with 150A SP MCCB breakers.

Elevator

Power = 18500 W
Let, pf = 0.7
Thus, current = 18500 / 3*220*0.7 = 40.0432 A

Thus, we need to use 2x25 rm NYY + 25 BYA ECC wires along with 50A SP MCCB breakers.

Pump

Power = 5000 W
Let, pf = 0.7
Thus, current = 5000 / 3*220*0.7 = 10.823 A

Thus, we need to use 2x4 rm NYY + 4 BYA ECC wires along with 15A SP MCCB breakers.

Conclusion:

Through this project, we had the opportunity to have a first hand experience of designing an electrical service for a practical residential buildings. We had to make simplifications and approximations in some cases based on our judgement and made some inevitable errors, which we have tried our best to resolve.

Acknowledgement:

We would like to thank our course teacher, Associate professor Yeasir Arafat, Department of EEE, BUET; and Mumtahina Islam Sukanya, adjunct lecturer, EEE, BUET for their kind support and guidance.

Reference Material:

1.

Selection of Cables & Circuit Breakers Size

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, mm² .... 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 : G1 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° C ambient temperature, underground, amps
- b") 35° 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° C, amps
- b"') Clipped to a surface or on a cable tray bunched and un-enclosed two cables single phase at 35° 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.

2. Relevant EEE 414 slides and lab sheets