ELECTRICAL DEPTH

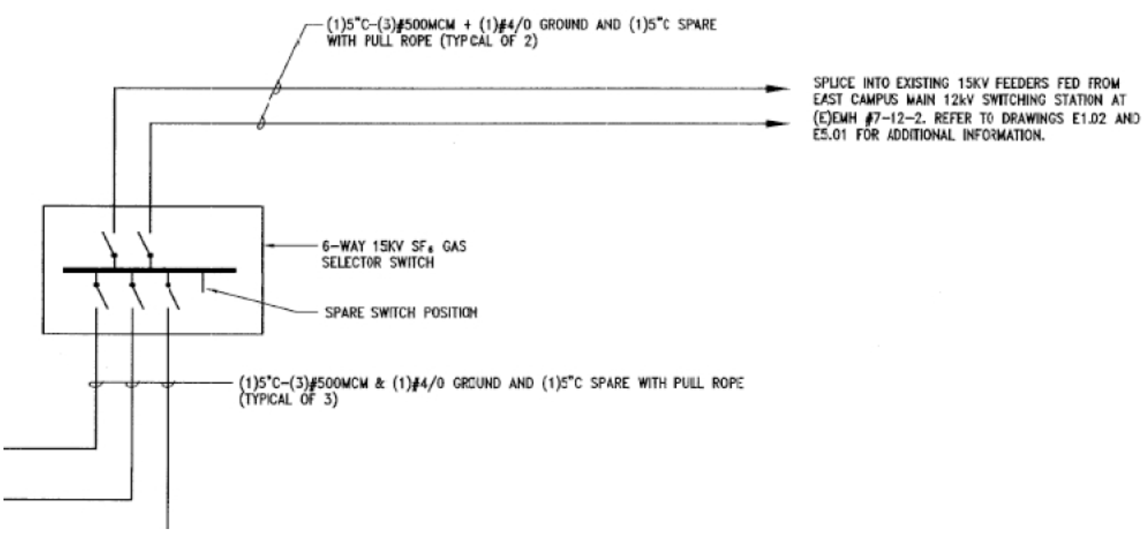
Introduction

The University of California, San Diego Cal IT^2 Building was electrically designed for a lot of future growth. With my changes in the lighting system and control zones, a study was done to check my new design incorporated into the existing conditions. I first showed the circuiting and zoning. I then chose the most affected panelboard and conducted a study on the circuit breaker size and feeder sizes. Finally, I checked the emergency power supply while providing emergency lighting plans to follow my redesigns.

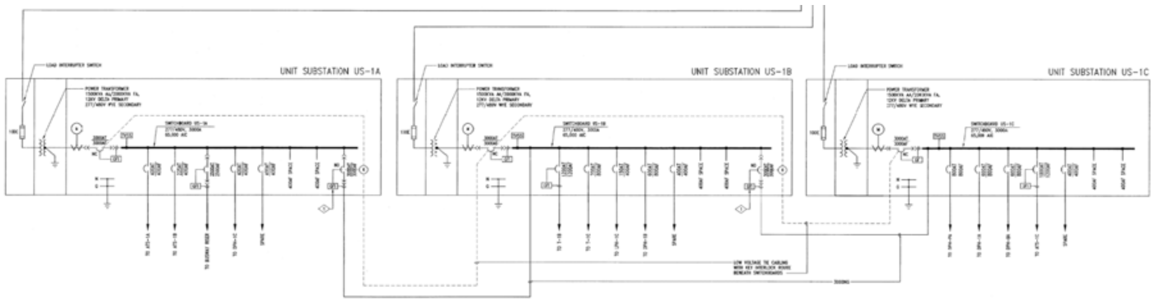
Basic Electrical Layout Background

Cal IT^2 is fed from a 15kV service from East Campus. This power is tapped to a six-way switch where it is distributed into three major substations. These substations all feed to the distribution panels and panelboards to power the building. As you can see in the next two diagrams, the substations are all connected in case of a gray-out where one substation circuit breaker fails. Being a telecommunication building, back-up power is essential for equipment and research being conducted. One substation is primarily connected to only the clean room equipment and HVAC. A 750 kW emergency diesel generator is connected the some distribution panels through three automatic transfer switches. In case of a black-out, only HVAC, elevator, some software back-ups, and emergency lighting loads will be powered for a short while. There is also one main bus duct running up the center of the tower for tapping the 7 floors of offices and research clusters. The rest of the panelboards are located in the electrical room located in the basement of building section A. This is the basic structure of the electrical system for Cal IT^2.

Incoming Service



Substations



Control Plans and Lighting Loads

I separated my lighting into various zones for different switching and circuiting. Below is a table showing the different zones of light, location, and types of switching used. Lutron Grafik Eye 4000 was used to switch most of the lighting in these spaces. I decided to use the Grafik Eye because of the type of building and various uses it will have. Using the Grafik Eye, I can provide multiple scenes in one room using only one control. I can also provide power and preset timed dimming abilities for my oscillating lighting display. Various Wattstopper sensors were also integrated into the system for ease of control.

Lighting Zones

Zone	Location	Fixtures	Panelboard	Control
A	Open Office	B2, B6	ELPH-2A	SA
B	Open Office Cut-outs	B3, B5	ELPH-2A	S1
C	Private Offices	B1	LPH-3A	SB
D	Black Box Theater Ceiling	B12	ELPH-BA	S3
E	Black Box Theater Ceiling	B9	ELPH-BA	S3
F	Black Box Theater Floor Level	B7, B11	ELPH-BA	S3
G	Black Box Theater Floor	B8	ELPH-BA	S3
H	Black Box Theater Floor Level	B10, B13	ELPH-BA	S3
I	Black Box Theater Floor Level	B10, B13	ELPH-BA	S3
J	Lobby Cove	B15	LPH-1B	S2
K	Gallery	B17, B18	LPH-1A	S2
L	Lobby	B14, B16	LPH-1B	S2
M	Lobby Entrance	B19	LPH-1B	SC
N	Façade and Theater Lobby	E6, E10	LPH-1B	SD
O	Tunnel Entrance	E3, E7, E8, E9	LPH-1B	SD
P	Courtyard Tree Uplights	E5	LP-1A	S4
Q	Courtyard Poles and Bollards	E1, E2	LPH-1B	SD
R	Tunnel Custom Fixture	E11	ELPH-1A	S5
S	Tunnel Uplight Fixtures	E12	ELPH-1A	S1

Below is a table showing the switches and sensors referred to above. Cut-sheets are available in the Appendix.

Switches & Sensors			
Labels	**Location**	**Manufacturer**	**Type**
SA	Open Office	WattStopper	Occupancy Sensor
SB	Private Offices	WattStopper	Occupancy/Daylight Sensor
SC	Lobby Entrance	WattStopper	Daylight Photosensor
SD	Building Section C Roof	WattStopper	Daylight Photosensor
S1	Open Office Cut-outs, Tunnel	Lutron	Single Switch
S2	Lobby (three locations)	Lutron	Control Zone Panel
S3	Black Box Theater	Lutron	Control Zone Panel
S4	Mechanical Room	WattStopper	Timer Switch
S5	Underground Tunnel	Lutron	Control Zone Panel

Grafik Eye 4000 Details

I chose the Grafik Eye 4000 to use in Cal IT². This system can easily control all the open office research clusters, the black-box theater, underground tunnel display, main lobby, and possibly the labs and clean rooms. The Grafik Eye 4000 can control 24 zones and can have scene selections for up to 16 scenes. This gives good flexibility for control of the lobby, theater and lab rooms. I placed each lighting zone on a separate circuit for each of the spaces as will be shown below. Using these zones, scenes and dimming can be chosen to accommodate each space to the people using them. The various other sensors and photosensors used are all compatible with the Grafik Eye based on manufacturer approval. Based on my circuiting and loads below, one Grafik Eye unit can control all of the research clusters on the upper floors since each floor carries only 4 circuits. The Black Box Theater will be controlled on a different unit along with the theater lobby and multi-purpose rooms next door. The underground tunnel will be put on its own unit because of the programmed dimming that will be occurring constantly throughout the non-day lit hours. Programmable timed dimming is essential for the lighting design in the tunnel which is why I chose the Grafik Eye 4000 for this space.

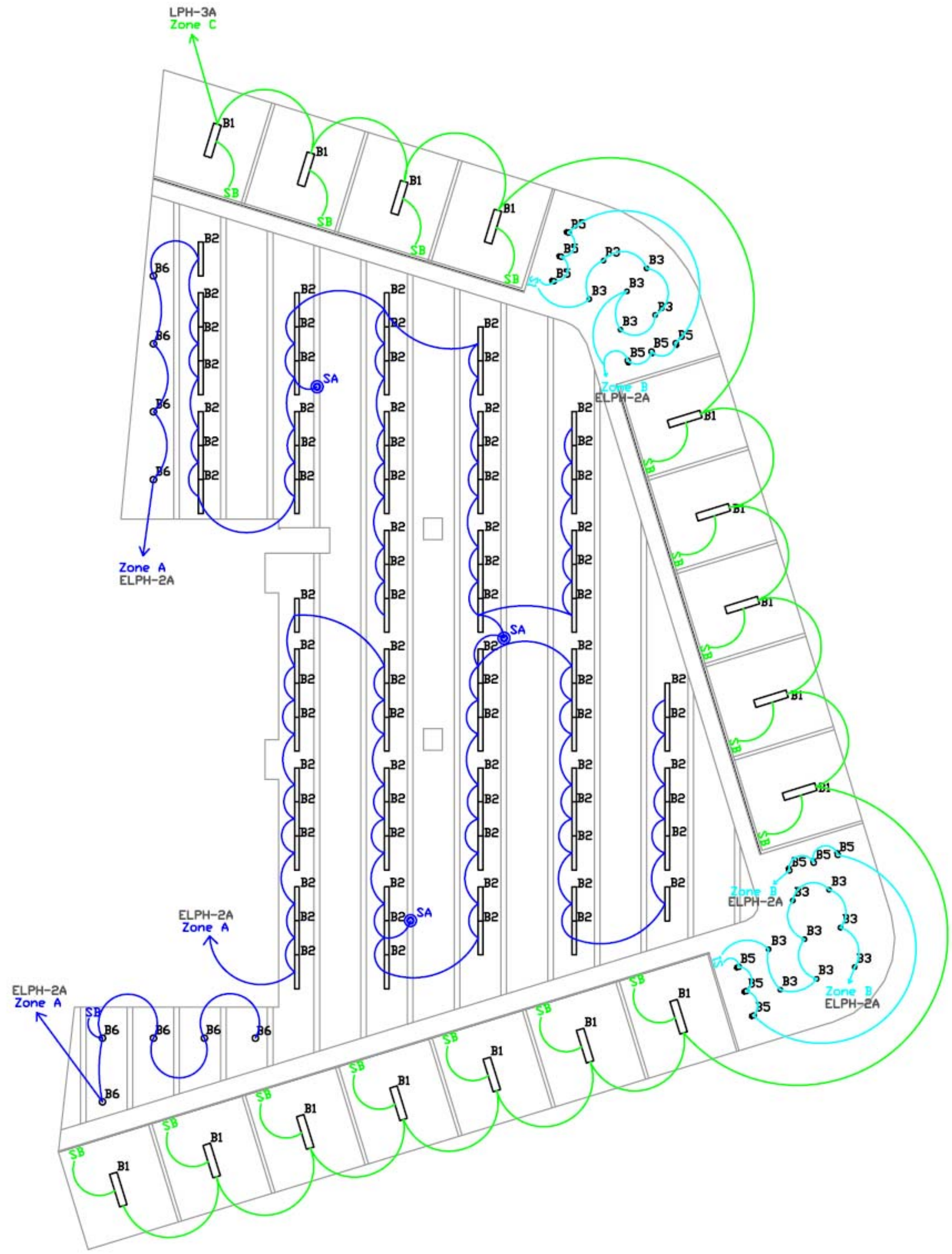
3100 Research Cluster

For this space, the private office fixtures were put on dimmable daylight photosensors with occupancy sensor automatic turn-off. These switches must be visible to the office and not behind a shelf or door for them to properly work. The open-office fixtures were put on infrared occupancy sensors for automatic turn-off. These were placed in 24 foot intervals which was the recommendation by Wattstopper. The only hand switching is for the open-office cut-outs which are put on single tap switches. These spaces are used intermittently and set next to full-length windows. Electric lights will only be needed during evening hours and possibly for highlighting works on the walls. Below is the circuiting calculations and power plan for this space.

Zone A:	(37) B2 and (4) B6 fixtures	= 2516 VA + 144 VA = 2660 VA = 2660 VA / sqrt(3)*480V = 3.199 A
Zone A:	(39) B2 and (5) B6 fixtures	= 2652 VA + 180 VA = 2832 VA = 2832 VA / sqrt(3)*480V = 3.406 A
Zone B:	(14) B3 and (12) B5 fixtures	= 504 VA + 432 VA = 936 VA = 936 VA / sqrt(3)*480V = 1.126 A
Zone C:	(16) B1 fixtures	= 1088 VA = 1088 VA / sqrt(3)*480V = 1.309 A

The VA values are all below the (480V)*(sqrt3)*(16A) = 13302 VA maximum per circuit allowed.

Circuiting and Switching Diagram



Black Box Theater

For this space, many different scenes are put into action using the Lutron Grafik Eye 4000. The theater is used for many different tasks, so variety in the lighting is important. Since every light in the space is put on electric dimming ballasts, all fixtures can be modified to provide just the right atmosphere you are looking for. I have preset 5 scenes for which the light levels and atmosphere work well with each use. Below is a schedule of the five scenes I have provided.

Theater Scenes

Scene	Name	Zones	Fixtures	Dimming
Scene 1	Performance Entrance	D, F, G, I	B7, B8, B10, B11, B12, B13	D(10%)
Scene 2	Educational	D, E, F, H	B7, B9, B10, B11, B12, B13	
Scene 3	Performance	G, F	B7, B8, B11	G(1%), F(1%)
Scene 4	Educational 2	D, E, H	B9, B10, B12, B13	
Scene 5	Performance Entrance 2	D, H, F	B7, B10, B11, B12, B13	D(10%), H(10%)

For the power plan, each lighting zone was put on a different circuit. The ceiling plan and floor contain different aspects of the lighting since the space is two stories tall with very different elements.

Zone D: (12) B12 fixtures = 780 VA
= 780 VA / sqrt(3)*480V = 0.938 A

Zone E: (19) B9 fixtures = 1520 VA
= 1520 VA / sqrt(3)*480V = 1.828 A

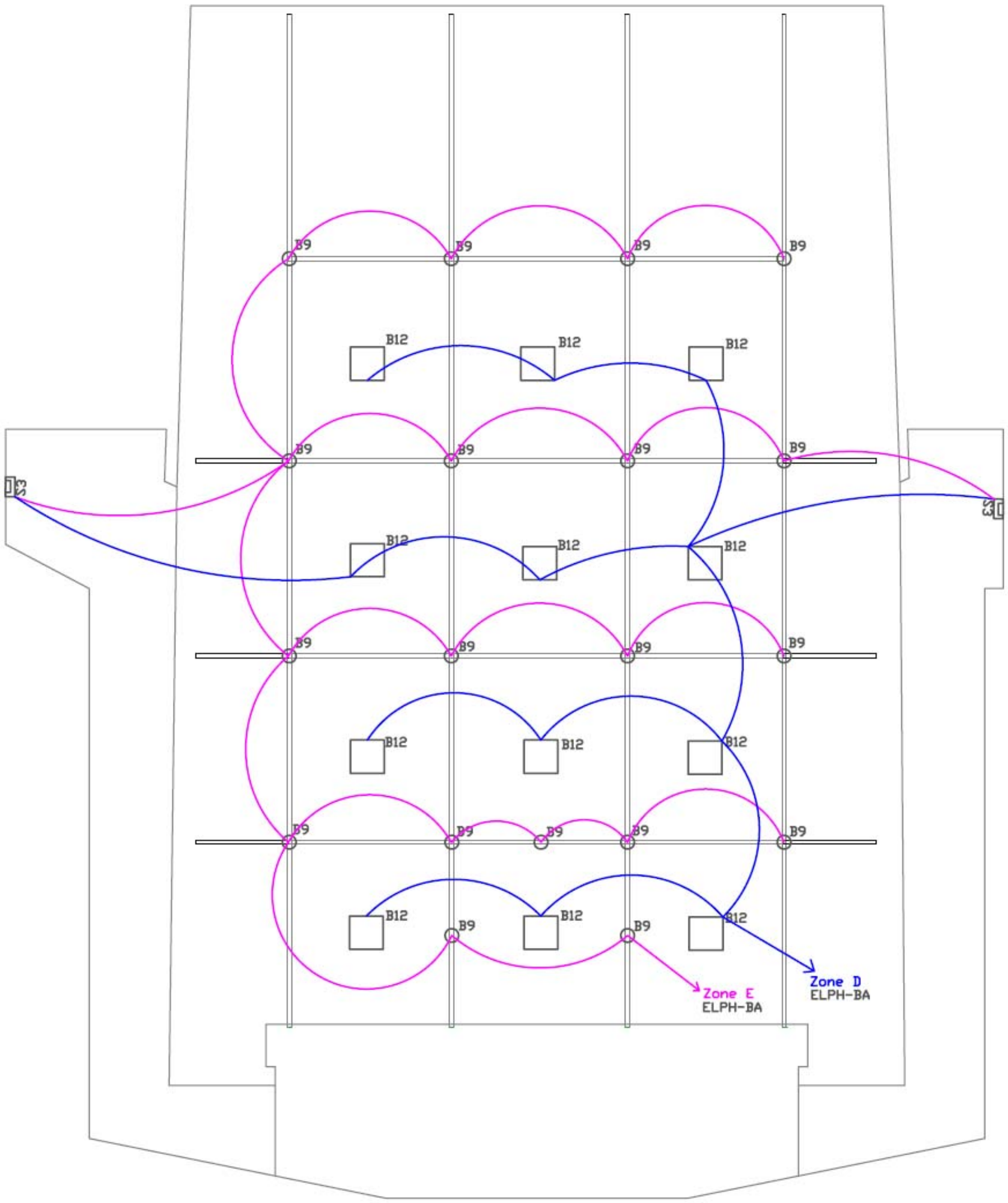
Zone F: (11) B7 and (4) B11 fixtures = 220 VA + 72 VA = 292 VA
= 292 VA / sqrt(3)*480V = 0.351 A

Zone G: (14) B8 fixtures = 238 VA
= 238 VA / sqrt(3)*480V = 0.286 A

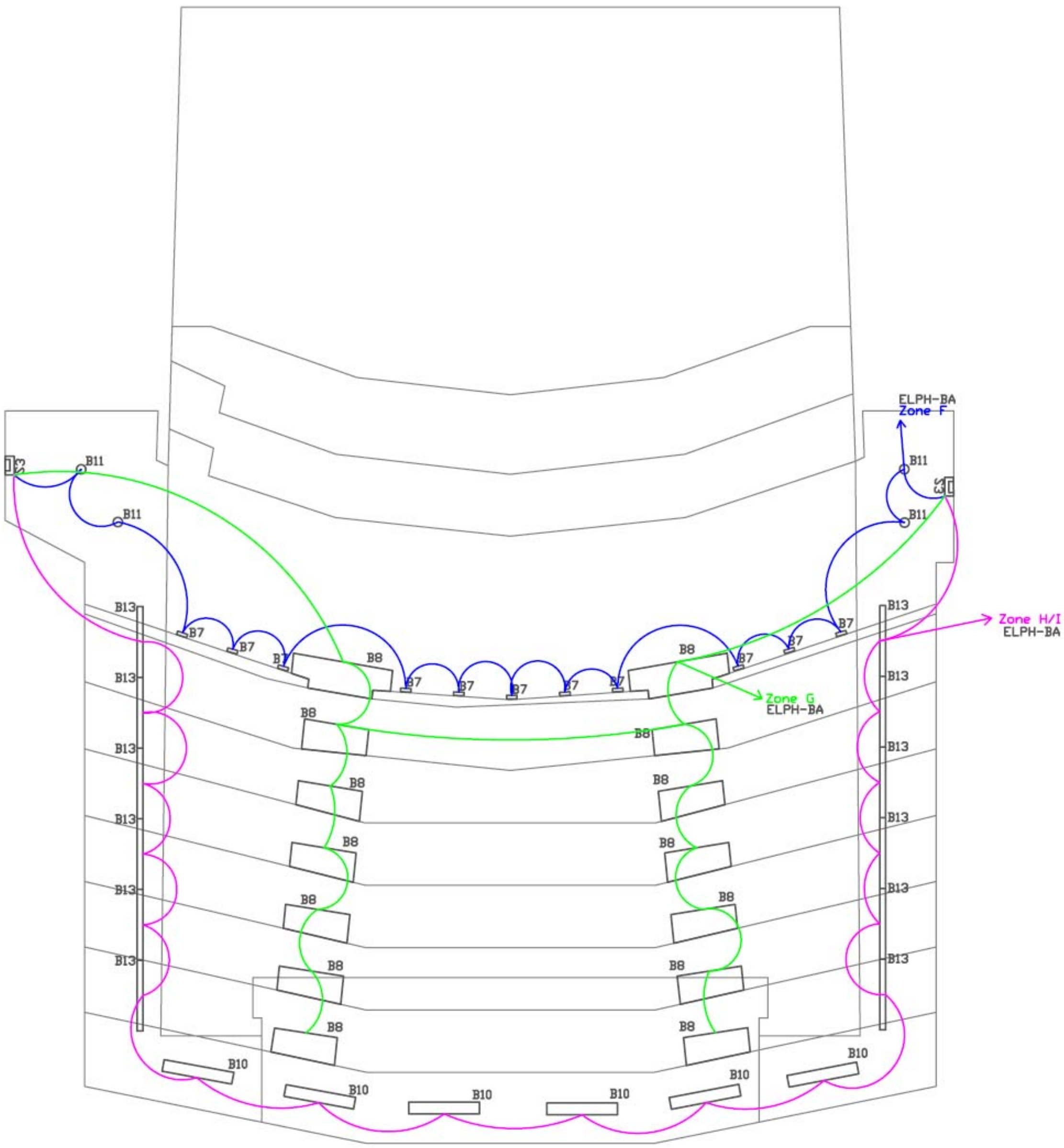
Zone H/I: (6) B10 and (12) B13 fixtures = 210 VA + 816 VA = 1026 VA
= 1026 VA / sqrt(3)*480V = 1.234 A

The VA values are all below the (480V)*(sqrt3)*(16A) = 13302 VA maximum per circuit allowed.

Black-Box Theater 2nd Floor Ceiling Circuiting Plan



Black-Box Theater 1st Floor Circuiting Plan



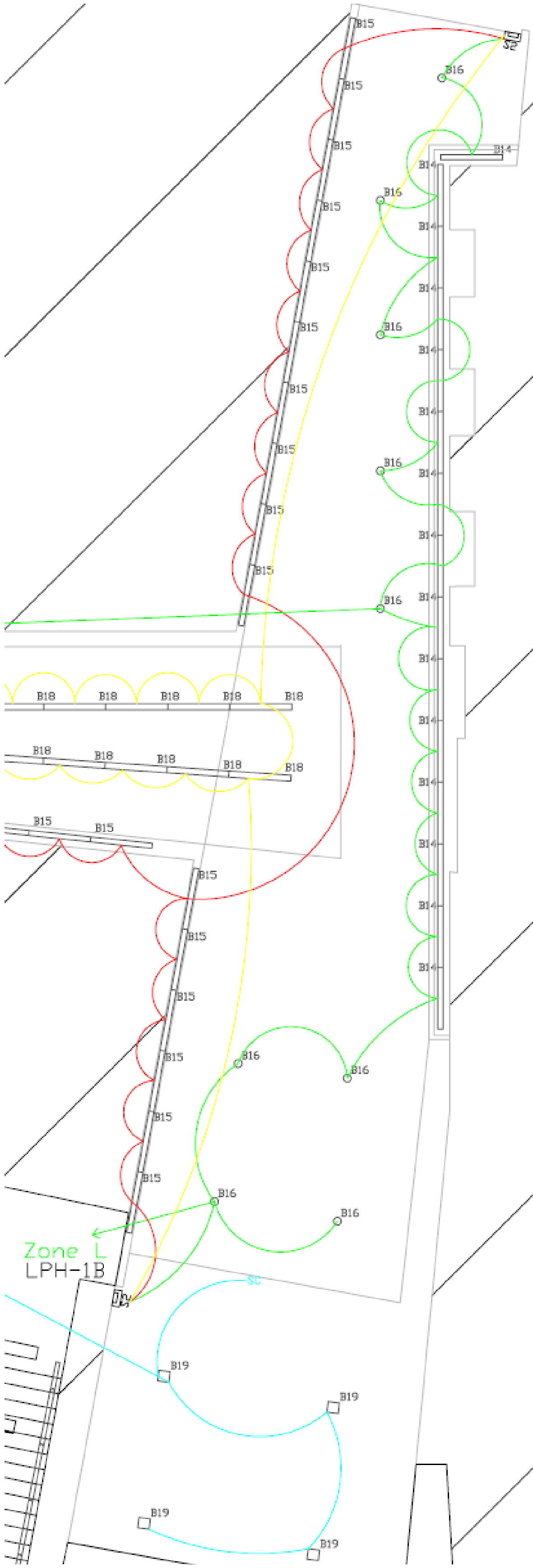
Main Lobby

For this space, the main concern was being able to switch all the different sets of light on one control pad. Using Lutron Grafik Eye 4000, all the lights in the main lobby and gallery can be adjusted pertaining to the times of day and comfort levels. A daylight photosensor is used for the four pendants in the main entrance from the courtyard to be turned on only when dusk is approaching. The other fixtures will be switched using three different control pads mounted at all three exits. During some daytime hours, the blue cove lights might not be needed due to the bright daylight conditions on San Diego, CA as well as to showcase the gallery photos and works using only the recessed accent lights.

Zone J:	(36) B15 fixtures	= 1062 VA
		= 1062 VA / 480V*sqrt(3) = 1.277 A
Zone K:	(26) B18 and (7) B17 fixtures	= 780 VA + 350 VA = 1130 VA
		= 1130 VA / 480V*sqrt(3) = 1.359 A
Zone L:	(16) B14 and (9) B16 fixtures	= 472 VA + 324 VA = 796 VA
		= 796 VA / 480V*sqrt(3) = 0.957 A
Zone M:	(4) B19 fixtures	= 288 VA
		= 288 VA / 480V*sqrt(3) = 0.346 A

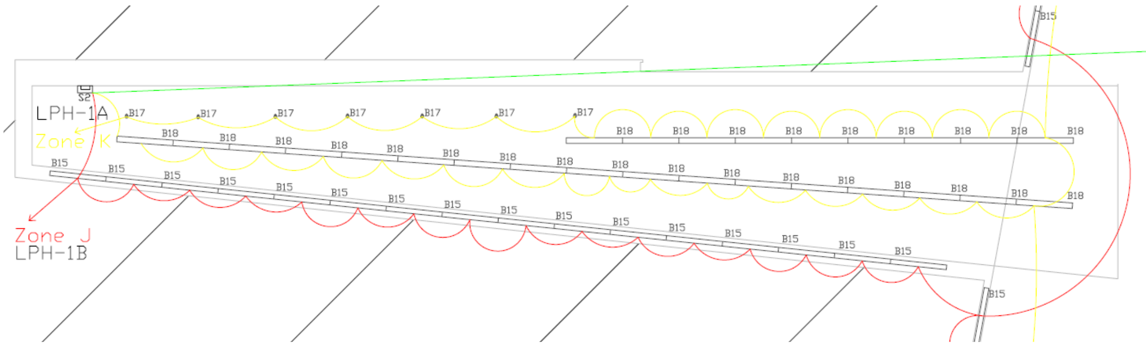
The VA values are all below the (480V)*(sqrt3)*(16A) = 13302 VA maximum per circuit allowed.

Below are the two circuiting diagrams of the lobby. The first diagram is the main entrance leading to the elevators. The second diagram illustrates the gallery corridor that juts out to the left of the lobby.



Lobby Main Entrance

Gallery Corridor off the Lobby



Academic Court

For this area, all the fixtures will be controlled by a daylight photosensor placed on the roof of building section C (the theater portion). This limits the fixtures from turning on too early or late and wasting energy. The up-lit tree fixtures are controlled separately since they will be turned off after midnight by a timer switch. These are turned off for reasons deemed by the University of California, San Diego's Facilities Office.

Zone N: (4) E6 and (11) E10 fixtures = 120 VA + 869 VA = 989 VA
= 989 VA / 480V*sqrt(3) = 1.189 A

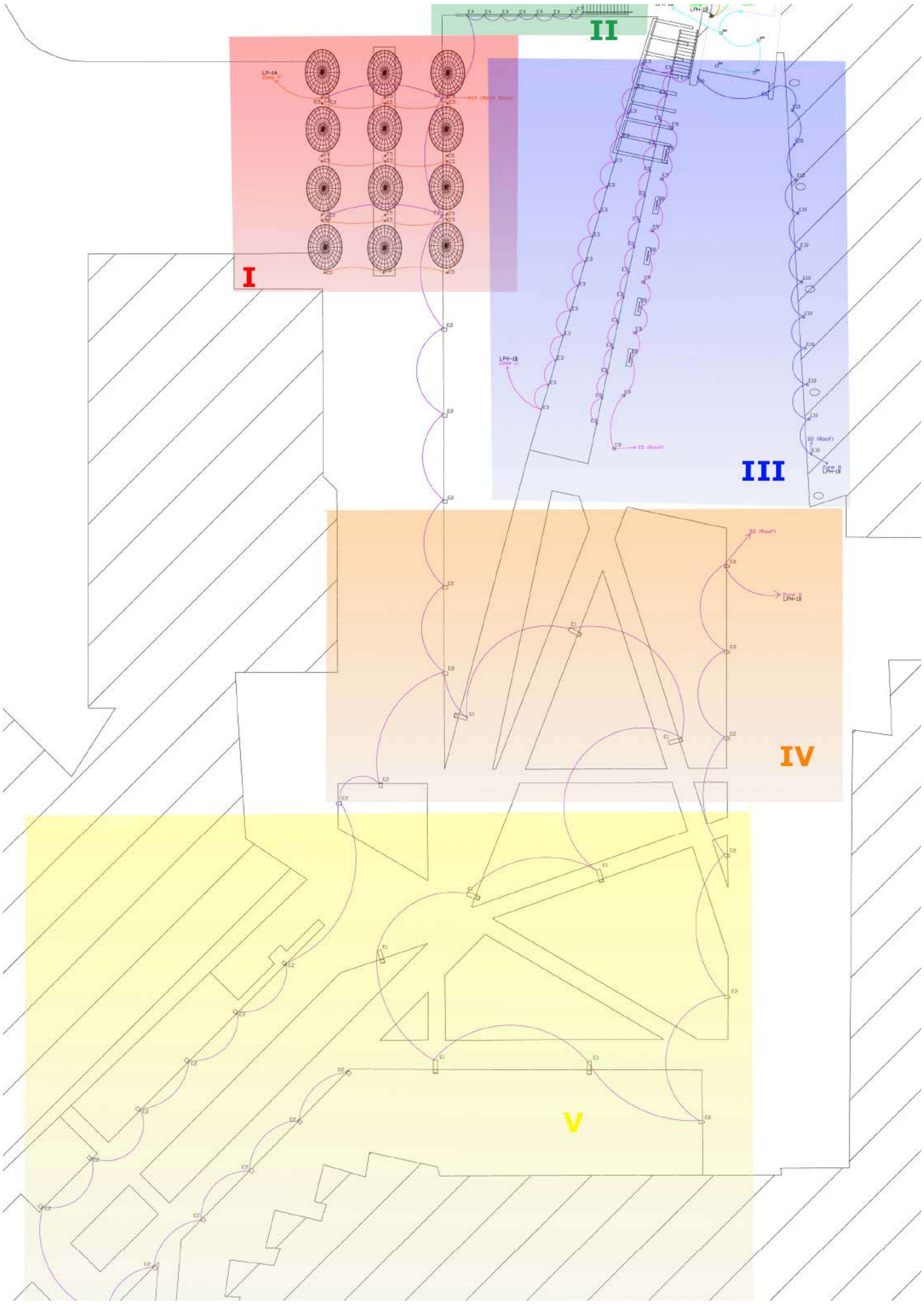
Zone O: (29) E3, (4) E7, (5) E8, (7) E9 = 406 + 118 + 40 + 308 = 872 VA
= 872 VA / 480V*sqrt(3) = 1.049 A

Zone P: (21) E5 fixtures =1050 VA
= 1050 VA / 208V*sqrt(3) = 2.914 A

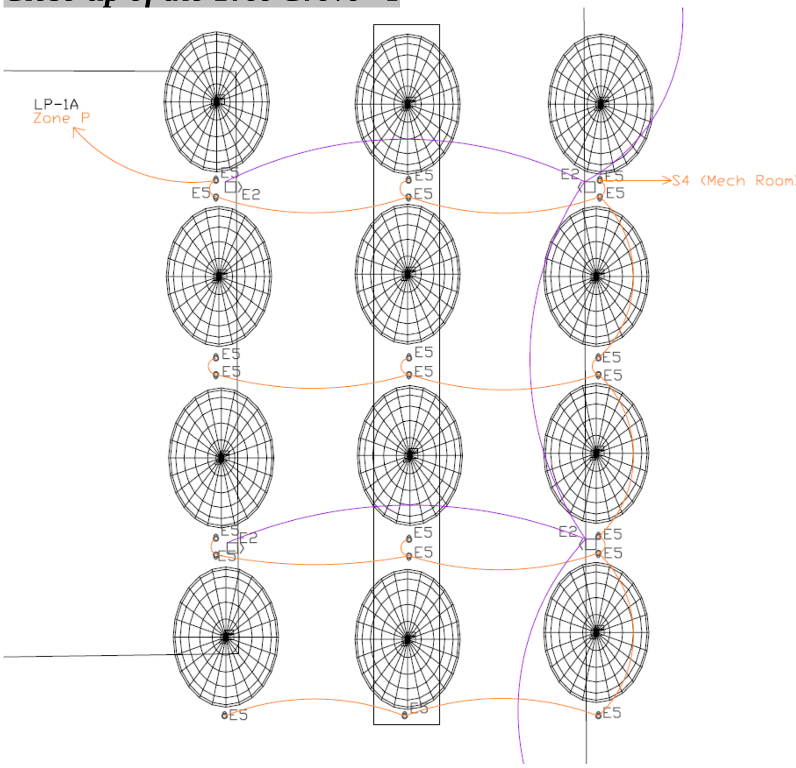
Zone Q: (8) E1 and (29) E2 fixtures = 1080 VA + 1276 VA = 2356 VA
= 2356 VA / 480V*sqrt(3) = 2.834 A

The VA values are all below the (480V)*(sqrt(3))*(16A) = 13302 VA and (208V)*(sqrt(3))*(16A) = 5764 VA maximum per circuit allowed.

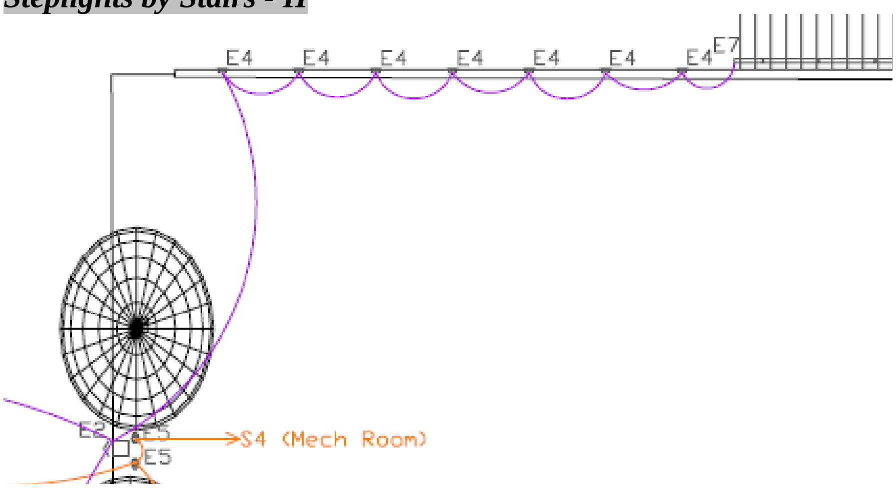
Academic Court Circuiting Diagram



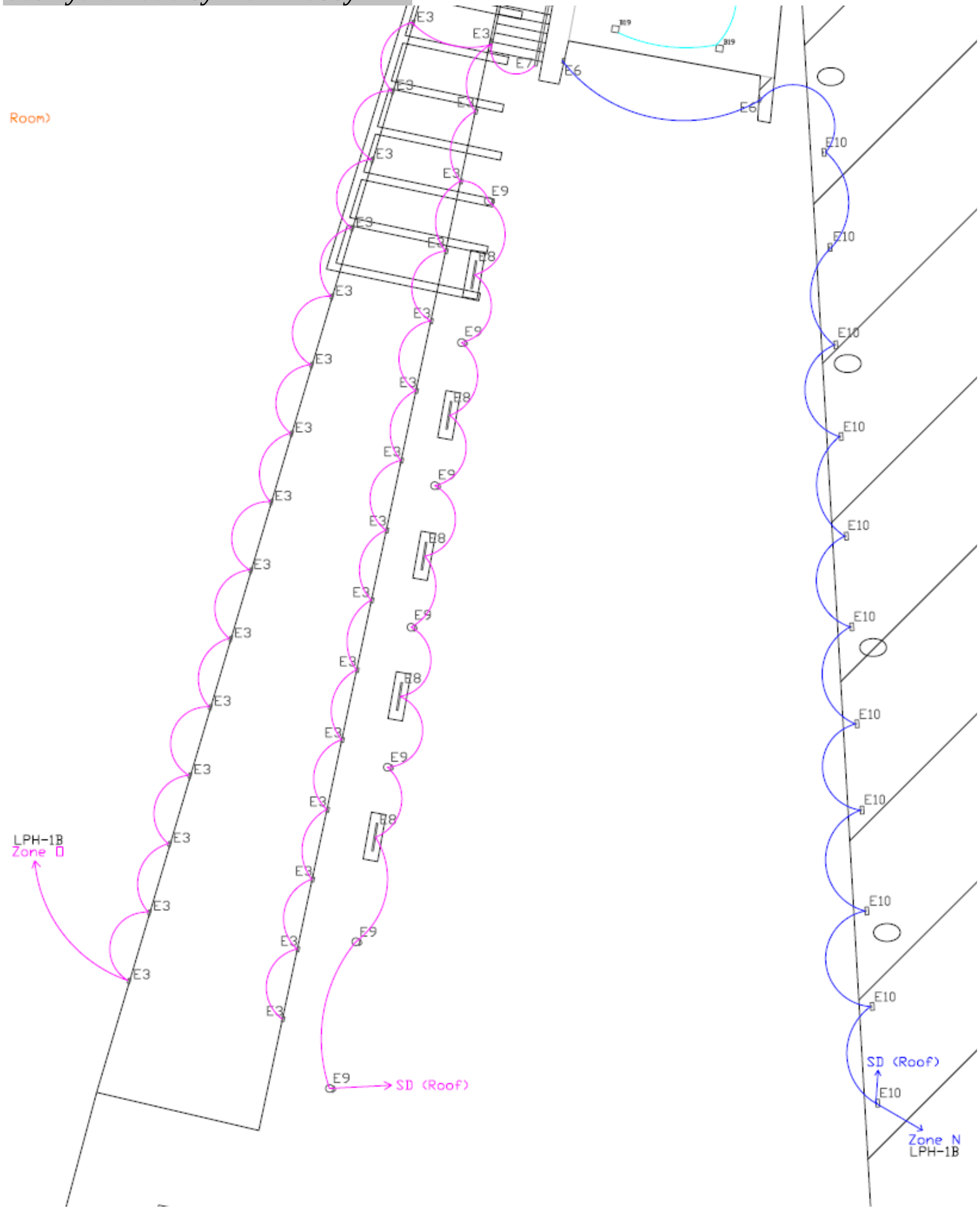
Close-up of the Tree Grove - I



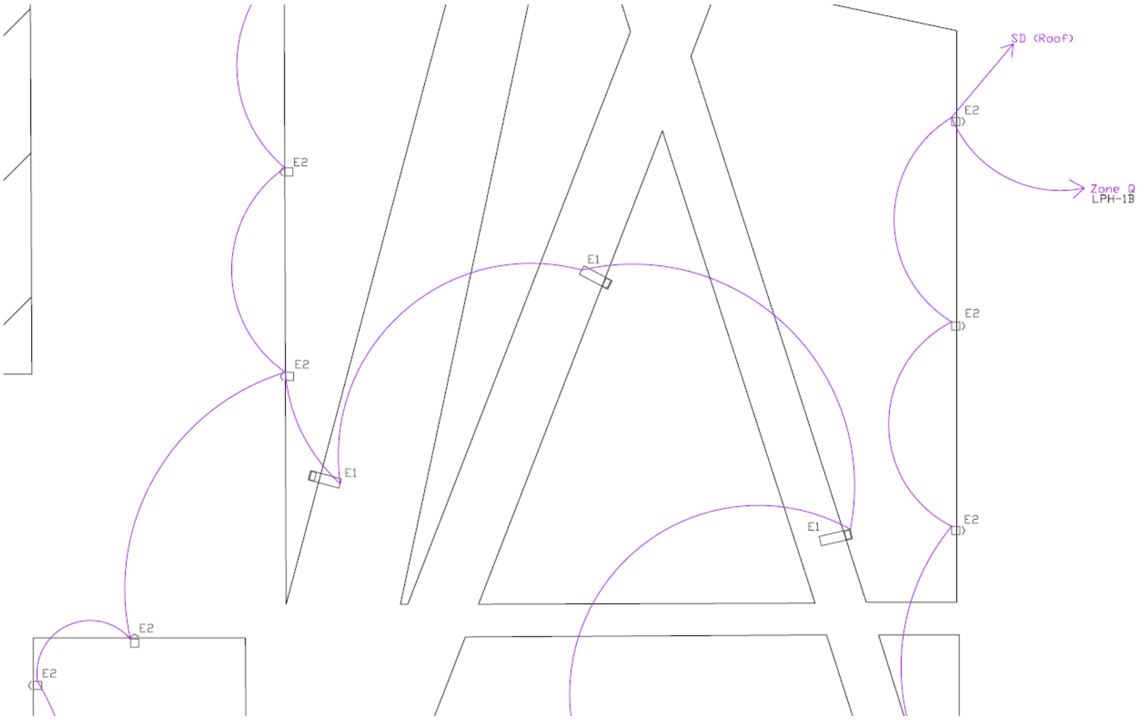
Steplights by Stairs - II



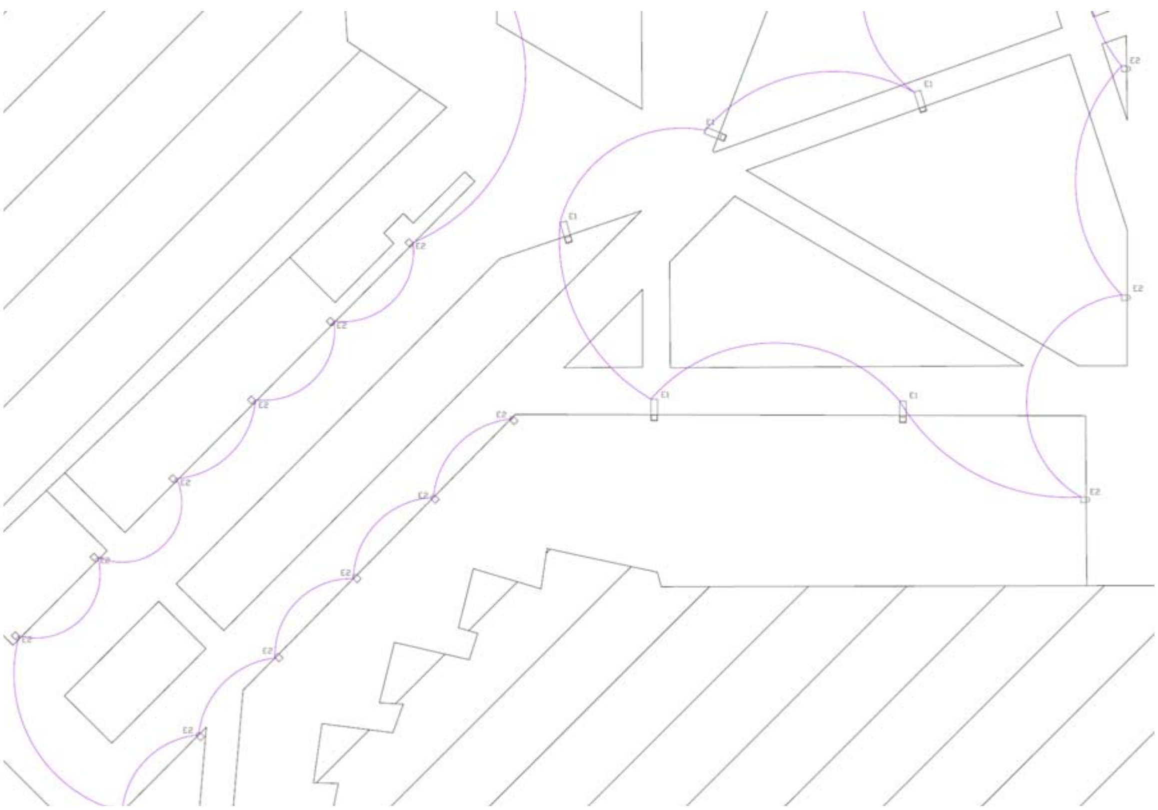
Courtyard Patio by Main Lobby - III



Middle Courtyard – IV



Courtyard East End – V



Underground Tunnel

For this area, there are two levels of lighting to be switched. The blue uplights in the glass windows will be single switched separately. The oscillating fluorescent panels will be controlled by the Lutron Grafik Eye 4000 control panel. These controls will be located in a locked case beside the stairwell to prevent people from adjusting the lights themselves. Shown below are the zone calculations and the circuiting diagram for the tunnel. The large custom panel is shown as a giant box for simplicity purposes. It will be broken into about 9 sections in the end for wiring and size constraint purposes. (See cut-sheets in Appendix for details)

Zone R:	(80) E11 fixtures	= 2880 VA
		= 2880 VA / 480V*sqrt(3) = 3.464 A
Zone S:	(24) E12 fixtures	= 864 VA
		= 864 VA / 480V*sqrt(3) = 1.039 A

The VA values are all below the (480V)*(sqrt(3))*(16A) = 13302 VA maximum per circuit allowed.


E11
E11
E11
E12
Zone R
ELPH-1A
E11
Zone S
ELPH-1A
S1,S5

Panelboard Analysis

After assessing all the panelboards, LPH-1B was the most affected by the lighting design changes made. A calculation of the loads was made to verify the circuit breaker size and wire sizing.

Panel Board LPH-1B		
Circuit	Label	Load
1	Lobby Zone J Lighting	1080
2	Conference Room 1601 Ltg	500
3	Audio Spat. 1604A Ltg	1140
4	Private Offices Ltg	1240
5	Performance 1606 Ltg	1140
6	Restrooms/Video Editing Ltg	1320
7	Lobby Zone L Lighitng	804
8	Storage/Classrooms	600
9	Open Office Suite Ltg	1000
10	Prefunction 1B, 1C Ltg	800
11	Corridor 1C Ltg	640
12	Prefunction 1B, 1C Ltg	900
13	Lobby Zone M	200
14	Reconfig Research Ltg	1920
15	Corridor Ltg	700
16	Equipment Gallery Ltg	500
17	Site Ltg (not in scope)	750
18	Auditorium Ltg (theatrical)	960
19	Future Academic Court Ltg	1500
20	Multi purpose Ltg	180
21	Exterior Ltg Zone O	872
22	Multi purpose Ltg	1650
23	Exterior Ltg Zone N	989
24	Multi purpose Ltg	1650
25	Exterior Ltg Zone Q	2356
26	Spare	
27	Site Ltg	200
28	Spare	
29	Site Ltg	500
30	Spare	
31	Site Ltg	200
32	Spare	
33	Site Ltg	750
34	Spare	
35	Site Ltg	800
36	Spare	
37	Spare	
38	Spare	
39	Spare	
40	Spare	
41	Spare	
42	Spare	
	TOTAL	27841

Connected Load = 27.841 kW
Demand Load = 27.841 * 1.25 = **34.8 kW**

Circuit Breaker Protection and Conductors

Maximum load on any circuit = 2356 VA
Maximum allowed Current/circuit = 2356 VA / 480 V*sqrt(3) = **2.834 A**
So, a standard **20 A** circuit breaker for each circuit is sufficient.
Since this is a three phase, four wire system, **(3) #12 AWG & (1) #12 Neutral in ½" C** will be used throughout the panelboards and all the branch circuiting.

Total load on Panel = 34.8 kW
Maximum allowed current = (34800 VA) / (480 V * sqrt(3)) = **41.858 A**
The **100 A** circuit breaker for the panelboard is sized correctly. The oversize is used for future growth.

Panelboard Schedules

The redesigned lighting loads are in **red.**

PANEL: ELPH-2A | MAIN: M.O | 277/480V, 3 PHASE-4 WIRE | BUS AMPACITY: 225A | SURFACE MOUNTED | 22,000 AIC RMS SYMMETRICAL

TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
L	STAIRWELL NO.1	20/1	1	500			500			2	20/1	STAIRWELL NO.2	L
L	CORRIDOR 3000	20/1	3		1,540			1,540		4	20/1	CORRIDOR 2000	L
L	CLUSTER RESEARCH 3300/3400	20/1	5			1,200			1,200	6	20/1	CLUSTER RESEARCH 2300/2400	L
L	CLUSTER RESEARCH 3100 ZONE A	20/1	7	2660			800			8	20/1	CLUSTER RESEARCH 2100	L
L	LOBBY 3000	20/1	9		1,120			1,120		10	20/1	LOBBY 2000	L
	CLUSTER RESEARCH 3100 ZONE B	20/1	11			936			840	12	20/1	MECHANICAL PLENUM	L
	CLUSTER RESEARCH 3100 ZONE A	20/1	13	2832						14	20/1	SPARE	
	SPARE	20/1	15							16	20/1	SPARE	
	SPARE	20/1	17							18	20/1	SPARE	
	SPARE	20/1	19							20	20/1	SPARE	
	SPARE	20/1	21							22	20/1	SPARE	
	SPARE	20/1	23							24	20/1	SPARE	
	SPARE	20/1	25							26	20/1	SPARE	
	SPARE	20/1	27							28	20/1	SPARE	
	SPARE	20/1	29							30	20/1	SPARE	
	SPARE	20/1	31							32		SPACE	
	SPARE	20/1	33							34		SPACE	
	SPARE	20/1	35							36		SPACE	
	SPACE		37							38	70/3	ET-2A	
	SPACE		39							40	"	"	
	SPACE		41							42	"	"	
	SUBTOTAL (VA)			5992	2,660	2136	1,300	2,660	2,040			SUBTOTAL (VA)	

TOTAL ALL PHASES (VA)	PHASE A	PHASE B	PHASE C	TOTAL ALL PHASES (AMPS)
16788	7292	5,320	4176	20

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	0 VA	1.00	0 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	0 VA	1.00	0 VA
L = LIGHTING	16788 VA	1.25	20985 VA
M = MOTOR	0 VA	1.00	0 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	0 VA	1.00	0 VA

CONNECTED LOAD SUMMARY
16788 VA
20 AMPS

NEC LOAD SUMMARY
20985 VA
25 AMPS

PANEL: ELPH-BA | MAIN: 100A/3P | 277/480V, 3 PHASE-4 WIRE | BUS AMPACITY: 100A | SURFACE MOUNTED | 14,000 AIC RMS SYMMETRICAL

TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
L	BASEMENT MECH. RM.	20/1	1	900			1,440			2	20/1	MULTI PURPOSE RM	L
L	THEATER ZONE D	20/1	3		780					4	20/1	SPARE	
L	THEATER ZONE E	20/1	5			1520				6	20/1	SPARE	
L	THEATER ZONE F	20/1	7	300						8	20/1	SPARE	
L	THEATER ZONE G	20/1	9		240					10	20/1	SPARE	
L	THEATER ZONE H/I	20/1	11			1026				12	20/1	SPARE	
	SPARE	20/1	13							14	20/1	SPARE	
	SPARE	20/1	15							16	20/1	SPARE	
	SPARE	20/1	17							18	20/1	SPARE	
	SPARE	20/1	19							20	20/1	SPARE	
	SPARE	20/1	21							22	20/1	SPARE	
	SPARE	20/1	23							24	20/1	SPARE	
	SPARE	20/1	25							26	20/1	SPARE	
	SPARE	20/1	27							28	20/1	SPARE	
	SPARE	20/1	29							30	20/1	SPARE	
	SPARE	20/1	31							32		SPACE	
	SPARE	20/1	33							34		SPACE	
L	SITE LIGHTING	20/1	35			720				36		SPACE	
	SPACE		37							38	50/3	ET-BA	E
	SPACE		39							40	"	"	E
	SPACE		41							42	"	"	E
	SUBTOTAL (VA)			1200	1020	2546	1,440	0	0			SUBTOTAL (VA)	

TOTAL ALL PHASES (VA)	PHASE A	PHASE B	PHASE C	TOTAL ALL PHASES (AMPS)
6206	2640	1020	2546	8

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	0 VA	1.00	0 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	0 VA	1.00	0 VA
L = LIGHTING	6206 VA	1.25	7758 VA
M = MOTOR	0 VA	1.00	0 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	0 VA	1.00	0 VA

CONNECTED LOAD SUMMARY
6206 VA
8 AMPS

NEC LOAD SUMMARY
7758 VA
10 AMPS

PANEL: LP-1A ⟨1⟩ MAIN: 225A/3P — 120/208V, 3 PHASE-4 WIRE, BUS AMPACTY: 225A — SURFACE MOUNTED, 10,000 AIC RMS SYMMETRICAL

TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
R	CONFERENCE RM 1601A	20/1	1	720			1,080			2	20/1	LOBBY	R
R	CONFERENCE RM 1601A	20/1	3		900			720		4	20/1	LOBBY	R
R	CONFERENCE RM 1601A – FLR	20/1	5			1,000			720	6	20/1	LOBBY	R
R	PRIVATE OFFICES	20/1	7	900			720			8	20/1	RESTROOMS	R
R	PRIVATE OFFICES	20/1	9		900			1050		10	20/1	EXTERIOR TREE UPLIGHTING	L
R	PRIVATE OFFICES	20/1	11			900				12	20/1	SPARE	
R	PRIVATE OFFICES	20/1	13	900						14	20/1	SPARE	
K	COFF	20/1	15		1,740					16	20/1	SPARE	
K	GD	20/1	17			996				18	20/1	SPARE	
K	MW	20/1	19	1,500						20	20/1	SPARE	
K	U/C REF	20/1	21		800					22	20/1	SPARE	
K	REF	20/1	23			1,800				24	20/1	SPARE	
K	PRINTER	20/1	25	1,680						26	20/1	SPARE	
K	FAX	20/1	27		470					28	20/1	SPARE	
K	COP	20/1	29			1,900				30	20/1	SPARE	
R	PRIVATE OFFICES	20/1	31	720						32	20/1	SPARE	
R	CONVENIENCE REC.	20/1	33		540					34	20/1	SPARE	
R	CONVENIENCE REC.	20/1	35			900			325	36	20/1	EF-1-1	M
	SPARE	20/1	37				5,520			38	100/3	LP-1A(2)	E
	SPARE	20/1	39					5,520		40	"	"	E
	SPARE	20/1	41						5,520	42	"	"	E
	SUBTOTAL (VA)			6,420	5,350	7,496	7,320	7290	6,565			SUBTOTAL (VA)	
	TOTAL ALL PHASES (VA)			PHASE A		PHASE B		PHASE C				TOTAL ALL PHASES (AMPS)	
	40441			13,740		12640		14,061				113	

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	16,560 VA	1.00	16,560 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	10,886 VA	1.00	10,886 VA
L = LIGHTING	1050 VA	1.25	1312 VA
M = MOTOR	325 VA	1.00	325 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	11,620 VA	1.00	10,810 VA

CONNECTED LOAD SUMMARY
40441 VA
113 AMPS

NEC LOAD SUMMARY
39893 VA
111 AMPS

PANEL: LPH-1A MAIN: MLO — 277/480V, 3 PHASE-4 WIRE, BUS AMPACITY: 225A — SURFACE MOUNTED, 30,000 AIC RMS SYMMETRICAL

TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
L	3D FABRICATION	20/1	1	1,000			750			2	20/1	ROOMS 120E & 1206A	L
L	Gallery Corridor	20/1	3		1130			1,000		4	20/1	PRIVATE OFFICES – NORTH	L
L	SERVER ROOM 1101	20/1	5			2,050			800	6	20/1	RESTROOMS	L
L	SERVER ROOM 1101	20/1	7	1,300						8	20/1	SPARE	
L	CLUSTER RESEARCH 1202	20/1	9		930					10	20/1	SPARE	
		20/1	11							12	20/1	SPARE	
	SPARE	20/1	13							14	20/1	SPARE	
	SPARE	20/1	15							16	20/1	SPARE	
	SPARE	20/1	17							18	20/1	SPARE	
	SPARE	20/1	19							20	20/1	SPARE	
	SPARE	20/1	21							22	20/1	SPARE	
	SPARE	20/1	23							24	20/1	SPARE	
	SPARE	20/1	25							26	20/1	SPARE	
	SPARE	20/1	27							28	20/1	SPARE	
	SPARE	20/1	29							30	20/1	SPARE	
	SPARE	20/1	31							32	20/1	SPARE	
	SPARE	20/1	33							34	20/1	SPARE	
	SPARE	20/1	35							36	20/1	SPARE	
	SPACE		37							38		SPACE	
	SPACE		39							40		SPACE	
	SPACE		41							42		SPACE	
	SUBTOTAL (VA)			2,300	2060	2,050	750	1,000	800			SUBTOTAL (VA)	
	TOTAL ALL PHASES (VA)			PHASE A		PHASE B		PHASE C				TOTAL ALL PHASES (AMPS)	
	8960			3,050		3060		2,850				11	

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	0 VA	1.00	0 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	0 VA	1.00	0 VA
L = LIGHTING	8960 VA	1.25	11200 VA
M = MOTOR	0 VA	1.00	0 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	0 VA	1.00	0 VA

CONNECTED LOAD SUMMARY
8960 VA
11 AMPS

NEC LOAD SUMMARY
11200 VA
14 AMPS

PANEL: LPH-1B | 277/480V, 3 PHASE-4 WIRE | SURFACE MOUNTED
MAIN: MLO | BUS AMPACITY: 100A | 30,000 AIC RMS SYMMETRICAL

TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
L	LOBBY 1000 ZONE J	20/1	1	1080			500			2	20/1	CONFERENCE ROOM – 1601A	L
L	AUDIO SPAT. -1604A	20/1	3		1,140			1,240		4	20/1	PRIVATE OFFICES – EAST	L
L	PERFORM. COMP. – 1606	20/1	5			1,140			1,320	6	20/1	RESTROOMS/VIDEO EDITING	L
L	LOBBY 1000 ZONE L	20/1	7	804			600			8	20/1	STORAGE / CLASSROOMS	L
L	OPEN OFFICE SUITE	20/1	9		1,000			800		10	20/1	PREFUNCTION – 1B, 1C	L
L	CORRIDOR – LEVEL 1C	20/1	11			640			900	12	20/1	PREFUNCTION – 1B, 1C	L
L	LOBBY 1000 ZONE M	20/1	13	200			1,920			14	20/1	RECONFIG. RESEARCH	L
L	CORRIDOR	20/1	15		700			500		16	20/1	EQUIPMENT GALLERY	L
L	SITE LIGHTING	20/1	17			750			960	18	20/1	AUDITORIUM	L
L	FUTURE ACADEMIC CT.	20/1	19	1,500			180			20	20/1	MULTIPURPOSE RM.	L
L	EXTERIOR LIGHTING ZONE O	20/1	21		872			1,650		22	20/1	MULTIPURPOSE LIGHTING	L
L	EXTERIOR LIGHTING ZONE N	20/1	23			989			1,650	24	20/1	MULTIPURPOSE LIGHTING	L
L	EXTERIOR LIGHTING ZONE Q	20/1	25	2356						26	20/1	SPARE	
L		20/1	27		200					28	20/1	SPARE	
L		20/1	29			300				30	20/1	SPARE	
L	SITE LIGHTING	20/1	31	200						32	20/1	SPARE	
L	SITE LIGHTING	20/1	33		750					34	20/1	SPARE	
L	SITE LIGHTING	20/1	35			800				36	20/1	SPARE	
	SPACE		37							38		SPACE	
	SPACE		39							40		SPACE	
	SPACE		41							42		SPACE	
	SUBTOTAL (VA)			6140	4662	4619	3,200	4,190	4,830			SUBTOTAL (VA)	
	TOTAL ALL PHASES (VA)			PHASE A		PHASE B		PHASE C				TOTAL ALL PHASES (AMPS)	
	27641			9340		8852		9449				34	

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	0 VA	1.00	0 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	0 VA	1.00	0 VA
L = LIGHTING	27641 VA	1.25	34551 VA
M = MOTOR	0 VA	1.00	0 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	0 VA	1.00	0 VA

CONNECTED LOAD SUMMARY
27641 VA
34 AMPS

NEC LOAD SUMMARY
34551 VA
42 AMPS

PANEL: LPH-3A | 277/480V, 3 PHASE-4 WIRE | SURFACE MOUNTED
MAIN: MLO | BUS AMPACITY: 225A | 30,000 AIC RMS SYMMETRICAL

TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
L	PRIVATE OFFICES 3100	20/1	1	550			2,060			2	20/1	PRIVATE OFFICES – NORTH	L
L	CLUSTER RESEARCH 3100	20/1	3		2,040			1,750		4	20/1	PRIVATE OFFICES – SOUTH	L
L	LOBBY 3000	20/1	5			2,500			650	6	20/1	RESTROOMS/PRIVATE OFFICES	L
L	CLUSTER RESEARCH 3300	20/1	7	2,090			2,500			8	20/1	PRIVATE OFFICES – NORTH	L
L	CORRIDOR 3200	20/1	9		1,030			1,860		10	20/1	PRIVATE OFFICES	L
L	OFFICE 3400A	20/1	11			1,470			1,900	12	20/1	PRIVATE OFFICES	L
L	ELEVATOR COVE	20/1	13	700			1,510			14	20/1	VENDING / COPY AREA	L
	SPARE	20/1	15							16	20/1	SPARE	
	SPARE	20/1	17							18	20/1	SPARE	
	SPARE	20/1	19							20	20/1	SPARE	
	SPARE	20/1	21							22	20/1	SPARE	
	SPARE	20/1	23							24	20/1	SPARE	
	SPARE	20/1	25							26	20/1	SPARE	
	SPARE	20/1	27							28	20/1	SPARE	
	SPARE	20/1	29							30	20/1	SPARE	
	SPARE	20/1	31							32	20/1	SPARE	
	SPARE	20/1	33							34	20/1	SPARE	
	SPARE	20/1	35							36	20/1	SPARE	
	SPACE		37							38		SPACE	
	SPACE		39							40		SPACE	
	SPACE		41							42		SPACE	
	SUBTOTAL (VA)			3340	3,070	3,970	6,070	3,510	2,550			SUBTOTAL (VA)	
	TOTAL ALL PHASES (VA)			PHASE A		PHASE B		PHASE C				TOTAL ALL PHASES (AMPS)	
	22610			9410		6,680		6,520				28	

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	0 VA	1.00	0 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	0 VA	1.00	0 VA
L = LIGHTING	22610 VA	1.25	28262 VA
M = MOTOR	0 VA	1.00	0 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	0 VA	1.00	0 VA

CONNECTED LOAD SUMMARY
22610 VA
28 AMPS

NEC LOAD SUMMARY
28262 VA
35 AMPS

PANEL: ELPH-1A MAIN: MLO				277/480V, 3 PHASE-4 WIRE BUS AMPACITY: 100A						SURFACE MOUNTED 14,000 AIC RMS SYMMETRICAL			
TYPE	DESCRIPTION	DEVICE	CKT	LOAD/PHASE (VA) A	B	C	A	B	C	CKT	DEVICE	DESCRIPTION	TYPE
L	WEST CORRIDOR - 1B	20/1	1	1,200			520			2	20/1	SOUTH STAIRWELL - 1B	L
L	EAST CORRIDOR - 1B	20/1	3		1,030			120		4	20/1	SOUTH CORRIDOR - 1B	L
L	RECON. RESEARCH LABS	20/1	5			640			200	6	20/1	STEPLIGHTS - 1A	L
L	CORRIDOR - 1C	20/1	7	300			400			8	20/1	STEPLIGHTS - 1A	L
L	CLASSROOMS - 1A	20/1	9		1,000			2880		10	20/1	TUNNEL LTG ZONE R	L
L	CORRIDOR - 1A	20/1	11			1,550			100	12	20/1	STEPLIGHTS - 1C	L
L	TUNNEL - 1B	20/1	13	500			100			14	20/1	STEPLIGHTS - 1C	L
L	METALIZATION 1425	20/1	15		200			200		16	20/1	METROLOGY 1423	L
L	METALIZATION 1429	20/1	17			200			200	18	20/1	METROLOGY 1419	L
L	THERMAL PROCESS 1431	20/1	19	200			200			20	20/1	LITHOGRAPHY 1417	L
L	BACK END PROCESS 1433	20/1	21		200			200		22	20/1	LITHOGRAPHY 1413	L
L	ETCH 1439	20/1	23			200			200	24	20/1	E-BEAM LITHOGRAPHY 1409	L
L	WET PROCESS 1443	20/1	25	200			200			26	20/1	DEVELOPMENT 1405	L
L	MAIN ELECTRICAL ROOM	20/1	27		230			864		28	20/1	TUNNEL LTG ZONE S	
L	PREFUNCTION	20/1	29			200				30	20/1	SPARE	
L	MULTIPURPOSE	20/1	31	100						32	20/1	SPARE	
	SPARE	20/1	33							34	20/1	SPARE	
	SPARE	20/1	35							36	20/1	SPARE	
	SPACE		37							38	50/3	ET-1B	E
	SPACE		39							40	"	"	E
	SPACE		41							42	"	"	E
	SUBTOTAL (VA)			2,600	2,660	2,790	1,420	3744	700			SUBTOTAL (VA)	
	TOTAL ALL PHASES (VA)			PHASE A		PHASE B		PHASE C				TOTAL ALL PHASES (AMPS)	
	13914			4,020		6404		3,490				17	

LOAD SUMMARY BY TYPE	CONNECTED LOAD	DEMAND FACTOR	NEC LOAD
E = EQUIPMENT	0 VA	1.00	0 VA
H = ELECTRIC HEAT	0 VA	1.00	0 VA
K = KITCHEN EQUIPMENT	0 VA	1.00	0 VA
L = LIGHTING	13914 VA	1.25	17392 VA
M = MOTOR	0 VA	1.00	0 VA
M = LARGEST MOTOR	VA	1.25	0 VA
R = RECEPTACLE	0 VA	1.00	0 VA

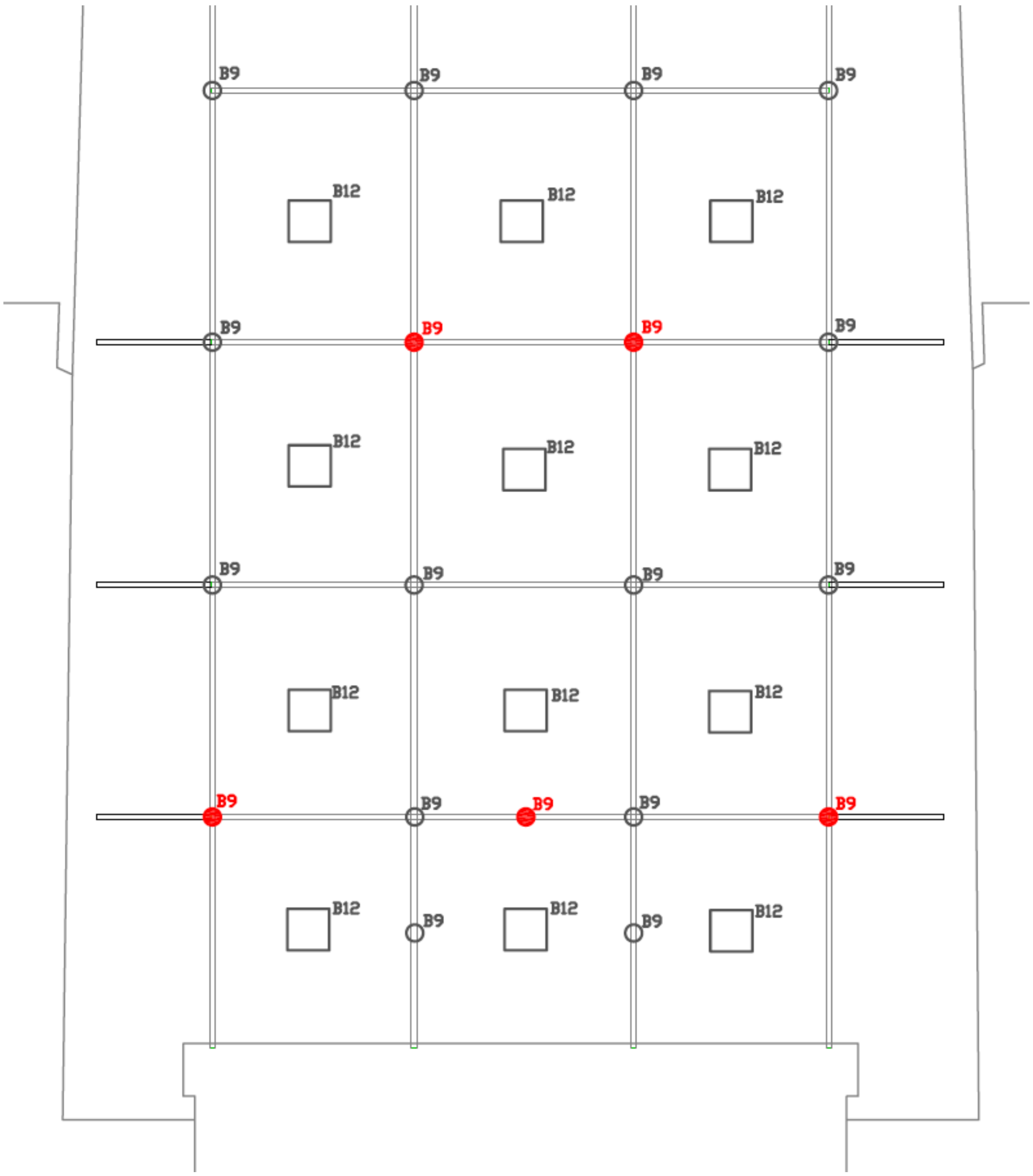
CONNECTED LOAD SUMMARY
13914 VA
17 AMPS

NEC LOAD SUMMARY
17392 VA
21 AMPS

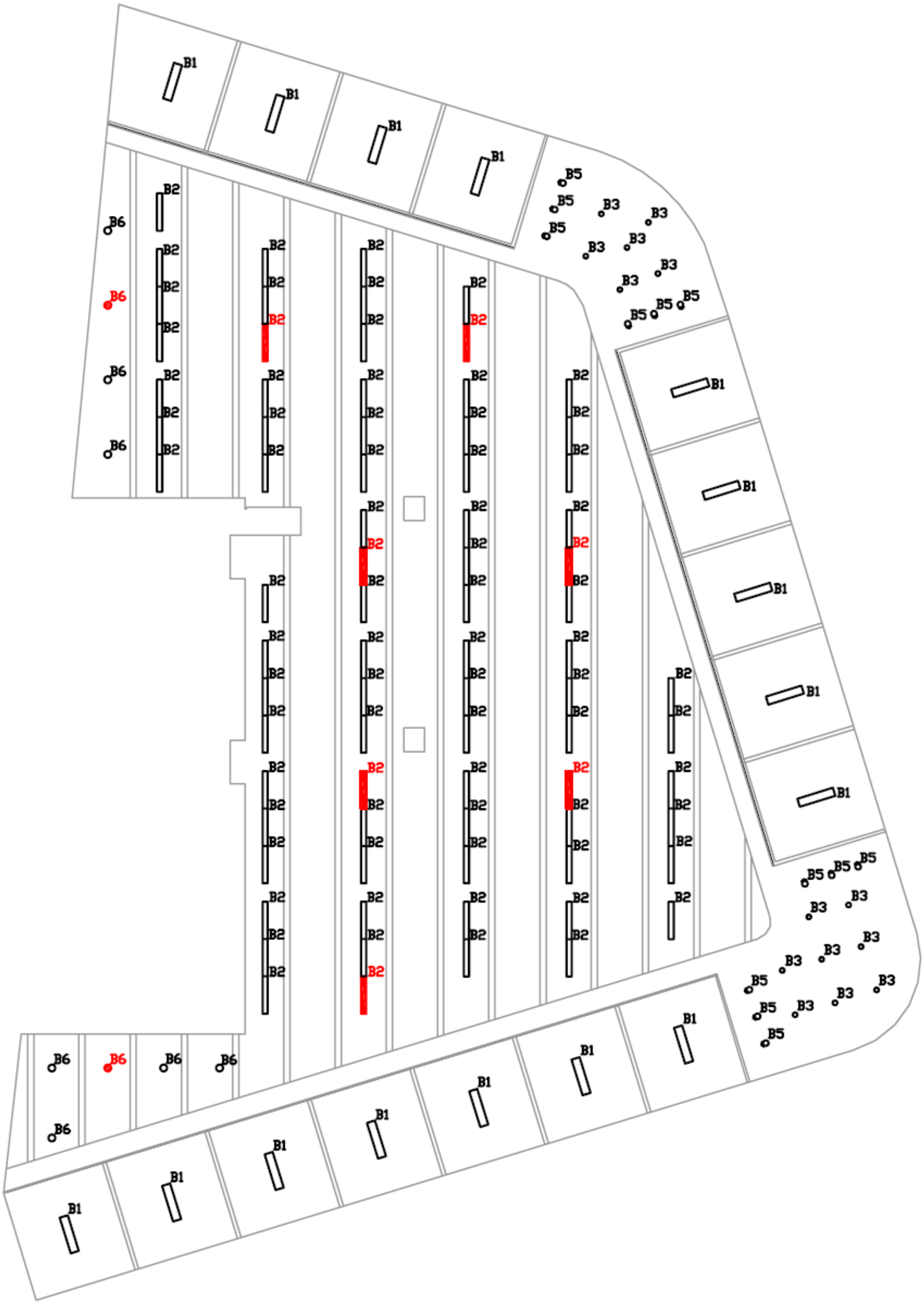
Emergency Lighting

I have provided emergency lighting plans to show the fixtures connected to the emergency panel boards in case of a black-out. They are shown in red. Not many are used because only light for evacuation is needed which entails only 1 fc. The lobby and academic court are not included in the emergency lighting plan.

Emergency Lighting Plans - Theater



Emergency Lighting Plans – 3100 Research Area

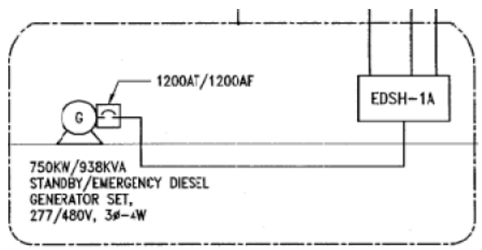


Emergency Power

Cal (IT)^2 currently uses a 750 kW (938 kVA), 1200A 3 phase, 4 wire standby emergency diesel powered generator. In case of a power outage, there are three automatic transfer switches to transfer the power from the emergency generator to the emergency power loads. The emergency power is distributed by the switch board EDSH-1A which contains emergency lighting, mechanical equipment, clean room equipment, and elevator loads. In this study, I will be resizing the emergency generator with my new current emergency lighting loads to verify the emergency power needed in case of a power outage.

EDSH-1A Loads

Distribution Panel	Circuit Loads	Loads (kVA)	Total
EDPH-1A			
	ELPH-BA	7.758	
	ELPH-1A	10.253	
	ELPH-2A	20.985	
	ELPH-4A	11.913	
	ELPH-PA	2.625	
			53.534
EDPH-ELEV-PA			
	ELEV-1	29.830	
	ELEV-2	29.830	
	ELEV-3	29.830	
	ELP-ELEV-PA	2.580	
			92.07
EDPH-1B			
	EDPH-2A	182.730	
	EDPH-PA	49.620	
	CH-1	0.750	
	CAC-1-1	3.730	
	CAC-1-2	3.730	
	CAC-1-3	3.730	
	MOCVD Equipment	100.000	
			344.29
		TOTAL kVA	489.894



The load values in this chart can be referred to in Technical Assignment #2.

Total kVA = 489.894 = about **500 kVA**
Current generator = 938 kVA > 500 kVA, so the generator is sized properly.

<u>Circuit breaker sizing for EDSH-1A</u>
(489.894 kVA) / (0.48 kV * sqrt(3)) = **590 A**
Current circuit breaker = 1200 A > 590 A, so the protection is sized properly.

Conclusions

The current electrical power loads for the building are sized properly. Being a technological research facility, I expected all the panelboards and distribution panels to be oversized by a significant amount due to the future installation of lab equipment and materials.