Electrical Depth

Overview:

The main power for the Life Sciences & Philosophy comes from the main switchgear for Franklin & Marshall College. Power is run from existing lines in the front of the building to a basement substation at the northwest corner of the building. The 12.47KV service voltage is transformed down to 480Y/277V secondary service. Power is then distributed to various basement panels, 2 bus ducts, and the penthouse level. Each bus ducts serves one half of the building (north or south), and there are 2 electrical rooms on each floor (again, one on the north side of the building, the other servicing the south side). Most of the lighting runs on 277V. There are transformers converting the voltage down to 208Y/120 V service in each electrical room, on the penthouse level, and the main mechanical room. The 208Y/120 service is used for receptacle loads, incandescent lighting, and much of the heating for the space.

This Electrical Depth will focus on several components of the electrical distribution system. I have divided this into four separate studies, and for consistency, I have elected to do these studies independently of one another. While I acknowledge that anything that I change in the electrical distribution may have an effect on the system as a whole, it would be impractical to compare, say, the impact of changing copper feeders to aluminum, between the original system and the new system with various enhancements. This is because it would be more difficult to pinpoint what is actually causing the results to be the way they are. Like any good experiment or study, one independent variable needs to be isolated, and everything else needs to remain the same.

The first study will look at the impact of the new lighting design on the branch circuits and panelboards serving it. The second study is an analysis of creating one central 480 to 208Y/120 transformer to replace the seven transformers distributed to the various electrical rooms in the building. The third study looks at changing all of the copper feeders in the building to aluminum, in the hopes of saving significant money. The final study is a protective device coordination and fault current analysis to ensure that the system was properly designed.

Analysis of Circuits Affected By Lighting Design

Overview :

Although the majority of the building uses lighting at 277V (and thus, relatively low current), it is nevertheless still important to analyze the lighting design's effect on the panelboards serving the lighting. I will summarize the effects of each space's new lighting design on the panelboards and feeders serving the panelboards, and will then show calculations of each panelboard affected. Since I was unable to get detailed load calculations from the electrical engineer, I will be assuming that the original panelboards were designed appropriately. All feeders were copper with type THHN insulation in EMT conduit. As a design decision, I have opted to change all of my panelboards up to a minimum of 100A, which is more common than the 60A panels originally used here.

Exterior and Façade:

Since much of the lighting design for the exterior had not been performed yet, the loading for the exterior did go up a bit. However, the original lighting panels were sized with dedicated circuits for lighting, and the panels were sized with an anticipated lighting load.

Frey Atrium:

The atrium lighting system was originally controlled off of separate dimming panels. Since I will not require dimming for my design, I have decided to place all of the luminaires directly on the existing lighting panels. A total of seven panels will receive additional (albeit very small) loads, and the four dimming panels will receive a reduced load.

Ecology Teaching Lab:

All of the lighting for the space is on one circuit. Because I saved energy off of the original design, as shown below, I can confidently state that the new lighting design will have no effect on the sizing of the panelboard L2NA.

Bonchek Lecture Hall:

The lecture hall was also controlled off of dimming panels. Since scene and dimming control is critical for this space, the dimming panels would still make sense here. However, since I have no 120V lighting in the space, there will no longer be any load on the two 208Y/120 dimming panels from either the atrium or the lecture hall.

Exterior and Façade Circuiting Plans:

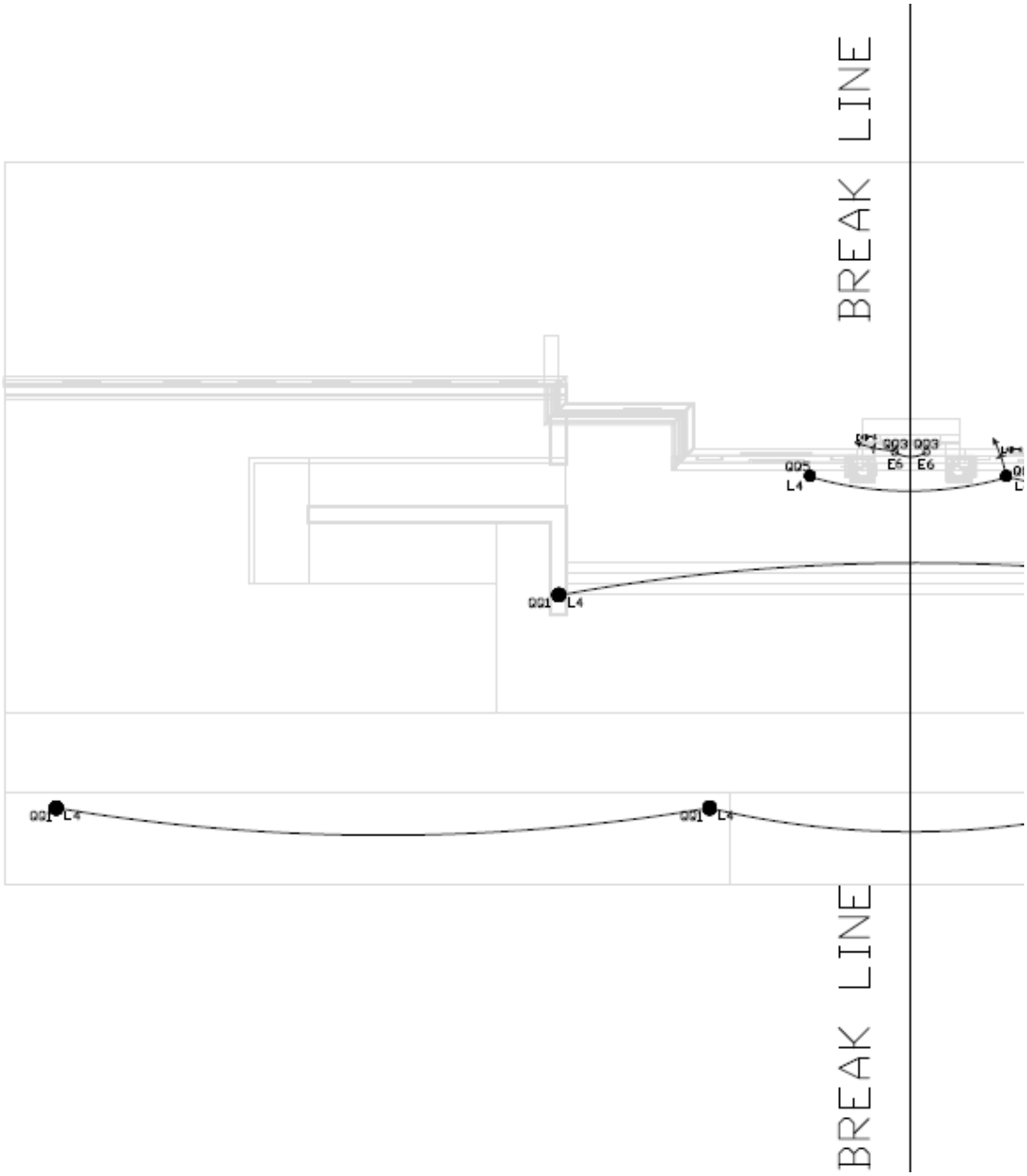

Figure 6.01 *First Floor Circuiting Plan for East Entry and Façade – South Of Entrance*

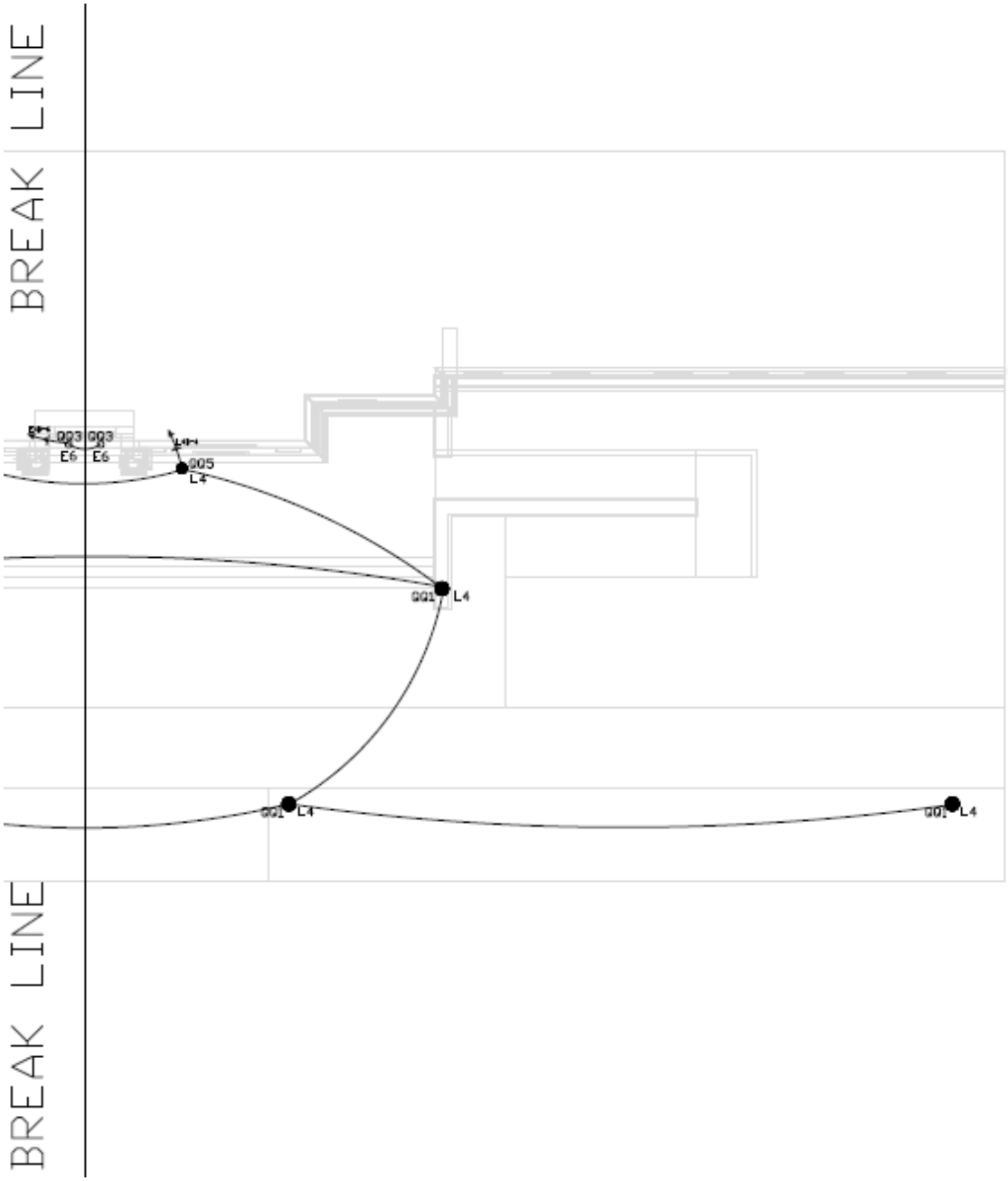

Figure 6.02 *First Floor Circuiting Plan for East Entry and Façade – North Of Entrance*

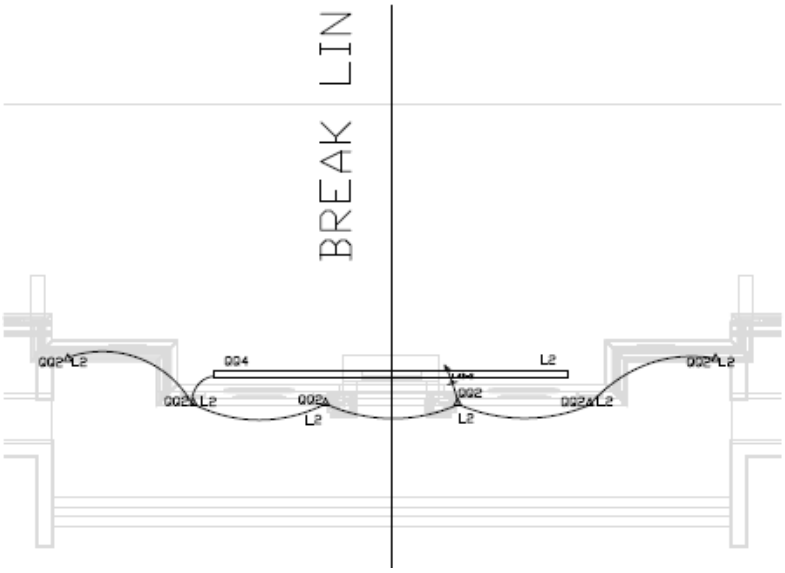

Figure 6.03 *Second Floor Circuiting Plan – East Entry and Façade*

Frey Atrium Circuiting Plans:

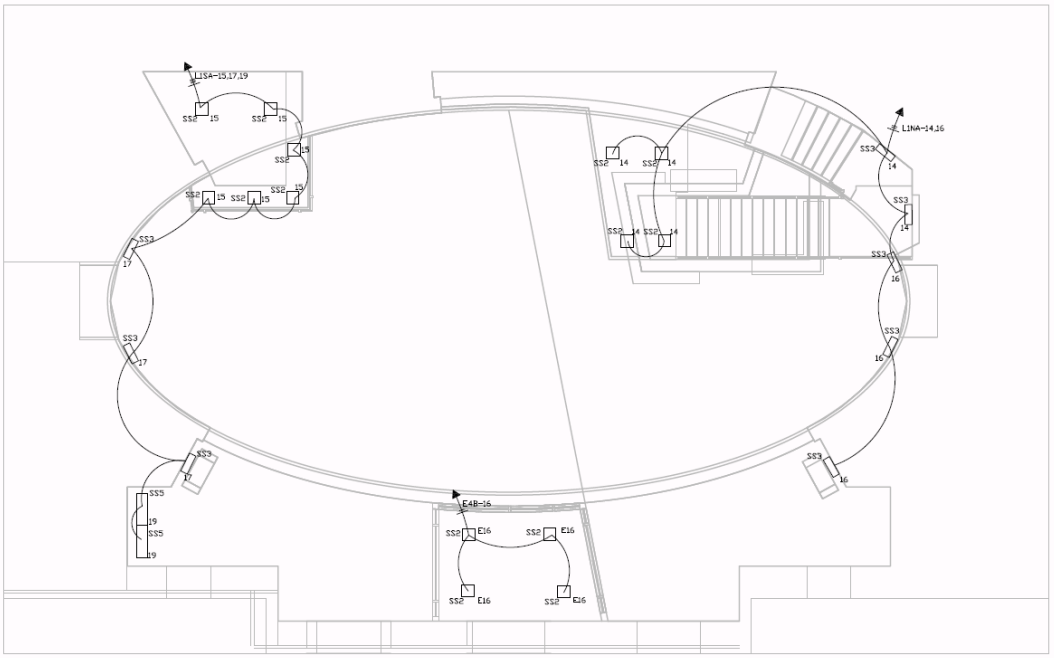

Figure 6.04 *First Floor Circuiting Plan – Atrium*

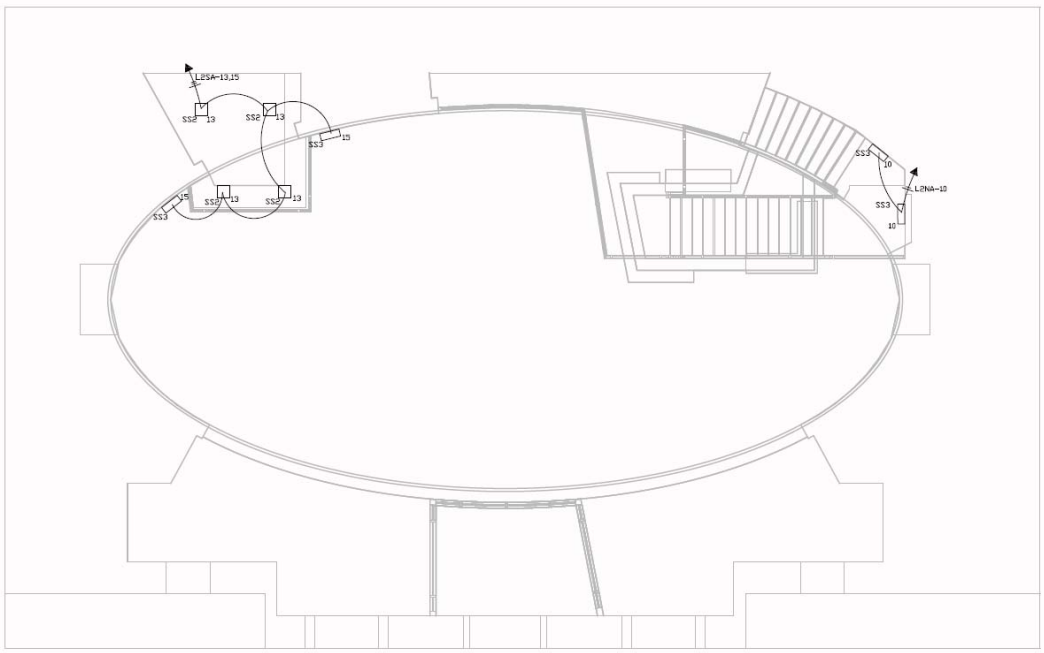

Figure 6.05 *Second Floor Circuiting Plan – Atrium*

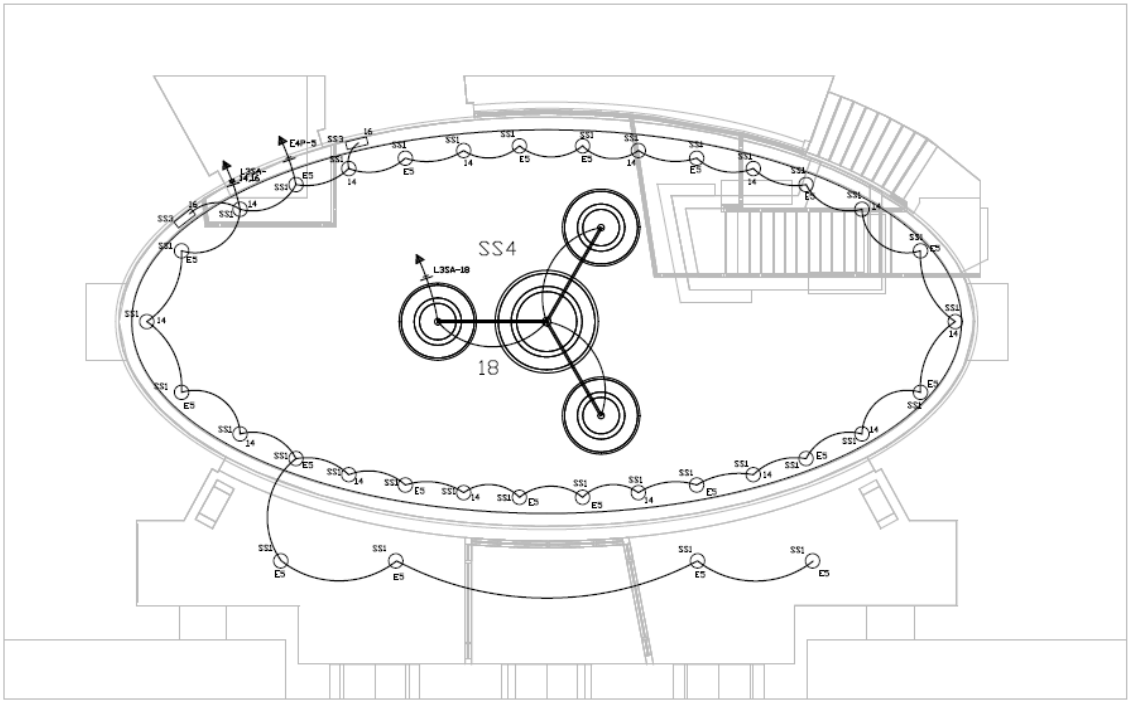

Figure 6.06 *Third Floor Circuiting Plan – Atrium*

Ecology Teaching Laboratory Circuiting Plan:

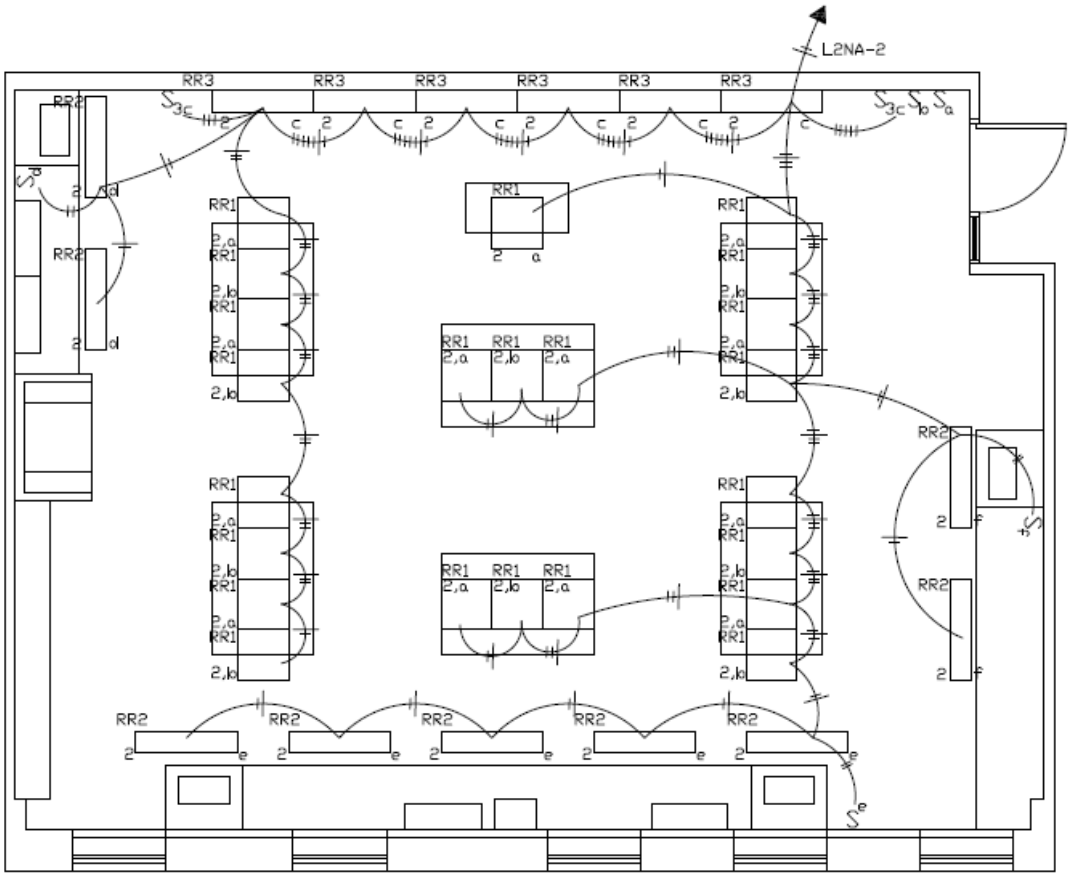

Figure 6.07 *Second Floor Circuiting Plan – Ecology Teaching Lab*

Bonchek Lecture Hall Circuiting Plan:

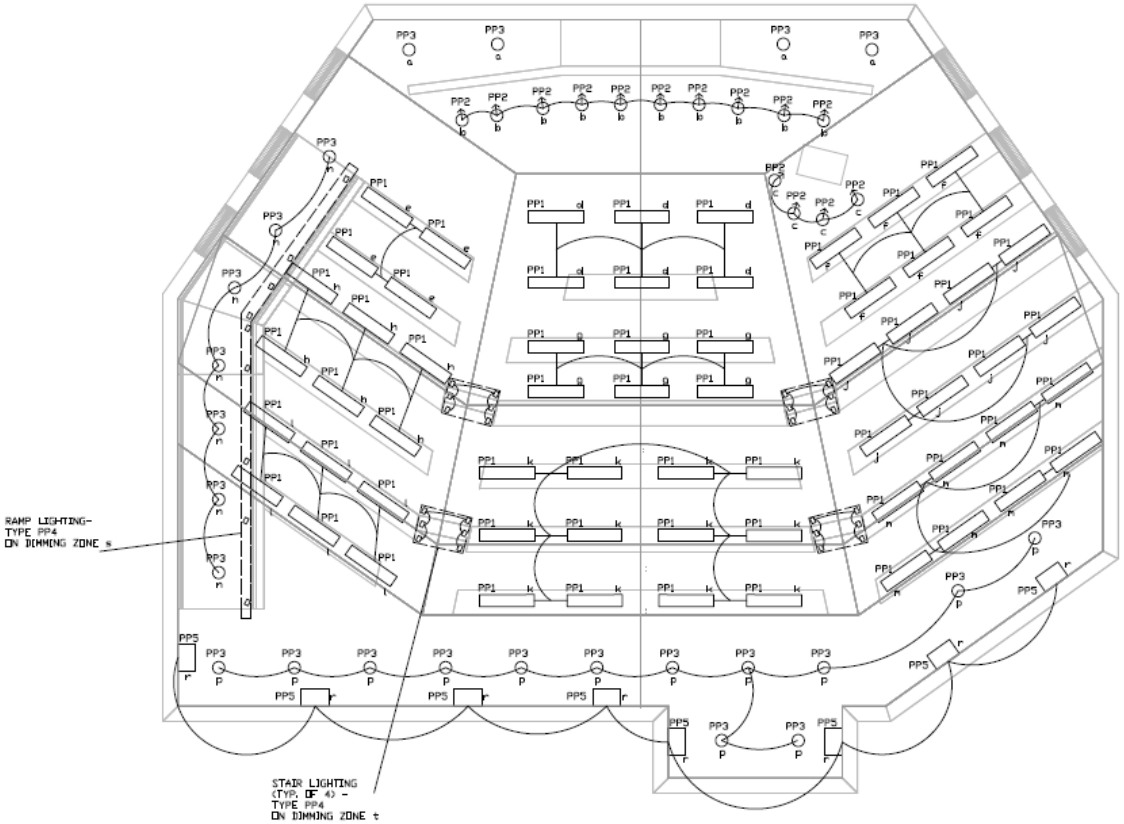

Figure 6.08 *First Floor Circuiting Plan – Lecture Hall*

Panel L4B:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Exterior

Circuit(s) Affected: 2, 4

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: L4B PANEL LOCATION: Main Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	RM 43-45	1625	20A/1P	1	*			2	20A/1P	0	Future Use	HID Lighting
Fluorescent Ltg	RM 33, 40	2005	20A/1P	3		*		4	20A/1P	525	POLE EAST	HID Lighting
Fluorescent Ltg	COR 000	1492	20A/1P	5			*	6	20A/1P	1295	POLE SOUTH WEST	HID Lighting
Fluorescent Ltg	RM 50-55	1206	20A/1P	7	*			8	20A/1P	1480	POLE WEST	HID Lighting
Fluorescent Ltg	STAIR WEST	314	20A/1P	9		*		10	20A/1P	750	GARDEN SOUTH	Incandescent Ltg
Fluorescent Ltg	STAIR SOUTH	216	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		4.31								TOTAL DESIGN LOAD (KW)		13.64
CONNECTED LOAD (KW) - B		3.59								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		17

Table 6.01 *Existing Panelboard Schedule – Lighting Panel L4B*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: L4B
PANEL LOCATION: Main Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	RM 43-45	1625	20A/1P	1	*			2	20A/1P	622	FRONT/EAST	HID Lighting
Fluorescent Ltg	RM 33, 40	2005	20A/1P	3		*		4	20A/1P	788	POLE EAST	HID Lighting
Fluorescent Ltg	COR 000	1492	20A/1P	5			*	6	20A/1P	1295	POLE SOUTH WEST	HID Lighting
Fluorescent Ltg	RM 50-55	1206	20A/1P	7	*			8	20A/1P	1480	POLE WEST	HID Lighting
Fluorescent Ltg	STAIR WEST	314	20A/1P	9		*		10	20A/1P	750	GARDEN SOUTH	Incandescent Ltg
Fluorescent Ltg	STAIR SOUTH	216	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		4.93								TOTAL DESIGN LOAD (KW)		14.74
CONNECTED LOAD (KW) - B		3.86								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		19

Table 6.02 *Revised Panelboard Schedule – Lighting Panel L4B*

Revised Panel Load: 19A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	D4BA
Phase Wire Size	600KCMIL
Feeder Length	35
Load (A)	169
Voltage Drop	-0.036%

Panel	L4B
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	19
Voltage Drop	-0.036%

Total Voltage Drop	-0.072%

Table 6.03 *Voltage Drop Calculation – Feeder for Lighting Panel L4B*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L4B as a result of change in load or voltage drop.

Panel L1NA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit(s) Affected: 14, 16

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: L1NA PANEL LOCATION: North Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1124	RM 100A, 114,120	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	2578	R 115-19, 121-24	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	1485	R 100B-C,131-2	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	2017	RM 110, 130	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	3079	RM 132A-E, 138	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1512	R 139, 9A-E, 140, A	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.14								TOTAL DESIGN LOAD (KW)		14.74
CONNECTED LOAD (KW) - B		5.66								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		19

Table 6.04 *Existing Panelboard Schedule – Lighting Panel L1NA*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: L1NA PANEL LOCATION: North Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1124	RM 100A, 114,120	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	2578	R 115-19, 121-24	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	1485	R 100B-C,131-2	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	2017	RM 110, 130	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	3079	RM 132A-E, 138	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1512	R 139, 9A-E, 140, A	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	38	STRS 1ST TO 2ND	Fluorescent Ltg
spare	0	0	20A/1P	15		*		16	20A/1P	57	SCNS NORTH	Fluorescent Ltg
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.18								TOTAL DESIGN LOAD (KW)		14.86
CONNECTED LOAD (KW) - B		5.71								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		19

Table 6.05 *Revised Panelboard Schedule – Lighting Panel L1NA*

Revised Panel Load: 19A

Revised Overcurrent Protection Trip Rating: 100A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	NORTH BUS DUCT
Phase Wire Size	#2AWG
Feeder Length	105
Load (A)	157
Voltage Drop	-0.578%

Panel	L1NA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	19
Voltage Drop	-0.036%

Total Voltage Drop	-0.614%

Table 6.06 *Voltage Drop Calculation – Feeder for Lighting Panel L1NA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L1NA as a result of change in load or voltage drop.

Panel L1SA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit(s) Affected: 15, 17, 19

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: L1SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 161,70,52, COR	3124	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	RM 156, 62-69	2184	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 173,74,75,81,84	1780	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 151A-J	2269	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	RM 151D,E,144,43	2850	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.39								TOTAL DESIGN LOAD (KW)		15.26
CONNECTED LOAD (KW) - B		5.03								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		1.78								TOTAL DESIGN LOAD (AMPS)		19

Table 6.07 *Existing Panelboard Schedule – Lighting Panel L1SA*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: L1SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 161,70,52, COR	3124	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	RM 156, 62-69	2184	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 173,74,75,81,84	1780	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 151A-J	2269	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	RM 151D,E,144,43	2850	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
Fluorescent Ltg	ATR CAFÉ	216	20A/1P	15		*		16	20A/1P	0	0	spare
Fluorescent Ltg	SCNS ATR NORTH	57	20A/1P	17			*	18	20A/1P	0	0	spare
Fluorescent Ltg	DISPLAY WALL	48	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.44								TOTAL DESIGN LOAD (KW)		15.66
CONNECTED LOAD (KW) - B		5.25								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		1.84								TOTAL DESIGN LOAD (AMPS)		20

Table 6.08 *Revised Panelboard Schedule – Lighting Panel L1SA*

Revised Panel Load: 20A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	SOUTH BUS DUCT
Phase Wire Size	350KCMIL
Feeder Length	240
Load (A)	188
Voltage Drop	-0.578%

Panel	L1SA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	20
Voltage Drop	-0.036%

Total Voltage Drop	-0.614%

Table 6.09 *Voltage Drop Calculation – Feeder for Lighting Panel L1SA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L1SA as a result of change in load or voltage drop.

Panel L2NA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Ecology Lab, Atrium

Circuit(s) Affected: 2 (Ecology Lab), 10 (Atrium)

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: L2NA PANEL LOCATION: North Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	2696	R 210-212	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	3498	R 213-214	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	3357	R 204-06, 238-41	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	3023	RM 200, 231-32	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.72								TOTAL DESIGN LOAD (KW)		15.72
CONNECTED LOAD (KW) - B		3.50								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		3.36								TOTAL DESIGN LOAD (AMPS		20

Table 6.10 *Existing Panelboard Schedule – Lighting Panel L2NA*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: L2NA
PANEL LOCATION: North Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1896	R 210-212	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	3498	R 213-214	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	3357	R 204-06, 238-41	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	3023	RM 200, 231-32	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	38	ATR STR 2ND 3RD	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		4.92								TOTAL DESIGN LOAD (KW)		14.77
CONNECTED LOAD (KW) - B		3.54								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		3.36								TOTAL DESIGN LOAD (AMPS		19

Table 6.11 *Revised Panelboard Schedule – Lighting Panel L2NA*

Revised Panel Load: 19A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	NORTH BUS DUCT
Phase Wire Size	#2AWG
Feeder Length	105
Load (A)	157
Voltage Drop	-0.578%

Panel	L2NA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	19
Voltage Drop	-0.036%

Total Voltage Drop	-0.614%

Table 6.12 *Voltage Drop Calculation – Feeder for Lighting Panel L2NA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L2NA as a result of change in load or voltage drop.

Panel L2SA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit(s) Affected: 13, 15

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 60A
SIZE/TYPE MAIN: 60A/3P C/B

PANEL TAG: L2SA
PANEL LOCATION: South Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 262, 262 A-M	3096	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	R 260, 261	2752	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 256-258	3197	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	R 248, 54	2699	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	R 243, 245, 42, 46	3543	20A/1P	9		*		10	20A/1P	0	0	spare
Fluorescent Ltg	R 200, 280, 255	2862	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.80								TOTAL DESIGN LOAD (KW)		22.69
CONNECTED LOAD (KW) - B		6.30								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		6.06								TOTAL DESIGN LOAD (AMPS)		29

Table 6.13 *Existing Panelboard Schedule – Lighting Panel L2SA*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: L2SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 262, 262 A-M	3096	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	R 260, 261	2752	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 256-258	3197	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	R 248, 54	2699	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	R 243, 245, 42, 46	3543	20A/1P	9		*		10	20A/1P	0	0	spare
Fluorescent Ltg	R 200, 280, 255	2862	20A/1P	11			*	12	20A/1P	0	0	spare
Fluorescent Ltg	DOWN BALC	144	20A/1P	13	*			14	20A/1P	0	0	spare
Fluorescent Ltg	SCNS BALC	38	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space

CONNECTED LOAD (KW) - A	5.94	TOTAL DESIGN LOAD (KW)	22.91
CONNECTED LOAD (KW) - B	6.33	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	6.06	TOTAL DESIGN LOAD (AMPS)	29

Table 6.14 *Revised Panelboard Schedule – Lighting Panel L2SA*

Revised Panel Load: 29A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	SOUTH BUS DUCT
Phase Wire Size	350KCMIL
Feeder Length	240
Load (A)	188
Voltage Drop	-0.578%

Panel	L2SA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	29
Voltage Drop	-0.072%

Total Voltage Drop	-0.650%

Table 6.15 *Voltage Drop Calculation – Feeder for Lighting Panel L2SA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L2SA as a result of change in load or voltage drop.

Panel L3SA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Exterior

Circuit(s) Affected: 14, 16, 18

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B			PANEL TAG: L3SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE							MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 374,75,76	3083	20A/1P	1	*			2	20A/1P	880	R 355G	Fluorescent Ltg
Fluorescent Ltg	R 361,62,63	3583	20A/1P	3		*		4	20A/1P	660	R 355F	Fluorescent Ltg
Fluorescent Ltg	R 373, CORR F-H	2039	20A/1P	5			*	6	20A/1P	880	R 355E	Fluorescent Ltg
Fluorescent Ltg	R 346,7,54	2918	20A/1P	7	*			8	20A/1P	880	R 355C	Fluorescent Ltg
Fluorescent Ltg	R 343,44,45,45A	4191	20A/1P	9		*		10	20A/1P	880	R 355B	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1760	R 355A	Fluorescent Ltg
HVAC Fans	HT TRACE CT	1040	20A/1P	13	*			14	20A/1P	0	0	spare
HVAC Fans	HT TRACE CT	1040	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		8.80								TOTAL DESIGN LOAD (KW)		29.27
CONNECTED LOAD (KW) - B		10.35								POWER FACTOR		0.94
CONNECTED LOAD (KW) - C		4.68								TOTAL DESIGN LOAD (AMPS)		37

Table 6.16 *Existing Panelboard Schedule – Lighting Panel L3SA*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: L3SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 374,75,76	3083	20A/1P	1	*			2	20A/1P	880	R 355G	Fluorescent Ltg
Fluorescent Ltg	R 361,62,63	3583	20A/1P	3		*		4	20A/1P	660	R 355F	Fluorescent Ltg
Fluorescent Ltg	R 373, CORR F-H	2039	20A/1P	5			*	6	20A/1P	880	R 355E	Fluorescent Ltg
Fluorescent Ltg	R 346,7,54	2918	20A/1P	7	*			8	20A/1P	880	R 355C	Fluorescent Ltg
Fluorescent Ltg	R 343,44,45,45A	4191	20A/1P	9		*		10	20A/1P	880	R 355B	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1760	R 355A	Fluorescent Ltg
HVAC Fans	HT TRACE CT	1040	20A/1P	13	*			14	20A/1P	504	ATR DWN NOR	Fluorescent Ltg
HVAC Fans	HT TRACE CT	1040	20A/1P	15		*		16	20A/1P	38	SCNS BALC	Fluorescent Ltg
spare	0	0	20A/1P	17			*	18	20A/1P	184	DECOR PEND	Fluorescent Ltg
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		9.31								TOTAL DESIGN LOAD (KW)		30.18
CONNECTED LOAD (KW) - B		10.39								POWER FACTOR		0.94
CONNECTED LOAD (KW) - C		4.86								TOTAL DESIGN LOAD (AMPS)		39

Table 6.17 *Revised Panelboard Schedule – Lighting Panel L3SA*

Revised Panel Load: 39A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1" conduit

Voltage Drop:

Panel	SOUTH BUS DUCT
Phase Wire Size	350KCMIL
Feeder Length	240
Load (A)	188
Voltage Drop	-0.578%

Panel	L3SA
Phase Wire Size	#6AWG
Feeder Length	10
Load (A)	39
Voltage Drop	-0.108%

Total Voltage Drop	-0.686%

Table 6.18 *Voltage Drop Calculation – Feeder for Lighting Panel L3SA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L3SA as a result of change in load or voltage drop.

Panel E4B:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Exterior, Atrium

Circuit(s) Affected: 6 (Exterior), 16 (Atrium)

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 60A
SIZE/TYPE MAIN: 60A/3P C/B

PANEL TAG: E4B
PANEL LOCATION: Main Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	VIVR EMERG	593	20A/1P	1	*			2	20A/1P	129	REAR EXTERIOR	HID Lighting
Fluorescent Ltg	MECH/ELEC NORTH	1365	20A/1P	3		*		4	20A/1P	1621	2ND FL N EMERG	Fluorescent Ltg
Fluorescent Ltg	2ND FL S EMERG	1267	20A/1P	5			*	6	20A/1P	326	EAST ENT EMERG	HID Lighting
Fluorescent Ltg	ELEV ROOM	130	20A/1P	7	*			8	20A/1P	556	WEST EMERG	HID Lighting
spare	0	0	20A/1P	9		*		10	20A/1P	703	GARDEN EMERG	HID Lighting
Fluorescent Ltg	N STAIR EMERG	1937	20A/1P	11			*	12	20A/1P	0	0	spare
Fluorescent Ltg	S STAIR EMERG	1900	20A/1P	13	*			14	20A/1P	0	0	space
Fluorescent Ltg	1ST FL N EMERG	1238	20A/1P	15		*		16	20A/1P	0	0	space
Fluorescent Ltg	1ST FL S EMERG	1515	20A/1P	17			*	18	20A/1P	1175	BASEMENT EMERG	Fluorescent Ltg
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.31								TOTAL DESIGN LOAD (KW)		18.07
CONNECTED LOAD (KW) - B		4.93								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		6.22								TOTAL DESIGN LOAD (AMPS)		23

Table 6.19 *Existing Panelboard Schedule – Lighting Panel E4B*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: E4B
PANEL LOCATION: Main Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	VIVR EMERG	593	20A/1P	1	*			2	20A/1P	129	REAR EXTERIOR	HID Lighting
Fluorescent Ltg	MECH/ELEC NORTH	1365	20A/1P	3		*		4	20A/1P	1621	2ND FL N EMERG	Fluorescent Ltg
Fluorescent Ltg	2ND FL S EMERG	1267	20A/1P	5			*	6	20A/1P	198	EAST ENT EMERG	HID Lighting
Fluorescent Ltg	ELEV ROOM	130	20A/1P	7	*			8	20A/1P	556	WEST EMERG	HID Lighting
spare	0	0	20A/1P	9		*		10	20A/1P	703	GARDEN EMERG	HID Lighting
Fluorescent Ltg	N STAIR EMERG	1937	20A/1P	11			*	12	20A/1P	0	0	spare
Fluorescent Ltg	S STAIR EMERG	1900	20A/1P	13	*			14	20A/1P	0	0	space
Fluorescent Ltg	1ST FL N EMERG	1238	20A/1P	15		*		16	20A/1P	184	VESTIBULE LTG	Fluorescent Ltg
Fluorescent Ltg	1ST FL S EMERG	1515	20A/1P	17			*	18	20A/1P	1175	BASEMENT EMERG	Fluorescent Ltg
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.31								TOTAL DESIGN LOAD (KW)		18.14
CONNECTED LOAD (KW) - B		5.11								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		6.09								TOTAL DESIGN LOAD (AMPS)		23

Table 6.20 *Revised Panelboard Schedule – Lighting Panel E4B*

Revised Panel Load: 23A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	E4P
Phase Wire Size	#8AWG
Feeder Length	285
Load (A)	29
Voltage Drop	-1.119%

Panel	E4B
Phase Wire Size	#8AWG
Feeder Length	200
Load (A)	23
Voltage Drop	-0.614%

Total Voltage Drop	-1.733%

Table 6.21 *Voltage Drop Calculation – Feeder for Lighting Panel E4B*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel E4B as a result of change in load or voltage drop.

Panel E4P:

Original Overcurrent Protection Trip Rating: 100A

Original Feeder: 4-#2AWG wires + 1-#8AWG wires in 1-1/4" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit Affected: 5

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 100A/3P C/B

PANEL TAG: E4P
PANEL LOCATION: Penthouse Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1318	EM 3RD FL COL N	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	1399	EM 3RD FL COL S	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 401	325	20A/1P	7	*			8	20A/1P	0	0	spare
spare	0	0	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space

CONNECTED LOAD (KW) - A	1.64	TOTAL DESIGN LOAD (KW)	3.80
CONNECTED LOAD (KW) - B	1.40	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	0.00	TOTAL DESIGN LOAD (AMPS)	5

Table 6.22 *Existing Panelboard Schedule – Lighting Panel E4P*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: E4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1318	EM 3RD FL COL N	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	1399	EM 3RD FL COL S	Fluorescent Ltg
Fluorescent Ltg	EM ATR DWN	720	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 401	325	20A/1P	7	*			8	20A/1P	0	0	spare
spare	0	0	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		1.64								TOTAL DESIGN LOAD (KW)		4.70
CONNECTED LOAD (KW) - B		1.40								POWER FACTOR		0.97
CONNECTED LOAD (KW) - C		0.72								TOTAL DESIGN LOAD (AMPS)		6

Table 6.23 *Revised Panelboard Schedule – Lighting Panel E4P*

Revised Panel Load: 6A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	E4P
Phase Wire Size	#8AWG
Feeder Length	285
Load (A)	29
Voltage Drop	-1.119%

Table 6.24 *Voltage Drop Calculation – Feeder for Lighting Panel E4P*

Remarks:

The original design was excessive. As a result, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel E4P as a result of change in load or voltage drop.

Panel DM4P:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Lecture Hall

Circuits Affected: 1, 2, 3, 4, 5, 6, 7

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 60A
SIZE/TYPE MAIN: 60A/3P C/B

PANEL TAG: DM4P
PANEL LOCATION: Penthouse Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC COVE	510	20A/1P	1	*			2	20A/1P	630	LEC COVE	Fluorescent Ltg
Fluorescent Ltg	LEC COVE	750	20A/1P	3		*		4	20A/1P	765	LEC COVE	Fluorescent Ltg
Fluorescent Ltg	LEC BACK DOWN	238	20A/1P	5			*	6	20A/1P	170	LEC WW SOUTH	Fluorescent Ltg
Fluorescent Ltg	LEC WW NORTH	306	20A/1P	7	*			8	20A/1P	1517	ATR DOWN COR	Fluorescent Ltg
Fluorescent Ltg	ATR WALL COR	1110	20A/1P	9		*		10	20A/1P	750	HUM WALL	Fluorescent Ltg
Fluorescent Ltg	HUM ACCENT	150	20A/1P	11			*	12	20A/1P	150	HUM ACCENT	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		2.96								TOTAL DESIGN LOAD (KW)		8.81
CONNECTED LOAD (KW) - B		3.38								POWER FACTOR		0.98
CONNECTED LOAD (KW) - C		0.71								TOTAL DESIGN LOAD (AMPS)		11

Table 6.25 *Existing Panelboard Schedule Dimming Panel DM4P*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: DM4P
PANEL LOCATION: Penthouse Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC CHALK	470	20A/1P	1	*			2	20A/1P	188	LEC SPEAKER	Fluorescent Ltg
Fluorescent Ltg	LEC CEN FRONT	174	20A/1P	3		*		4	20A/1P	116	LEC LEFT FRON	Fluorescent Ltg
Fluorescent Ltg	LEC RIGHT FRON	174	20A/1P	5			*	6	20A/1P	152	LEC SCONCES	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	1517	ATR DOWN COR	Fluorescent Ltg
Fluorescent Ltg	ATR WALL COR	1110	20A/1P	9		*		10	20A/1P	750	HUM WALL	Fluorescent Ltg
Fluorescent Ltg	HUM ACCENT	150	20A/1P	11			*	12	20A/1P	150	HUM ACCENT	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		2.18								TOTAL DESIGN LOAD (KW)		6.19
CONNECTED LOAD (KW) - B		2.15								POWER FACTOR		0.99
CONNECTED LOAD (KW) - C		0.63								TOTAL DESIGN LOAD (AMPS)		8

Table 6.26 *Revised Panelboard Schedule – Dimming Panel DM4P*

Revised Panel Load: 8A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	D4BA
Phase Wire Size	600KCMIL
Feeder Length	35
Load (A)	169
Voltage Drop	-0.036%

Panel	DM4P
Phase Wire Size	#6AWG
Feeder Length	20
Load (A)	8
Voltage Drop	-0.036%

Total Voltage Drop	-0.072%

Table 6.27 *Voltage Drop Calculation – Feeder for Dimming Panel DM4P*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel DM4P as a result of change in load or voltage drop.

Panel EDM4P:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Lecture Hall

Circuits Affected: 1, 2, 3, 4, 5, 7, 8, 11, 12, 13, 14

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B			PANEL TAG: EDM4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE							MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC DOWN CENT	384	20A/1P	1	*			2	20A/1P	1152	LEC DOWN CENT	Fluorescent Ltg
Fluorescent Ltg	LEC DOWN CENT	1088	20A/1P	3		*		4	20A/1P	180	LEC STEP	Fluorescent Ltg
Fluorescent Ltg	LEC RAMP	36	20A/1P	5			*	6	20A/1P	68	LEC DOWN VEST	Fluorescent Ltg
Fluorescent Ltg	LEC DOWN EGRS	68	20A/1P	7	*			8	20A/1P	200	ATR DOWN VEST	Fluorescent Ltg
Fluorescent Ltg	ATR DOWN COR	962	20A/1P	9		*		10	20A/1P	1200	HUM EMERG DOWN	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		1.80								TOTAL DESIGN LOAD (KW)		6.67
CONNECTED LOAD (KW) - B		3.43								POWER FACTOR		0.98
CONNECTED LOAD (KW) - C		0.10								TOTAL DESIGN LOAD (AMPS)		8

Table 6.28 *Existing Panelboard Schedule – Dimming Panel EDM4P*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: EDM4P
PANEL LOCATION: Penthouse Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC DOWN FRONT	124	20A/1P	1	*			2	20A/1P	174	LEC CEN MIDDLE	Fluorescent Ltg
Fluorescent Ltg	LEC LEFT MIDDLE	174	20A/1P	3		*		4	20A/1P	232	LEC RIGHT MIDDLE	Fluorescent Ltg
Fluorescent Ltg	LEC CEN BACK	348	20A/1P	5			*	6	20A/1P	68	LEC VEST	Fluorescent Ltg
Fluorescent Ltg	LEC LEFT BACK	174	20A/1P	7	*			8	20A/1P	232	LEC RIGHT BACK	Fluorescent Ltg
Fluorescent Ltg	ATR DOWN COR	962	20A/1P	9		*		10	20A/1P	1200	HUM EMERG DOWN	Fluorescent Ltg
Fluorescent Ltg	LEC DOWN RAMP	217	20A/1P	11			*	12	20A/1P	403	LEC DOWN BACK	Fluorescent Ltg
spare	LEC STAIRS	38	20A/1P	13	*			14	20A/1P	101	LEC RAMP	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		0.84								TOTAL DESIGN LOAD (KW)		5.39
CONNECTED LOAD (KW) - B		2.57								POWER FACTOR		0.98
CONNECTED LOAD (KW) - C		1.04								TOTAL DESIGN LOAD (AMPS)		7

Table 6.29 *Revised Panelboard Schedule – Dimming Panel EDM4P*

Revised Panel Load: 7A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	EQD4P
Phase Wire Size	600KCMIL
Feeder Length	210
Load (A)	250
Voltage Drop	-0.397%

Panel	EDM4P
Phase Wire Size	#8AWG
Feeder Length	20
Load (A)	7
Voltage Drop	-0.036%

Total Voltage Drop	-0.433%

Table 6.30 *Voltage Drop Calculation – Feeder for Dimming Panel EDM4P*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel EDM4P as a result of change in load or voltage drop.

Analysis of Central vs. Distributed Transformers

Overview:

In the original design, there was a 480Δ to 208Y/120V transformer in each electrical room to step down voltage for receptacle, motor, and other equipment loads. Each of these transformers was rated at 112.5 KVA, and with the exception of the basement transformer, each was connected to the building's distribution system through a 600A bus duct. I felt that it might be possible to combine these transformers (seven in all) into one central transformer in the hopes of lowering costs (both for materials and labor).

Specific Transformers Being Replaced:

Label	Level	Room	KVA Rating	Primary Voltage	Secondary Voltage	Type	Primary OLP	Secondary OLP
A	1st Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
B	2nd Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
C	3rd Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
D	1st Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
E	2nd Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
F	3rd Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
G	Basement	Main Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A

Table 7.01 *Details for Existing Transformers to be Combined*

From a calculation of the loads that these transformers service, and adding approximate 15% spare capacity, it was determined that a 750 KVA transformer would be most appropriate for handling these loads. This transformer would be placed in the basement, in the approximate location where transformer G is currently. The calculation for this can be found in Appendix E.

Label	Level	Room	KVA Rating	Primary Voltage	Secondary Voltage	Type	Primary OLP	Secondary OLP
A	Basement	Main Electrical	750	480Δ	208Y/120	Dry Type	1000A	2500A

Table 7.02 *Details for Proposed Central Transformer*

Other Components Affected:

The first issue that arose was locating a distribution panel for the secondary side feeder from the central transformer to connect into. The logical choice was distribution panel D2BA, which was originally being fed by transformer G. Since D2BA would have to be sized at 2500A, this put D2BA into the switchboard class.

The 480Y/277V bus ducts would only be servicing 3 lighting panelboards each. Each duct would be used for no more than 80 A, making bus duct impractical here. Instead, I chose to feed the lighting panels from distribution panel D4BA. The panelboards would change to “feed-through” panelboards, allowing the panels to be fed directly through each other. This allows for the least length of wire to be used, and for the lowest installation costs.

Bus duct would still be useful, but for 208Y/120Vdistribution. In the same locations as the original location, I chose to use 1200A bus ducts for the 208Y/120V system. As stated above, these are being fed off of distribution panel (now switchboard) D2BA. Breakers off of the bus ducts would change accordingly.

Distribution panel D4BA would remain the same size, as all six lighting panels and the original 112.5 KVA transformer in the basement require about the same amount of power. Other than that, the only other major change would be the various feeders.

Riser Diagrams of Main Electrical Room:

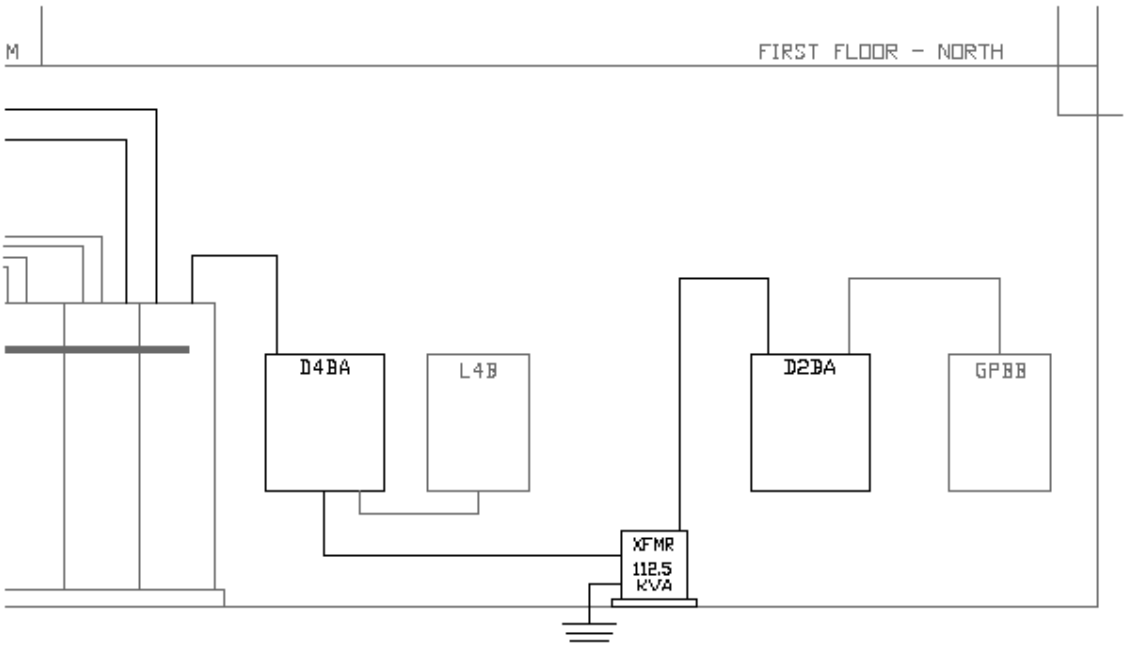

Figure 7.01 *Riser Diagram of Main Electrical Room – Existing System*

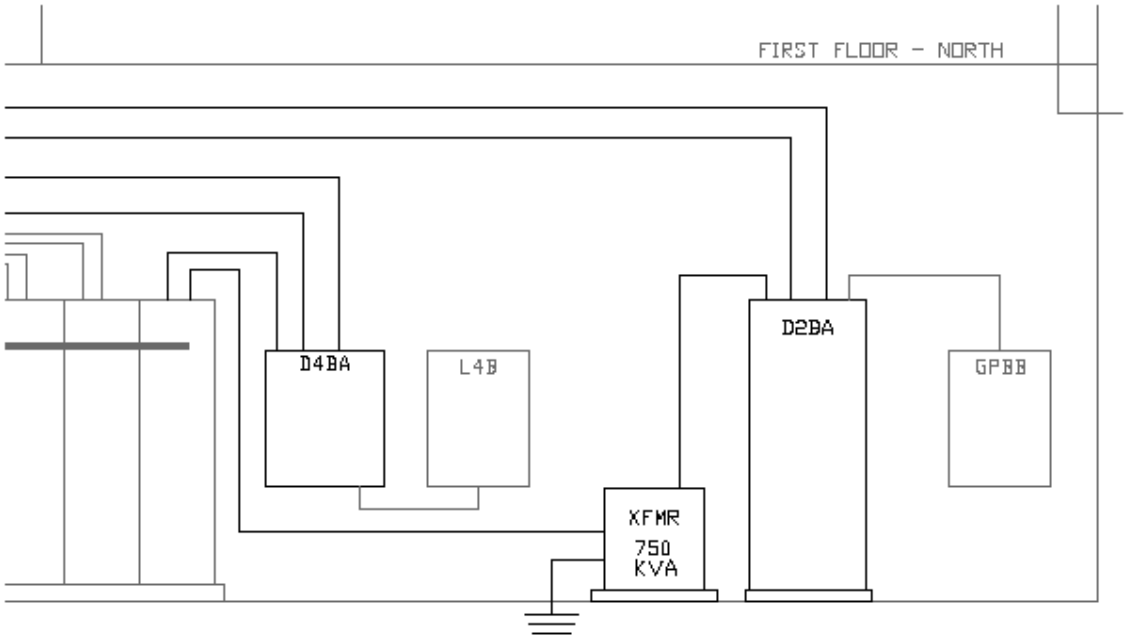

Figure 7.02 *Riser Diagram of Main Electrical Room – Proposed System*

Riser Diagrams of First Floor South Electrical Room:

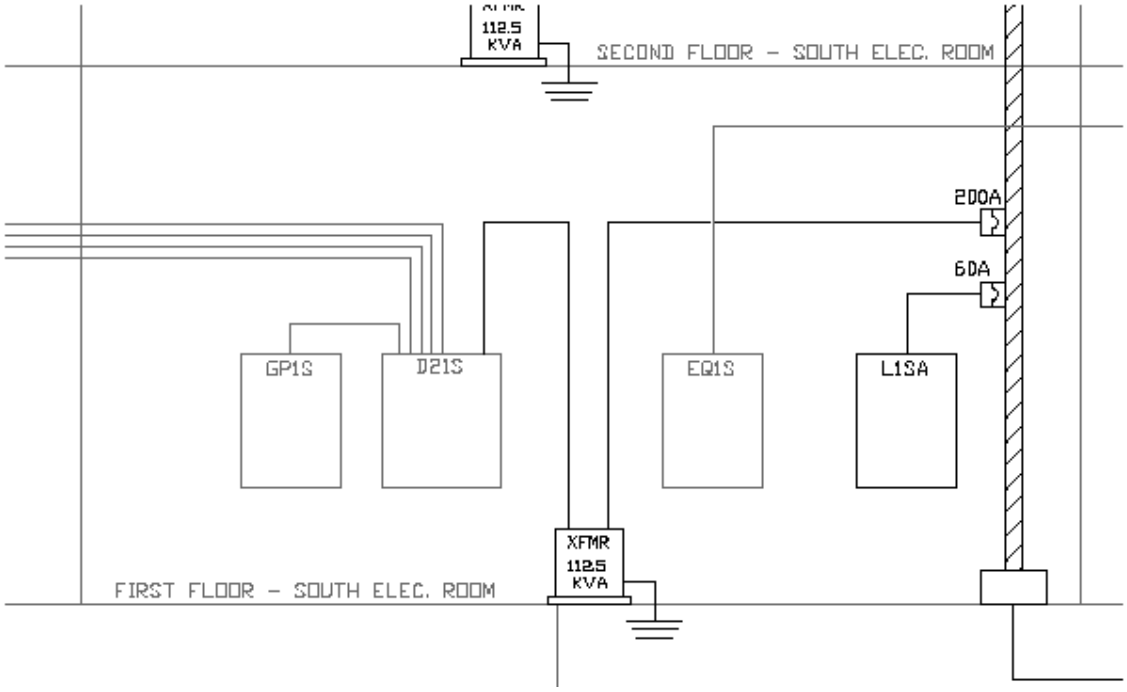

Figure 7.03 *Riser Diagram of South Electrical Room – Existing System*

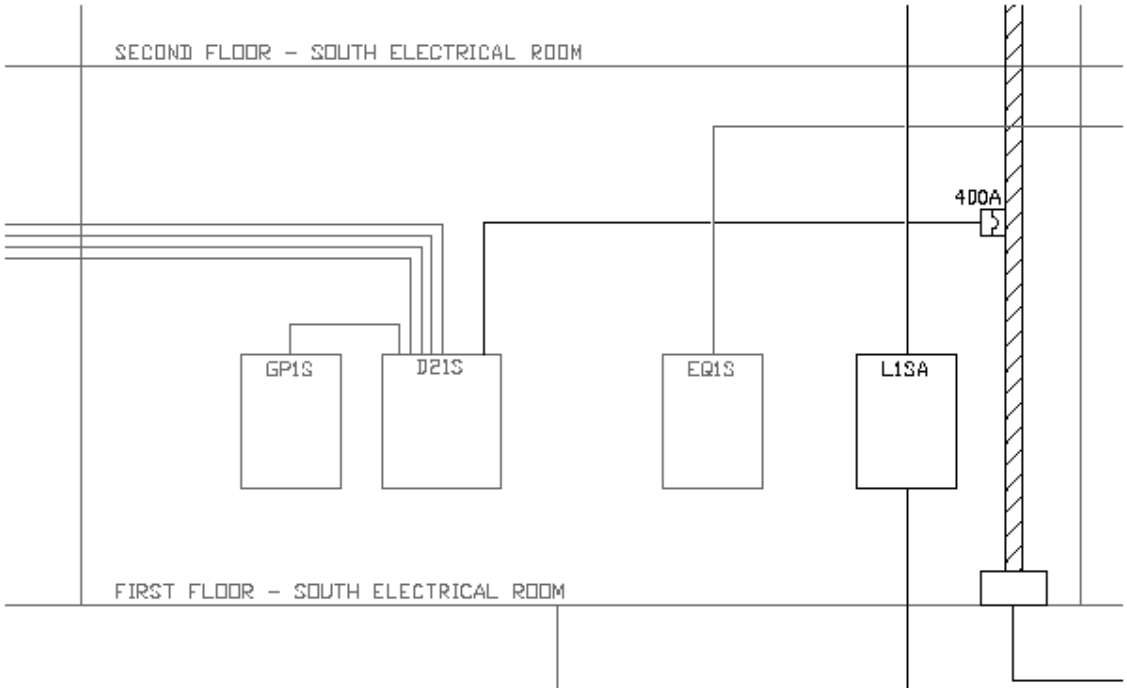

Figure 7.04 *Riser Diagram of South Electrical Room – Proposed System*

Cost Analysis:

The following data was compiled using the 2008 version of RS Means Electrical Cost Data. Full calculations are available in Appendix E of this report.

Category	Cost of Existing System	Cost Of New System	Difference
Feeders	$61,096.37	$141,472.34	$80,375.97
Transformers	$56,832.30	$46,737.00	($10,095.30)
Breakers	$23,222.70	$36,720.00	$13,497.30
Bus Ducts	$22,680.00	$36,720.00	$14,040.00
Panelboards	$30,341.25	$49,762.35	$19,421.10
TOTAL	$194,172.62	$311,411.69	$117,239.07
TOTAL w/ Loc. Factor	$177,862.12	$285,253.11	$107,390.99

Table 7.03 *Cost Analysis for Central and Distributed Transformer Systems*

This chart clearly showed that using a central transformer in this scenario is not an economically viable option, and since the original design works just as effectively, I would recommend remaining with the existing transformer layout.

Reasons for This Outcome:

A further look at the calculations shows why the central transformer system is so much more expensive. The feeders distributing power to the bus ducts are among the longest in the building. To accommodate the higher currents required for the lower voltage system, the wires had to be greatly upsized and use many sets of wires. As a result, the feeder to the South Bus Duct increased in cost by over $40,000; the feeder to the North Bus Duct nearly $30,000. In addition, the fact that distribution panel D2BA had to be upsized and changed to a switchboard greatly increased the cost of that panel (by nearly $25,000).

One of the aspects of this building that works against a central transformer system is the location of the main electrical room. The main electrical room is located at the northwest corner of the building, requiring great distance to feed both bus ducts, especially the South Bus Duct. Had the electrical room been more centrally located, the costs of these feeders, and many other feeders throughout the basement floor, could have been greatly reduced. It would be incorrect to state that changing the location would make a central transformer system more viable; other factors would still leave it as a more expensive option. However, the differences would have been less pronounced.

Analysis of Aluminum vs. Copper Feeders

Overview:

The price of copper continues to increase, and many electrical designers and contractors are exploring aluminum as a more cost-effective option. Given the number of feeders in the building and the lengths of many of these feeders, this may be a good building to take advantage of potentially significant savings.

Besides providing cost-savings, aluminum is significantly lighter than copper, which can make labor for wire installation easier and potentially less time consuming. It is for these reasons that the vast majority of utility transmission is done using aluminum wiring. That said, many owners are still leery of using aluminum wiring. One of the major reasons for this is reported fires as a result of improper terminations of the aluminum wire. Most of these were caused by poor installation, and improved technology and labor practices have made this virtually a non-issue today. Aluminum wiring is still banned for use for branch circuit wiring, but is approved by the NEC and NFPA for use in feeders.

There are a couple of steps for aluminum wire installation that are different than copper installation, and thus must be considered. Aluminum is much more prone to oxidation that copper, which can block connections from being complete and can potentially result in fire. Therefore, prior to terminating the feeders, the wires need to be cleaned to remove any oxidation already formed and treated with an antioxidant joint compound. Also, like copper wiring, aluminum wiring connections must be properly torqued. If the connection is too loose, this can create an open circuit scenario. If the connection is too tight, this can reduce the ability of the current to flow properly, which can create a hot termination, and once again can result in fire. All that said, the majority of electrical contractors are knowledgeable in the safe installation of aluminum wiring, and can help owners take advantage of significant cost-savings without compromising the safety of their occupants.

Cost Analysis:

The following calculations were done using data from the 2008 version of RS Means Electrical Cost Data. Full details of these calculations can be found in Appendix F.

Feeder Label	Start	End	Wires (LF)	Conduit (LF)	Copper Feeder Cost	Aluminum Feeder Cost
3	SWB-1	NORTH DUCT	105	95	16,611.62	10,780.02
4	NORTH DUCT	L1NA	10	6	110.04	106.50
5	NORTH DUCT	XFMR 1	10	6	294.81	257.18
6	XFMR 1	D21N	10	6	1,063.53	608.04
7	D21N	GP1N	15	10	290.66	232.94
8	D21N	R1NA	55	50	3,052.72	2,221.86
9	D21N	R1NB	65	60	848.78	866.33
10	D21N	R1NC	90	85	1,187.46	1,215.47
11	D21N	R1ND	75	70	984.25	1,005.99
12	NORTH DUCT	L2NA	10	6	110.04	106.50
13	NORTH DUCT	XFMR 2	10	6	294.81	257.18
14	XFMR 2	D22N	10	6	1,063.53	608.04
15	D22N	GP2N	25	20	620.87	529.34
16	D22N	R2NA	90	85	1,187.46	1,215.47
17	D22N	R2NB	40	35	1,214.53	951.01
18	D22N	R2NC	70	65	2,169.11	1,707.95
19	NORTH DUCT	L3NA	10	6	110.04	106.50
20	NORTH DUCT	XFMR 3	10	6	294.81	257.18
21	XFMR 3	D23N	10	6	1,063.53	608.04
22	D23N	GP3N	10	6	188.24	148.80
23	D23N	R3NA	55	50	713.31	726.67
24	D23N	R3NB	60	55	1,850.92	1,455.64
25	D23N	R3NC	50	45	1,532.72	1,203.32
26	SWB-1	SOUTH DUCT	240	230	38,623.77	25,294.41
27	SOUTH DUCT	L1SA	10	6	110.04	106.50
28	SOUTH DUCT	XFMR 4	10	6	294.81	257.18
29	XFMR 4	D21S	10	6	1,063.53	608.04
30	D21S	GP1S	10	6	188.24	148.80
31	D21S	R1SA	65	60	848.78	866.33
32	D21S	R1SB	105	100	1,390.67	1,424.96
33	D21S	R1SC	55	50	713.31	726.67
34	D21S	R1SD	100	95	1,322.93	1,355.13
35	SOUTH DUCT	L2SA	10	6	110.04	106.50
36	SOUTH DUCT	XFMR 5	10	6	294.81	257.18
37	XFMR 5	D22S	10	6	1,063.53	608.04
38	D22S	GP2S	10	6	271.59	205.71
39	D22S	R2SA	45	40	1,373.63	1,077.17
40	D22S	R2SB	100	95	2,172.56	1,829.12
41	SOUTH DUCT	L3SA	10	6	110.04	106.50

Table 8.01a *Compressed Version of Copper and Aluminum Feeder Cost Comparison*

Feeder Label	Start	End	Wires (LF)	Conduit (LF)	Copper Feeder Cost	Aluminum Feeder Cost
42	SOUTH DUCT	XFMR 6	10	6	294.81	257.18
43	XFMR 6	D23S	10	6	1,063.53	608.04
44	D23S	GP3S	10	6	188.24	148.80
45	D23S	R3SA	50	45	1,065.56	890.19
46	D23S	R3SB	65	60	2,010.02	1,581.80
47	D23S	R3SC	85	80	4,776.20	3,492.15
48	D23S	R3SD	75	70	984.25	1,005.99
49	D23S	R3SE	30	25	622.76	514.62
50	SWB-1	D4P	200	190	32,101.65	20,993.85
51	D4P	G4P	20	15	486.95	411.82
52	SWB-1	D4BA	35	30	3,998.16	2,513.30
53	D4BA	XFMR 7	10	6	294.81	257.18
54	XFMR 7	D2BA	10	6	1,063.53	608.04
55	D2BA	GPBA	10	6	188.24	148.80
56	D4BA	L4B	10	6	110.04	106.50
57	SWB-1	D4BB	280	270	8,792.96	6,948.32
58	D4BB	XFMR 8	10	6	86.01	94.35
59	XFMR 8	GPBB	10	6	188.24	148.80
60	SWB-1	ATS 100	200	190	4,345.11	3,658.23
61	GEN	ATS 100	70	65	1,508.36	1,265.76
62	ATS 100	E4P	15	10	290.66	232.94
63	E4P	XFMR 9	10	6	62.72	57.94
64	XFMR 9	E2P	10	6	84.66	85.74
65	E4P	E4B	200	190	2,645.87	2,710.26
66	SWB-1	ATS 400	200	190	23,415.75	15,156.45
67	GEN	ATS 400	70	65	8,149.55	5,240.57
68	ATS 400	EQD4P	15	10	1,625.94	954.86
69	EQD4P	EQD4B	200	195	15,855.41	10,404.11
70	EQD4B	V4BA	10	6	110.04	106.50
71	EQD4B	XFMR 10	10	6	213.73	174.80
72	XFMR 10	EQD2B	10	6	554.24	369.70
73	EQD2B	V2BA	10	6	271.59	205.71
74	EQD4P	XFMR 11	10	6	294.81	257.18
75	XFMR 11	EQD2P	10	6	1,063.53	608.04
76	EQD2P	EQ1S	140	135	1,864.82	1,913.76
77	EQD2P	EQ2S	125	120	7,074.17	5,185.86
78	EQD2P	EQ3S	110	105	3,441.89	2,717.21
79	EQD2P	EQ3SA	110	105	3,441.89	2,717.21
80	EQD2P	EQ2P	15	10	754.75	528.15

Table 8.01b *Compressed Version of Copper and Aluminum Feeder Cost Comparison*

Type of Wiring	Total Cost
Copper	$222,195.49
Aluminum	$157,434.85

Table 8.02 *Summary of Total Cost of Copper and Aluminum Feeders*

Type of Wiring	Total Cost
Copper	$203,531.07
Aluminum	$144,210.32

Table 8.03 *Summary of Total Cost of Copper and Aluminum Feeders With Location Factor of 91.6%*

Conclusion:

With the potential to save nearly $60,000, I would recommend that the owner consider using aluminum feeders for this building. When properly installed, an aluminum wiring system provides no additional risk of fire over a comparable copper wiring system. The benefits of this system outweigh any perceived disadvantages to this system.

Protective Device Coordination and Fault Current Study

Overview:

In order to avoid a potential shut-down of an entire wing, or the entire building, it is important to make sure that the protective devices will trip in an appropriate order. I chose to study a basement path: from main switchboard SWB-1 to the distribution panel D4BA to the lighting panelboard L4B.

It is also crucial to analyze the fault current at every point in the system. Panelboards must be able to handle at least the available fault current at their location, so that in the case of a fault current occurring, damage to the equipment is limited and the risk of fire is greatly reduced. I will analyze the path from the main switchboard SWB-1 to the receptacle panel R3SC.

Protective Device Coordination:

The path I am analyzing is from the main switchboard circuit breaker (rated at 1600A), to the distribution panel circuit breaker D4BA (rated at 400A), and finally to the basement lighting panel L4B. Panel L4B is a main lugs only (MLO) panelboard, so the only protective device for the panel is the breaker on panel D4BA.

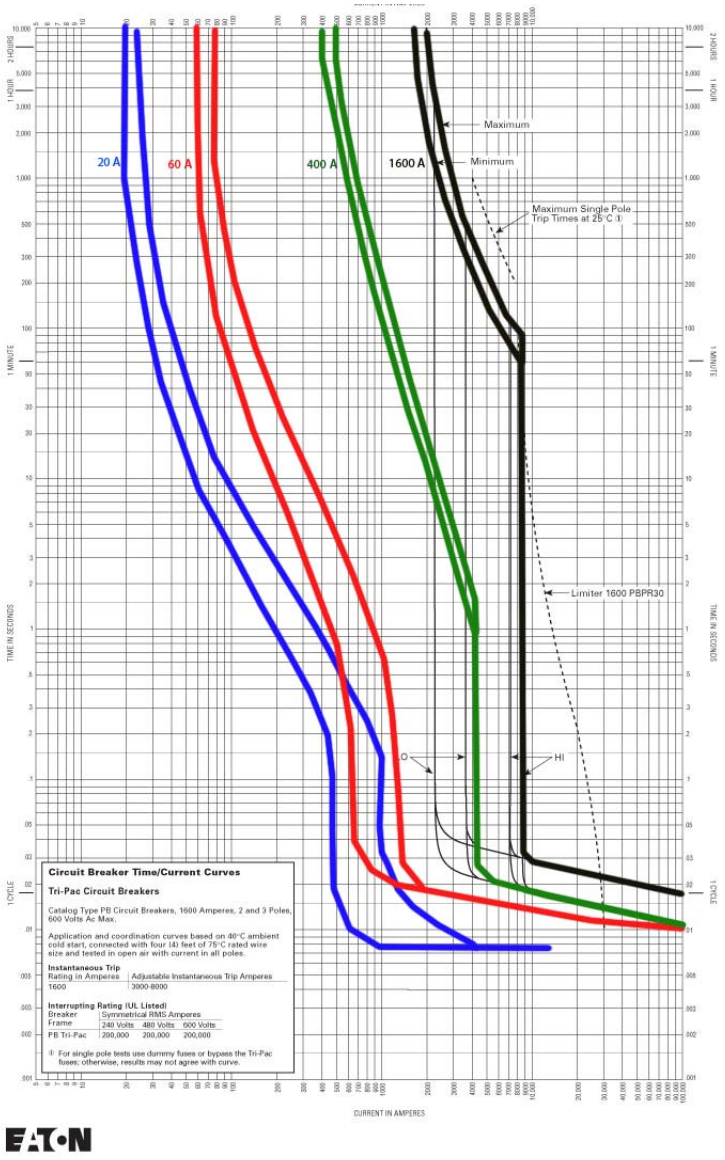

Figure 9.01 *Protective Device Coordination – Time-Current Curves for Circuit Breakers*

There is a small area of concern here. There is a slight overlap between the maximum trip line for the 20 A branch circuit breaker and the minimum trip line for the 60 A lighting panel breaker. However, judging from the graph above, it is very unlikely that the 60 A would trip before the branch circuit. Therefore, I feel that the protective devices are properly coordinated here, and they will trip in the correct order (branch circuit, lighting panel, distribution panel, switchboard).

Fault Current Analysis:

The path to receptacle panel R3SE started at the main switchboard SWB-1, and goes to the South Bus Duct in the basement. At the third floor, a feeder connects the bus duct to a 112.5 KVA transformer, which transforms the power to 208Y/120 and feeds into distribution panel D23S. D23S then connects to R3SC.

Utility

$KV_{secondary}$	0.48 KV
$KVA_{utility}$	173010 KVA
$Z_{utility}$	1.33 mΩ
$(X/R)_{utility}$	4.8
$R_{utility}$	0.27
$X_{utility}$	1.30 j

Main Transformer

$KV_{secondary}$	0.48 KV
$KVA_{main\ xfmr}$	1000 KVA
$(\%Z)_{main\ xfmr}$	5.8
$(X/R)_{main\ xfmr}$	2.38
$R_{main\ xfmr}$	5.18
$X_{main\ xfmr}$	12.32 j

Feeder to South Bus Duct

Size of Phase Wire	350KCMIL
$R_{SBD\ feeder}$	3.33
$X_{L,\ SBD\ feeder}$	4.07
Length	240 ft
Number of Sets	2
$R_{cond,\ SBD\ feeder}$	4.00
$X_{cond,\ SBD\ feeder}$	4.88 j

South Bus Duct

Bus Duct Rating	600 A
$R_{bus\ duct}$	1.78
$X_{bus\ duct}$	2.3
Length	40 ft
$R_{south\ bus\ duct}$	0.71
$X_{south\ bus\ duct}$	0.92 j

Table 9.01a *Fault Current Analysis – Impedance Calculations*

Feeder to XFMR 6

Size of Phase Wire	3/0AWG	
$R_{xfmr\ 6\ feeder}$	6.68	
$X_{L,\ xfmr\ 6\ feeder}$	4.22	
Length	10	ft
Number of Sets	1	
$R_{cond,\ xfmr\ 6\ feeder}$	0.67	
$X_{cond,\ xfmr\ 6\ feeder}$	0.42	j

Transformer 6

$KV_{secondary}$	0.208	KV
$KVA_{xfmr\ 6}$	112.5	KVA
$(\%Z)_{xfmr\ 6}$	6.1	
$(X/R)_{xfmr\ 6}$	1.51	
$R_{xfmr\ 6}$	12.95	
$X_{xfmr\ 6}$	19.56	j

Feeder to D23S

Size of Phase Wire	600KCMIL	
$R_{D23S\ feeder}$	2.09	
$X_{L,\ D23S\ feeder}$	4.01	
Length	10	ft
Number of Sets	1	
$R_{cond,\ D23S\ feeder}$	0.21	
$X_{cond,\ D23S\ feeder}$	0.40	j

Feeder to R3SC

Size of Phase Wire	4/0AWG	
$R_{R3SC\ feeder}$	5.34	
$X_{L,\ R3SC\ feeder}$	4.14	
Length	85	ft
Number of Sets	1	
$R_{cond,\ R3SC\ feeder}$	4.54	
$X_{cond,\ R3SC\ feeder}$	3.52	j

Table 9.01b *Fault Current Analysis – Impedance Calculations*

Point	R	X	|Z|	I_{sc}
Utility	0.27	1.30	1.331715	20800.2
Main Xfmr Secondary	5.45	13.62	14.67256	18878.78
Tap Box SBD	9.44	18.51	20.77791	13331.47
3rd Floor South Bus Duct	10.16	19.43	21.92207	12635.67
Xfmr 6 Primary	10.82	19.85	22.609	12251.76
Xfmr 6 Secondary	23.78	39.41	46.02542	2607.255
D23S	23.99	39.81	46.47675	2581.936
R3SC	28.52	43.33	51.87479	2313.263

Table 9.02 *Fault Current Analysis – Short Circuit Current Calculations*

The panelboards are all rated for an AIC of 22,000A. Based on this, I can confidently state that the system was properly designed to account for potential fault current.