Electrical Depth

Introduction

For the Electrical portion of this report, several panelboards on the Third Floor were analyzed and examined to combine and move loads to reduce the number of panelboards. Several pieces of art equipment were analyzed from a voltage standpoint to try and reduce the conductor size by increasing the voltage. Along with this, any additional design loads required from other systems designed for this thesis were added to the electrical distribution system. This includes the addition of the EcoSystem to the Third Floor, any changes from the Lighting Redesign, and the Air Handler Redesign. Breaker sizes, feeder sizes, conduit sizes, panelboards, transformers and main switch board sizes were be changed according to the new design conditions.

Assumptions

Several assumptions were made for this portion of the report. These assumptions were made as a last resort when information about a certain portion of the system was made unclear or a clear solution could not be found. The assumptions are listed below.

- 180 VA per receptacle
- EcoSystem Ballasts were used for the Linear Fluorescent Luminaires.
- Compact Fluorescent dimming ballasts were used for the CF Luminaires.
- Dryer specifications came from GEappliances.com
- All other assumptions for circuits and equipment were made by assuming the maximum amount of amps on the circuit breaker protecting the circuit or equipment. This is 80% of the rated circuit breaker sizes (ex. for a 20 amp breaker, the maximum amount of protection is 16 amps).
    - These assumptions are in bold on the spread sheets given in the body of the report as well as the data appendix.

Analysis

Six different analyses and redesigns were performed for this portion of the report. As noted in the introduction, the analysis was performed on the Third Floor of the building. These six analyses are:

1. Move all of the receptacles and equipment from LB31 and LB32 and have a dedicated panelboard just for receptacles and a dedicated panelboard for equipment.
2. Combination of panelboards LB35 and LB37.
3. Examine the 208 volt or 120 volt equipment on panelboards LA21, LA22, LA23, LA24, and LA25, with the possibility of specifying new equipment at a voltage of 480 or 277 to reduce the conductor size.
4. Combine and move equipment from panelboards HB32, HB34, HB35 onto two new panelboards.
5. Lighting panelboards and Mechanical Equipment addition to the system.
6. Redesign of the distribution system due to the changes made above.

Several multipliers were used in conducting this Electrical Study. These multipliers are set-forth in the National Electric Code book. The multipliers can be seen in the table below.

Multipliers Used For Electrical Calculations		
Factor	Association	Location
2.5	Motor Design: For a Circuit Breaker with inverse time-delay element	NEC Table 430-152
1.5	Motor Design: Conductors to motors can not be less than 125% of the full-load Current	NEC Table 430-22
1.0	Receptacle Load: First 10 kVA	NEC Table 220-13
0.5	Receptacle Load: Remainder over 10 kVA	NEC Table 220-13
20% @ 0.9 PF	Spare Capacity Addition (assumption)	
0.8 PF	Mechanical Equipment Power Factor (assumption)	
1.0	Any other Demand Factors not listed are assumed to be 1	

With these redesigns, the distribution system will be redesigned accordingly.

LB31 & LB32

Panelboards LB31 and LB32 are supplied voltage at 208Y/120. Between these two panelboards there are several pieces of equipment as well as receptacle circuits. The major equipment on the panels include a single phase 208 volt dryer, a three phase dye vat and steam compressor, all of which are used by the costume department and several lighting branches. The new panelboards are split into a dedicated panelboard for just receptacles and a dedicated panelboard for the equipment. The receptacle panelboard being proposed is a 54 slot panel. All of the calculations for the new panelboards can be seen in the Electrical Data Appendix. The new panelboard layouts can be seen below. The receptacle panelboard layout is the first panelboard shown and it is labeled LB31. The second panelboard for the equipment is below the LB31 layout. This panelboard is labeled LB32.

Voltage: 208Y/120 Main Breaker: 100 A Feeder: 4-#4 THHN, 1.25" Conduit (#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	LB 31				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Existing Stage Lighting	2862			30	#10	1	2	#10	20	1440			Existing Recepts-3053
"		2862		30	#10	3	4	#10	20		1440		Existing Recepts-3053
"			2862	30	#10	5	6	#10	20			1440	Recepts- C311C
Existing Recepts-3053E	1080			20	#10	7	8	#10	20	720			Existing Recepts-3051
Existing Recepts-3053G		1080		20	#10	9	10	#10	20		720		Existing Recepts-3051
Existing Recepts-3053G			1080	20	#10	11	12	#10	20			720	Existing Recepts-3051
Existing Recepts-3053E	720			20	#10	13	14	#10	20	720			Existing Recepts-3054
Existing Recepts-3053E		720		20	#10	15	16	#10	20		720		Existing Recepts-3054
Existing Recepts-3053G			720	20	#10	17	18	#10	20			720	Existing Recepts-3054
Existing Recepts-3049	720			20	#10	19	20	#10	20	720			Existing Recepts-3054
Existing Recepts-3049		720		20	#10	21	22	#10	20		720		Existing Recepts-3055
Existing Recepts-3049			720	20	#10	23	24	#10	20			720	Existing Recepts-3055
Existing Recepts-3056	720			20	#10	25	26	#10	20	720			Existing Recepts-3055
Existing Recepts-3056		720		20	#10	27	28	#10	20		720		Existing Recepts-3055
Existing Recepts-3056			720	20	#10	29	30	#10	20			720	Existing Recepts-3055
Existing Recepts-3056	720			20	#10	31	32	#10	20	720			Existing Recepts-3057
Existing Recepts-3056		720		20	#10	33	34	#10	20		720		Existing Recepts-3057
Existing Recepts-3058			720	20	#10	35	36	#10	20			720	Existing Recepts-3057
Existing Recepts-3058	720			20	#10	37	38	#10	20	720			Existing Recepts-3059
Existing Recepts-3058		720		20	#10	39	40	#10	20		720		Existing Recepts-3059
Existing Recepts-3058			720	20	#10	41	42	#10	20			720	Existing Recepts-3059
Existing Recepts-3058	720			20	#10	43	44	#10	20	720			Existing Recepts-3059
Existing Recepts-3052		540		20	#10	45	46	#10	20		360		Clg. Mtd. Recept.-3055
Existing Recepts-3052			540	20	#10	47	48	#10	20			360	Clg. Mtd. Recept.-3058
ATC Panel- AUH-15	360			20	#10	49	50						
Recepts- C309D		720		20	#10	51	52	#10	20		360		ATC Control Ckt.
Existing Stage Lighting			1800	20	#10	53	54						
	8622	8802	9882							6480	6480	6120	

Total Load on Phase A: 15.102 kVA
Total Load on Phase B: 15.282 kVA
Total Load on Phase C: 16.002 kVA

Total Load on Panel: 33.789 kVA Demand
94 A
Panel Size: 225 A

Panel LB31 has to accommodate a 33.79 kVA demand load at 94 amps. The panel is specified as a 100 A panel. The conductors feeding the 100 amp circuit breaker are four, #3 THW copper wires in 1 ¼" EMT conduit. This panel is feed through a transformer from panel HB31. The effects on the distribution system will be examined later on in this portion of the report.

Voltage: 208Y/120 Main Breaker: 175 A Feeder: 4-#1/0 THHN, 2" conduit (#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	LB32				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Steam Compressor	3838			60	#10	1	2	#6	1000	7197			Dye Vat
"		3838		-	#10	3	4	#6	-		7197		"
"			3838	-	#10	5	6	#6	-			7197	"
Dryer-3053B	2200			40	#10	7	8	#10	20	1920			Existing Spot Lights
"		2200		-	#10	9	10	#10	20		1920		Existing Spot Lights
Lighting Branch			1800	20	#10	11	12	#10	20			736	Spray Booth Fan-3053
Lighting Branch	900			20	#10	13	14	#10	20	506			Preheating Pump P-15
Lighting Branch		900		20	#10	15	16	#10	20		506		Electric Door Opener
			900	20	#10	17	18	#10	20			230	CUH-1 Vestibule V31
						19	20						
Lighting Branch		900		20	#10	21	22						
Lighting Branch			900	20	#10	23	24						
						25	26						
						27	28						
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						
	6938	7838	7438							9623	9623	8163	

Total Load on Phase A: 16.561 kVA
Total Load on Phase B: 17.461 kVA
Total Load on Phase C: 15.601 kVA

Total Load on Panel: 58.6 kVA Demand
163 A
Panel Size: 225 A

Panel LB32 has to accommodate a 58.6 kVA demand load at 163 amps. The panel is specified as a 200 A panel. The conductors feeding the 175 amp circuit breaker are four, #2/0 THW copper wires in 2" EMT conduit. This panel is feed through a transformer from panel HB31. The effects on the distribution system will be examined later on in this portion of the report.

LB35 & LB37

Between Panels LB35 and LB37, approximately 49 percent is dedicated to spare space. This is much higher the industry acceptance. The new proposed panel will combine the two panels with an addition of 20 percent spare calculated into it. The new panel is almost at capacity but there is an opportunity to expand with a sub-panel due to the spare added into the calculations. The layout of the panelboard can be seen below. The panel is labeled LB35.

Voltage: 208Y/120 **Main Breaker:** 90 A **Feeder:** 4-#4 THHN, 1.25" Conduit (#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	LB35				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
3060 (L21-20R)	1919			20	#10	1	2	#10	20	1440			Recepts- 3060
"		1919		-	#10	3	4	#10	20		1440		Recepts- 3060
"			1919	-	#10	5	6	#10	20			1440	Recepts- 3060
Recepts- 3060	2160			20	#10	7	8	#10	20	720			Recepts- 3060
Recepts- 3060		1440		20	#10	9	10	#10	20		720		Recepts- 3060
Recepts- 3060			1440	20	#10	11	12	#10	20			720	Recepts- 3060
Recepts- 3060	1080			20	#10	13	14	#10	20	720			Recepts- 3060
Recepts- 3062		360		20	#10	15	16	#10	20		720		Recepts- 3060
Microwave- 3061			360	20	#10	17	18	#10	20			360	Refrigerator- 3061
Recepts-C309A	360			20	#10	19	20	#10	20	360			Recepts- 3061
Projection Screen		360		20	#10	21	22	#10	20		360		Disposal- 3061
EL4			360	20	#10	23	24	#10	20			360	Water Removal- 3061
Recpts-3061	360			20	#10	25	26	#10	20	360			Elev Machine Room
Recepts- 3043G		1800		20	#10	27	28	#10	20		1080		Recepts- 3043G
Recpts-3061			1440	20	#10	29	30	#10	20			720	Elev Cab
ATC AHU-14&15	720			20	#10	31	32	#10	20	736			Supply Fan F-14-1A
Recepts- 3043E		720		20	#10	33	34	-	-				
Recepts- C309C			720	20	#10	35	36	#10	20			506	Preheat Coil Pump P-5
Lighting Branch	480			20	#10	37	38	#10	20	640			Lighting Branch
Lighting Branch		800		20	#10	39	40	#10	20		640		Lighting Branch
Lighting Branch			960	20	#10	41	42	#10	20			640	Lighting Branch
	7079	7399	7199							4976	4960	4746	

Total Load on Phase A: 12.055 kVA
Total Load on Phase B: 12.359 kVA
Total Load on Phase C: 11.945 kVA

Total Load on Panel: 29.8 kVA Demand
83 A
Panel Size: 100 A

Panel LB35 has to accommodate a 29.8 kVA demand load at 83 amps. The panel is specified as a 100 A panel. The conductors feeding the 90 amp circuit breaker are four, #4 THW copper wires in 1 ¼" EMT conduit. With the combination of the two panels, this adds space in the system where LB37 was. Panel LB35 is feed through Panel LB38 which leads to HB33 via transformer. The effects on the distribution system will be examined later on in this portion of the report.

Equipment Examination

Several pieces of equipment were examined on Panels LA21, LA22, LA23, LA24, and LA25. These pieces of equipment include Clay Mixers, Amaco Kilns, Bailey Kilns, Cress Kilns, Sno Kilns, and Paragon High Fire Kilns, all of which operate at 208Y/120 volt. If new equipment was found it would be placed on one of the following Panels; HB32, HB34, or HB35.

To try and reduce the size of the feeders to this equipment, new equipment operating at 480Y/277 Volts were explored. After exploring the various manufactures websites, it was found that new equipment could not be specified due to the non-existence of the equipment.

Since no new equipment was specified the combination of panels HB32, HB34, and HB35 will be explored in the next section of this depth study.

HB32 HB34 & HB35

Between the three panels being examined, 79 percent of the maximum capacity is spare capacity. With this in mind, two new panels are going to be introduced to replace the three existing panels. The existing and new panels are 480Y/277 volt panels. On one of the panels will house several lighting branches as well as two exhaust fans, the other panel will house several other light branches as well as all of the bus power supplies for the added Lutron EcoSystem to the Third Floor. The panel layouts are shown below. HB32 is the first one shown; this is the panel without the EcoSystem on it. The second panel, HB34, shown is the panel that supplies power to the EcoSystem.

Voltage: 480Y/277 Main Breaker: 50 A Feeder: 4- #10 THHN, 1" Conduit (#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	HB 32				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Exhaust Fan EF-11	664			15	#10	1	2	#10	15	354			Exhaust Fan EF-3A
"		664		-	#10	3	4	#10	-		354		"
"			664	-	#10	5	6	#10	-			354	"
Lighting Branch-3053	715			20	#10	7	8	#10	20	2243			Lighting Branch-C313
Lighting Branch-3045		1040		20	#10	9	10	#10	20		2250		Lighting Branch-3045
Lighting Branch-3045			1500	20	#10	11	12	#10	20			2250	Lighting Branch-3045
Lighting Branch-3056	4272			20	#10	13	14	#10	20	3230			Lighting Branch-3053
Lighting Branch-3057		3990		20	#10	15	16	#10	20		1710		Lighting Branch-3054
Lighting Branch-3055			3230	20	#10	17	18	#10	20			2570	Lighting Branch-3053
						19	20						
Lighting Branch-3048		1015		20	#10	21	22						
						23	24						
						25	26						
						27	28						
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						
	5651	6709	5394							5827	4314	5174	

Total Load on 11.478 kVA
Total Load on 11.023 kVA
Total Load on 10.568 kVA

Total Load on Panel: 39.027 kVA Demand
47 A
Panel Size: 100 A

Panel HB32 has to accommodate a 39.027 kVA demand load at 47 amps. The panel is specified as a 100 A panel. The conductors feeding the 50 amp circuit breaker are four, #8 THW copper wires in 1" EMT conduit. HB32 is fed from panel HB21 which is directly fed from Main Switch Board 1. The effects on the distribution system will be examined later on in this portion of the report.

Voltage: 480Y/277 Main Breaker: 200 A Feeder: 4-#2/0 THHW, 2" Conduit
(#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	HB 34				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Lighting Branch-Lobby	4313			20	#10	1	2	#10	20	621			LB-C309D
LB-Lobby/Coatroom		3228		20	#10	3	4	#10	20		1468		LB-Costume
LB Vestibule			892	20	#10	5	6	#10	20			3230	Lighting Branch-3058
EcoSystem Bus#1	4432			20	#10	7	8	#10	20	4432			EcoSystem Bus#16
EcoSystem Bus#2		4432		20	#10	9	10	#10	20		570		LB-C309C
EcoSystem Bus#3			4432	20	#10	11	12	#10	20			830	LB-C312A
EcoSystem Bus#4	4432			20	#10	13	14	#10	20	4432			EcoSystem Bus#17
EcoSystem Bus#5		4432		20	#10	15	16	#10	20		4432		EcoSystem Bus#18
EcoSystem Bus#6			4432	20	#10	17	18	#10	20			4432	EcoSystem Bus#19
EcoSystem Bus#7	4432			20	#10	19	20	#10	20	4432			EcoSystem Bus#20
EcoSystem Bus#8		4432		20	#10	21	22	#10	20		4432		EcoSystem Bus#21
EcoSystem Bus#9			4432	20	#10	23	24	#10	20			4432	EcoSystem Bus#22
EcoSystem Bus#10	4432			20	#10	25	26	#10	20	4432			EcoSystem Bus#23
EcoSystem Bus#11		4432		20	#10	27	28	#10	20		4432		EcoSystem Bus#24
EcoSystem Bus#12			4432	20	#10	29	30	#10	20			4432	EcoSystem Bus#25
EcoSystem Bus#13	4432			20	#10	31	32	-	-				
EcoSystem Bus#14		4432		20	#10	33	34	#10	20		4432		EcoSystem Bus#26
EcoSystem Bus#15			4432	20	#10	35	36	#10	20			4432	EcoSystem Bus#27
						37	38						
						39	40						
						41	42						
	26473	25388	23052							18349	19766	21788	

Total Load on I	44.822	kVA	Total Load on Panel:	147.03 kVA Demand
Total Load on I	45.154	kVA		177 A
Total Load on I	44.84	kVA	Panel Size:	225 A

Panel HB34 has to accommodate a 147.03 kVA demand load at 177 amps. The panel is specified as a 225 amps panel. The conductors feeding the 200 amp circuit breaker are four, #3/0 THW copper wires in 2" EMT conduit. HB34 is fed from panel HB33 which is directly fed from Main Switch Board 2. The effects on the distribution system will be examined later on in this portion of the report.

Paint Studio

Voltage: 208Y/120 Main Breaker: 100 A Feeder: 4-#6 THHN, 1.25" Conduit
(#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	LD42				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Preheat Coil P-PHC-9	506					1	2			506			Exhaust Fan EF-2B
Snorkel Exhaust-4006		506				3	4				360		ATC Control Ckt
AHU-16 ATC Panel			360			5	6					306	AHU-9 ATC Panel
AHU-16E ATC Panel	360					7	8			360			AHU-17 ATC Panel
AHU-18 ATC Panel		360				9	10				360		Roof Recepts
Recepts-4028			720			11	12					1080	Recepts-4026
Recepts-4028	1080					13	14			1080			Recepts-4026
Recepts-4028		1080				15	16				1080		Recepts-4026
Recepts-4028			1080			17	18					1080	Recepts-4025
Recepts-4026D	1080					19	20			1080			Recepts-4024
Recepts-4012		720				21	22				1800		Recepts- C402
Recepts-4012			720			23	24					720	Recepts-4006A
Recepts-4012	720					25	26			720			Recepts-4006A
Recepts-4012		720				27	28				720		Recepts-4006A
Recepts-4012			720			29	30					720	Recepts-4006A
Recepts-4012	1080					31	32			720			Recepts-4006A
Recepts-4012		720				33	34				720		Recepts-4006A
Recepts-4012			1080			35	36					360	Recepts-4006A
Recepts-4012	720					37	38			720			Recepts-4006A
Lighting Branch		400				39	40				1760		PAINT STUDIO
Lighting Branch			400			41	42					1740	PAINT STUDIO
	5546	4506	5080							5186	6800	6006	

Total Load on Phase A: 10732 kVA
Total Load on Phase B: 11306 kVA
Total Load on Phase C: 11086 kVA

Total Load on Panel: 34.8 kVA Demand
97 A
Panel Size: 100 A

Even though the new lighting design added load to Panel LD42, the existing panel is capable enough to handle the additional load with the additional spare capacity already calculated in. No redesigning is needed for this panel.

Dance Studio

Voltage: 208Y/120 V Main Breaker: 175 A Feeder: 4-#1/0, 2" Conduit (#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	LD 22				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Unison Control	720			20	#10	1	2	#10	20	360			Recepts-Dimmer 1003
Recepts-1003		360		20	#10	3	4	#10	20		1440		Recepts-1003
Recepts-1003			1441	20	#10	5	6	#10	20			2160	Recepts-1003
Recepts-1003	2160			20	#10	7	8	#10	20	2160			Recepts-1003
Recepts-1003		2160		20	#10	9	10	#10	20		2160		Recepts-1003
Recepts-1003			2160	20	#10	11	12	#10	20			2160	Recepts-1003
Recepts-1003	360			20	#10	13	14	#10	20	2160			Recepts-1003
Wire Mold 1003		2160		20	#10	15	16	#10	20		720		Recepts-1003
Wire Mold 1003			2160	20	#10	17	18	#10	20			360	Recepts-1003
Special Recepts-1003	1919			20	#10	19	20	#10	20	1919			Special Recepts-1003
"		1919		20	#10	21	22	#10	20		1919		"
"			1919	20	#10	23	24	#10	20			1919	"
Recepts-1003	360			20	#10	25	26	#10	20	1919			Special Recepts-1003J
Recepts-1003		360		20	#10	27	28	#10	20		1919		"
Recepts-1003J			360	20	#10	29	30	#10	20			1919	"
Recepts-1003J	360			20	#10	31	32	#10	20	2160			Recepts-1003J
Recepts-1003J		2880		20	#10	33	34	#10	20		360		Recepts-1003J
Project Screen-1003			360	20	#10	35	36	#10	20			360	Recepts-1003J
Retract Seat riser	720			20	#10	37	38	#10	20	1919			Special Recepts-1003J
Dance Studio Control		720		20	#10	39	40	#10	20		1919		"
Wire Mold 1003J			2160	20	#10	41	42	#10	20			1919	"
Wire Mold 1003J	2160			20	#10	43	44	#10	20	1050			DANCE STUDIO
Light Branch		1800		20	#10	45	46						
Light Branch			1800	20	#10	47	48	#10	20			2020	DANCE STUDIO
Light Branch	1800			20	#10	49	50						
Light Branch		1800		20	#10	51	52						
Light Branch			260	20	#10	53	54						
Light Branch	1200			20	#10	55	56						
				20	#10	57	58						
Light Branch			60	20	#10	59	60						
	11759	14159	12680							13647	10437	12817	

Total Load on Phase A: 25.406 kVA
Total Load on Phase B: 24.596 kVA
Total Load on Phase C: 25.497 kVA

Total Load on Panel: 57.5 kVA Demand
160 A
Panel Size: 200 A

Even though the new lighting design added load to Panel LD22, the existing panel is capable enough to handle the additional load with the additional spare capacity already calculated in. No redesigning is needed for this panel.

Lobby Solution A

For the Lobby Solution A refer to Page 50 of this section of the report for the panel layout and redesign.

Lobby Solution B

Voltage: 480Y/277 Main Breaker: 200 A Feeder: 4-#2/0 THHW, 2" Conduit
(#, size wire & conduit)

Description	LOAD (VA)			Brk. Trip (A)	HB 34				Brk. Trip (A)	LOAD (VA)			Description
	A	B	C		Cond. Size	Ckt. #		Cond. Size		A	B	C	
Lighting Branch-Lobby	2945			20	#10	1	2	#10	20	621			LB-C309D
LB-Lobby/Coatroom		3386		20	#10	3	4	#10	20		1468		LB-Costume
LB Vestibule			892	20	#10	5	6	#10	20			3230	Lighting Branch-3058
EcoSystem Bus#1	4432			20	#10	7	8	#10	20	4432			EcoSystem Bus#16
EcoSystem Bus#2		4432		20	#10	9	10	#10	20		570		LB-C309C
EcoSystem Bus#3			4432	20	#10	11	12	#10	20			830	LB-C312A
EcoSystem Bus#4	4432			20	#10	13	14	#10	20	4432			EcoSystem Bus#17
EcoSystem Bus#5		4432		20	#10	15	16	#10	20		4432		EcoSystem Bus#18
EcoSystem Bus#6			4432	20	#10	17	18	#10	20			4432	EcoSystem Bus#19
EcoSystem Bus#7	4432			20	#10	19	20	#10	20	4432			EcoSystem Bus#20
EcoSystem Bus#8		4432		20	#10	21	22	#10	20		4432		EcoSystem Bus#21
EcoSystem Bus#9			4432	20	#10	23	24	#10	20			4432	EcoSystem Bus#22
EcoSystem Bus#10	4432			20	#10	25	26	#10	20	4432			EcoSystem Bus#23
EcoSystem Bus#11		4432		20	#10	27	28	#10	20		4432		EcoSystem Bus#24
EcoSystem Bus#12			4432	20	#10	29	30	#10	20			4432	EcoSystem Bus#25
EcoSystem Bus#13	4432			20	#10	31	32	-	-				
EcoSystem Bus#14		4432		20	#10	33	34	#10	20		4432		EcoSystem Bus#26
EcoSystem Bus#15			4432	20	#10	35	36	#10	20			4432	EcoSystem Bus#27
						37	38						
						39	40						
						41	42						
	25105	25546	23052							18349	19766	21788	

Total Load on I 43.454 kVA
Total Load on I 45.312 kVA
Total Load on I 44.84 kVA

Total Load on Panel: 147.03 kVA Demand
177 A
Panel Size: 225 A

The existing Panelboard needed to be redesigned for this new lighting design. For the redesign of this panel and others affected by it, refer to Pages 56 thru 58.

Mechanical Load Addition

HD43				
Circuit Number	Service	Amps Drawn	Breaker Size	Conductor
1	AHU-16 F-16-1A	65	175	#8 THHN
2	AHU-16 F-16-1B	65	175	#8 THHN
3	AHU-16 F-16-2A	52	150	#10 THHN
4	AHU-16 F-16-2B	52	150	#10 THHN
5	AHU-18 F-18-1A	65	175	#8 THHN
6	AHU-18 F-18-1B	65	175	#8 THHN
7	AHU-18 F-18-2	34	90	#10 THHN
8	Enthalpy Wheel	5	20	#10 THHN
	Total Amps Drawn:	403	450	250 kcmil

As shown above, the addition of the new enthalpy wheel to the mechanical system does not affect Panel HD43. No additional redesigning of the existing panel with a circuit breaker of 800 amps is required.

Electrical Distribution System Changes

With the changes and additions to the distribution system, redesigning of existing Panelboards upstream from the new Panelboards need to be considered. A single line diagram of the affected panels for each of the Main Switch Boards is shown below in Image One. In each of these images, the powering of the system can be seen. The first image, Main Switch Board 1 is shown.

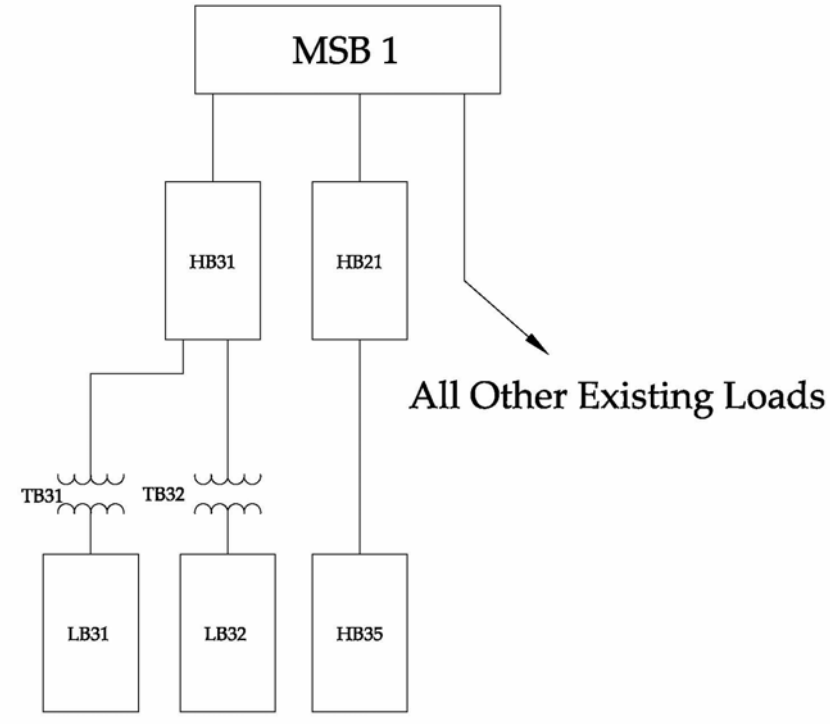

Image One

As seen in the image above, there are several pieces of electrical equipment that need to be examined and possibly redesigned, transformers TB31 and TB32 as well as Panelboards HB31 and HB21. Main Switch Board 1 also needs to be examined.

The new transformer calculations for calculations TB31and TB32 can be seen in the table below.

Transformer Identification Number	KVA Demand	XFMR Size KVA	Primary Voltage	Secondary Voltage	Primary Design Amps (1.25 multiplier)	Secondary Design Amps (1.25 multiplier)	Primary Protection Amp	Secondary Protection Amp
TB31	33.789	45	480	208	67.7	156.3	70	175
TB32	58.55	75	480	208	112.9	260.5	125	300

The existing transformer TB31 has the ability to house the additional load enforced on it. Transformer TB32 needed to be resized. The existing transformer is rated for 45 kVA. This will not be able to handle the new load of almost 59 kVA. Transformer TB32 will need to be increased to a 75 kVA transformer. With

the increase of the amperage from the new transformer, panel HB31 needs to be examined and possibly redesigned. The table below shows the new calculations for HB31.

HB31				
Circuit Number	Service	Amps Drawn	Breaker Size	Conductor
1	Elevator EL4	40	100	#10 THHN
2	Panel LB31 (xfmr TB31)	67.7	70	#6 THHN
3	Panel LB32 (xfmr TB32)	112.9	125	#2 THHN
4	AHU-10	97.8	100	#3 THHN
5	AHU-15 Supply Fan F-15-1	65	175	#6 THHN
6	AHU-15 Return Fan F-15-2	21	60	#10 THHN
7	AHU-19 Supply Fan F-19-1	52	150	#8 THHN
8	AHU-19 Return Fan F-19-2	14	35	#10 THHN
9	**Panel HB32**	48	60	#8 THHN
	Total Amps Drawn:	518.4	600	2 sets of 500 kcmil

The new HB31 panel shows that it draws 518.4 amps. The existing breaker is able to withstand this load, so HB31 does not need to be redesigned. From this, Main Switch Board One also can withstand the new load, and therefore from these new loads, Main Switch Board One does not need to be redesigned. Panel HB21also needs to be examined with the new loads provided by HB32. The table below shows the new calculations for HB21.

HB21				
Circuit Number	Service	Amps Drawn	Breaker Size	Conductor
1	Elevator EL2	34	70	#10 THHN
2	**Panel LB21**	140	175	#1 THHN
3	**Panel HB22**	56	70	#6 THHN
4	**Panel HB41**	120	150	#2 THHN
5	Panel HB32	46.82	50	#4 THHN
	Total Amps Drawn:	396.82	400	4- 500 kcmil

The new HB21 panel shows that it draws 396.8 amps. The existing breaker is able to withstand this load, so HB21 does not need to be redesigned. From this, Main Switch Board One also can withstand the new load, and therefore from these new loads, the switch board does not need to be redesigned.

In Image Two below, the distribution of Main Switch Board 2 is show.

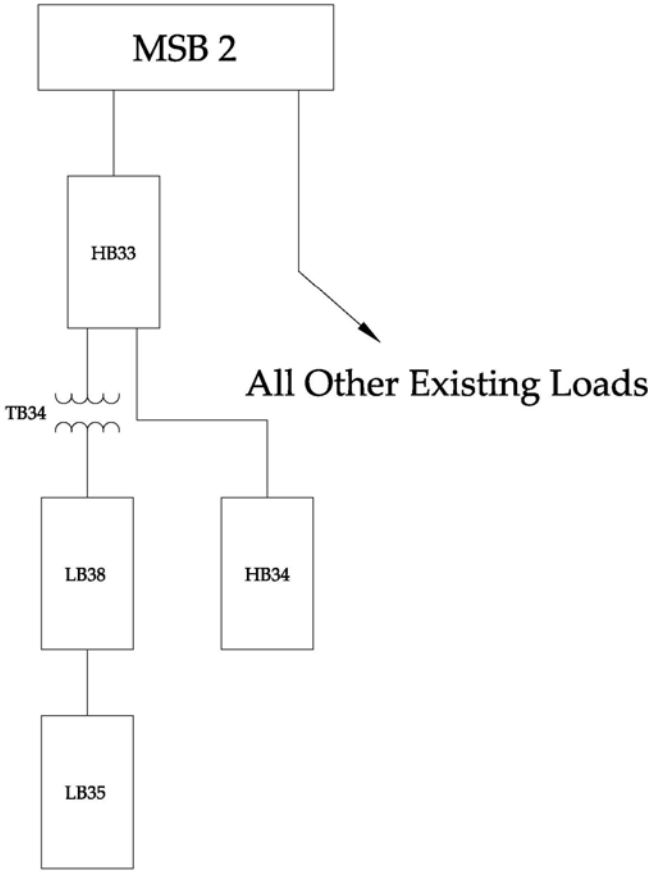

Image Two

With the new design of LB35, Panel LB38 and Transformer TB34 need to be examined and redesigned if the new load is bigger than the original load. Calculations for LB 38 and Transformer TB34 can be seen in the tables below.

LB38				
Circuit Number	Service	Amps Drawn	Breaker Size	Conductor
1	Panel LB35	83	90	#4 THHN
2	**Panel LB44**	120	150	#2 THHN
3	**400A Company Switch**	400	400	500 kcmil
4	**100 A Company Switch**	100	100	#3 THHN
5	**Panel SA-WLCB**	40	50	#10 THHN
	Total Amps Drawn:	743	800	2 sets of 500 kcmil

Transformer Identification Number	KVA Demand	XFMR Size KVA	Primary Voltage	Secondary Voltage	Primary Design Amps (1.25 multiplier)	Secondary Design Amps (1.25 multiplier)	Primary Protection Amp	Secondary Protection Amp
TB34	213.9	225	480	208	338.7	781.6	350	800

The new LB38 panel shows that it draws 743 amps. The existing breaker is able to withstand this load. The existing transformer TB31, like the existing panel, has the ability to house the additional load enforced on it. With this, HB33 is not affected by these new loads. With HB34's new loads, HB33 needs to be examined.

HB33				
Circuit Number	Service	Amps Drawn	Breaker Size	Conductor
1	Panel HB34	178	200	#2/0 THHN
2	**Panel LB42**	400	400	500 kcmil
3	**Panel LB38 (xfmr TB 34)**	338.7	350	350 kcmil
4	AHU-5 F-5-1	52.5	75	#8 THHN
5	AHU-5 F-5-2	27.5	30	#10 THHN
	Total Amps Drawn:	996.7	1000	3 sets of 500 kcmil

The new load on HB33 is more than the existing panel can handle. The new HB panel needs to be rated for at least 1000 amps. Knowing this, Main Switch Board Two needs to be examined and possibly redesigned. The calculations for Main Switch Board Two can be seen in the table below.

MSB 2				
Circuit Number	Service	Amps Drawn	Breaker Size	Conductor
1	Chiller CH-3	450.8	500	2 sets of 500 kcmil
2	Panel HB33	996.7	1000	3 sets of 500 kcmil
3	**Panel HD21**	640	700	2 sets of 500 kcmil
4	Panel HD42	435	450	2 sets of 500 kcmil
5	Panel HD43	403	450	2 sets of 500 kcmil
6				
7	**MCC2**	480	500	2 sets of 500 kcmil
8	Panel HC42	384.1	400	2 sets of 500 kcmil
	Total Amps Drawn:	3789.6	4000	

With the new load that LB35 and HB34 have put on Main Switch Board Two, a new Switch Board needs to be specified for 4000 Amps.

Below in Images Three and Four are the new single line diagrams showing the Panel Sizes, Transformer Sizes, and Conductor Sizes.

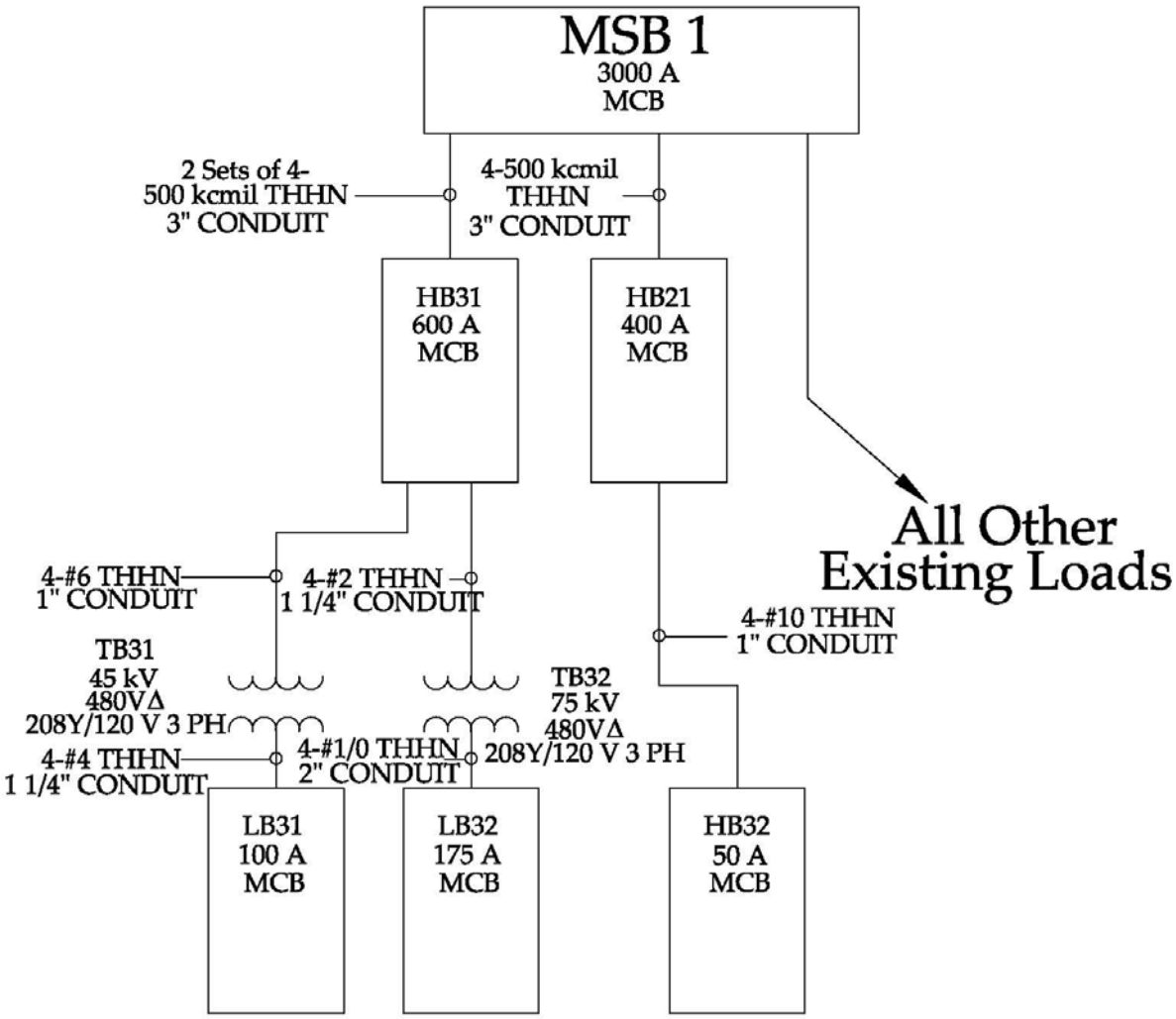

Image Three

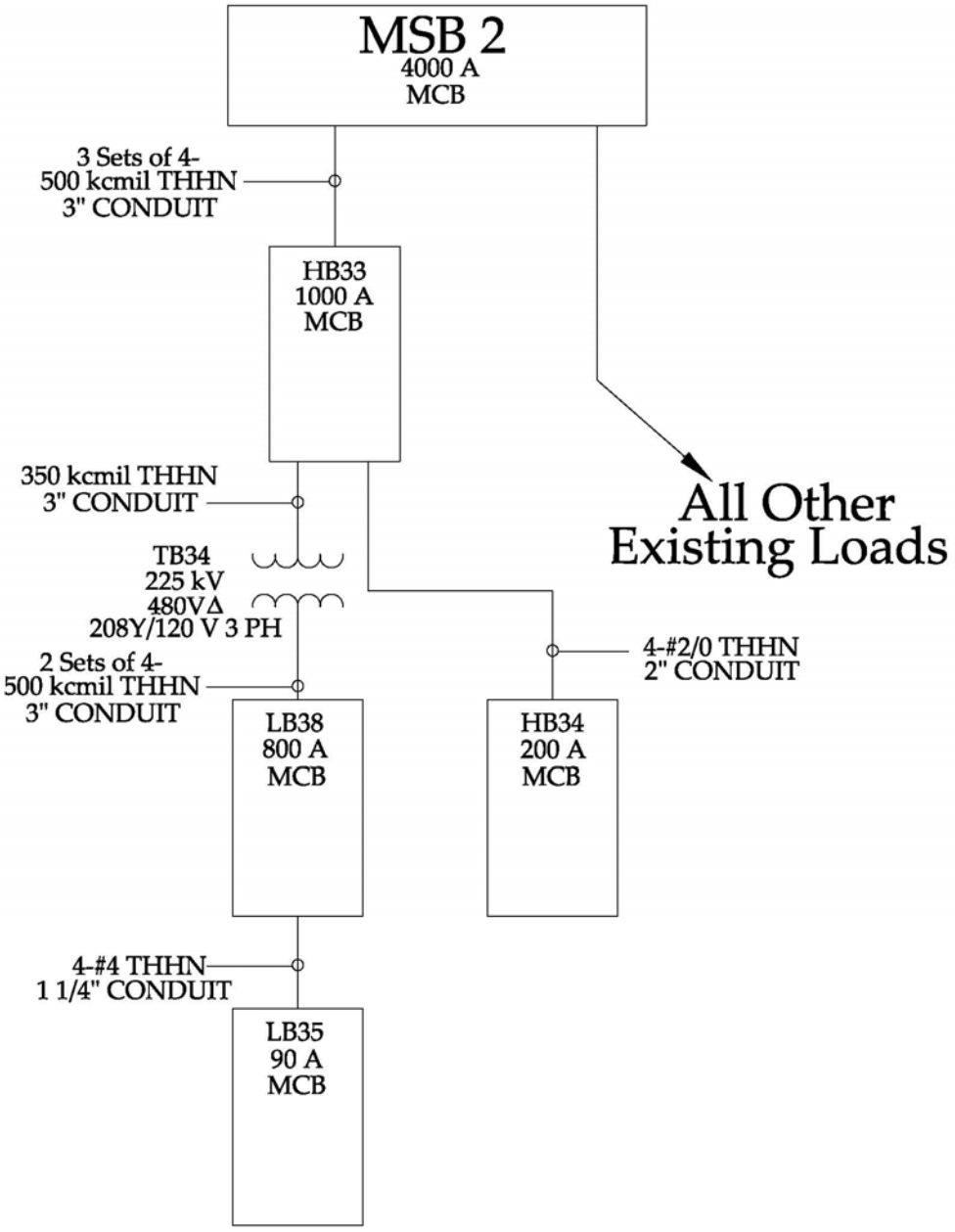

Image Four

All Supplemental information and calculations can be found in the Electrical Data and Electrical Equipment appendix. The table below lists the panels that were resized and the new break and panel sizes. Cut Sheets can be found in the Electrical Appendix.

New Panel Boards			
Panel	Slots	Breaker	Panel Size
LB31	54	100 A	225 A
LB32	42	175 A	225 A
LB35	42	90 A	115 A
HB32	42	50 A	115 A
HB34	42	200 A	225 S
HB33		1000 A	
MSB 2		4000 A	

Fault Current Analysis

In order to find the Fault Current, a program provided by Electrical Design Reference was used. This program calculates the fault current from panel to panel, panel to transformer, and transformer to panel with length of runs. In order to use this program, some assumptions were made.

- The incoming amperage the utility provides is assumed to be infinite.
- Impedence in the transformers is 5%.

Image Five below shows the Fault Current Path chosen for analysis.

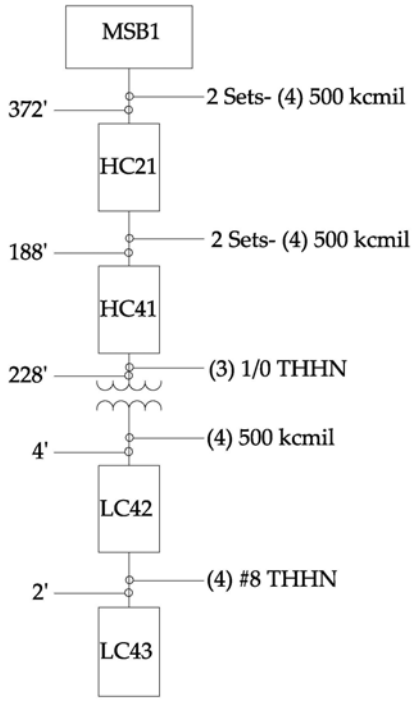

Image Five

A list of inputs into the program is provided in the table below.

EDR Fault Current Analysis Program Inputs						
Transformer	Assumed Impedence	Panel	Length	Feeder	Fault Current	AIC Rating
Utility	5%				487114	65000
		MSB1	10	8-500 kcmil	47727	54000
		HC21	373	8-500 kcmil	36718	45000
		HC41	188	4-500 kcmil	29776	35000
TC42	5%		228	3-1/0 THHN	15869	22000
		LC42	4	4-250 kcmil	15758	22000
		LC43	2	4-#8 THHN	15122	22000

The program shows that the fault current analysis is at a tolerable level for design practice. It is well above the lowest possible AIC rating so the fault current analysis passes any requirements.

Conclusion

As seen in this section of the report, there is much that can be done to move equipment and change loads in a building. As an electrical engineer, a good knowledge of every type of load and equipment is a must in the industry. In the electrical world, the National Electric Code is viewed by almost all States, Cities, Towns, and Boroughs as the Bible of Electric Codes. A thorough understanding of this code is very helpful in the building industry. Certain criterion, which is set-forth by the NEC must be met not only for the safety of people occupying the building, but everything around the building and the building itself. When it comes to electric and as in any other engineering practice, the safety of the people is in the hands of the engineer.