Electrical Systems, Commercial Building Design

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Executive Summary

The following 21,000sqft office building utilizes a radial distribution system which consists of a 480Y/277V lighting panel, a 208Y/120V power panel, and a 480Y/277V motor control center. 1"C-4#2THW (cu) conductors protected by a 100 A breaker, supply two types of lights and occupancy sensors. There are two circuits per floor with a centrally located panel board in the utility room on the second floor. The down lights have a battery option in order to double as egress lighting in a power outage. Occupancy sensors are used to help save energy. The power panel is fed by a 1"C-4#8 THW (cu) through a 100A breaker and supplies 36 individual receptacle branches. Emergency exit signs with a backup battery are hard wired into the same circuits as nearby outlets. Care has been taken to leave plenty of room for large and potentially continuous loads that may be a result of multiple computers and other office gadgets. Each floor has a plug wired for a refrigerator and circuit available for a small appliance load.

The motor control center is fed by 2"C-3#3/0 THW (cu) protected by a 300 A breaker. There are 13 individual motor loads. The control center is located in the mechanical and electrical room on the first floor and next to the 9'6" X 4'6" X 7'6" unit substation. The 225kV transformer that feeds the power panel is directly below the power panels in the same room. The chiller is the largest motor at 30hp and is selected from the line of Carrier products.

The second floor of the building is home to the power panels but the chiller, boiler, and the hot and chilled water pumps. These feed the AHU that is located directly above on the third floor. The goals project goals established by the design team include safety, flexibility, minimal energy demand, low voltage drops, and minimal equipment sizing to save money.

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NEC Code Compliance Summary

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Table 3: Articles Referenced in NEC	
Article	**Summary**
430.6	Describes how to size the conductors of the equipment
430.32	Any continuous motor that is more than 1hp shall have overcurrent protection.
430.37	All 3-Phase motors must be provided with overload units.
430.39	Motor controllers need to be installed that is capable of interrupting a stalled rotor current of the motor.
450.42	The vault that holds the transformer shall provide 3 hour fire resistance.
450.43	doorways shall also be fire protected
430.40	If there is a maximum short circuit then there is a maximum limit on the fuse or circuit breaker.
430.52	The motor branch-circuit short-circuits and ground-fault protective device shall be capable of carrying the starting current in the motor, and much more.
430.72	Describes overcurrent protection for motor control circuits.
220.14 (I)	Receptacle demand loads.
220.18 (A)	Continuous motors are 125% DF.
250.122	Size equipment grounding
110.26	Defines Space Requirements around Unit Substation.
700.12 (F)	Lights with rechargeable batteries are required

Lighting Types

Throughout the building, three different types of luminaires will be used. Lighting for the exterior of the building will be provided by exterior wall luminaire hood downlights. These luminaires are only located on the outer perimeter. The layout of this specific lighting can be seen on CAD Sheet E3.1. As for the main lighting for all office spaces in the building, troffers are used on each level. Spaces where troffers are located include utility rooms, open office areas, the cafeteria, and storage rooms. For conference rooms and private offices, a more ambient lighting fixture was chosen. For the ambient lighting, commercial downlighting is implemented. For energy savings, occupancy sensors are also installed. These sensors can be set to a specified time and will automatically turn off the lights if there is no movement in the room/space.

Luminaire Description						
Fixture	**Model #**	**Manufacturer**	**Wattage**	**Voltage**	**Quantity**	**Notes**
Exterior Wall Lighting	697-WP-MH/1/100-277V-BK-C	Shaper	100	277	10	Exterior lighting near entrances
Troffers	2-VRM-S-2-54T5-PA3-75-277-LE0C8-GL	ISO	122	277	96	All troffers per floor are wired together and connected to a single fuse on the 2nd floor.
Down Lights	PD8H142-E-82H-1G-C-HB128APK	Halo	45	277	182	Used for private offices/conference rooms and hallways.
Occupancy Sensors	VAC-DT-2000-R	Greengate	0.75	277	32	Purpose is to help improve energy consumption.

Table 4: Shows the purpose and use for each luminaire in various spaces of the commercial building.

Lighting Loads

Fixture	**# of Fixtures**	**Watts per Fixture**	**PF**	**P_T per Fixture, VA**	**Connected Load, kVA**	**Demand Load, kVA**
Exterior Wall Lighting	10	100	0.98	102.04	1.02	1.28
Troffer	96	122	0.98	124.49	11.95	14.94
Down Light	182	45	0.98	45.92	8.36	10.45
Occupancy Sensor	32	0.75	1	0.75	0.02	0.03
				TOTAL:	**21.35**	**26.69**

Table 5: The amount of each fixture was totaled. The connected loads and demand loads are calculated and displayed. In a commercial building, a demand factor of 1.25 should be applied to all lights.

Equations/Sample Calculations using Exterior Wall Lighting:

$$Total\ Power\ per\ Fixture, P_T/fixture = \frac{(\frac{W}{Fixture})}{PF} = \frac{100}{0.98} = \mathbf{102.04\ VA}$$

$$Connected\ Load = \frac{(\#\ of\ Fixtures)\left(\frac{P_T}{Fixture}\right)}{1000\ VA} * kVA = \frac{(10\ Fixture)(102.04\ VA)}{1000\ VA} = \mathbf{1.02\ kVA}$$

$$Demand\ Load = 1.25 * Connected\ Load = 1.25 * 1.02\ kVA = \mathbf{1.28\ kVA}$$

Lighting Panel: Lighting Branch Circuits

All lighting used is fluorescent lighting which requires a smaller amount of power. Because of this, a total of six branch circuits are needed. The load for branches L1-L6 are shown below. The total load should add up to the already calculated connected load and demand load shown above in Table 5.

Branch Circuit	Troffers	Exterior Lights	Down Lights	Occupancy Sensor	Connected Load, kVA	Demand Load, kVA	Current, Amps
L1	28	10	0	4	4.51	5.64	20.35
L2	0	0	58	6	2.67	3.33	12.04
L3	34	0	0	4	4.24	5.29	19.11
L4	0	0	62	7	2.85	3.57	12.87
L5	34	0	0	4	4.24	5.29	19.11
L6	0	0	62	7	2.85	3.57	12.87
				TOTAL:	**21.35**	**26.69**	**96.36**

Table 6: Shows the load associated with each branch circuit in the lighting panel based on the luminaire ratings for each fixture.

POWER PANEL LOADS				
Circuit	Receptacles*	Exit Signs**	Connected Load, kVA	Current, Amps
1	8	0	1.44	12
2	8	0	1.44	12
3	7	0	1.26	10.5
4	7	0	1.26	10.5
5	10	0	1.8	15
6	7	2	1.269	10.575
7	4	3	0.7335	6.1125
8	8	0	1.44	12
9	1	0	0.18	1.5
10	2	0	0.36	3
11	10	0	1.8	15
12	8	0	1.44	12
13	8	0	1.44	12
14	8	0	1.44	12
15	8	0	1.44	12
16	9	0	1.62	13.5
17	6	1	1.0845	9.0375
18	9	0	1.62	13.5
19	10	0	1.8	15
20	9	2	1.629	13.575
21	1	0	0.18	1.5
22	2	0	0.36	3
23	8	0	1.44	12
24	6	1	1.0845	9.0375
25	8	2	1.449	12.075
26	8	0	1.44	12
27	8	0	1.44	12
28	8	0	1.44	12
29	9	0	1.62	13.5
30	9	0	1.62	13.5
31	10	0	1.8	15
32	9	2	1.629	13.575
33	1	0	0.18	1.5
34	2	0	0.36	3
35	8	0	1.44	12
36	8	2	1.449	12.075
		SUM:	**45.43**	**378.56**

Table 7: Displays the load associated with each circuit in the power panel. The circuiting is laid out from the one-line diagrams provided.

Equations/Sample Calculations using Circuit 7:

*According to NEC Article 220.14(I), receptacle loads should be rated at 180 VA per receptacle.

**Referring to the cut sheets in the Appendix, exit signs are rated at 4.5 VA.

$$Connected\ Load\ (Circuit\ 7) = \frac{(\#\ of\ receptacles)(180\ VA) + (\#\ of\ exit\ signs)(4.5\ VA)}{1000\ VA} * kVA$$

$$= \frac{(4\ receptacles)(180\ VA) + (3\ exit\ signs)(4.5\ VA)}{1000\ VA} = \mathbf{0.7335\ kVA}$$

Demand Load:

According to NEC Article 220.44, the calculated demand load for receptacle loads is found through the following equation:

$$DL = 100\% * 10\ kVA + 50\%(remainder - 10\ kVA)$$

In this case, the connected load was calculated to be 45.43 kVA as shown in Table 7. Therefore:

$$DL = (100\% * 10\ kVA + 50\%(45.43\ kVA - 10\ kVA) = \mathbf{27.72\ \ kVA}$$

Emergency Load Description

In case of emergency, load requirements include egress lighting and exit signs. The egress lighting luminaires used are the same commercial Halo downlights used throughout the building as described in the lighting loads section. These luminaires have the option to change the ballast from a regular downlight to a downlight with a dual-tap emergency battery ballast with a remote test switch plate. This means that these luminaires are used daily for general lighting and are powered through the lighting panel and when an emergency occurs, the battery back-up will then be the source of power.

In addition to egress lighting, exit signs will also be needed for safety purposes. The exit signs chosen to be installed in the building will be energy efficient, long life LEDs. This specific type was chosen for its low operating costs and zero maintenance requirements.

Emergency Load Description						
Fixture	**Model #**	**Manufacturer**	**Wattage**	**Voltage**	**Quantity**	**Notes**
Emergency Down Lights	PD8H142-E-82H-1G-C-HB128APK	Halo	45	277	182	Includes battery backup ballast.
Exit Signs	ECHX-2-ST-A-WH	Sure-Lights	4.5	277	15	Ordered with arrows facing in the proper direction.

Table 8: Emergency loads are shown. Refer to the cut sheets in the Appendix for more information.

As mentioned above, the emergency downlights are a part of the lighting panel with battery back-up. The exit signs are connected to the power panel along with receptacle loads. See CAD sheets E4.1-E4.3 for exit sign layout and sheets E3.1-E3.3 for emergency downlighting layout.

Exit signs will have a very low load to the LED type exit sign. For load contribution to the power panel, see Table 7 in the Power Panel Design section.

According to NEC article 700.12(F), lights with rechargeable batteries are required. This complies with the ballast and luminaire type specified.

Motor #	Motor	HP	# of Motors	PF	Efficiency	Control	Total Power, P_T	Real Power, P_R	Reactive Power, P_X	NEMA Starter*	SF/Motor **	SF Total
M1	AHU Supply Fan	25	1	0.9	0.92	RVNR	22.52	20.27	9.82	2	5	5
M2	AHU Return Fan	15	1	0.9	0.92	RVNR	13.51	12.16	5.89	2	5	5
M3	CHW Pump	20	1	0.9	0.92	RVNR	18.02	16.22	7.85	2	5	5
M4	Elevator	20	1	0.9	0.9	RVR	18.42	16.58	8.03	2	5	5
M5	AHU Exhaust Fan	10	1	0.9	0.92	RVNR	9.01	8.11	3.93	1	5	5
M6	HW Pump	10	1	0.9	0.92	RVNR	9.01	8.11	3.93	1	5	5
M7-M12	Exhaust Fans (6 Restrooms)	1	6	0.85	0.95	FVNR	0.92	0.79	0.49	00	1	6
M13	Chiller	30	1	0.9	0.9	RVNR	27.63	24.87	12.04	3	8	8
						Total	**119.05**	107.1	51.98			**44**

Table 9: A summary of all motor loads present in the commercial building.

*NEMA Starter based on three-phase, 460 V motor loads

*SF/motor based on fusible switch type

Equations/Sample Calculations using AHU Supply Fan, Motor 1:

$$Real\ Power, P_R = \frac{P_{mech}}{\eta} = \frac{25\ HP}{0.92} * \frac{0.746\ kW}{HP} = \mathbf{20.27\ kW}$$

$$Total\ Power, P_T = \frac{P_R}{PF} = \frac{20.27\ kW}{0.9} = \mathbf{22.52\ kVA}$$

$$Reactive\ Power, P_X = \sqrt{P_T^2 - P_R^2} = \sqrt{22.52^2 - 20.27^2} = \mathbf{9.82\ kvar}$$

Demand Load:

Connected Load = 119.05 kVA from Table 9

To calculate the demand load, a demand factor of 1.25 must be applied to the power of the largest motor. In this case, the largest motor present is the chiller at 27.87 kVA.

$$DL = 1.25 * P_{T,largest} + \sum P_{T,remainder} = 1.25 * 27.87\ kVA + 91.42\ kVA = \mathbf{126.26\ kVA}$$

Number of Modules:

Total Space Factor

- 44 SF for all motors
- 1 SF for main feeder

TOTAL SF = 44 + 1 = 45 SF

12 Space Factors are allowed in one module → 45 SF/12 = 3.75 → ***4 modules*** are needed to house all motors

Motor Control Center Horizontal and Vertical Bus Sizes:

Standard Horizontal Bus Sizes (continuous current rating)-
[600 A, 1000 A, 1200 A, 1600 A, 2000 A]

Horizontal Bus Size				
Motor	**HP**	**I (Amps)**	**# Motors**	**DL**
AHU Supply Fan	25 HP	34	1	34
AHU Return Fan	15 HP	21	1	21
CHW Pump	20 HP	27	1	27
Elevator	20 HP	27	1	27
AHU Exhaust Fan	10 HP	14	1	14
HW Pump	10 HP	14	1	14
Exhaust Fans (6 Restrooms)	1 HP	1.8	6	10.8
Chiller	30 HP	40	1	40
			SUM:	**187.8**
			Horizontal Bus Size:	**600 A**

Table 10: Summary of calculations used to find the horizontal bus size of the motor control center.

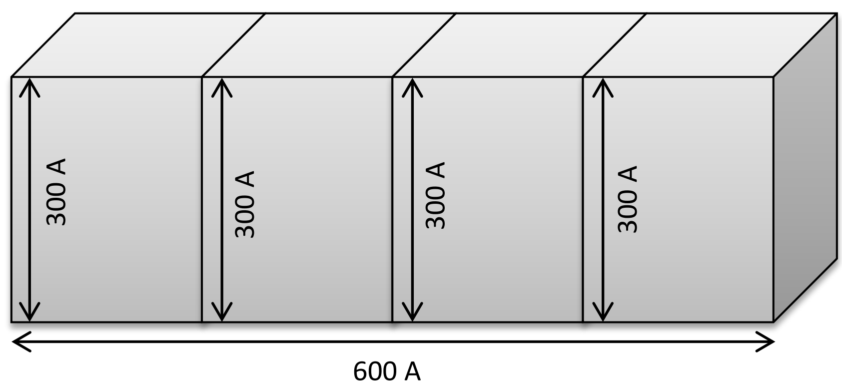
Standard Vertical Bus Sizes-
[300 A, 450 A, 600 A]

Sample Calculation using Module 1:
In order to find the standard vertical bus size, the demand load must be calculated.
Module 1 contains the AHU Supply Fan and AHU Return Fan only. A demand factor of 1.25 should be applied to the largest motor within the module.
DL for Module 1 = $1.25*I_{L,AHU\ Supply\ Fan} + I_{L,AHU\ Return\ Fan}$ = 1.25*34 A + 21 A = **63.5 A**
Therefore, a 300 A vertical bus size is selected for Module 1.

Vertical Bus Size		
Module 1		
	DL (A)	63.5
	VB 1 Size	**300 A**
Module 2		
	DL (A)	64.35
	VB 2 Size	**300 A**
Module 3		
	DL (A)	57.2
	VB 2 Size	**300 A**
Module 4		
	DL (A)	31.5
	VB 2 Size	**300 A**

Table 11: Summary of vertical bus sizes for all four modules in the motor control center

Horizontal and Vertical Bus Size Schematic
*For an overall layout of the MCC, see CAD Sheet E8.



Motor 1: AHU Supply Fan, RVNR

25 HP, 460 V, 3 phase, SF = 10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	34	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	85	
	Use 90 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond}=	42.5	A	continuous
	#8 THW (Cu)		NEC(310.15B)
	3/4"C - 3#8 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**100 A**	T13.4
Unfused Switch		**60 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	34	A	
I_{OC} =	**39.1**	A	
STEP 6			
Controller	**RVNR**		

Motor 2: AHU Return Fan, RVNR

15 HP, 460 V, 3 phase, SF =10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	21	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	52.5	
	Use 60 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond} =	26.25	A	continuous
	#12 THW (Cu)		NEC(310.15B)
	1/2"C - 3#12 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**60 A**	T13.4
Unfused Switch		**30 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	21	A	
I_{OC} =	**24.15**	A	
STEP 6			
Controller	**RVNR**		

Motor 3: CHW Pump, RVNR

20 HP, 460 V, 3 phase, SF =10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	27	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	67.5	
	Use 70 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond} =	33.75	A	continuous
	#10 THW (Cu)		NEC(310.15B)
	1/2"C - 3#10 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**100 A**	T13.4
Unfused Switch		**60 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	27	A	
I_{OC} =	**31.05**	A	
STEP 6			
Controller	**RVNR**		

Motor 4: Elevator, RVR

20 HP, 460 V, 3 phase, SF =10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	27	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	67.5	
	Use 70 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond} =	33.75	A	continuous
	#10 THW (Cu)		NEC(310.15B)
	1/2"C - 3#10 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**100 A**	T13.4
Unfused Switch		**60 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	27	A	
I_{OC} =	**31.05**	A	
STEP 6			
Controller	**RVR**		

Motor 5: AHU Exhaust Fan, RVNR

10 HP, 460 V, 3 phase, SF = 10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	14	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	35	
	Use 35 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond}=	17.5	A	continuous
	#12 THW (Cu)*		NEC(310.15B)
	1/2"C - 3#12 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**60 A**	T13.4
Unfused Switch		**30 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	14	A	
I_{OC} =	**16.1**	A	
STEP 6			
Controller	**RVNR**		

Motor 6: HW Pump, RVNR

10 HP, 460 V, 3 phase, SF = 10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	14	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	35	
	Use 35 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond}=	17.5	A	continuous
	#12 THW (Cu)*		NEC(310.15B)
	1/2"C - 3#12 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**60 A**	T13.4
Unfused Switch		**30 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	14	A	
I_{OC} =	**16.1**	A	
STEP 6			
Controller	**RVNR**		

Motors 7-12: Exhaust Fans, FVNR

1 HP, 460 V, 3 phase, SF = 10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	1.8	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	300%		NEC(430.52)
I_{fuse}=	3* I_L=	5.4	
	Use 15 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond}=	2.25	A	continuous
	#12 THW (Cu)*		NEC(310.15B)
	1/2"C - 3#12 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**30 A**	T13.4
Unfused Switch		**15 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	1.8	A	
I_{OC} =	**2.07**	A	
STEP 6			
Controller	**FVNR**		

Motor 13: Chiller, RVNR

30 HP, 460 V, 3 phase, SF = 10%, Nontime-Delay Fuse Protection

STEP 1: LOAD			
I_L =	40	A	NEC(430.250)
STEP 2: PROTECTION DEVICE			
DF =	250%		NEC(430.52)
I_{fuse}=	2.5* I_L=	100	
	Use 100 A Fuse		T7.1
STEP 3: CONDUCTOR/CONDUIT			
I_{cond}=	50	A	continuous
	#8 THW (Cu)		NEC(310.15B)
	3/4"C - 3#8 THW		NEC(AnnexC)
STEP 4: SWITCHES			
Nontime-Delay			
Fused Switch		**200 A**	T13.4
Unfused Switch		**60 A**	T13.4
STEP 5: OVERLOAD PROTECTION			
I_{FLC} =	40	A	
I_{OC} =	**46**	A	
STEP 6			
Controller	**RVNR**		

*Upsized from a #14 THW (Cu): #12 THW (Cu) is the minimum required size for a motor branch circuit.

Sizing the Main MCC Feeder

CONDUCTOR/CONDUIT			
I_{cond}=	$1.25*I_{largest, M} + Sum\ I_{L, remainder}$		
	197.8	A	
	#3/0 THW (Cu)		NEC(310.15B)
	2"C - 3#3/0 THW		NEC(AnnexC)

PROTECTION DEVICE: Circuit Breaker			
DF =	250%		NEC(430.52)
I_P =	$DF*I_{largest, M} + Sum(I_{L,remainder})$		
	247.8	A	
	Use 300 A CB		T8.2

Demand Load Summary		
Load	**Demand Load, kVA**	**Calculations Found in Section:**
Lighting	26.69	Lighting Panel Design
Receptacles	27.72	Power Panel Design
Motors	126.26	Motor Control Center Design
SUM:	**180.67 kVA**	

Table 12: Collected demand load summary.

To allow for flexibility in the design, the unit substation transformer is sized to be approximately 20% larger than the demand load requires.

Sizing the Transformer:

Power Rating (kVA)	Height (in)	Width (in)	Depth (in)	Weight (lbs)	Average Impedance (%Z)	Average X/R Ration
15.0	23.00	22.25	15.00	230	3.6	1.94
30.0	23.00	22.25	15.00	285	6.4	0.92
45.0	26.00	24.00	15.00	369	6.6	1.13
75.0	30.00	30.00	20.00	590	5.7	1.38
112.5	37.00	30.00	20.00	690	6.1	1.51
150.0	42.00	36.00	24.00	1050	5.5	1.53
225.0	42.00	36.00	24.00	1350	6.6	2.00
300.0	48.00	48.00	29.50	2000	3.6	1.81
500.0	58.00	48.00	29.50	2700	5.0	2.89
750.0	90.00	72.00	54.00	5200	5.0	1.98
1000.0	90.00	72.00	54.00	6000	5.8	2.38

Table 13: Typical Ratings of Three-Phase General Purpose Transformers. See reference 1 for source citation.

FromTable X, a transformer that is approximately 20% larger than a 180.67 kVA demand load is a **225 kVA** transformer.

Unit Substation Dimensions	
Unit Substation Element	Sizing
Primary Switchgear Current	$I_{L,P} = \frac{P_T}{\sqrt{3}(E_{L,P})} = \frac{180.67\ kVA}{\sqrt{3}(13.8\ kV)} = 7.56\ A$ Use low current: 600 A **Size: W = 36”**
Transformer	Use 15 kV, 225 kVA **Size: T15.5 – H =90”, W = 42”, D = 54”**
Main Secondary Current	$I_{L,S} = \frac{P_T}{\sqrt{3}(E_{L,S})} = \frac{180.67\ kVA}{\sqrt{3}(0.48\ kV)} = 217.31\ A$ $I_{CB} = 1.25 * I_{L,S} = 1.25 * 217.31\ A = 271.64\ A$ Frame Size: T8.2 – 600 AF/3P

	Size: Fig15.8 – Unit 2 **W = 18"** Check: 480 V I_{SC} = 30,000 A → OK (see Short Circuit calculations)
Subfeeders	**Size: Fig 15.8 – Unit 2** **W = 18"**

Table 14: A summary of calculations showing the process of finding the final dimensions for the unit substation.

The layout of the unit substation can be found on CAD sheet E7.

Electrical Room Substation Layout

The unit substation must have at least a six foot clearance on all sides from the substation to the room walls. This is a general rule and is done for safety purposes. A schematic of the minimum dimensions is shown below in Figure 1. The schematic is solely for illustration purposes and is not to scale.

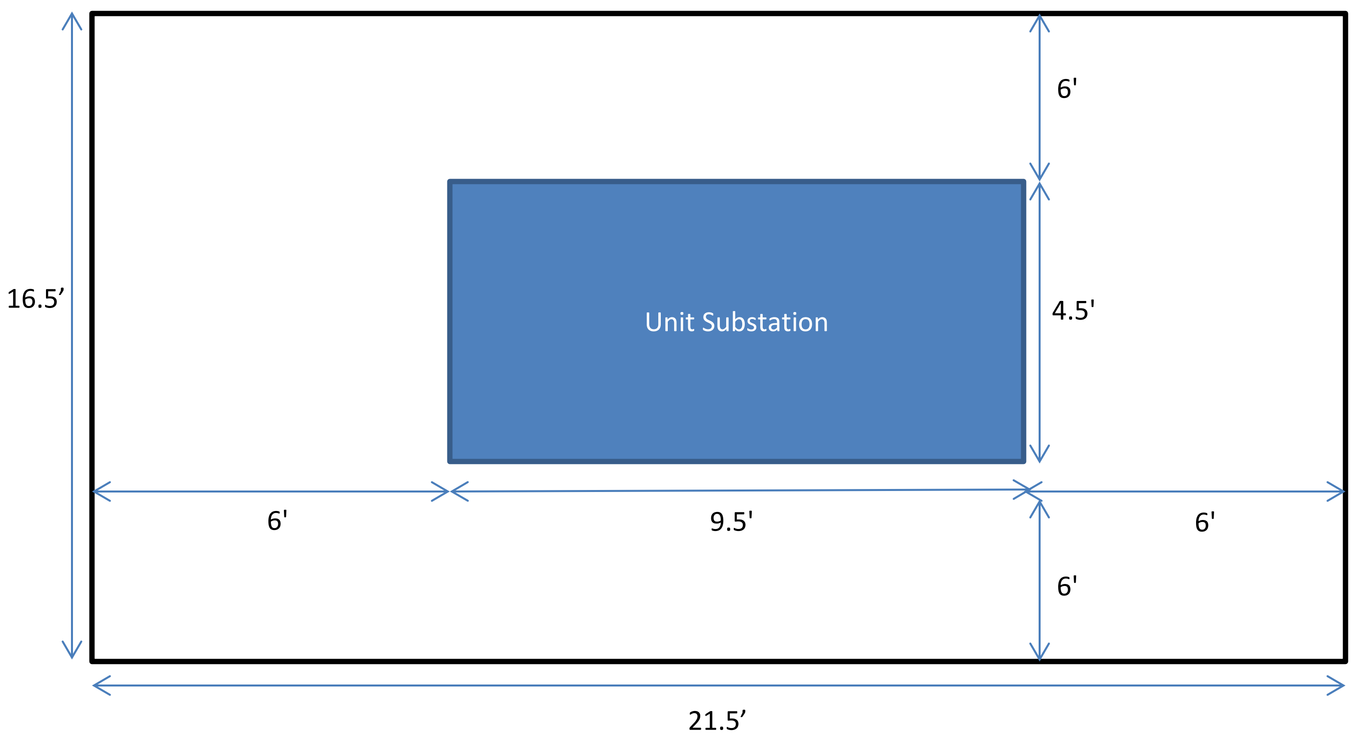


Figure 1: Minimum dimensions for electrical room size housing the unit substation.

According to Table 14 and Figure 1, the electrical room must be a minimum of 21.5' x 16.5'. Looking at CAD sheet E5.1, the drawing shows the placement of the electrical room and unit substation. The actual dimensions of the room are 24.83' x 26.33' and the substation is a minimum of 6' away from any wall which satisfies the safety requirements.

Voltage Drop Analysis

Feeder and branch circuit wires were sized to provide less than 3% voltage drop for branch circuits and 2% for feeders. This design criterion was easily met due to the small nature of the building, as well as the centrally located lighting and power panels. The tables below show the process used to estimate voltage drop, based on per length voltage drop values obtained courtesy of Canada Wire and Cable Limited.

Subfeeder Voltage Drop Analysis							
	Connected Current	**Length (Ft.)**	**Thousand Amp-Ft**	**VD/1000 Amp-ft**	**Max VD**	**Voltage Drop**	**% VD**
Motor Sub	143.195	10	1.431949	0.11	8.31	0.158	0.033%
Lighting Sub	24.979	20	0.499585	0.485	8.31	0.254	0.053%
Primary Power Sub	54.641	10	0.546408	0.462	8.31	0.252	0.053%
Secondary Power Sub	126.094	30	3.782824	0.699	3.6	2.644	0.551%
Main Feeder	252.564	5	1.262822	0.07	8.31	0.089	0.019%

Table 15: Voltage Drop Analysis for Each Subfeeder

Lighting Panel Voltage Drop Analysis					
	Connected Current (Amps)	**Max Length (Ft.)**	**Thousand Amp-Ft**	**Voltage Drop**	**% VD for #10 wire**
L1	17.86	135	2.41	2.89	1.04%
L2	9.63	85	1.02	1.23	0.44%
L3	15.29	125	2.39	2.87	1.04%
L4	10.30	75	0.97	1.16	0.42%
L5	15.29	135	2.58	3.10	1.12%
L6	10.30	85	1.09	1.31	0.47%

Table 16: Voltage Drop Analysis for Lighting Panel

Power Panel Voltage Drop Analysis					
Circuit	Connected Current (Amps)	Max Length (Ft.)	Thousand Amp-Ft	Voltage Drop	% VD for #12 wire
1	12.00	110	1.32	2.53	2.11%
2	12.00	120	1.44	2.76	2.30%
3	10.50	132	1.39	2.66	2.21%
4	10.50	120	1.26	2.42	2.01%
5	15.00	90	1.35	2.59	2.16%
6	10.58	52	0.55	1.05	0.88%
7	6.11	88	0.54	1.03	0.86%
8	12.00	88	1.06	2.02	1.69%
9	1.50	55	0.08	0.16	0.13%
10	3.00	67	0.20	0.39	0.32%
11	15.00	60	0.90	1.73	1.44%
12	12.00	47	0.56	1.08	0.90%
13	12.00	105	1.26	2.42	2.01%
14	12.00	117	1.40	2.69	2.24%
15	12.00	95	1.14	2.19	1.82%
16	13.50	125	1.69	3.23	2.70%
17	9.04	25	0.23	0.43	0.36%
18	13.50	80	1.08	2.07	1.73%
19	15.00	40	0.60	1.15	0.96%
20	13.58	81	1.10	2.11	1.76%
21	1.50	24	0.04	0.07	0.06%
22	3.00	24	0.07	0.14	0.12%
23	12.00	30	0.36	0.69	0.58%
24	9.04	10	0.09	0.17	0.14%
25	12.08	24	0.29	0.56	0.46%
26	12.00	85	1.02	1.96	1.63%
27	12.00	90	1.08	2.07	1.73%
28	12.00	80	0.96	1.84	1.53%
29	13.50	120	1.62	3.11	2.59%
30	13.50	70	0.95	1.81	1.51%
31	15.00	55	0.83	1.58	1.32%
32	13.58	84	1.14	2.19	1.82%
33	1.50	35	0.05	0.10	0.08%
34	3.00	35	0.11	0.20	0.17%
35	12.00	42	0.50	0.97	0.81%
36	12.08	90	1.09	2.08	1.74%

Table 17: Voltage Drop Analysis for Power Panel

Short Circuit Calculations Procedure

The short Circuit current at the main secondary feeder (point A) was calculated as follows.

Base kVA=225
Voltage(line to line)= 480V

$I_s = \frac{225}{\sqrt{3} * .48} = 270.6329 \text{ A}$
$Z_{\text{utility}} = 0$ (Conservative Assumption)
$Z_{\text{transformer}} = 5.75\ \%$
$I_T = \frac{1.0}{.0575} = 17.3913\ P.U.$
$I_T = 17.3913 \times 271\ A = 4706.6598\ A$
$I_{\text{motor}} = 4 \times 271\ A = 1082.53\ A$
$I_{\text{sc},A} = 5789.1916\ A_{\text{sym}}$

This was used as the basis to calculate the short circuit current at each of the subfeeders. The available fault current at B is calculated below as an example.

$I_{\text{sc},A} = 5789.1916\ A_{\text{sym}}$
$I_{\text{sc},A} = \frac{5789.1916}{271} = 21.3955\ P.U.$
$Z_{\text{sys}} = \frac{1}{21.3955} = .0467$
Assume $x_{\frac{\text{system}}{R_{\text{system}}}} = 4 \rightarrow \theta = 76$
$R_{\text{sys}} = Z_{\text{sys}} * \cos(76) = .01298\ P.U.$
$X_{\text{sys}} = Z_{\text{sys}} * \sin(76) = .0453\ P.U.$

Per unit resistance of feeder,

$R_{\text{ac}} = .1\ \Omega / 1000 \text{ ft}$
$X_{\text{ac}} = .054\ \Omega / 1000 \text{ ft}$

Base Impeadence = $\frac{277}{271} = 1.022\ \Omega$

$R_F = \frac{.002}{1.022} = .00196\ P.U.$
$X_F = \frac{.00108}{1.022} = .00106 \text{ P.U.}$
$Z_{\text{total}} = \left(R_F + R_{\text{sys}}\right) + j\left(X_F + X_{\text{Sys}}\right) = .0485\ P.U.$
$I_{\text{sc},B} = \frac{1.0}{.0485} = 20.645\ P.U.$
$I_{\text{sc},B} = 20.645 * I_{\text{ref}} = 5594\ A_{\text{sym}}$

The available short circuit current at the remaining feeders was determined in same manner shown above. The results of thses calculations are shown in the following table.

Point A	
Base kVA	225
Voltage (Line to Line)	480
Rated Secondary Current	270.63294
$Z_{utility}$ (P.U)	0
Z_{trans}	5.75%
Z_{ut}	5.75%
I_{trans} (P.U.)	17.391304
I_{trans} (Amps)	4706.6598
I_{motor}	1082.5318
I_{SC}	**5789.1916**

Table 18: Short Circuit Calculations at A

	Point B	Point C	Point D	Point E	Point F	Point G
PreviousI_{SC}	5789	5712	5712	5712	5484	1132
Rated Current (A)	270.6	270.6	270.6	270.6	83.3	83.3
Zreference	1.02353	1.02353	1.02353	1.02353	1.4	1.4
Previous Rated Current (PU)	21.39	21.10	21.10	21.10	65.85	13.60
Transformer Z(pu)	0	0	0	0	0.0575	0
Zs	0.0467	0.0474	0.0474	0.0474	N/A	0.0735
Rs	0.0113	0.0115	0.0115	0.0115	N/A	0.0178
Xs	0.0454	0.0460	0.0460	0.0460	N/A	0.0713
Rl	0.063	0.49	0.1	0.49	0	0.78
Xl	0.051	0.064	0.054	0.064	0	0.065
Length	10	20	10	10	0	30
RF(ohms)	0.00063	0.0098	0.001	0.0049	0	0.0234
XF(ohms)	0.00051	0.00128	0.00054	0.00064	0	0.00195
RF(pu)	0.000616	0.009575	0.000977	0.004787	0	0.016238
XF(pu)	0.000498	0.001251	0.000528	0.000625	0	0.001353
Rtotal(pu)	0.0119	0.0210	0.0124	0.0163	0.037307018	0.0340
Xtotal (pu)	0.0459	0.0472	0.0465	0.0466	0.063362054	0.0733
Ztotal (pu)	0.0474	0.0517	0.0481	0.0494	0.0735	0.0808
Isc (PU)	21.10	19.34	20.77	20.26	13.60	12.37
Isc (A)	**5712**	**5235**	**5622**	**5484**	**1132**	**1030**

Table 19: Short Circuit Calculations at points B-G.

The wire sizes were selected based on ampacity, short circuit current and voltage drop. Wires were selected to provide a voltage drop no greater than 3% for branch circuits and 2 % for feeders. All wires are copper with THW insulation, and based on an ampacitiy of 75 C. The final wire selections are summarized in Table20, while the sizing criteria are detailed in Table 21. The asymmetrical short circuit current was obtained based on a K factor of 1.3 and a clearing time of 2 cycles. The methodology for the calculations is outlined below.

Demand load calculations

$$Motors\ DL = 1.25 * Largest + 1.0 * Remaining$$

$$Lighting\ DL = 1.25 * Connected\ Load$$

$$Power\ DL = 1.0 * Connected\ Loads$$

Other Calculations

$$I_{CL} = \frac{P_t}{\sqrt{3}\, V_{Line}}$$

$$I_{asym} = K * I_{SC}$$

	Min. Wire Sizes		
	Ampacity[1]	I_{SC}[2]	Voltage Drop[3]
Motor Sub Feeder	2/0 AWG	#6 AWG	Any
Lighting Sub Feeder	#8 AWG	#6 AWG	Any
Power Sub Feeder, Primary	#8AWG	#6 AWG	Any
Power Sub, Secondary	#8 AWG	#8AWG	#12 AWG
Main Secondary	250 MCM	#6 AWG	Any
Lighting Branch Ckts	#10 THW	#10 THW	#10 THW
Power Branch Ckts	#12 THW	Any	#12 THW

Table 20: Summary of the wire sizes selected (highlighted)

1. NFPA 70-87
2. NEC, CSA Type TW75
3. Courtesy of Canada cable. See Voltage Drop Analysis Section.

	Calculations										
	P_T	PF	P_R	P_X	I_{CL}	DL, kVA	Minimum Ampacity, A	Length, ft	10^3 Amp*ft	Isc	Iasym
Motor Sub Feeder	126.26	0.85	107.10	66.87	151.87	126.26	156.30	10	1.52	5622	7308.63
Lighting Sub Feeder	21.352	0.98	20.92	4.25	25.68	26.69	32.10	20	0.51	5235	6805.12
Power Sub Feeder, Primary	45.4275	0.9	40.88	19.80	54.64	27.71375	33.33	10	0.55	5484	7128.75
Power Sub, Secondary	45.4275	0.9	40.88	19.80	126.09	27.71375	76.93	30	3.78	1132	1472.24
Main Secondary	193.04	0.87	168.91	90.92	232.19	208.38	250.64	5.00	1.16	5789.16	7525.91

Table 21: Ampacity Calculations Summary

References

1. Krarti, Moncef. "AREN 4570 - Electrical Systems for Buildings." *AREN 4570 - Electrical Systems for Buildings*. N.p., n.d. Web. 31 Mar. 2013.
2. Earley, Mark W., Jeffrey S. Sargent, Christopher D. Coache, and Richard J. Roux. *National Electrical Code. Handbook*. Quincy, MA: National Fire Protection Association, 2011. Print.
3. Hughes, S. David. *Electrical Systems in Buildings*. Boston: Delmar Pub., 1988. Print.

Legend and Schedule

Lighting Schedule

Drawing Symbol	Description	Model #	Manufacturer	Wattage	Voltage	Quantity	Notes
	Exterior Wall Lighting	697-WP-MH/1/100-277V-BK-C	Shaper	100	277	10	Exterior Lighting near entrances
	Troffers	2-VRM-S-2-54T5-PA375-277-LE0C8-GL	ISO	122	277	96	All Troffers per floor are wired together and go to a single fuse on the second floor
	Down Lights	PD8H142-E-82H-1G-C-HB128APK	Halo	45	277	113	Downlights for private offices/ conference rooms and hallways.
	Emergency Down Lights	PD8H142-REM-82H-1G-C-HB128APK	Halo	45	277	113	Emergency Down lights must include battery backup.
	Exit Signs	ECHX-2-ST-AR-WH	Sure-Lites	4.50	277	15	Exit Signs Should be ordered with the arrows facing the proper direction.
	Occupancy Sensors	VAC-DT-2000-R	Greengate	.75	277	32	Occupancy Sensors in nearly all spaces help improve energy consumption.

Motor Schedule

Drawing Symbol	Motor #	Description	Manufacturer	HP	# of Motors	PF	Efficiency	Control	Notes
	M1	AHU Supply Fan	Moncef Motors	25	1	0.9	0.92	RVNR	Located in utility room on 3rd floor
	M2	AHU Return Fan	Moncef Motors	15	1	0.9	0.92	RVNR	Located in utility room on 3rd floor
	M3	CHW Pump	Moncef Motors	20	1	0.9	0.92	RVNR	Located in utility room on 2nd floor
	M4	Elevator	Moncef Motors	20	1	0.9	0.9	RVR	Located below elevator on1st floor
	M5	AHU Exhaust	Moncef Motors	10	1	0.9	0.92	RVNR	Located in utility room on 3rd floor
	M6	HW Pump	Moncef Motors	10	1	0.9	0.92	RVNR	Located in utility room on 2nd floor
	M7-M12	Exhaust Fans (6 Restrooms)	Moncef Motors	1	6	0.85	0.95	FVNR	Located in bathrooms on each floor
	M13	Chiller	Carrier	30	1	0.90	0.9	RVNR	Located in utility room on 2nd floor

Legend

Symbol	Description
	Troffers
	Occupancy Sensor
	8" Down Light
	8" Emergency Down Light
	Circuit Breaker
	Switch
	Over Current Protection
	Fuse
	Motor Controller
	Transformer
	Lighting Panel Board
	Power Panel Board
	Toilet
	Urinal
	Light Switch
	Wall Outlet
	Bathroom Fan
	AHU Fan
	Water Pump
	Chiller
	Door
GFCI	Ground Fault Circuit Interrupter
	Exit Sign
	Wiring
	Sink
	Home Run
	Motor Control Center
	Boiler
	Grounding
	Exterior Wall Lighting

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Legend/Schedules

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E0

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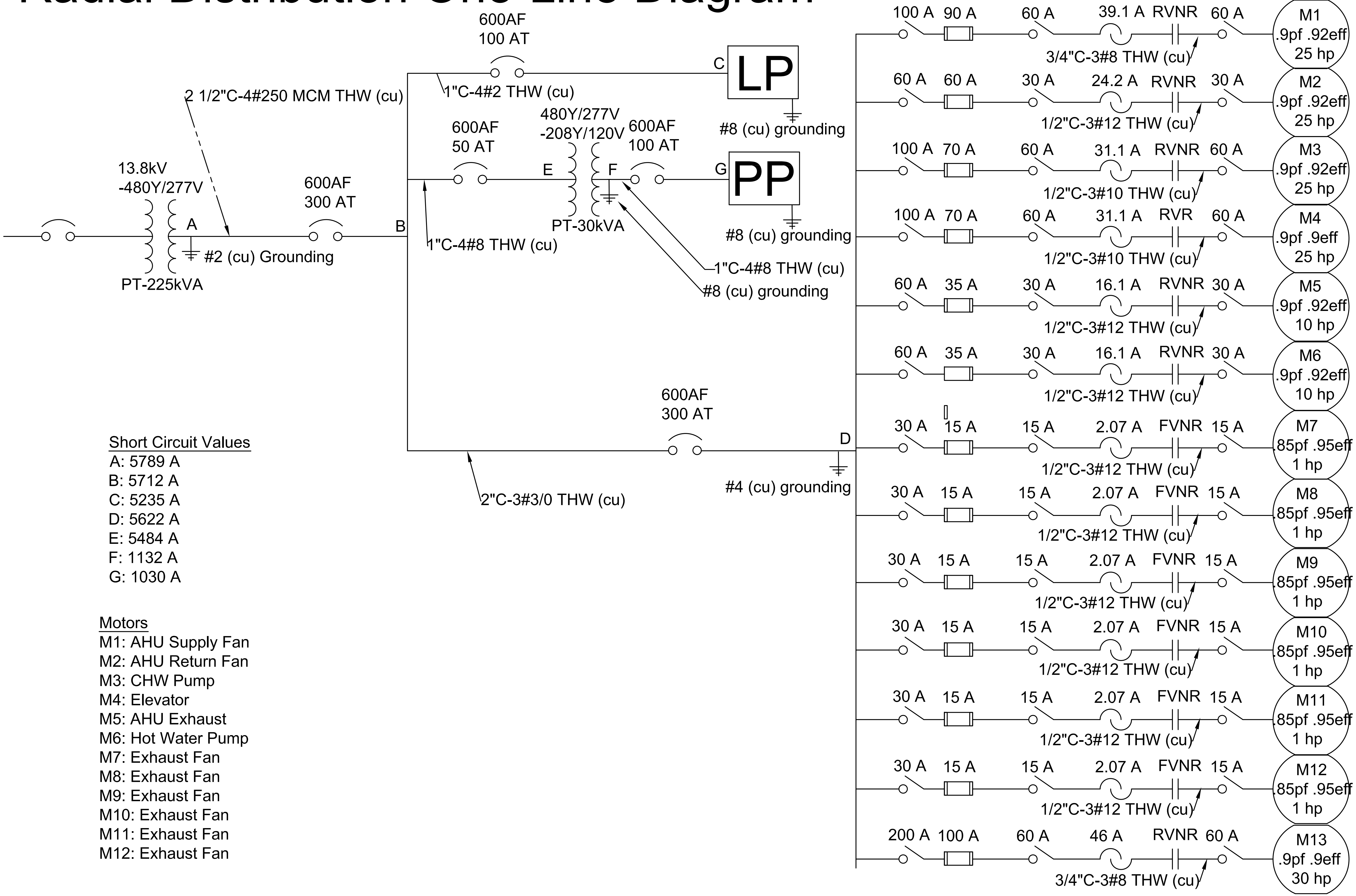
Radial Distribution One-Line Diagram



Short Circuit Values
A: 5789 A
B: 5712 A
C: 5235 A
D: 5622 A
E: 5484 A
F: 1132 A
G: 1030 A

Motors
M1: AHU Supply Fan
M2: AHU Return Fan
M3: CHW Pump
M4: Elevator
M5: AHU Exhaust
M6: Hot Water Pump
M7: Exhaust Fan
M8: Exhaust Fan
M9: Exhaust Fan
M10: Exhaust Fan
M11: Exhaust Fan
M12: Exhaust Fan

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Radial Distribution One Line Diagram

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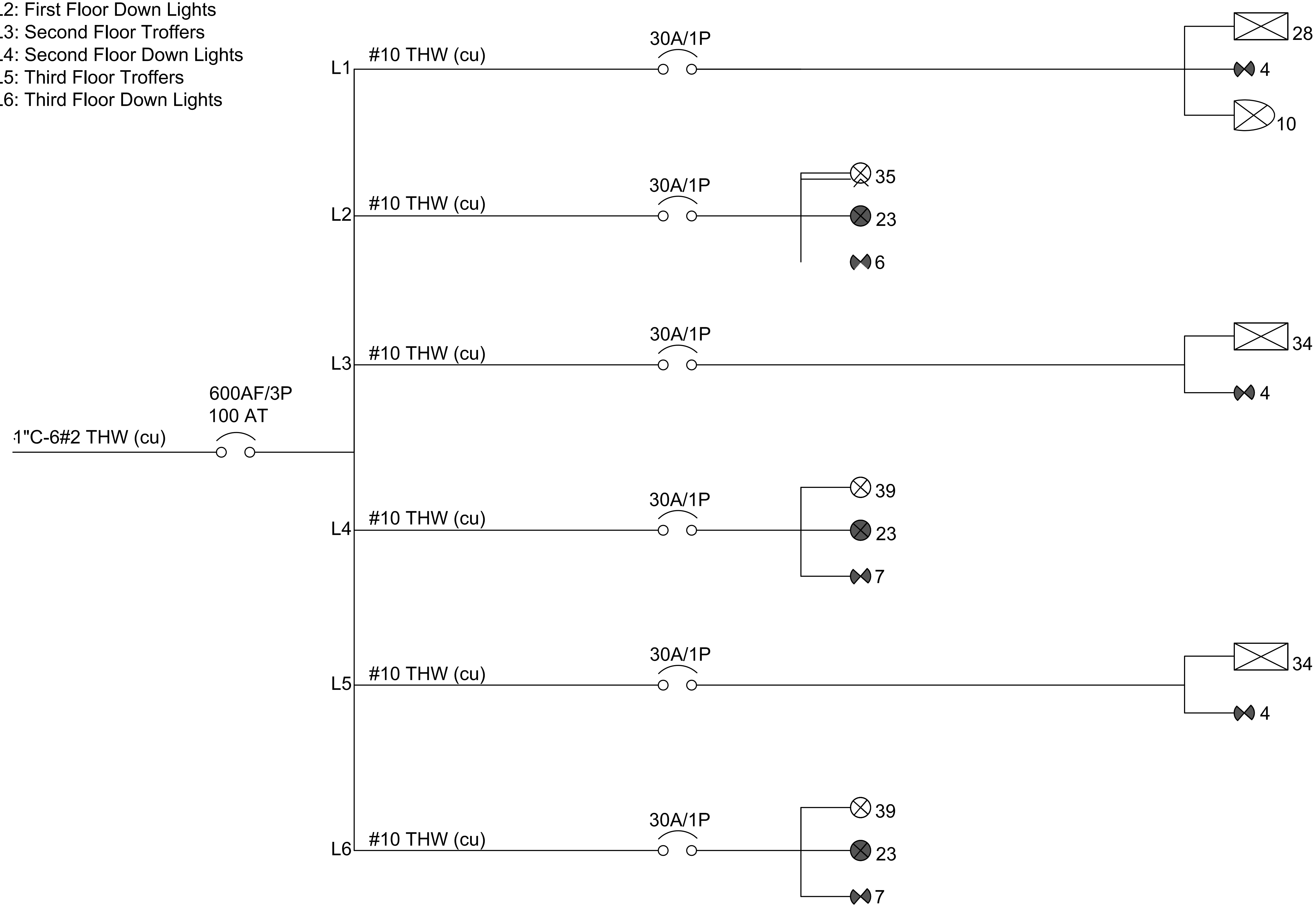
E1.1

Lighting Panel One-Line Diagram

Branch Descriptions
L1: First Floor Troffers
L2: First Floor Down Lights
L3: Second Floor Troffers
L4: Second Floor Down Lights
L5: Third Floor Troffers
L6: Third Floor Down Lights



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Lighting Panel One-Line Diagram

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E1.2

Power Panel One-Line Diagram

Branch Descriptions First Floor

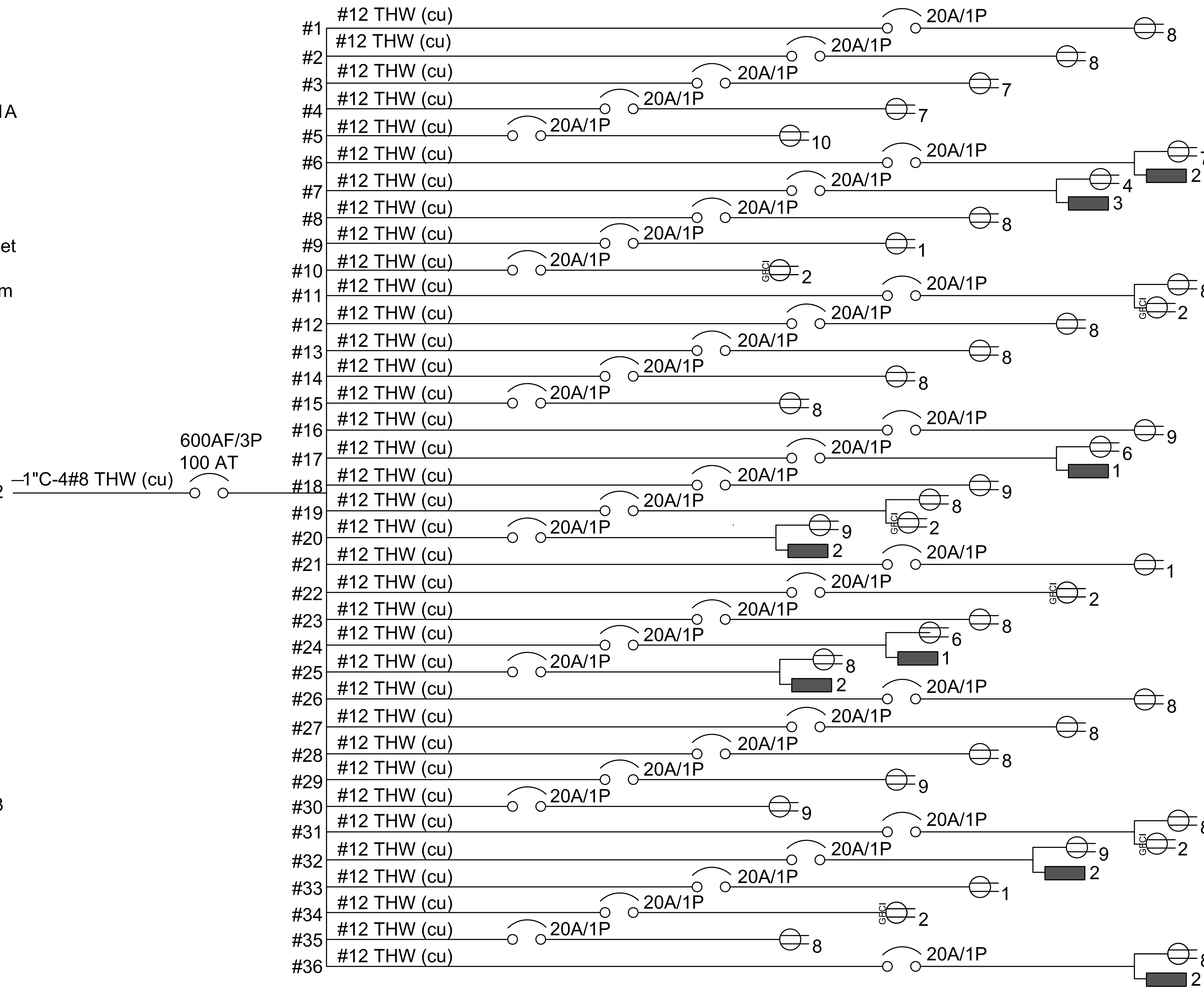
#1 Conference Room 1A
#2 Conference Room 1B
#3 Open Office Area 1A
#4 Open Office Area 1A / Hallway 1A
#5 Hallway 1A / Lobby
#6 Hallway 1B / Lobby
#7 Hallway 1C / Lobby
#8 Cafeteria
#9 Refrigerator 1
#10 Cafeteria Small Appliance Outlet
#11Restrooms 1 / Storage Room 1
#12 Mechanical and Electrical Room

Second Floor

#13 Conference Room 2
#14 Private Office 2A
#15 Private Office 2B
#16 Open Office 2
#17 Stairwell B
#18 Private Office 2D
#19 Restrooms 2 / Storage Room 2
#20 Private Office 2C
#21 Refrigerator 2
#22 Small Appliance Second Floor
#23 Utility Room 2
#24 Stairwell A
#25 Hallway 2A

Third Floor

#26 Conference Room 3
#27 Private Office 3A
#28 Private Office 3B
#29 Open Office 3
#30 Private Office 3D
#31 Restrooms 3 / Storage Room 3
#32 Private Office 3C
#33 Refrigerator 3
#34 Small Appliance Third Floor
#35 Utility Room 3
#36 Hallway 3A



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Power Panel One-Line Diagram

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E1.3

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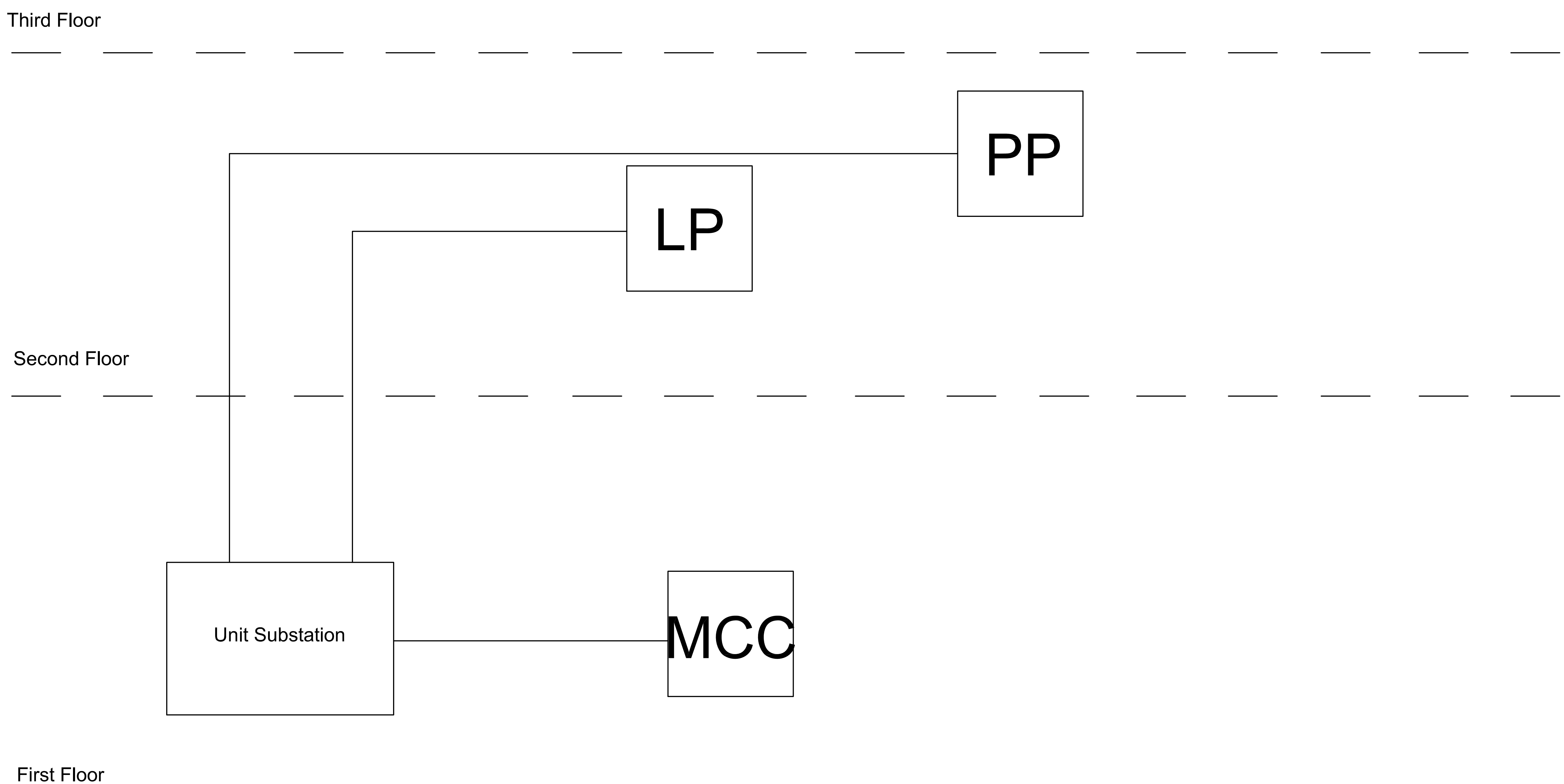
Riser Diagram



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Riser Diagram

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E2

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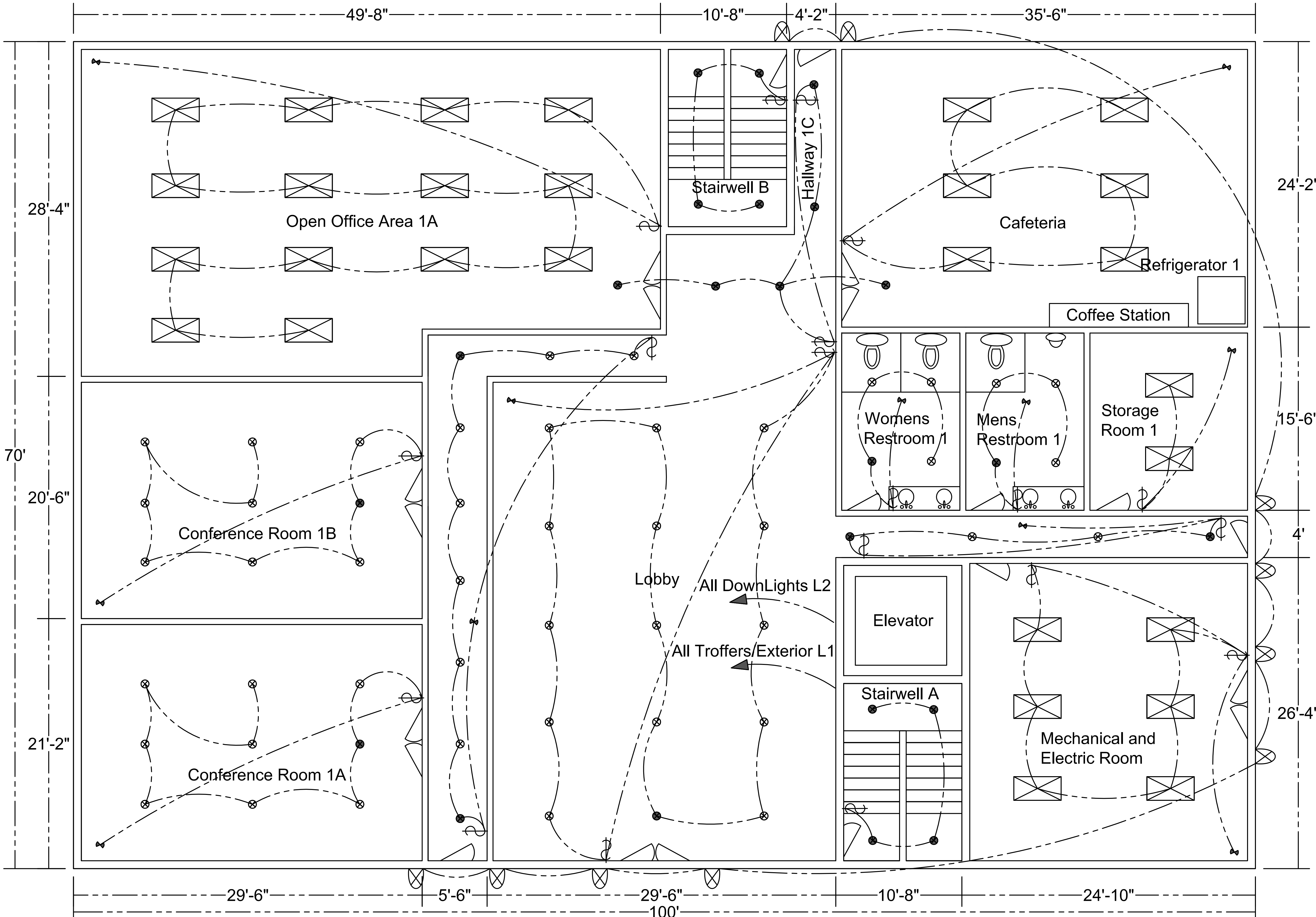
First Floor Lighting Layout



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First Floor Lighting Layout

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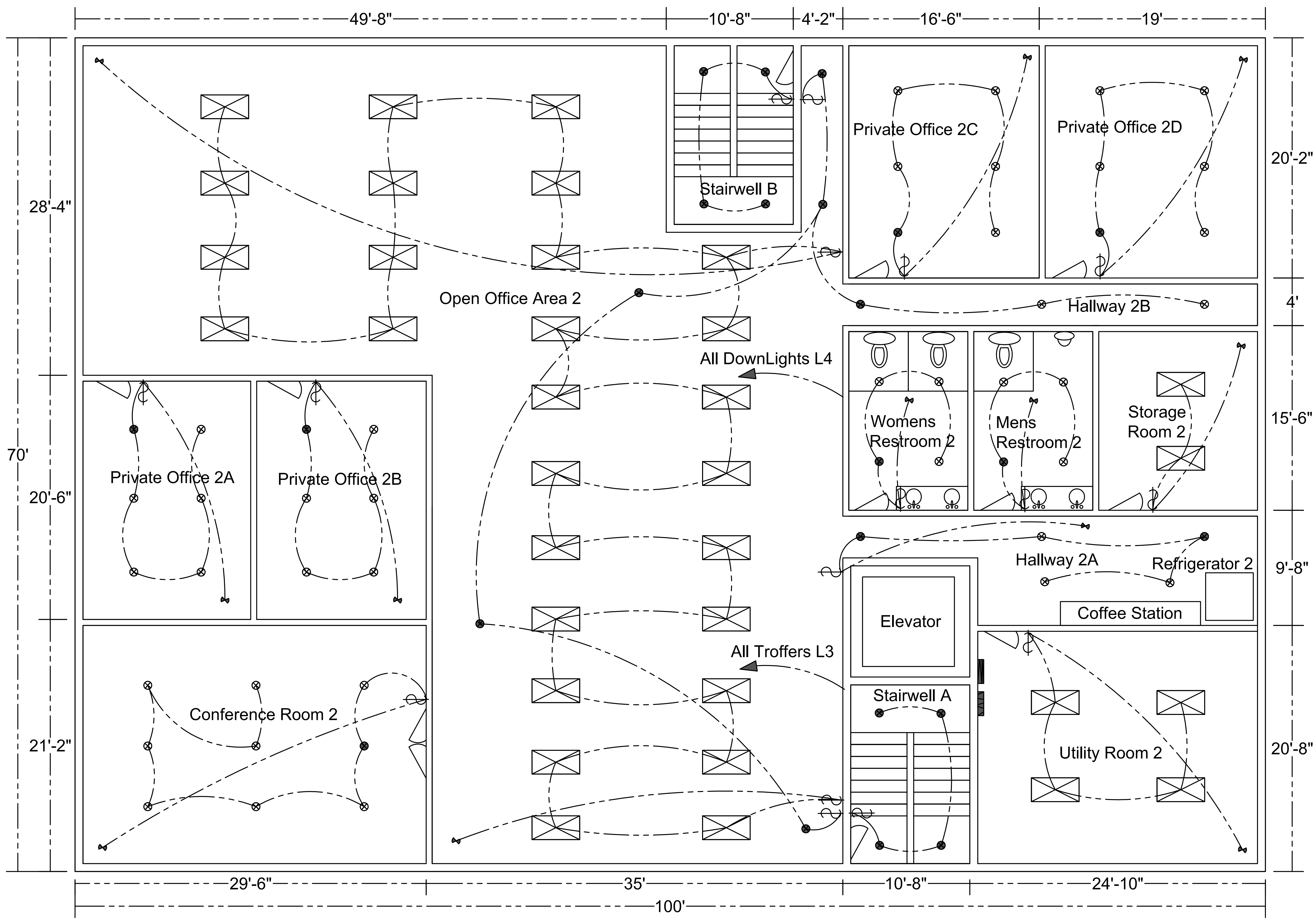
Second Floor Lighting Layout



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Second Floor Lighting Layout

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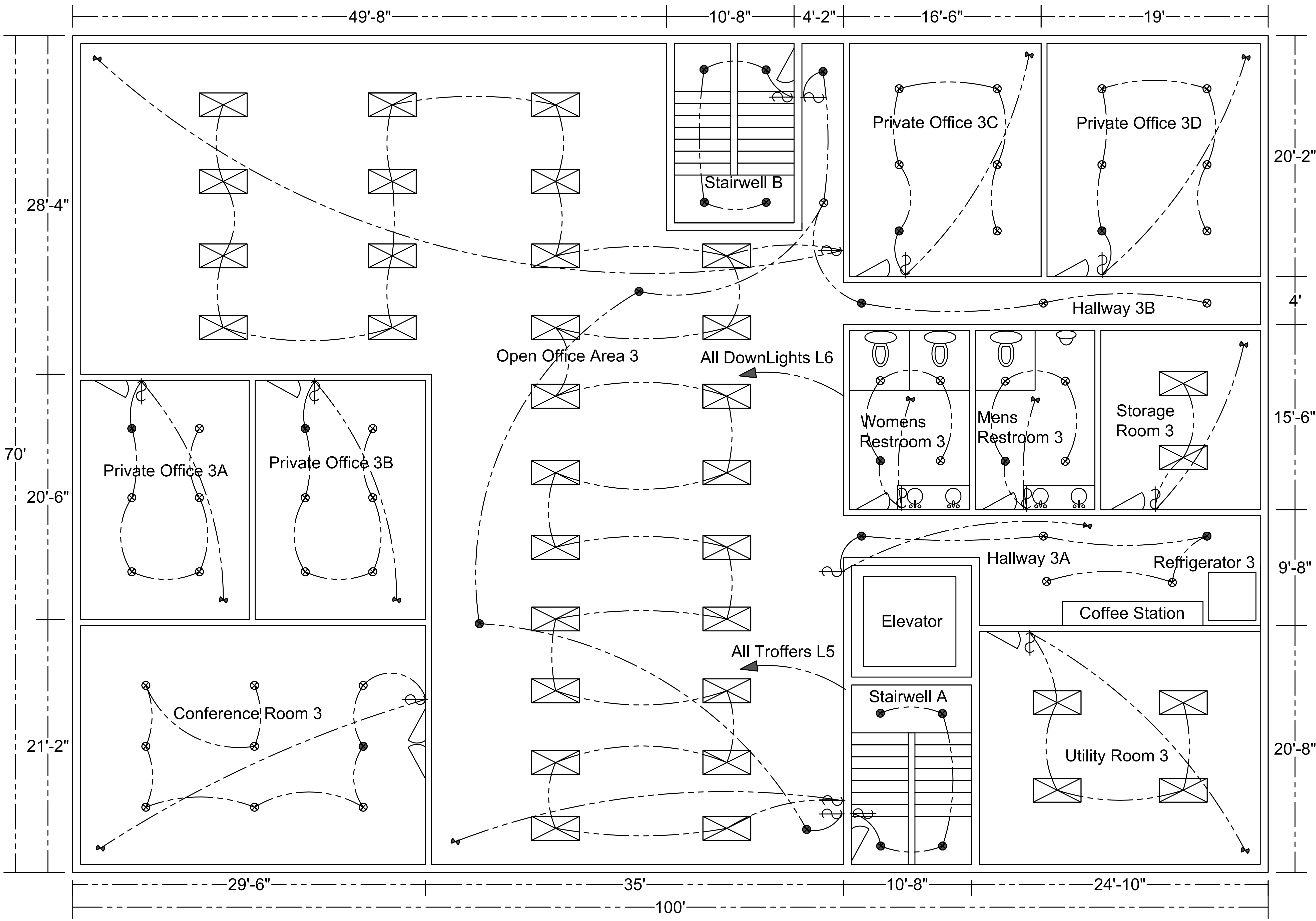
E3.2

Third Floor Lighting Layout



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Third Floor Lighting Layout

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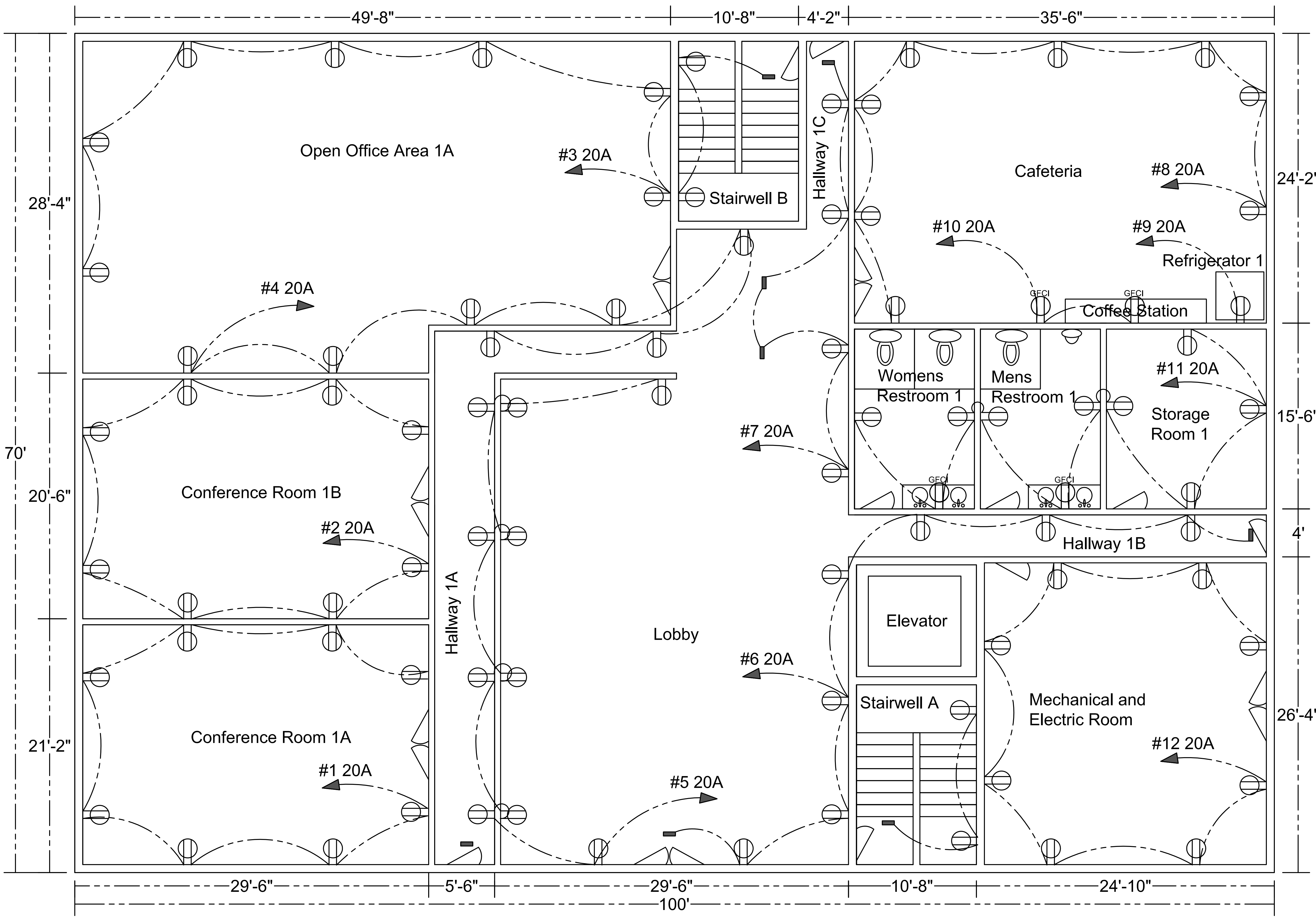
SHT NO. 8 OF 18

E3.3

First Floor Power Receptacle Layout



COLORADO REMODELING ENGINEERS FOR ENVIRONMENTAL KINDNESS
1260 ELDER AVE.
BOULDER, COLORADO 80304
303.533.4822
marcillatravis@yahoo.com

REVISIONS

DATE	REVISION	BY
4/27/2013	None	T,J,M

DRAWN BY: Travis, Janay, and Matt.

PROJECT NUMBER 3

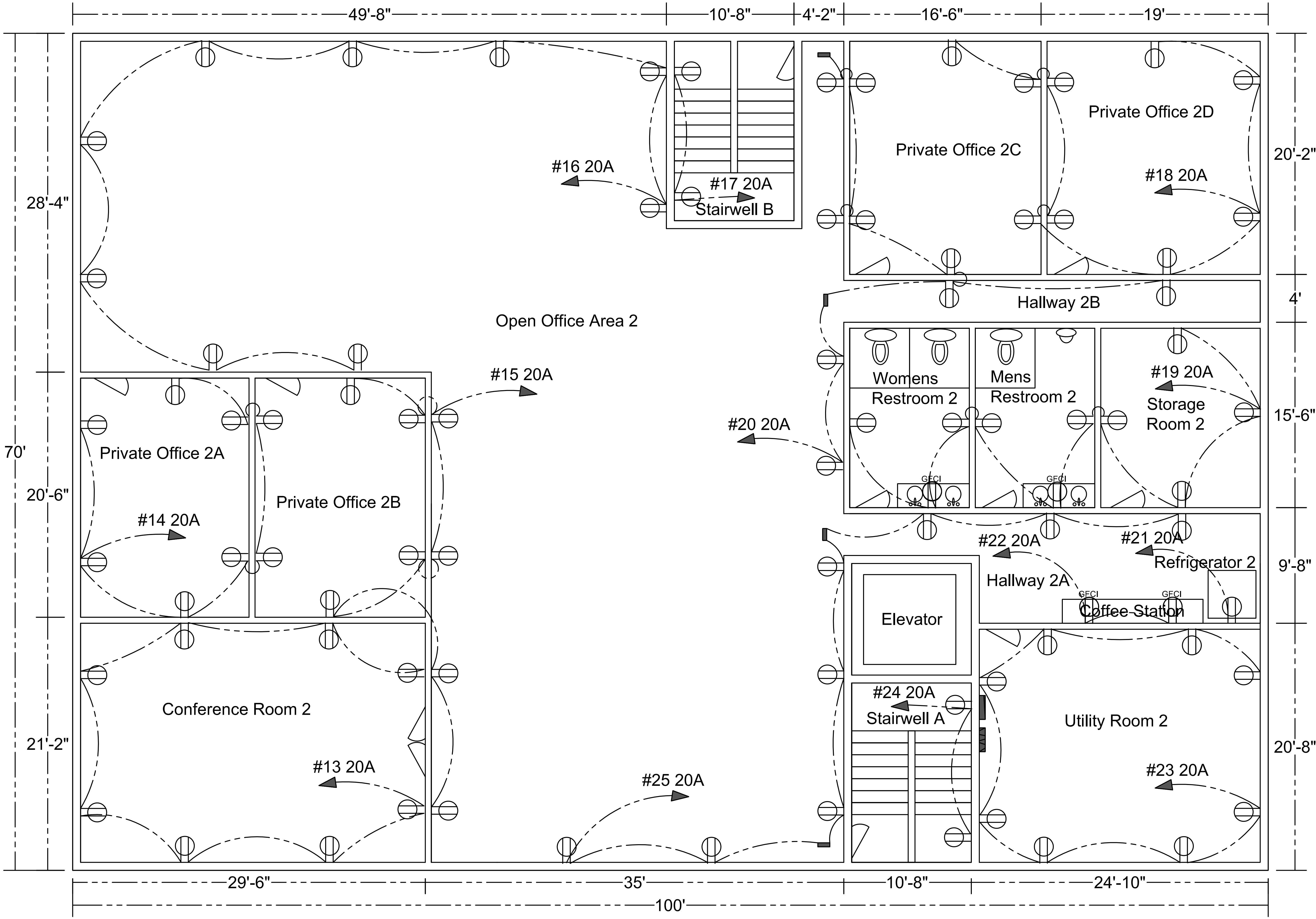
First Floor Power Receptacle Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 9 OF 18

E4.1

Second Floor Power Receptacle Layout



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REVISIONS		
DATE	REVISION	BY
2/27/2013	None	T,J,M

DRAWN BY: Travis, Janay, and Matt.

PROJECT NUMBER 3

Second Floor Power Receptacle Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 10 OF 18

E4.2

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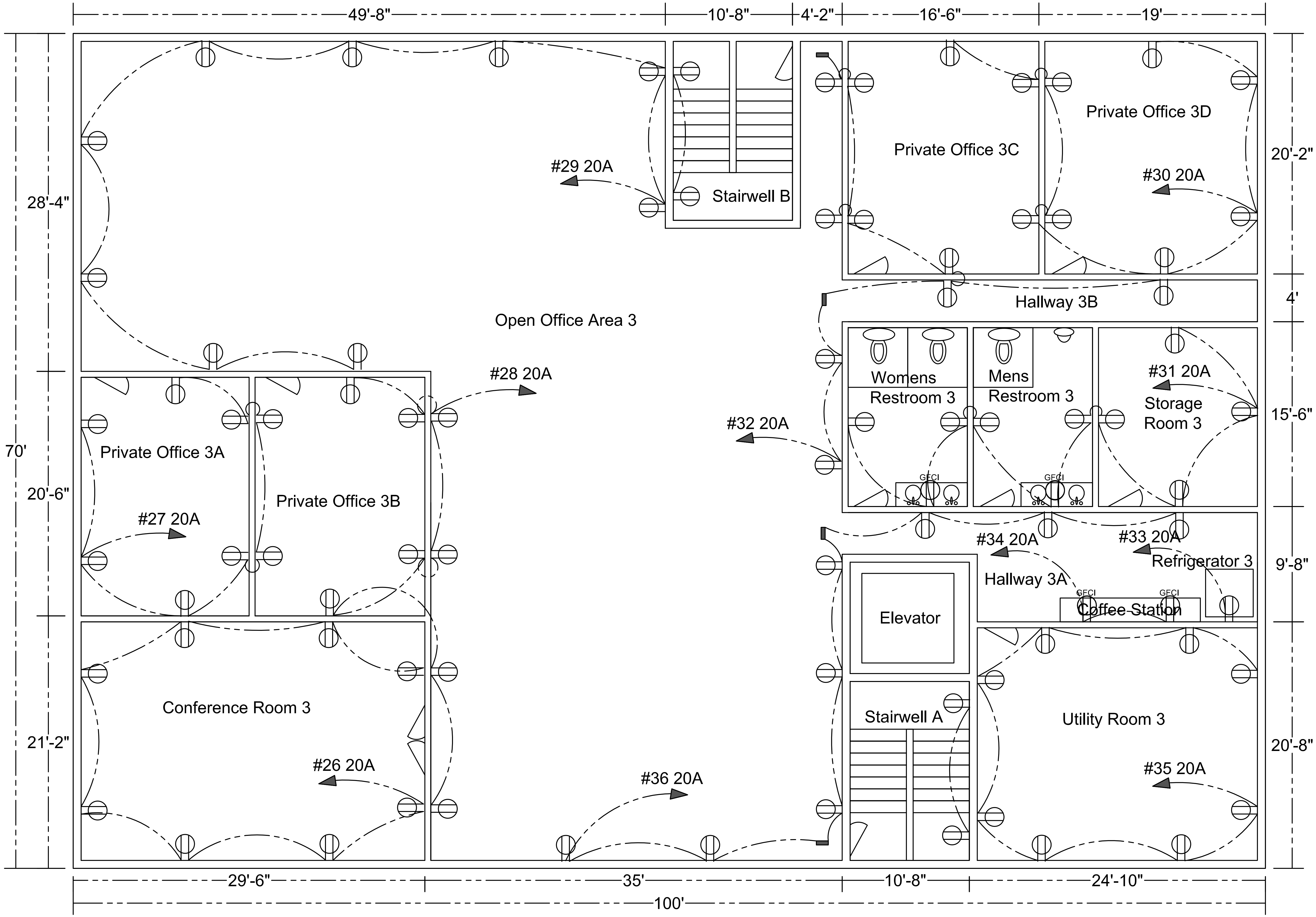
Third Floor Power Receptacle Layout



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DATE	REVISION	BY
4/27/2013	None	T,J,M

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PROJECT NUMBER 3

Third Floor Power Receptacle Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 11 OF 18

E4.3

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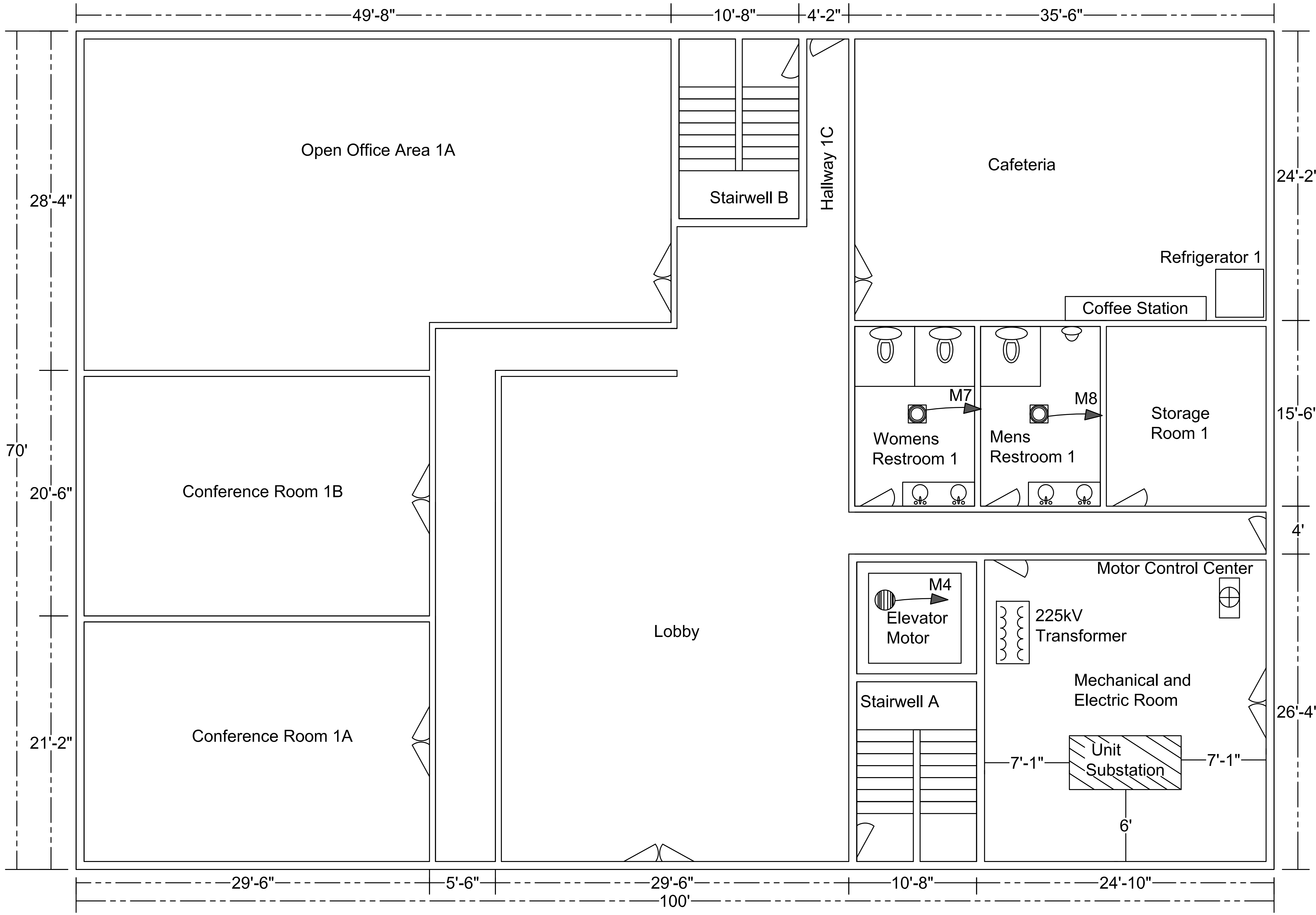
First Floor Motor / Electrical Equipment Layout



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CREEK

REVISIONS		
DATE	REVISION	BY
4/27/2013	None	T.J.M

DRAWN BY: Travis, Janay, and Matt.

PROJECT NUMBER 3

First Floor Motor/Electrical Equipment Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 12 OF 18

E5.1

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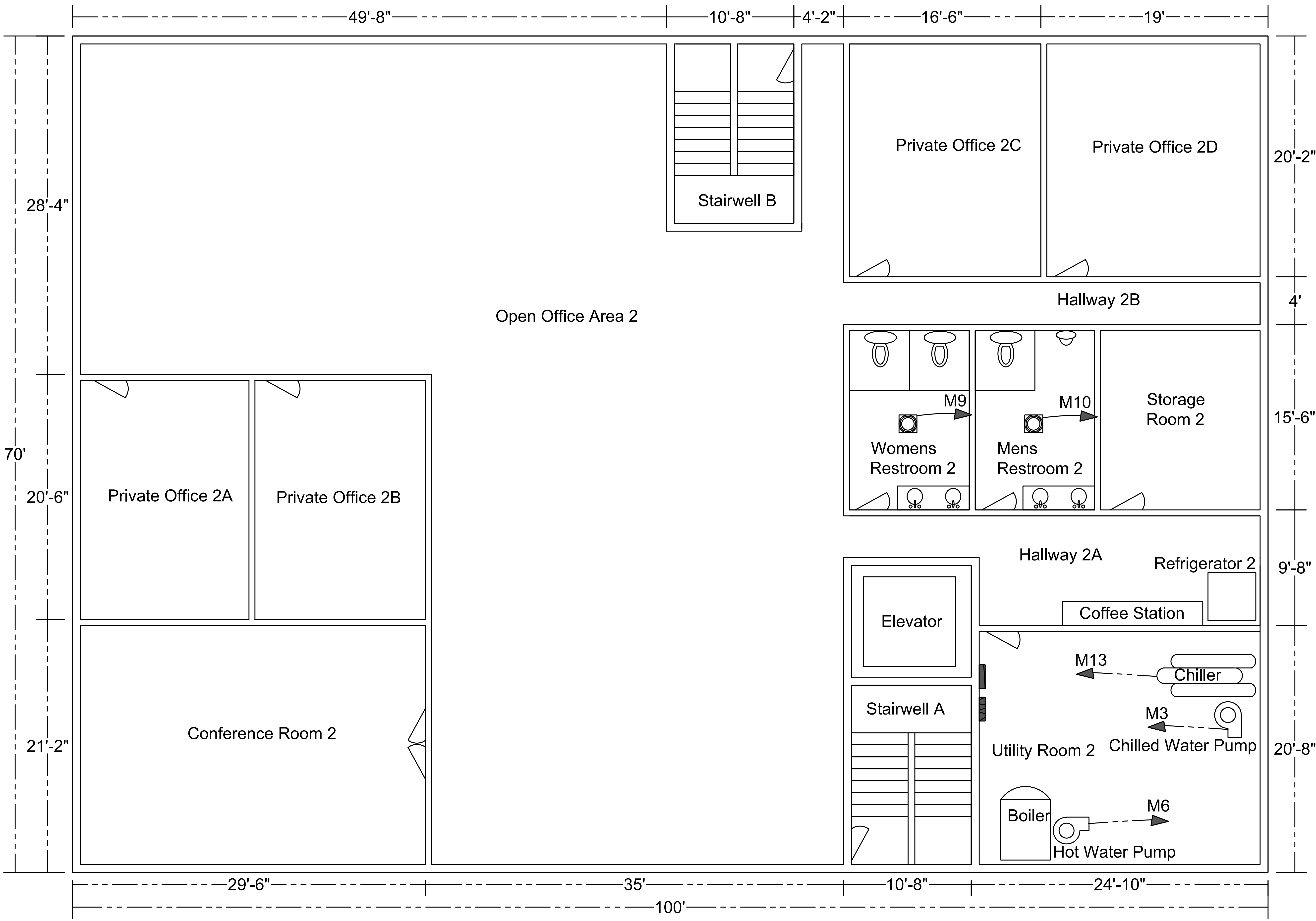
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

Second Floor Motor / Electrical Equipment Layout



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PROJECT NUMBER 3

DRAWN BY: Travis, Janay, and Matt.

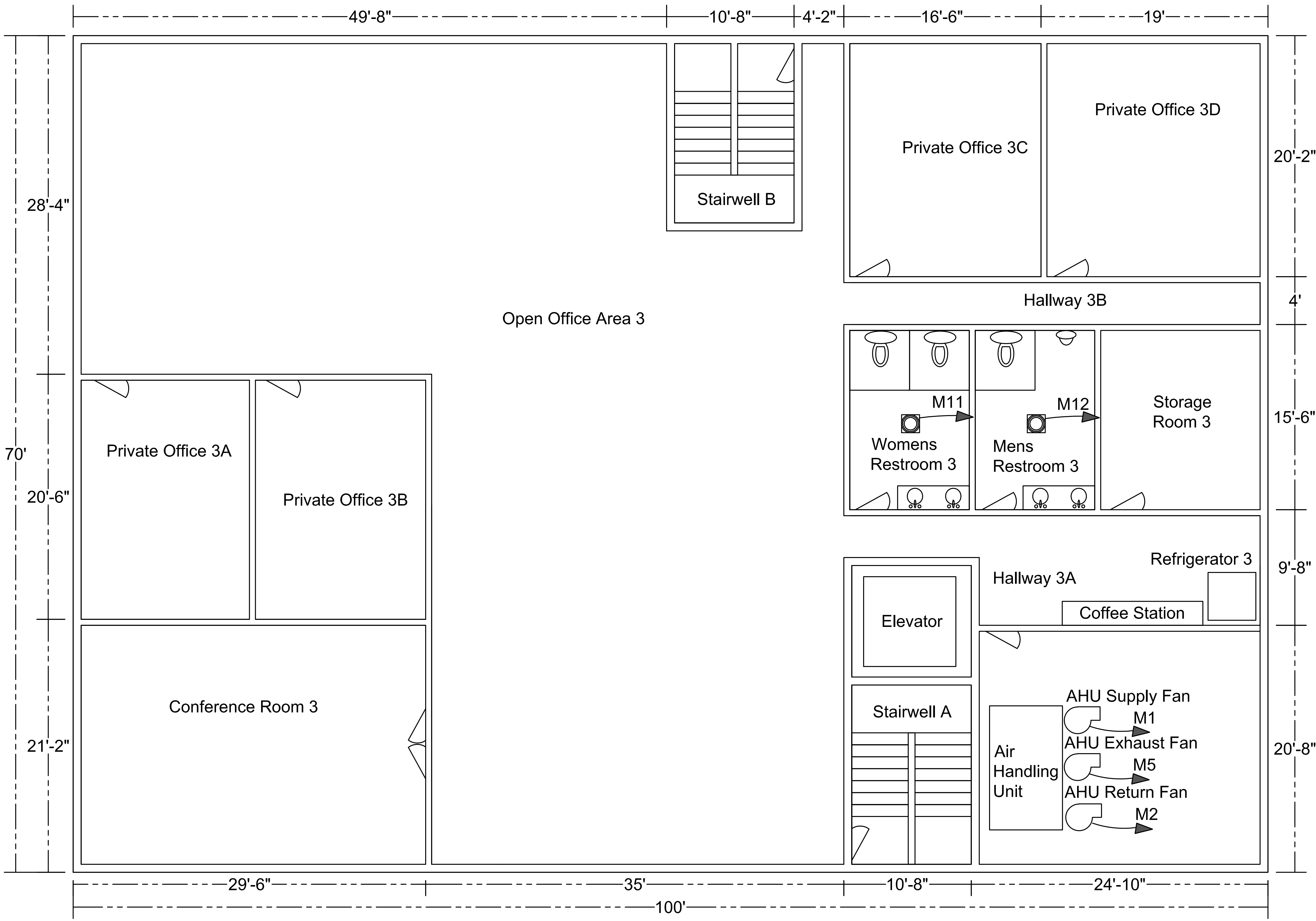
Second Floor Motor/Electrical Equipment Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 13 OF 18

E5.2

Third Floor Motor / Electrical Equipment Layout



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DRAWN BY: Travis, Janay, and Matt.

PROJECT NUMBER 3

Third Floor Motor/Electrical Equipment Layout

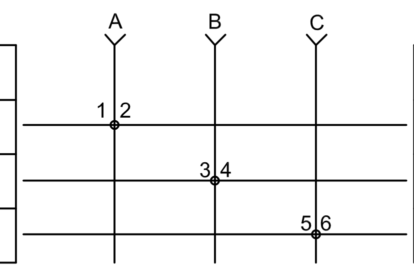
Office Building
1234 Downtown
Right Downtown

SHT NO. 14 OF 18

E5.3

Lighting Panel Schedule

LOAD DESCRIPTION	A (Amps)	B (Amps)	C (Amps)	CB
L1	20.35			30A/1P
L2		12.04		30A/1P
L3			19.11	30A/1P



CB	A (Amps)	B (Amps)	C (Amps)	LOAD DESCRIPTION
30A/1P	12.87			L4
30A/1P		19.11		L5
30A/1P			12.87	L6

LOAD TOTALS (Amps)	
LOAD A, T	33.22
LOAD B, T	31.15
LOAD C, T	31.98

% UNBALANCED	
%AB =	6.63
%BC =	2.60
%CA =	3.71

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PROJECT NUMBER 3

Lighting Panel Schedule

Office Building
1234 Downtown
Right Downtown

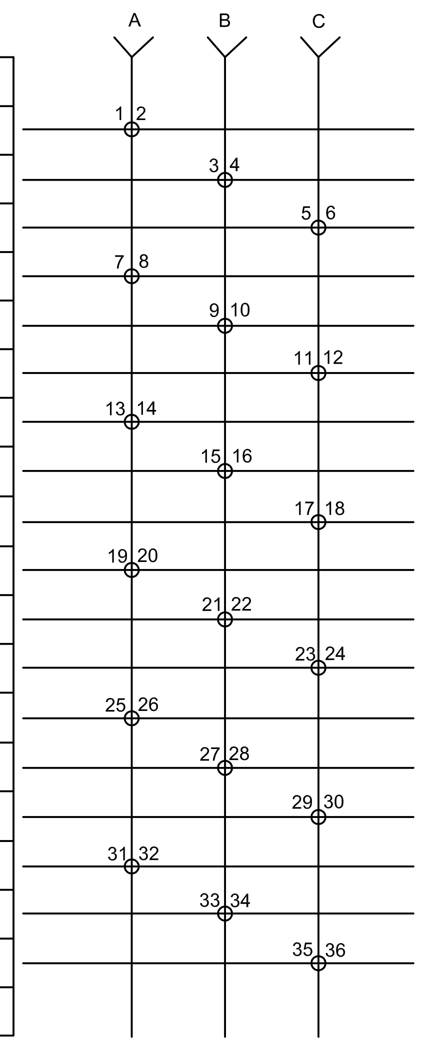
SHT NO. 15 OF 18

E6.1

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

Power Panel Schedule

LOAD DESCRIPTION	A (Amps)	B (Amps)	C (Amps)	CB
#1 Conference Room 1A	12			20A/1P
# Conference Room 1B		12		20A/1P
#8 Cafeteria			12	20A/1P
#12 Mechanical and Electrical Room	12			20A/1P
#13 Conference Room 2		12		20A/1P
#14 Private Office 2A			12	20A/1P
#3 Open Office Area 1 A	10.5			20A/1P
#4 Open Office Area/Hallway 1A		10.5		20A/1P
#6 Hallway 1B/Lobby			10.75	20A/1P
#9 Refrigerator 1	1.5			20A/1P
#21 Refrigerator 2		1.5		20A/1P
#33 Refrigerator 3			1.5	20A/1P
#19 Restrooms 2/Storage Room 2	15			20A/1P
#20 Private Office 2C		13.58		20A/1P
#5 Hallway 1A/Lobby			15	20A/1P
#29 Open Office 3	13.5			20A/1P
#25 Hallway 2A		12.08		20A/1P
#16 Open Office 2			13.5	20A/1P
SUM:	64.5	61.65	64.75	



CB	A (Amps)	B (Amps)	C (Amps)	LOAD DESCRIPTION
20A/1P	12			#15 Private Office 2B
20A/1P		12		#23 Utility Room 2
20A/1P			12	#26 Conference Room 3
20A/1P	12			#27 Private Office 3A
20A/1P		12		#28 Private Office 3B
20A/1P			12	#35 Utility Room 3
20A/1P	9.04			#17 Stairwell B
20A/1P		9.04		#24 Stairwell A
20A/1P			6.11	#7 Hallway 1C/Lobby
20A/1P	3			#10 Cafeteria Small Appliance Outlet
20A/1P		3		#22 Small Appliance Second Floor
20A/1P			3	#34 Small Appliance Third Floor
20A/1P	13.58			#32 Private Office 3C
20A/1P		15		#31 Restrooms 3/Storage Room 3
20A/1P			15	#11 Restrooms 1/Storage Room 1
20A/1P	12.08			#36 Hallway 3A
20A/1P		13.5		#30 Private Office 3D
20A/1P			13.5	#18 Private Office 2D
SUM:	61.69	64.54	61.61	

LOAD TOTALS (Amps)	
LOAD A, T	126.19
LOAD B, T	126.19
LOAD C, T	126.36

% UNBALANCED	
%AB =	0
%BC =	0.14
%CA =	0.14

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DATE	REVISION	BY
4/27/2013	None	T.J.M

DRAWN BY: Travis, Janay, and Matt.

PROJECT NUMBER 3

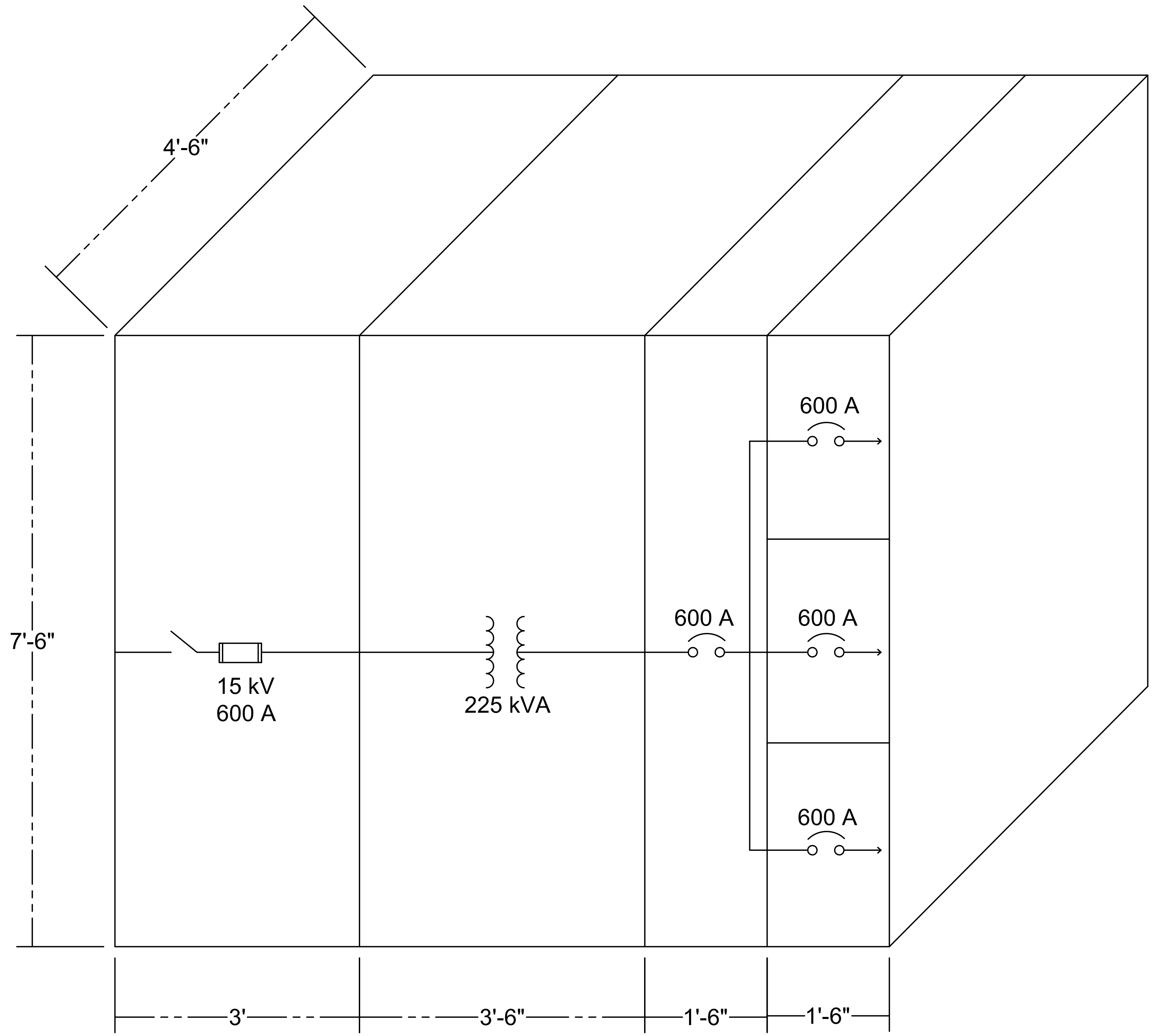
Power Panel Schedule

Office Building
1234 Downtown
Right Downtown

SHT NO. 16 OF 18

E6.2

Unit Substation Layout



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DATE	REVISION	BY
2/27/2013	None	T,J,M

DRAWN BY: Travis, Janay, and Matt.

PROJECT NUMBER 3

Unit Substation Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 17 OF 18

E7

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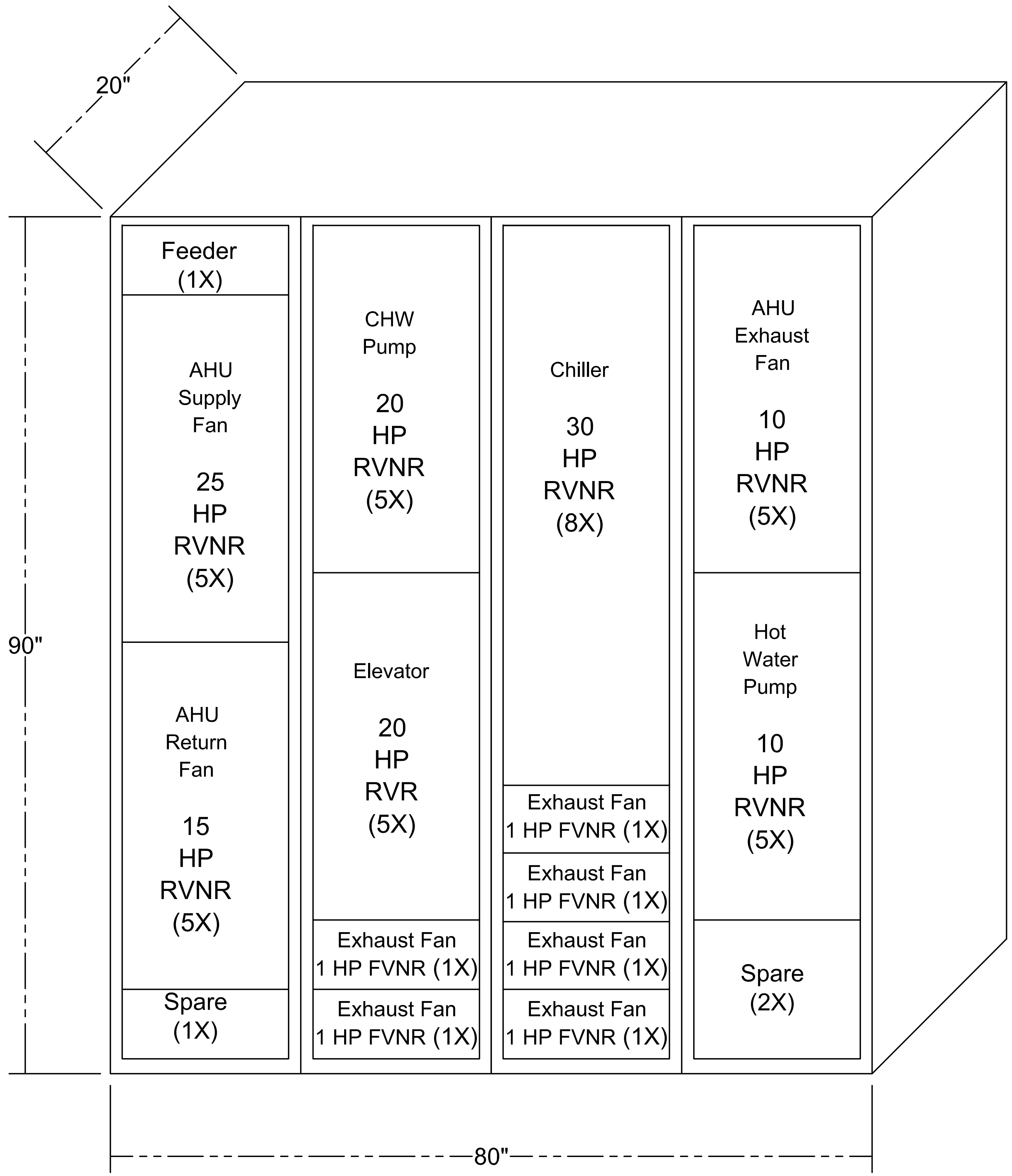
Motor Control Center Layout



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REVISIONS		
DATE	REVISION	BY
2/27/2013	None	T.J.M

PROJECT NUMBER 3

DRAWN BY: Travis, Janay, and Matt.

Motor Control Center Layout

Office Building
1234 Downtown
Right Downtown

SHT NO. 18 OF 18

E8

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
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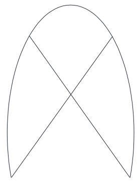
DESCRIPTION

The 697-WP features a compact cast Aluminum Hood Downlight.

Exterior Entrance Lighting



Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Material
Cast aluminum construction with clear tempered refractive glass for MH incandescent or 1/8" white acrylic for incandescent and CFL lamps. Optional clear tempered glass for full cut-off.

Finish
PremiumTGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear.
Standard: Black (BK) or White (WH).
Premium: Aluminum Paint (ALP), Bronze Metallic Paint (BM), Gold Metallic Paint (GM), Dark Platinum Paint (DP), Graphite Metallic Paint (GRM), Grey Paint (GY) or Custom Color (CC).

Optics
Refer to www.shaperlighting.com for complete photometrics.

Ballast
Integral electronic HPF, multi-volt 120/277V (347V Canada), thermally protected with end-of-life circuitry to accommodate the specified lamp wattage. Metal halide ballasts are electronic HPF, multi-volt 120/277V for the specified lamp wattage. 347V ballasts for metal halide - Contact factory.

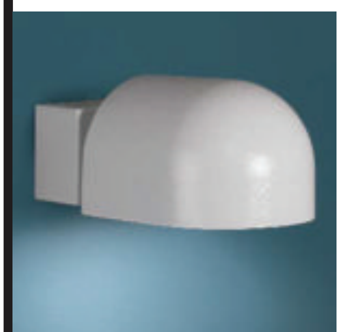
Lamp
One (1) 26W, 32W (GX24q-3) or 42W (GX24q-4) 4-pin triple tube CFL lamp or one (1) 50W, 70W or 100W ED-17 metal halide lamp or one (1) 100W A-19 lamp.
CFL socket injection molded plastic. INC socket fired ceramic rated for 660W-250V. Metal halide socket ceramic pulse-rated, 4KV.
Lamps furnished by others.

Installation
Supplied with a mounting back for a standard 4" J-box or stucco ring. Optional rear (through wall) feed conduit mounting.

Options
Rear (through wall) Feed Conduit Mounting (C), ClearTempered Glass Lense - for full cut-off Quartz (TGL) [Dark Sky Compliant], Restrike (MH only) (QR).

Labels
U.L. and C.U.L. listed for wet location.

Modifications
Shaper's skilled craftspeople with their depth of experience offer the designer the flexibility to modify standard exterior wall luminaires for project specific solutions. Contact the factory regarding scale options, unique finishes, mounting, additional materials/colors, or decorative detailing.



697-WP SERIES

Exterior Wall Luminaire
Hood Downlight

ARRA
Shaper Lighting certifies that its products satisfy the requirements of Section 1605 of the American Recovery and Reinvestment Act (also known as the ARRA Buy American provision).

DARK SKY
Shaper offers a selection of exterior luminaires that are "Dark Sky Compliant". The IESNA (Illuminating Engineering Society of North America) defines Full Cut-Off as fixtures with light distributions of 0% candela at 90 ° and 10% at 80 °. Full Cut-Off lumina ires carry the endorsement of the International Dark-Sky Association (IDA) for their effectiveness in limiting the detrimental effects of sky glow, also referred to as "Light Pollution". Many exterior luminaires offer a clear, tempered glass option that meets the IES criteria for Full Cut-Off.

FAIL-SAFE

DESCRIPTION

The VRM combines a low-profile, surface modular design with the latest in energy-efficient technology.The dihedral recessed top design allows for cooler fixture operation. Other features include a die-formed housing, surface or stem mounting (single or continuous row), full seam-welded corners and a broad selection of attractive door frames. The durable, versatile VRM is perfect for use in commerical spaces, schools, hospitals, correctional or industrial facilities and high volume public access areas.

Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Construction
Housing is die-formed, code gauge, prime cold-rolled steel. Smooth sides permit flush joint for continuous row mounting. Full seam-welded corners. Dihedral recessed top design insures cooler ballast operation. Die-formed captive lampholder bracket fully encloses wiring permitting easy lampholder replacement. Ballast covers easily removed without tools.

Finish
Painted after fabrication. Electrostatically-applied baked white polyester powder enamel finish. Multistage cleaning cycle, iron phosphate coating with rust inhibitor. Conveyorized application and baking timing accurately controlled at an elevated temperature.

Hinging/Latching
Positive cam action steel latches with baked white enamel finish. Safety lockT-hinges allow hinging and latching either side.

Frame/Shielding
Die-formed, heavy gauge, flat steel door with reinforced mitered corners and baked white enamel finish. Positive light seals. Frame and lens are secured to housing with 4 or 6T20 stainless steel TORX ® screws.

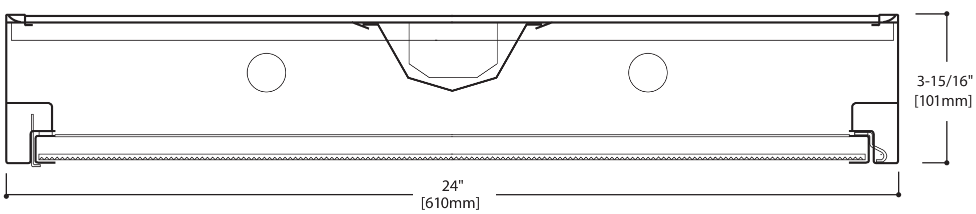
Electrical*
Ballasts are CBM/ETL Class "P" and are positively secured by mounting bolts. Pressure lock lampholders.

Labels
UL/cUL listed for damp locations.

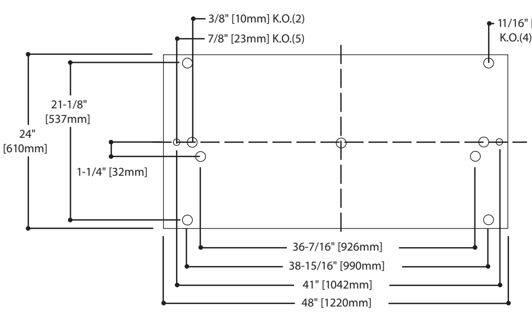
2VRM

2x4
Vandal Resistant

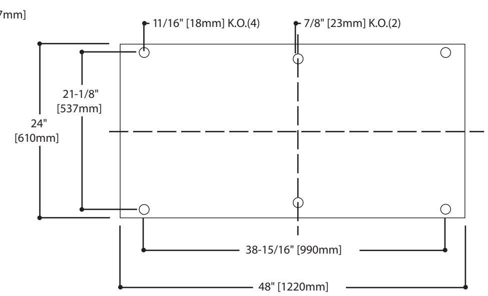
SURFACE
Lens Troffer



MOUNTING DATA



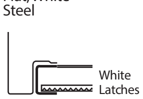
2 Lamp Configuration



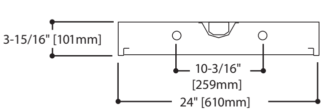
3 Lamp Configuration

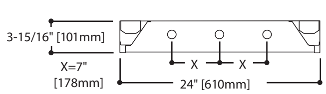
DOOR FRAMES

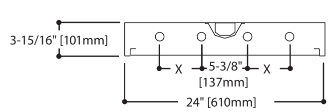
2VRM
Flat, White
Steel



LAMP CONFIGURATIONS







ENERGY DATA

Input Watts:
EB Ballast & STD Lamps
232 (61)
432 (122)

ES Ballast & STD Lamps
232 (71)
432 (142)

Luminaire Efficacy Rating
LER = FL-71
Catalog Number:
Yearly Cost of 1000 lumens:
3000 hrs at .08 KWH = $3.38

* Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

COOPER Lighting
www.cooperlighting.com

ORDERING INFORMATION

SAMPLE NUMBER: VRM-432A

Width	Series	Door Type	No. of Lamps	Wattage (Length)	Lens Type	Voltage	Ballast Type	Options (Add as Suffix)	Accessories (Order Separately)
2	VRM								

2 = 2′

VRM

Standard = Flat White Steel Door (Leave Blank)

2, 3 or 4 Lamps (Not included)

28T5 =28W T5 (48″)
32 =32W T8 (48″)
54T5 =54W T5HO (48″)

ACTF140= .140 Thick
ACTF187= .187 Thick
PA375 = .250 polycarbonate with .125 prismatic overlay (standard with 6S option)

120=120V
277=277V
347=347V
UNV=Universal Voltage (120-277V)

LEOC8= Energy Saving Ballast (T8 Lamp only)
EB _ _ = Generic Electronic Ballast
- **No. of Ballasts** 1 or 2
- **Lamp Size** **8** =T8

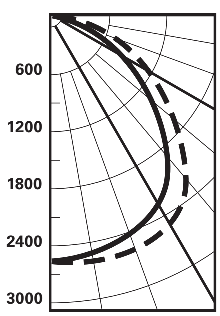
(For specific Electronic Ballast specify Brand and Catalog Number.)

GL= Internal Single Element Fusing
GM= Dual Element Fusing
EL4= Emergency Lighting, self contained
SMB= Side-Mounted Ballast for Stem Applications (Recommended for 4-Point Suspension)
RIF1 = Radio Interference Suppressor
EKO= End Plate with 7/8″ KO (Required for Continuous Row Mounting)
RLS= Rotor-Lock Socket (T8 Lamps only)
6S= Six TORX®-head Screws (3 per side)
SC =Safety Chain

VRSD=T20 Center Pin Tamperproof TORX®-head bit

PHOTOMETRICS

Candlepower Distribution



Test No. M-2071
2VRM-340-ACTF140
Lamp=F40T12/CW
Lumens=3150
Spacing Criteria
⊥=1.4 II=1.2
Efficiency=70.3%

Candlepower

Deg.	⊥	II
0	2659	2659
5	2650	2663
15	2559	2650
25	2373	2587
35	2056	2391
45	1553	1839
55	986	1127
65	541	526
75	253	259
85	105	111
90	0	0

Typical VCP Percentages

Room Size (in Feet)	Height Along II 8'6"	Height Along II 10'0"	Height Across ⊥ 8'6"	Height Across ⊥ 10'0"
20 x 20	68	71	67	70
30 x 30	60	65	60	64
30 x 60	52	56	51	55
60 x 30	62	66	61	66
60 x 60	52	55	51	54

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Luminaire
0-30	2136	22.6	32.2
0-40	3540	37.5	53.3
0-60	5746	61.1	56.9
0-90	6641	70.3	100.0
90-180	0	0.0	0.0
0-180	6641	70.3	100.0

Coefficient of Utilization

rc	80%				70%			50%		30%		10%		0%
rw	70	50	30	10	50	30	10	50	10	50	10	50	10	0
RCR														
0	84	84	84	84	82	82	82	78	78	75	75	72	72	70
1	77	74	71	69	73	70	68	70	66	67	64	64	62	60
2	71	66	61	58	64	60	57	62	56	60	54	58	53	52
3	65	58	53	49	57	52	49	55	48	53	47	52	46	45
4	60	52	47	42	51	46	42	50	41	48	41	47	40	39
5	56	47	41	37	46	41	37	45	36	44	36	42	36	34
6	51	43	37	32	42	36	32	41	32	40	32	39	32	30
7	48	39	33	29	38	33	29	37	29	36	28	35	28	27
8	45	36	30	26	35	30	26	34	26	33	26	32	25	24
9	42	33	27	23	32	27	23	31	23	31	23	30	23	22
10	39	30	25	21	30	25	21	29	21	28	21	28	21	20

rc=Ceiling reflectance, rw=W all reflectance, RCR=Room cavity ratio
CU Data Based on 20% Effective Floor Cavity Reflectance.

DownLighting: Emergency lights Require Batteries

HALO Commercial

Catalog #		Type
Project		
Comments		Date
Prepared by		

DESC RIPTION

Recessed 8 inch aperture lens downlight for one horizontal 26W double twin tube or 26/32/42W triple twin tube compact fluorescent lamp. Fixture is suitable for commercial construction and wet location listed. Insulation must be kept 3" from top and sides of housing. Universal input electronic ballast with dimming and emergency options.

PD8H142 82H

(1) 26W DTT
26/32/42WTTT

Compact Fluorescent

8-Inch Aperture
Lens Downlight

New Construction or
Remodel
Non-IC

SPECIFICATION FEAT UR ES

MEC HANICA L

Frame
Boat shaped galvanized steel frame with 1/2" plaster lip accommodates ceilings up to 2" thick. May be used for new construction or remodeling installations. Provided with (2) remodel clips to secure frame when installed from below the ceiling.

Mounting Brackets
Bar hanger receivers adjusts 2" vertically from above the ceiling or thru the aperture. Use with No Fuss™ bar hangers or with 1/2" EMT. Removable to facilitate installation from below the ceiling.

No Fuss™ Bar Hangers
Pre-installed and centered bar hanger locks to tee grid with a screwdriver or pliers. Centering marks on the bar hanger mechanism allows consistent positioning of fixtures.

OPTICA L

Reflector
One piece aluminum reflector secures lens in place with integrated spring clips for a visually comfortable optic and allows for tool-less lens exchange from below the ceiling. Available with clear, diffuse, prismatic, fresnel or drop opal glass lens. Optional cross blade louver provides sharper cutoff to lamp. Self flanged standard.
- Specular Reflectors - Polished flange standard with white painted flange option.
- Baffles and White Reflector - White painted flange standard.

Trim Retention
Reflector is retained with two torsion springs and held tightly to the finished ceiling surface.

EL ECT RICA L

Junction Box
(6) 1/2" and (2) 3/4" trade size pry outs positioned to allow straight conduit runs. Listed for (12) #12 AWG (six in, six out) 90°C conductors and feed thru branch wiring.

Lamp Socket
4-pin G24q base accepts (1) 26W DTT or 26/32/42W TTT lamp.

Socket Housing
Galvanized steel socket housing attached securely to reflector with captive thumbscrew. Vents provide effective lamp thermal management.

Control Gear
Universal 120V - 277V UNV or 347V input electronic ballast for 26/32/42W compact fluorescent lamp.

Emergency Battery Pack
REM – Remote emergency test switch. Housing includes 120V/277V, 60Hz dual-tap battery pack provides 90 minutes of emergency illumination. Long life maintenance free sealed nickel cadmium batteries recharge fully in 24 hours. REM configuration includes prewired and attached remote test switch plate and indicator light. REM option is the standard emergency configuration, and is compatible with all standard reflector options, ordered separately.

IEM – Integral emergency test switch. Housing includes 120V/277V, 60Hz dual-tap battery pack provides 90 minutes of emergency illumination. Long life maintenance free sealed nickel cadmium batteries recharge fully in 24 hours. IEM configuration includes a prewired integral emergency test switch and indicator light that are both accessible inside the reflector. The IEM option requires "EM" designated reflectors only, ordered separately.

Emergency Battery Pack - Average Lamp Lumen Ratings

REM option: 26W 425lm, 32W 600lm, 42W 750lm

IEM option: 26W 810lm, 32W 910lm, 42W 1040lm

(Note: average lamp lumens are based upon REM and IEM manufacturer ratings. Delivered lumens depend upon trim; refer to trim photometry to factor delivered lumens).

Code Compliance
- Thermally protected and cULus listed for wet locations.
- IP44 rated for lens trims
- NFPA Life Safety (Emergency Battery Pack)
- EMI/RFI per FCCTitle 47 CFR, Part 18, non consumer limits.
- Peel down wattage label from 42W to 32W and 26W. Allows de-rating to set max. relamp wattage per project specifications (multi-wattage housings only).
- DR - De-rated label housings are wattage specific for 26/32W or 26W.
- High efficacy luminaire may be used to meet IECC, ASHRAE, and Title 24 commercial standards.

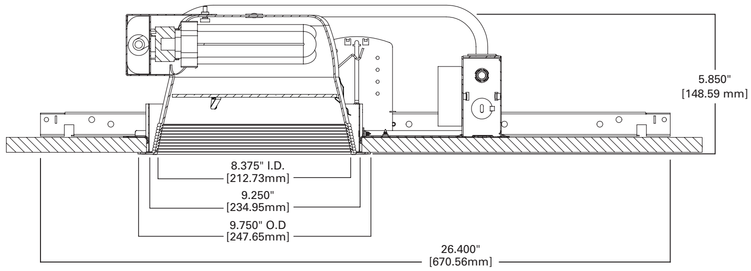
HALO Commercial

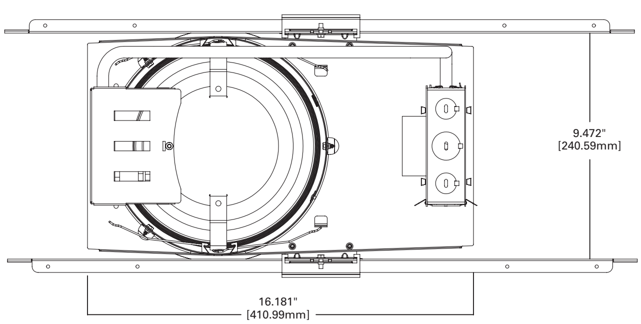
ENERGY DATA

PD8H142E, PD8CPH142E	
Min. Starting Temp -5°F / -20°C	Sound Rating Class A
EMI/RFI Emissions FCC 47CFR Part 18 Non-Consumer Limits	
Input Frequency 50/60 Hz	Power Factor > 0.98
THD < 10%	Input Voltage 120V - 277V ±10%
Crest factor < 1.7	
Operating Frequency > 40kHz	UL Listed Class P, Type 1 Outdoor, CSA or C/UL Certified
CFQ26W/G24Q	Input Power 28W
	Input Current 0.50A @ 120V
	Input Current 0.22A @ 277V
	Ballast factor 1.00
CFTR26W/GX24Q	Input Power 28W
	Input Current 0.50A @ 120V
	Input Current 0.22A @ 277V
	Ballast factor 1.00
CFTR32W/GX24Q	Input Power 35W
	Input Current 0.50A @ 120V
	Input Current 0.22A @ 277V
	Ballast factor .98
CFTR42W/GX24Q	Input Power 45W
	Input Current 0.50A @ 120V
	Input Current 0.22A @ 277V
	Ballast factor .96

PD8H1423E	
Min. Starting Temp 0°F / -18°C	Sound Rating Class A
EMI/RFI Emissions FCC 47CFR Part 18 Non-Consumer Limits	
Input Frequency 60 Hz	Power Factor > 0.98
THD < 10%	Input Voltage 347VAC ±10%
Operating Frequency 50-60 kHz	cULus Listed Class P, Type 1 Outdoor, Type CC
CFQ26W/G24Q	Input Power 31W
	Input Current 0.09A @ 347V
	Ballast factor 1.02
	Crest factor < 1.6
CFTR26W/GX24Q	Input Power 31W
	Input Current 0.09A @ 347V
	Ballast factor 1.02
	Crest factor < 1.6
CFTR32W/GX24Q	Input Power 36W
	Input Current 0.11A @ 347V
	Ballast factor 0.98
	Crest factor < 1.5
CFTR42W/GX24Q	Input Power 50W
	Input Current 0.15A @ 347V
	Ballast factor 1.00
	Crest factor < 1.5

DIMENSIONS





HALO Commercial

ORDERING INFORMATION

SAMPLE NUMBER: PD8H142E 82H1GC

Order housing, reflector and lamp separately for a complete luminaire.

Housing
Multi-Wattage
PD8H142 =
8 Inch horizontal
(1) 26/32/42W DTT/TTT CFL
PD8CPH142 = 8 Inch horizontal
(1) 26/32/42W DTT/TTT CFL,
CCEA listed (Chicago Plenum)

De-Rated Label
PD8H132 =
8 Inch horizontal
(1) 26/32W DTT/TTT CFL
PD8CPH132 = 8 Inch horizontal
(1) 26/32W DTT/TTT CFL,
CCEA listed (Chicago Plenum)
PD8H126 =
8 Inch horizontal
(1) 26W DTT/TTT CFL
PD8CPH126 = 8 Inch horizontal
(1) 26W DTT/TTT CFL,
CCEA listed (Chicago Plenum)

Ballast Option
E = 120V – 277V 50/60Hz UNV
REM = 120V/277V 60Hz dual-tap emergency battery ballast with remote test switch plate
3E = 347V, 50/60Hz
1DMARKX = 5% two-wire (26/32/42W) dimming, 120V
2DMARKX = 5% two-wire (26/32/42W) dimming, 277V
EDMARK7 = 5% 0-10V discrete two-wire (26/32/42W) dimming, 120-277V
1DMARKXREM = 5% two-wire (26/32/42W) dimming, 120V; with REM emergency option
2DMARKXREM = 5% two-wire (26/32/42W) dimming, 277V; with REM emergency option
EDMARK7REM = 5% 0-10V discrete two-wire (26/32/42W) dimming, 120-277V; with REM emergency option

Integral Emergency Ballast Option
IEM = 120/277V 60Hz dual-tap, Integral Emergency battery ballast with test switch through reflector*
1DMARKXIEM = 5% two-wire (26/32/42W) dimming, 120V; with IEM emergency option*
2DMARKXIEM = 5% two-wire (26/32/42W) dimming, 277V; with IEM emergency option*
EDMARK7IEM = 5% 0-10V discrete two-wire (26/32/42W) dimming, 120-277V; with IEM emergency option*
*Requires "EM" reflectors only, ordered separately

Reflector
82H = 8" horizontal
82HEM = 8" Horizontal, Emergency (required with IEM ballast option)

Regressed Lens Option
1G=Prismatic Glass
2G=Diffuse Glass
3G=Clear Glass
4G=Fresnel Glass

Finish Option
C=Specular Clear
G=Specular Gold
H=Semi Specular Clear
W=White (White Flange)
BB = Black baffle (White Flange)
WB = White baffle (White Flange)

Flange Option
Blank=Polished Flange (C, G, H)
Blank=White Flange (W, BB, WB)
WF=White Flange (C, G, H)

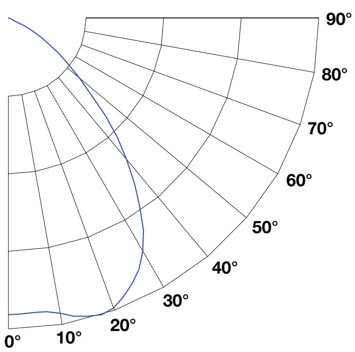
Accessories
HB128APK = L channel hanger bar, 26", 'No-Fuss', pair (replacement)
RMB22 = 22" long wood joist mounting bars

PHOTOMETRY

PD8H142E-82H1GC_32TTT

Spacing Criteria = 1.22
Lumens per Watt = 44 LpW
Test No. P31433
Test Model: PD8H142E-82H1GC_32TTT

Candlepower Distribution Curve



Candela Distribution

Degrees Vertical	Candela
0*	782
5	789
15	798
25	722
35	552
45	359
55	166
65	39
75	1
85	0
90	0

*CBCP

Luminance

(Average Candela/M²)

Degree	Avg. 0° Luminance
45	11744
55	6285
65	1818
75	63
85	0

Cone of Light Footcandles

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam (ft.) L Length	Beam (ft.) W Width
5.5'	26	6.5	7.1
7'	16	8.3	9
8'	12	9.5	10.3
9'	10	10.6	11.6
10'	8	11.8	12.9
12'	5	14.2	15.5
14'	4	16.5	18

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.
Footcandle values are initial, apply appropriate light loss factors where necessary.

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0-30	640.21	26.70	44.20
0-40	990.80	41.30	68.40
0-60	1398.25	58.30	96.60
0-90	1447.59	60.30	100.00

SURE-LITES

DESCRIPTION

The ECHX Series Surface and recessed mount Edge-lit Exits, provide an attractive yet easy to install universal edge-lit exit sign. The crystal clear wedge shape lens panel with white background standard provides excellent light distribution, exit visibility and easy installation. Long life, energy efficient LED lamps reduce energy costs and eliminate routine lamp maintenance. Durable extruded aluminum construction, attractive styling and high efficiency illumination make this series compatible in commercial, institutional and multi-housing applications.

Catalog #		Type
Project		
Comments		Date
Prepared by		

ECHX Series

EDGE-LIT EXITS
SELF POWERED
EMERGENCY
LED LAMPS
CHICAGO EXIT LIGHTING

SPECIFICATION FEATURES

Electrical
- Dual Voltage Input 120/277 VAC, 60Hz
- Line-latching
- Solid-state Voltage Limited Charger
- Solid-state Switching
- Brownout Circuit
- Test Switch / Power Indicator Light

Lens
- Injection molded, UV stabilized high impact, silk screened acrylic panels
- Bright red exit letter colors
- Panels customized with full stroke arrows for selected directional indicators
- White insert background included with single or double face exit panels
- Edge reflector for optimized efficiency and visibility

Battery
- Sealed Nickel Cadmium.
- Maintenance-Free, Long-Life
- Full Recharge Time, 24 hrs. (Max.)

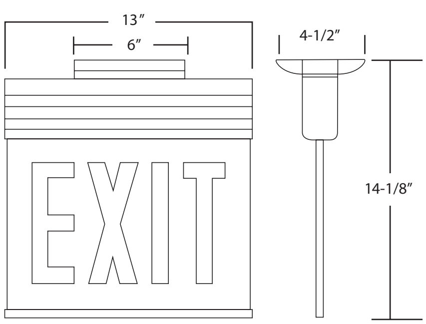
Housing Construction
- Anodized extruded aluminum housing
- Designer white textured finish available
- Components are of snap-fit construction to facilitate easy installation
- All components including battery and electronics are located inside the exit housing (surface) or the back (recessed).
- Die cast aluminum canopy with mounting screws included with all surface exits
- Surface mount exit can be universally mounted, ceiling, wall, or end, with Tri-Mount™ System
- Universal J-box mounting plate on surface mount exit
- Recessed Mount Unit can be installed in dry wall or drop thru ceilings

Code Compliance
- UL 924 Listed
- Life Safety NFPA 101
- NEC/OSHA
- Most State and Local Codes
- City of Chicago fire code
- Chicago Plenum Approved

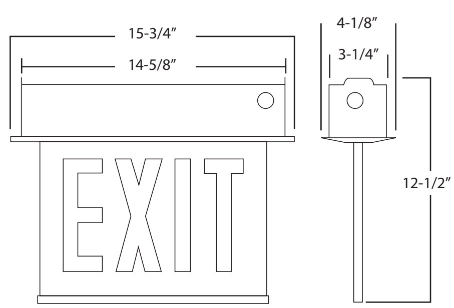
Warranty
- Exit: 1-Year
- Battery: 15-year pro-rated (Nickel Cadmium)

Lamp Data
- AC LED: Long life LED lamps provide uniform diffused illumination
- DC: LED DC lamps

Surface Mount



Recessed Mount



ORDERING INFORMATION

HOUSING - SAMPLE NUMBER: ECHX72SARLWH

Family	LED	Mounting / Trim Options
ECHX =Chicago Edge-Lit Exit Series	6=LED Lamps 7=LED Lamps, Self-powered	RH =Recessed SHA =Surface, Brushed Aluminum SHWH =Surface, White

TRIM - SAMPLE NUMBER: ECHX72SARLWH

Family	Face Options	Mounting Option	Arrow Options	Trim Finish	Stairs Option
ECHX =Chicago Edge-Lit Exit Series	1=Single 2=Double	ST =Surface RT =Recessed	[Blank] =No Arrow AR =Arrow Right (Single Face only) AL =Arrow Left (Single Face only) DA =Double Arrow ARL =Arrow Right/Left (Double Face only)	[Blank] =Brushed Aluminum WH =White	[Blank] =Exit Sign -Stair =Stair Sign (include dash)

TOTALLY PREDICTABLE RELIABILITY

ENERGY DATA

Maximum power consumption under all charge conditions:

LED Exits - Red

Input Power:
120V = 4.5W
277V = 4.9W
Input Current (Max.):
120V = 0.04A
277V = 0.02A

TECHNICAL DATA

Lamps
The ECHX Series Exits use energy efficient, long-life LEDs to provide uniform diffuse illumination of the exit face. These white LEDs require no maintenance. The low operating costs and zero maintenance requirement makes LED lamps the wisest choice for exit signs today. Emergency illumination is provided by LED lamps.

Housing Construction
Rugged, durable, anodized extruded aluminum materials are used in the ECHX Series Exits. All structural components are designed with reinforcing ribs to add additional rigidity and to maximize structural integrity. These materials are impact and scratch-resistant. All components are designed to be of snap-fit construction to facilitate easy installation. ECHX Series surface mount exits can be wall-, ceiling- or end-mounted. A Die-Cast Aluminum mounting canopy with installation screws is included. Recessed mount exits can be installed in drywall or drop-thru ceilings.

Lens
Trim panels for the ECHX Series Edgelit Exits are injection-molded from impact-resistant clear acrylic. Silk screened red letters, with white background insert is standard with all panels. Panels are customized with full stroke arrows for selected directional indicators. The edge reflector further enhances visibility.

Line-Latched (Self-Powered Only)
Sure-Lites' line-latched electronic circuitry makes installation easy and economical. A labor efficient AC activated load switch prevents the lamps from turning on during installation to a non-energized AC circuit. Line-latching eliminates the need for a contractor's return to a job site to connect the batteries when the building's main power is turned on.

Solid-State Charger (Self-Powered Only)
Supplied with a 120/277 VAC, voltage regulated solid-state charger, the battery is recharged immediately upon restoration of AC current after a power failure. The charge circuit reacts to the condition of the battery in order to maintain peak battery capacity and maximize battery life. Solid-state construction recharges the battery following a power failure in accordance with UL 924.

Brownout Circuit (Self-Powered Only)
The brownout circuit on Sure-Lites' exits monitors the flow of AC current to the exit and activates the emergency lighting system when a predetermined reduction of AC power occurs. This dip in voltage will cause most ballasted fixtures to extinguish causing loss of normal lighting even though a total power failure has not occurred.

Solid-State Transfer (Self-Powered Only)
The ECHX Series Exit incorporates solid-state switching which eliminates corroded and pitted contacts or mechanical failures associated with relays. The switching circuit is designed to detect a loss of AC voltage and automatically energizes the lamps using DC power. Upon restoration of AC power, the DC power will be disconnected and the charger will automatically recharge the battery.

Test Switch/Power Indicator Light (Self-Powered Only)
A test switch located on the side of the exit (surface) or on the trim plate (recessed) permits the activation of the emergency circuit for a complete operational systems check. The Power Indicator Light provides visual assurance that the AC power is on.

Sealed Nickel Cadmium Battery (Self-Powered Only)
Sure-Lites sealed nickel cadmium batteries are maintenance-free with a life expectancy of 15 years. The sealed rechargeable nickel cadmium battery offers high discharge rates and stable performance over a wide range of temperatures. The specially designed resealable vent automatically controls cell pressure, assuring safety and reliability. This battery is best suited for harsh ambient temperatures because the electrolyte is not active in the electrochemical process.

Warranty
All Sure-Lites' products are backed by a firm one-year warranty against defects in material and workmanship. Maintenance-free, long-life, sealed nickel cadmium batteries carry a fifteen-year pro-rated warranty.

Note: Specifications and Dimensions subject to change without notice.

Visit our web site at www.cooperlighting.com
Customer First Center 1121 Highway 74 South Peachtree City, GA 30269 770.486.4800 FAX 770 486.4801
Cooper Lighting 5925 McLaughlin Rd. Mississauga, Ontario, Canada L5R 1B8 905.507.4000 FAX 905.568.7049

Greengate

Catalog #		Type	
Project			
Comments			
Prepared by		Date	

VAC-DT, MicroSet Dual Tech Vacancy Ceiling Sensor Low Voltage

PIR Activated | Ultrasonic Activated | MicroSet Self-Adjusting (AUTO) | California Title 24 Compliant

- MicroSet self-adjusting Time Delay and sensitivity
- Optional built-in light level sensor
- Optional BAS/HVAC isolated relay
- Products tested to NEMA WD 7 - 2011 Occupancy Motion Sensors Standard
- Requires Manual ON for activation

Specifications:

Technology: Passive Infrared (PIR) and Ultrasonic (US)
Power Requirements:
Input:
- 10-30 VDC from Greengate Switchpack or Greengate system.
- Maximum current needed is 25mA per sensor.

Output:
- Open collector output to switch up to ten Greengate Switchpacks.
- BAS with Isolated Form C Relay in (-R) model.
- Isolated Form C Relay Ratings: 1A 30 VDC/VAC.

Time Delays: Self-adjustable, 15 seconds/test (10 min. Auto), or Selectable 5, 15, 30 minutes, or Zero Time Delay
Coverage: 500, 1000, and 2000 sq. ft.
Light Level Sensing (-R models): 0 to 300 foot-candles
Operating Environment:
- Temperature: 32°F to 104°F (0°C to 40°C)
- Relative humidity: 20% to 90%, non-condensing
- For indoor use only

Housing: Durable, injection molded housing. Polycarbonate resin complies with UL 94V0.
Size: 4.5"H x 1.42"W (114.3mm x 36.068mm)
LED lamp: Green LED for Ultrasonic
Red LED for Passive Infrared
Warranty: Five year

FCC Compliant
cULus Listed
RoHS Compliant c UL us RoHS

Overview

The Dual Technology sensor's combination of Ultrasonic and Passive Infrared technologies offers the most complete sensing equipment available today. This pairing helps eliminate false deactivations for additional energy savings. The VAC-DT sensors are also equipped with MicroSet self-adjusting technology which provides an adaptive and airflow tolerant technology, making them ideal for spaces which have increased airflow due to higher occupant levels. MicroSet self-adjusting Dual Technology sensors drastically simplify and reduce a contractor's installation and adjustment time period.

Technology

The MicroSet self-adjusting technology continuously monitors multiple sub-frequencies in the event that if a continuous Doppler shift occurs, such as those created by airflow from an air duct, the sensor will identify the noise as continuous and then block it out of view at a select sub-frequency. It will continue to monitor other sub-frequencies for human motion. This avoids false activation, while still maintaining the high level of sensitivity that is necessary for sensing minor motion in a changing environment. Separate concurrent time delays for both Passive Infrared and Ultrasonic technologies avoid false activations or deactivations. The lights are turned ON by activating a momentary switch (model # GMDS-*) that is connected to the sensor. When enabled, the daylighting feature (-R models only) prevents lights from turning ON when the room is adequately illuminated by natural light.

Applications

classrooms	common areas	other indoor office spaces
conference rooms	computer rooms	
office spaces	break rooms	

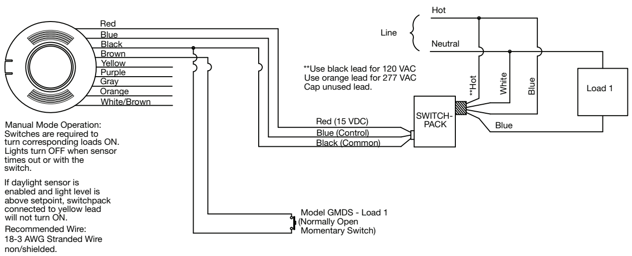
Ordering

Catalog #	Recommended Room Size	Field of View	Frequency	Features
VAC-DT-2000-R	2,000 sq.ft.	Two Way (360°)	32 kHz	w/BAS Relay & Daylight Sensor
VAC-DT-1000-R	1,000 sq.ft.	Two Way (360°)	32 kHz	w/BAS Relay & Daylight Sensor
VAC-DT-0501-R	500 sq.ft.	One Way (180°)	40 kHz	w/BAS Relay & Daylight Sensor

203 Cooper Circle
Peachtree City, GA 30269
P: 800-553-3879
F: 800-954-7016
COOPER Controls

VAC-DT, MicroSet Dual Tech Low Voltage

One Sensor, One Switchpack

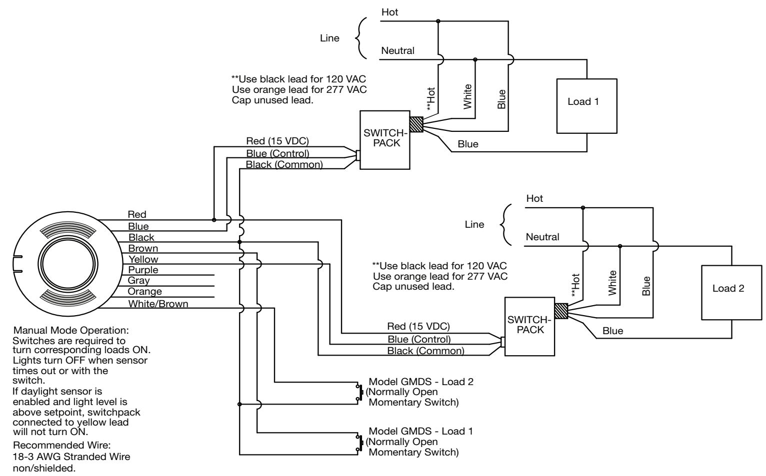


SENSOR WIRE LEAD LEGEND

Black	(Common)
Red	(10-30 VDC)
Blue	(Control - Occupancy)
Yellow	(Control - Occupancy and Daylight)
Brown	(Switch-Blue Lead Control)
Brown/White	(Switch-Yellow Lead Control)
Sensor's Isolated Relay	
Orange	(Normally Open)
Gray	(Common)
Purple	(Normally Closed)

Recommended Wire: 18-3 AWG stranded non-shielded

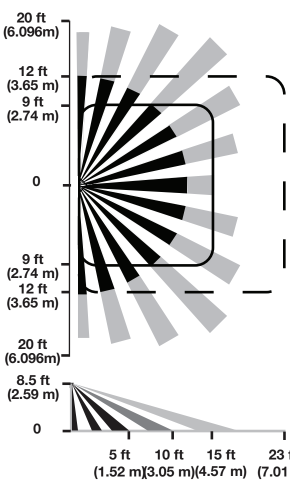
Manual On Control of Two Standard Switchpacks



Coverage

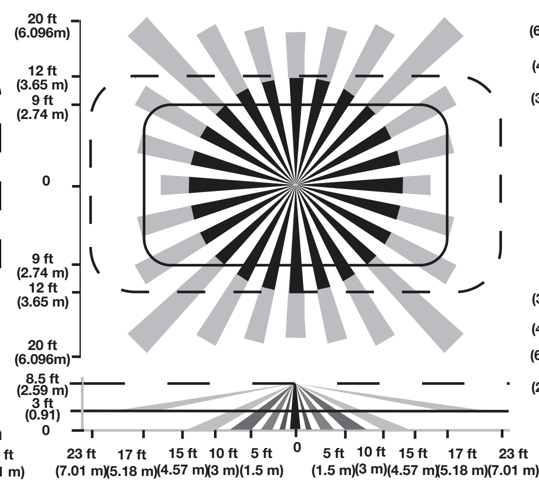
VAC-DT-0501-R

500 sq. ft.



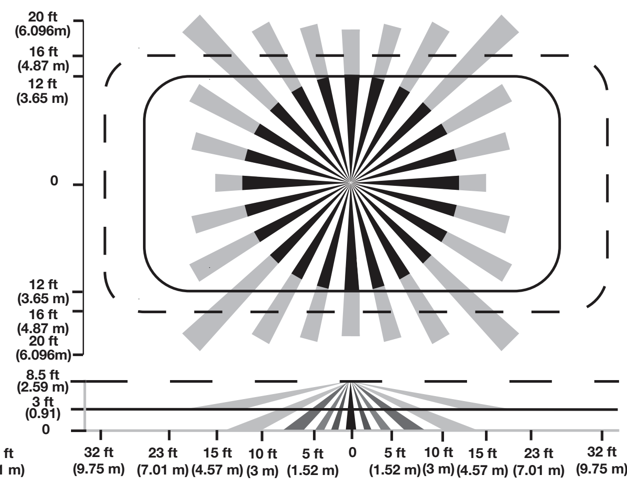
VAC-DT-1000-R

1,000 sq. ft.

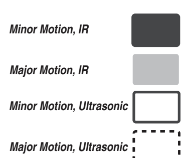


VAC-DT-2000-R

2,000 sq. ft.



Recommended Mounting Height: 8 to 12 ft



Maximum coverage area may vary somewhat according to room shape and the presence of obstacles.

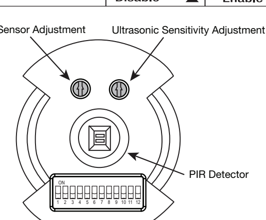
Controls

DIP Switch Legend

	Time Delay		Not Used		PIR Sensitivity	Not Used	LEDs	Override	Sweep	Full/Half Logic	HVAC/Tracking	Zero Time Delay
DIP Switch	1	2	3	4	5	6	7	8	9	10	11	12
Auto*	▼	▼			Full ▼		Enable ▼	Disable ▼	Disable ▼	Full ▼	Disable ▼	Disable ▼
5 Minutes	▼	▲			50% ▲		Disable ▲	Enable ▲	Enable ▲	Half ▲	Enable ▲	Enable ▲
15 Minutes	▲	▼										
30 Minutes	▲	▲										
										(-R model only)	(-R model only)	

**Self-Adjusts to 10 min. user mode*

Default = (shaded)



www.coopercontrol.com
203 Cooper Circle, Peachtree City, GA 30269
P: 800-553-3879 F: 800-954-7016

COOPER Controls

30HX Evergreen®

High-Efficiency
Indoor Liquid Screw Chillers

70 to 265 Nominal Tons

30HXA - Condenserless
30HXC - Water-cooled

Back to Product Description

30HXC 60 Hz Water-Cooled

Size	Capacity (Tons)	IPLV (kW/Ton)	Dimensions (ft)			Operating Weight (lbs)
			Length	Width	Height	
076	74	.53	8.5	2.8	5.4	5700
086	82	.54	8.5	2.8	5.4	5723
096	92	.53	8.5	2.8	5.4	5855
106	103	.55	8.5	2.8	5.6	6177
116	112	.53	8.5	2.8	5.4	6415
126	121	.53	11.1	2.8	5.4	6465
136	134	.56	11.1	2.8	5.4	6688
146	143	.55	11.1	2.8	5.4	6718
161	155	.58	11.1	2.9	5.8	7452
171	164	.56	11.1	2.9	5.8	7660
186	176	.59	11.1	2.9	5.8	7854
206	211	.53	11.1	3	6.2	10581
246	245	.54	12.4	3	6.2	10696
261	255	.54	12.4	3	6.2	10992
271	265	.54	12.4	3	6.2	11029

Contact your local Carrier representative for condenserless ratings.