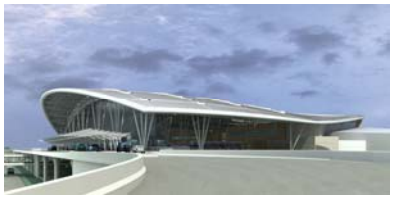


Electrical Depth

Introduction

The electrical redesign for the Indianapolis International Airport is performed to only three of the interior spaces. Exterior electrical study is not included in this report. While most of my spaces are tremendously large, electrical system analysis is narrowed down to, and tightly joint with only the redesign of its lighting system. This report is a result of changes occurred to the electrical systems due to the modification of the existing lighting system and hence, readjustment is needed. Since the emergency power system and the uninterruptible power system should be left unaltered, mechanical and receptacle loads are also left unchanged to leave the overall picture the way it was. My primary focus is on the resizing of the distribution and lighting panels based on a primary voltage of 480/277V. Feeders will be resized and a voltage drop study will be performed to ensure the new distribution system is a efficient addition. LED luminaires are installed into the Passenger Concourse area, which as a result, requires a step down transformer to accommodate its low voltage needs. A cost analysis of the additional electrical equipments is included in my Construction Management Breadth Study.

Problem Statement

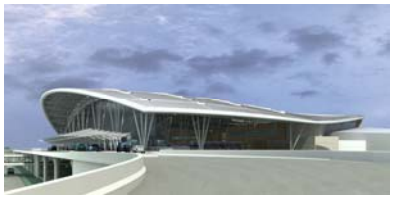
It is necessary to provide adequate power to additional lighting, following the NEC recommended practice. After the redesign of a new panelboard layout, with spares for future expansion and development, electrical equipments are specified according to the system demand.

Design Criteria

All electrical resizing was completed using requirements and tables from the 2002 National Electrical Code.

Design Goals

Upon completing technical assignment 2, it was evident that there are not many options, nor is it feasible for redesigning of the existing electrical system in this scale. Hence, I have only focused on the lighting distribution panelboard as part of my electrical depth requirement. I will re-design panelboard layout specifically to the addition of new lighting system, size feeders according to load demand, perform voltage drop study, as well as specifying new required electrical equipment such as panelboards and step down transformers. To illustrate the wiring layout, a switching and circuiting diagram for each analyzed space will be included. The retrofitted sytem should then to be included in the construction management breadth analysis of cost.



Concourse Electrical Details

Circuit, Control and Wiring Layout

Please see attached Concourse Control Layout

Panelboard Layout

Please see attached Concourse panelboard layout

Equipment Specification:

Eaton Cutler-Hammer PRL-1a Distribution + Lighting Panel (see attached specification sheet)
Price: USD $7,280.00
Designation: HA/L

Eaton Cutler-Hammer PRL-2a Distribution + Lighting Panel (see attached specification sheet)
Price: USD $7,280.00
Designation: LA/L

Eaton 45 KVA K-factor Dry Type Transformer (see attached specification sheet)
480 - 208Y/120V
Price: USD $6,460.00
Catalog Number: H48M28F45CU

Load calculation for feeders leaving panel board HA/L:

Total Load: 179.8 KVA

Load Current: 179.8 KVA/sqrt(3)*0.48 KV*1000 = 216.3 A

Feeder Size: 1 set of (3) #300 1” copper conductor rated at 75 degree Celsius

Voltage Drop

Length: 600 feet

Power Factor: 90%

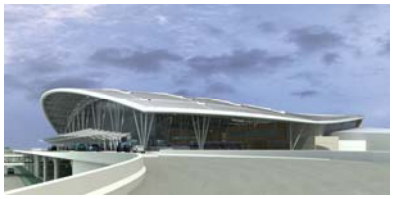
Ampere-feet = 216.3 A x 600 ft = 129780 Amp-ft = 130 x 1000 Amp-ft

Voltage Drop (line to neutral) = 130 Amp-ft x 0.055 V/Amp-ft = 7.15 V

Voltage Drop (line to line) = 7.15 x 1.73 = 12.3 V

% Voltage Drop = 12.3 V / 480V x100 = 2.5 % (within 5%)

Load calculation for feeders leaving panel board LA/L:



Total Load: 33.8 KVA

Load Current: 33.8 KVA/sqrt(3)*0.208 KV*1000 = 93.8 A

Feeder Size: 1 sets of (3) #2/0 1" copper conductor rated at 75 degree Celsius

Voltage Drop

Length: 600 feet

Power Factor: 80%

Ampere-feet = 93.8 A x 600 ft = 56280 Amp-ft = 56.2 x 1000 Amp-ft

Voltage Drop (line to neutral) = 56.2 Amp-ft x 0.104 V/Amp-ft = 5.6 V

Voltage Drop (line to line) = 5.6 V x 1.73 = 9.7 V

% Voltage Drop = 9.7 V / 208 V x100 = 4.6 % (within 5%)

Civic Plaza & Ticket Hall Electrical Details

Circuit, Control and Wiring Layout

Please see attached Civic Plaza and Ticket Hall Control Layout

Panelboard Layout

Please see attached panelboard layout

Equipment Specification:

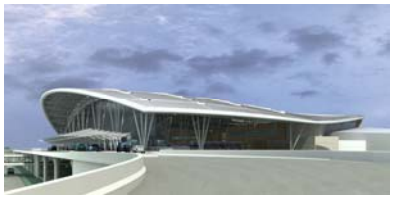
Eaton Cutler-Hammer PRL-1a Distribution + Lighting Panel (see attached specification sheet)
Price: USD $7,280.00
Designation: HB/L

Eaton Cutler-Hammer PRL-2a Distribution + Lighting Panel (see attached specification sheet)
Price: USD $7,280.00
Designation: LB/L

Eaton 45 KVA K-factor Dry Type Transformer (see attached specification sheet)
480 □ - 208Y/120V
Price: USD $6,460.00
Catalog Number: H48M28F45CU

Load calculation for feeders leaving panel board HB/L:

Total Load: 69.95 KVA



Load Current: 69.95 KVA/sqrt(3)*0.48 KV*1000 = 84.1 A

Feeder Size: 1 sets of (3) #1 1” copper conductor rated at 75 degree Celsius

Voltage Drop

Length: 230 ft

Power Factor: 90%

Ampere-feet = 216.3 A x 230 ft = 49749 Amp-ft = 50 x 1000 Amp-ft

Voltage Drop (line to neutral) = 50 Amp-ft x .156 V/Amp-ft = 7.8 V

Voltage Drop (line to line) = 7.8 V x 1.73 = 13.5 V

% Voltage Drop = 13.5 V/ 480 V x 100 = 2.8% (within 5%)

Load calculation for feeders leaving panel board LB/L:

Total Load: 47 KVA

Load Current: 47 KVA/sqrt(3)*0.208 KV*1000 = 130.7 A

Feeder Size: 1 sets of (3) #2/0 1” copper conductor rated at 75 degree Celsius

Voltage Drop

Length: 230 feet

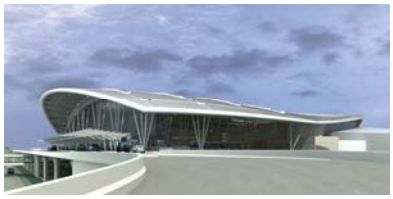
Power Factor: 80%

Ampere-feet = 130.7 A x 230 ft = 30061 Amp-ft = 30 x 1000 Amp-ft

Voltage Drop (line to neutral) = 30 Amp-ft x 0.104 V/Amp-ft = 3.12 V

Voltage Drop (line to line) = 3.12 V x 1.73 = 5.4 V

% Voltage Drop = 5.4 V / 208 V x100 = 26 % (within 5%)



Conclusion

The redesign of the electrical distribution system has presented potential problems such the length of the concourse can cause a very high value of voltage drop. However, this problem can be easily overcome with sizing a larger wire size to achieve a reasonable voltage drop value (within 5%). All panel boards, feeders, breakers, and transformers were resized based on this new system. The main adjustment of this system is the addition of several step down transformers to low voltage panels for LED lighting loads. Additional Lighting system resulted from the redesign had very little impact on the distribution system. Changes were made accordingly for the new lighting loads.

The redesign of my Civic Plaza lighting system has been effective. It yields a significantly lower lighting load which allows the consolidation of distribution panels with the Ticket Hall panelboard. A dedicated circuit is connected to each level of spotlights for flexible controls, accommodating the Civic Plaza's the multiple-purpose usage. For cost analysis, please refer to Construction Management Breadth Study.

Concourse Lighting Panelboard

Panel	HA / L	**Voltage**	480/277V 3P, 4W				Eaton Culter-Hammer PRL-2a										
		Breaker	250														
Location	Concourse	**Bus**	400														
							A	B	C								
Ckt	Equipment	Demand	kVA	Amp	Bkr	Pole				Pole	Bkr	Amp	kVA	Demand	Equipment	Ckt	
1	MH Lighting Zone 1-1	1.25	4.25	15.34	20	1	8.5			1	20	15.34	4.25	1.25	Fluor. Lighting Zone 1-1	2	
3	Fluor. Lighting Zone 2-1	1.25	4.25	15.34	20	1		8.5		1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-1	4	
5	Fluor. Lighting Zone 2-1	1.25	4.25	15.34	20	1			8.5	1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-1	6	
7	MH Lighting Zone 3-1	1.25	3.75	13.53	20	1	7.5			1	20	13.53	3.75	1.25	MH Lighting Zone 3-1	8	
9	Fluor. Lighting Zone 1-2	1.25	3.75	13.53	20	1		7.5		1	20	13.53	3.75	1.25	MH Lighting Zone 3-1	10	
11	Fluor. Lighting Zone 2-2	1.25	4.25	15.34	20	1			8.5	1	20	15.34	4.25	1.25	Fluor. Lighting Zone 1-2	12	
13	Fluor. Lighting Zone 2-2	1.25	4.25	15.34	20	1	8.5			1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-2	14	
15	MH Lighting Zone 3-2	1.25	4.25	15.34	20	1		8.5		1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-2	16	
17	Fluor. Lighting Zone 1-3	1.25	3.75	13.53	20	1			7.5	1	20	13.53	3.75	1.25	MH Lighting Zone 3-2	18	
19	Fluor. Lighting Zone 2-3	1.25	3.75	13.53	20	1	7.5			1	20	13.53	3.75	1.25	MH Lighting Zone 3-2	20	
21	Fluor. Lighting Zone 2-3	1.25	4.25	15.34	20	1		8.5		1	20	15.34	4.25	1.25	Fluor. Lighting Zone 1-3	22	
23	MH Lighting Zone 3-3	1.25	4.25	15.34	20	1			8.5	1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-3	24	
25	Fluor. Lighting Zone 1-4	1.25	4.25	15.34	20	1	8.5			1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-3	26	
27	Fluor. Lighting Zone 2-4	1.25	3.75	13.53	20	1		7.5		1	20	13.53	3.75	1.25	MH Lighting Zone 3-3	28	
29	Fluor. Lighting Zone 2-4	1.25	3.75	13.53	20	1			7.5	1	20	13.53	3.75	1.25	MH Lighting Zone 3-3	30	
31	MH Lighting Zone 3-4	1.25	4.25	15.34	20	1	8.5			1	20	15.34	4.25	1.25	Fluor. Lighting Zone 1-4	32	
33	SPARE	1	0	0	-	-		4.25		1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-4	34	
35	SPARE	1	0	0	-	-			4.25	1	20	15.34	4.25	1.25	Fluor. Lighting Zone 2-4	36	
37	LA / L	1	33.8	40.66	50	3	37.55			1	20	13.53	3.75	1.25	MH Lighting Zone 3-4	38	
39	LA / L	1						3.75		1	20	13.53	3.75	1.25	MH Lighting Zone 3-4	40	
41	LA / L	1							0	-	-		0	1	SPARE	42	
			Total Load per phase				86.55	48.5	44.75								
					Total Load		179.8	KVA									
					Total Amps		216.3	A									

Concourse Lighting Panelboard

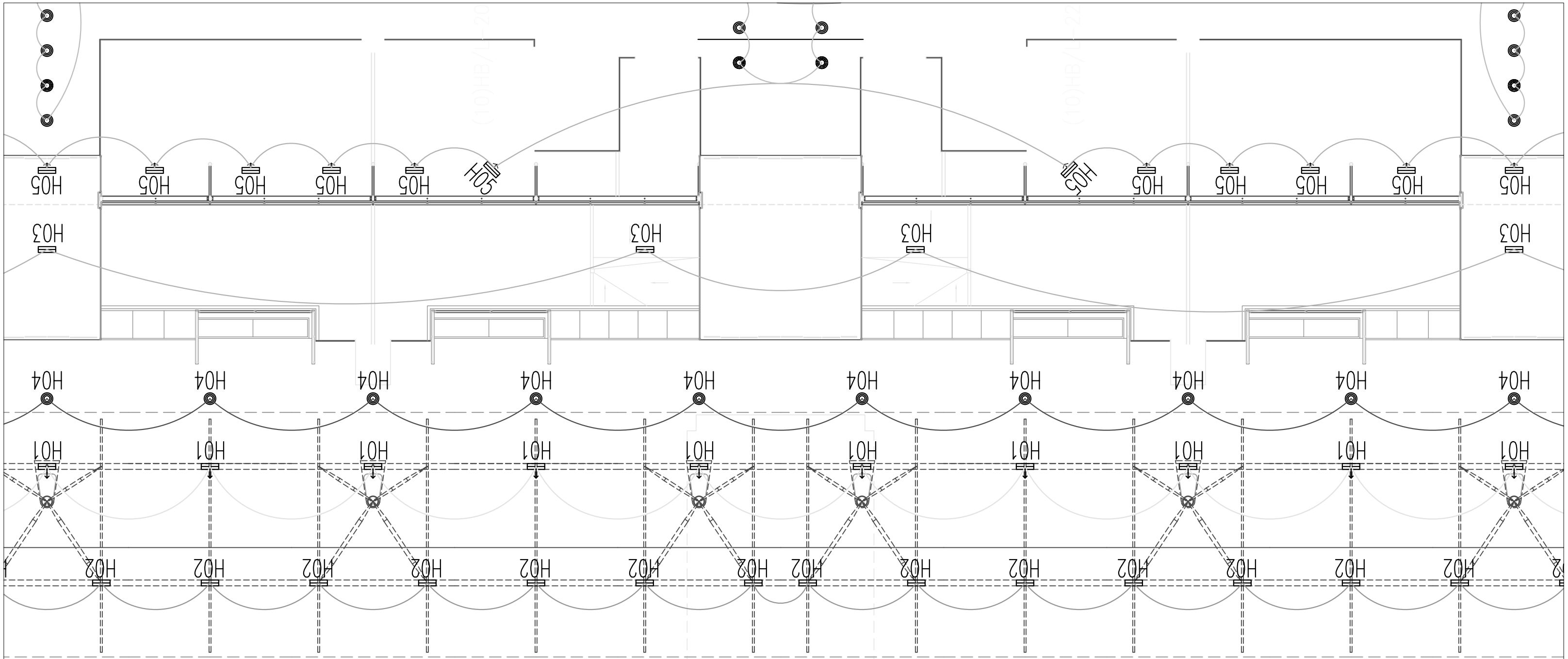
Panel	LA / L	**Voltage**	208/120V 3P, 4W				Eaton Cutler-Hammer PRL-1a										
		Breaker	40														
Location	Concourse	**Bus**	100														
							A	B	C								
Ckt	Equipment	Demand	kVA	Amp	Bkr	Pole				Pole	Bkr	Amp	kVA	Demand	Equipment	Ckt	
1	LED 1-1	1.25	2.113	17.59	20	1	4.225			1	20	17.59	2.11	1.25	LED 2-1	2	
3	LED 3-1	1.25	2.113	17.59	20	1		4.225		1	20	17.59	2.11	1.25	LED 4-1	4	
5	LED 1-2	1.25	2.113	17.59	20	1			4.225	1	20	17.59	2.11	1.25	LED 2-2	6	
7	LED 3-2	1.25	2.113	17.59	20	1	4.225			1	20	17.59	2.11	1.25	LED 4-2	8	
9	LED 1-3	1.25	2.113	17.59	20	1		4.225		1	20	17.59	2.11	1.25	LED 2-3	10	
11	LED 3-3	1.25	2.113	17.59	20	1			4.225	1	20	17.59	2.11	1.25	LED 4-3	12	
13	LED 1-4	1.25	2.113	17.59	20	1	4.225			1	20	17.59	2.11	1.25	LED 2-4	14	
15	LED 3-4	1.25	2.113	17.59	20	1		4.225		1	20	17.59	2.11	1.25	LED 4-4	16	
17	SPARE	1	0	0	20	1			0	1	20	0	0	1	SPARE	18	
19	SPARE	1	0	0	20	1	0			1	20	0	0	1	SPARE	20	
21	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	22	
23	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	24	
25	SPACE	1	0	0	-	1	0			1	-	0	0	1	SPACE	26	
27	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	28	
29	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	30	
31	SPACE	1	0	0	-	1	0			1	-	0	0	1	SPACE	32	
33	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	34	
35	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	36	
37	SPACE	1	0	0	-	1	0			1	-	0	0	1	SPACE	38	
39	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	40	
41	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	42	
			Total Load per phase				12.68	12.68	8.45								
					Total Load		33.8	KVA									
					Total Amps		93.8	A									

Civic Plaza & Ticket Hall Lighting Panelboard

Panel	HB / L	**Voltage**	480/277V 3P, 4W				Eaton Culter-Hammer PRL-2a										
		Breaker	250														
Location	Civic Plaza + Ticket Hall	**Bus**	400														
							A	B	C								
Ckt	Equipment	Demand	kVA	Amp	Bkr	Pole				Pole	Bkr	Amp	kVA	Demand	Equipment	Ckt	
1	MH Lighting Zone 1-1	1.25	3	10.83	20	1	4.5			1	20	5.413	1.5	1.25	MH Lighting Zone 1-1	2	
3	MH Lighting Zone 2-1	1.25	3	10.83	20	1		6		1	20	10.83	3	1.25	MH Lighting Zone 2-1	4	
5	MH Lighting Zone 3-1	1.25	3	10.83	20	1			6	1	20	10.83	3	1.25	MH Lighting Zone 3-1	6	
7	Fluor. Lighting Zone 1-1,2	1.25	1.75	6.315	20	1	3.5			1	20	6.315	1.75	1.25	Fluor. Lighting Zone 1-2,4	8	
9	Fluor. Lighting Zone 2-1,2	1.25	1.75	6.315	20	1		3.5		1	20	6.315	1.75	1.25	Fluor. Lighting Zone 2-3,4	10	
11	MH Lighting Zone 3-1	1.25	5.25	18.94	20	1			10.5	1	20	18.94	5.25	1.25	MH Lighting Zone 3-3	12	
13	MH Lighting Zone 3-1	1.25	5.25	18.94	20	1	10.5			1	20	18.94	5.25	1.25	MH Lighting Zone 3-3	14	
15	MH Lighting Zone 3-2	1.25	5.25	18.94	20	1		10.5		1	20	18.94	5.25	1.25	MH Lighting Zone 3-4	16	
17	MH Lighting Zone 3-2	1.25	5.25	18.94	20	1			10.5	1	20	18.94	5.25	1.25	MH Lighting Zone 3-4	18	
19	SPARE	1	0	0	-	-	4.375			1	20	15.79	4.38	1.25	MH Lighting Zone 4-1	20	
21	SPARE	1	0	0	-	-		4.375		1	20	15.79	4.38	1.25	MH Lighting Zone 4-2	22	
23	SPARE	1	0	0	-	-			0	-	-	0	0	1	SPARE	24	
25	SPARE	1	0	0	-	-	0			-	-	0	0	1	SPARE	26	
27	SPARE	1	0	0	-	-		0		-	-	0	0	1	SPARE	28	
29	SPARE	1	0	0	-	-			0	-	-	0	0	1	SPARE	30	
31	SPARE	1	0	0	-	-	0			-	-	0	0	1	SPARE	32	
33	SPARE	1	0	0	-	-		0		-	-	0	0	1	SPARE	34	
35	SPARE	1	0	0	-	-			0	-	-	0	0	1	SPARE	36	
37	LB / L	1	47.08	56.62	50	3	47.075			-	-	0	0	1	SPARE	38	
39	LB / L	1						0		-	-	0	0	1	SPARE	40	
41	LB / L	1							0	-	-	0	0	1	SPARE	42	
				Total Load per phase			69.95	24.375	27								
					Total Load		69.95	KVA									
					Total Amps		84.1	A									
		Civic Plaza															

Civic Plaza & Ticket Hall Lighting Panelboard

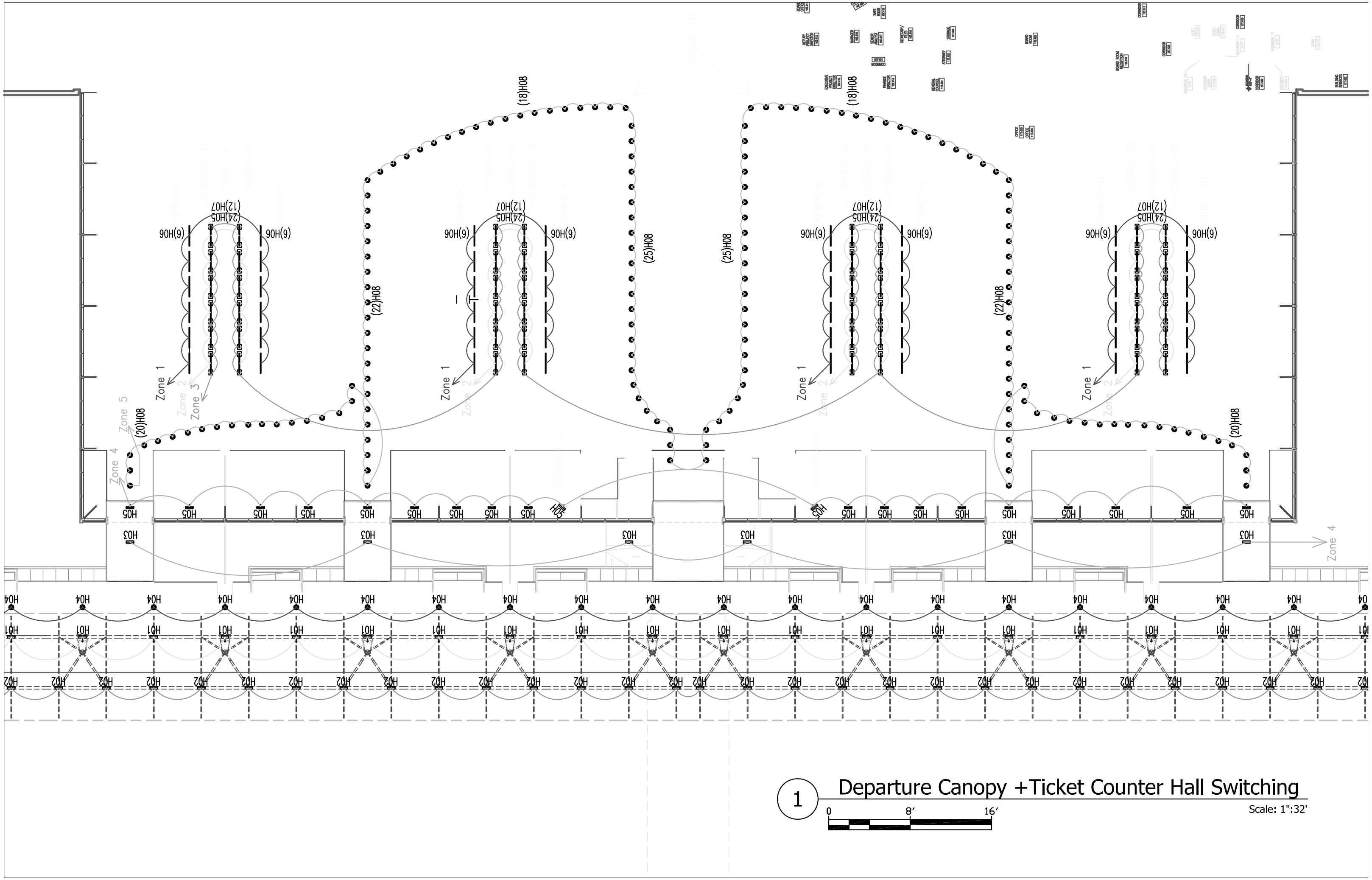
Panel	LB / L	**Voltage**	208/120V 3P, 4W				Eaton Cutler-Hammer PRL-1a										
		Breaker	40														
Location	Civic Plaza + Ticket Hall	**Bus**	100														
							A	B	C								
Ckt	Equipment	Demand	kVA	Amp	Bkr	Pole				Pole	Bkr	Amp	kVA	Demand	Equipment	Ckt	
1	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1	4.575			1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	2	
3	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1		4.575		1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	4	
5	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1			4.575	1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	6	
7	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1	4.575			1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	8	
9	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1		4.575		1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	10	
11	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1			4.575	1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	12	
13	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1	4.575			1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	14	
15	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1		4.575		1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	16	
17	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1			4.575	1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	18	
19	LED Zone 4 (78ft)	1.25	2.288	19.05	20	1	4.575			1	20	19.05	2.29	1.25	LED Zone 4 (78ft)	20	
21	SPARE	1	0	0	-	1		1.325		1	20	4.781	1.33	1.25	LED Zone 5 (Ticket Hall)	22	
23	SPARE	1	0	0	-	1			0	1	-	0	0	1	SPARE	24	
25	SPACE	1	0	0	-	1	0			1	-	0	0	1	SPACE	26	
27	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	28	
29	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	30	
31	SPACE	1	0	0	-	1	0			1	-	0	0	1	SPACE	32	
33	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	34	
35	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	36	
37	SPACE	1	0	0	-	1	0			1	-	0	0	1	SPACE	38	
39	SPACE	1	0	0	-	1		0		1	-	0	0	1	SPACE	40	
41	SPACE	1	0	0	-	1			0	1	-	0	0	1	SPACE	42	
			Total Load per phase				18.3	15.05	13.725								
					Total Load		47.075	KVA									
					Total Amps		130.7	A									
		Civic Plaza															



1 Departure Canopy Switching Enlarged

0 8′ 16′

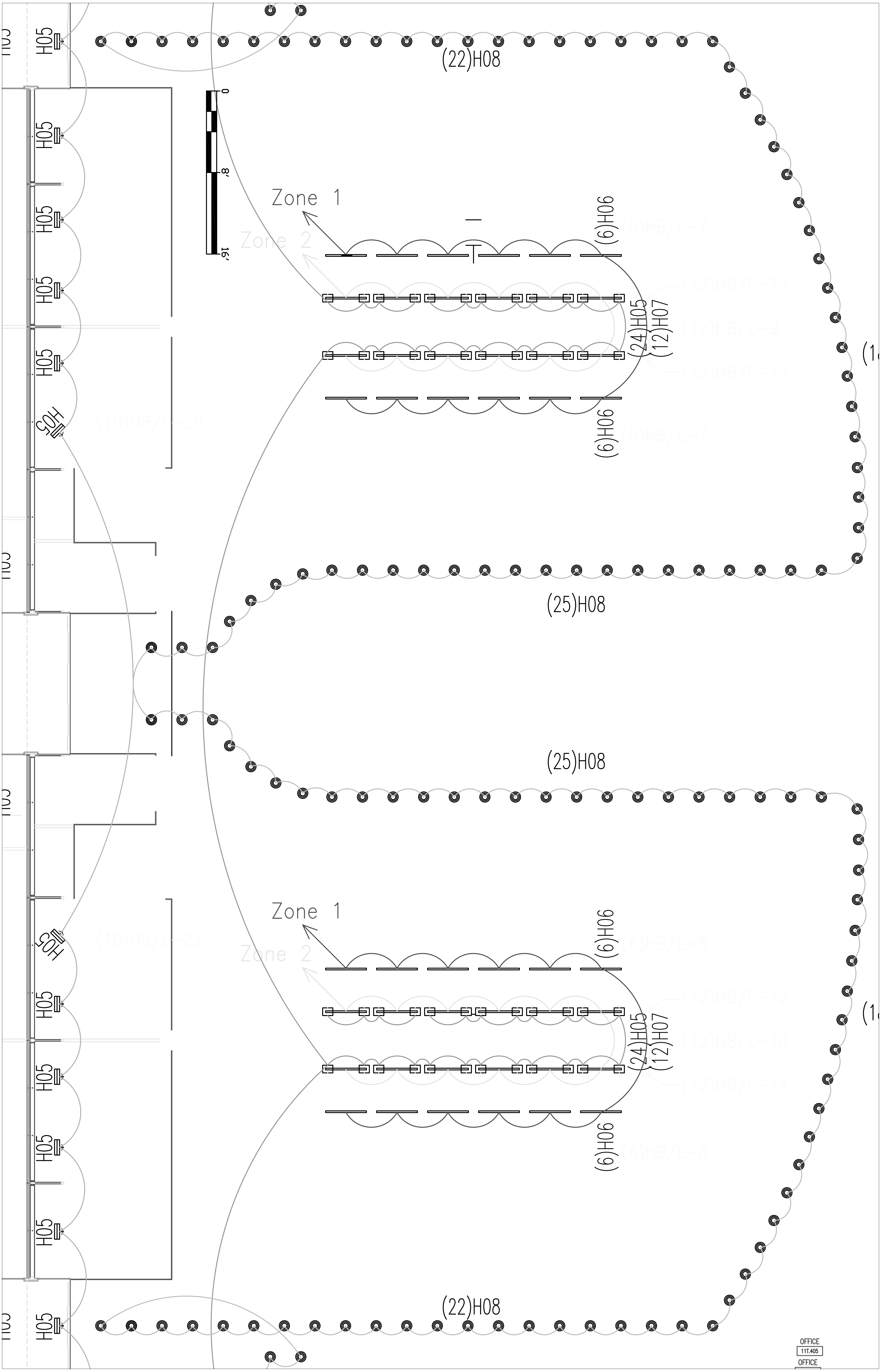
Scale: 1":32'



1 Departure Canopy +Ticket Counter Hall Switching

0 8′ 16′

Scale: 1":32'



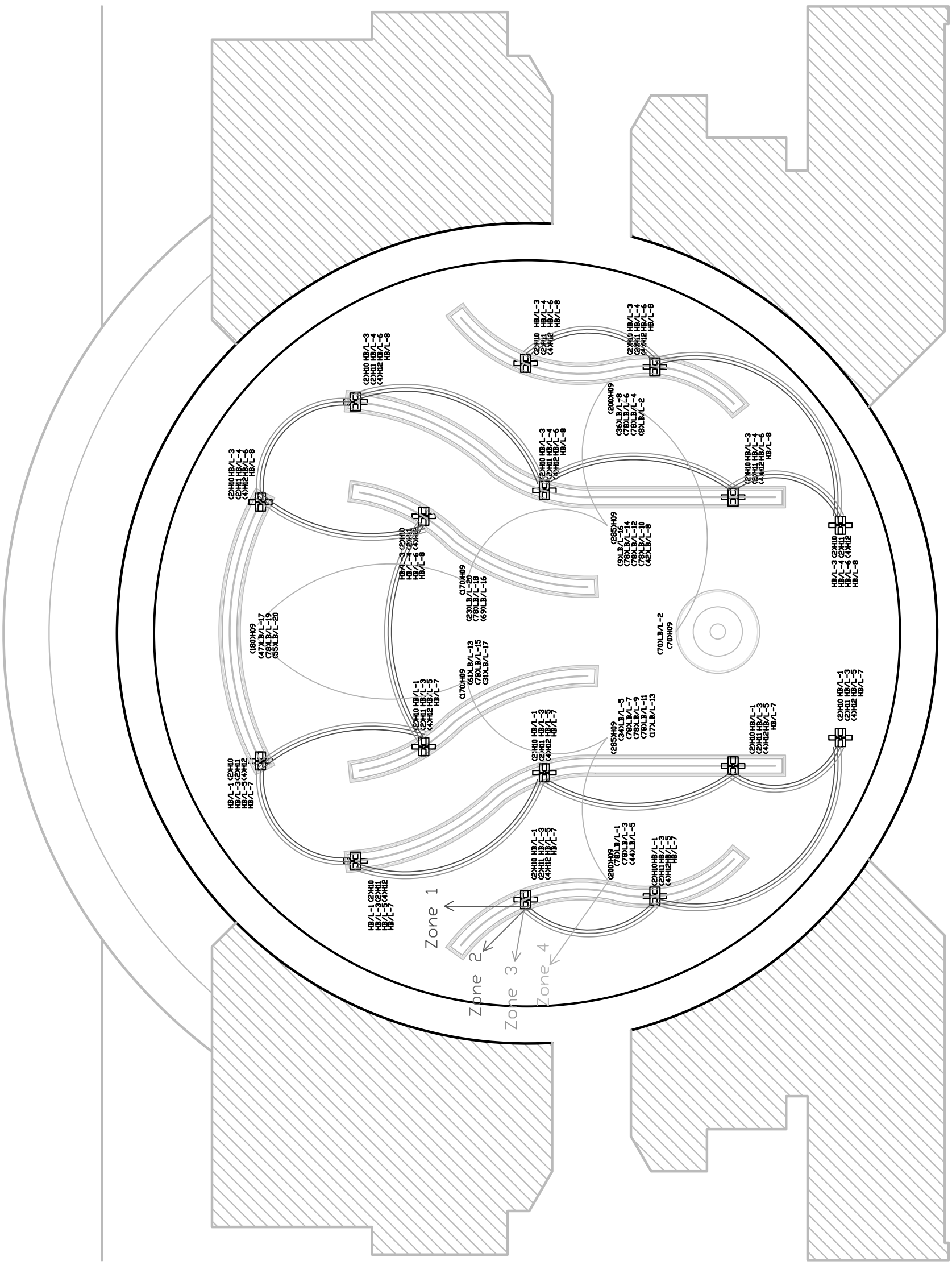
(22)H08
H05
0
8'
16'
Zone 1
Zone 2
(6)H06
(6)HB/L-7
(12)HB/L-15
(24)H05
(12)H07
(12)HB/L-9
(12)HB/L-17
(10)HB/L-20
(25)H08
(25)H08
(10)HB/L-22
Zone 1
Zone 2
(6)H06
(6)HB/L-8
(12)HB/L-12
(24)H05
(12)H07
(12)HB/L-10
(12)HB/L-14
(22)H08
OFFICE
11T.405
OFFICE

1

Civic Plaza Control + Switching

0 16′ 32′

Scale: 1":32'



GATE B15
GATE B13
GATE B11
Zone 1
Zone 2
Zone 2
GATE B12 (RJ HOLD)
GATE B14
36 SF SUPPLY
FF
SR
TYPICAL 90
LA/L-1
H16 (180x2)
H15 (7)
H14 (20)
H13 (20)
HA/L-1
HA/L-2
HA/L-3
HA/L-4
HA/L-5
HA/L-6
HA/L-7
HA/L-8

1 Concourse Control Zone

0 8' 16'

Scale: 1":16'