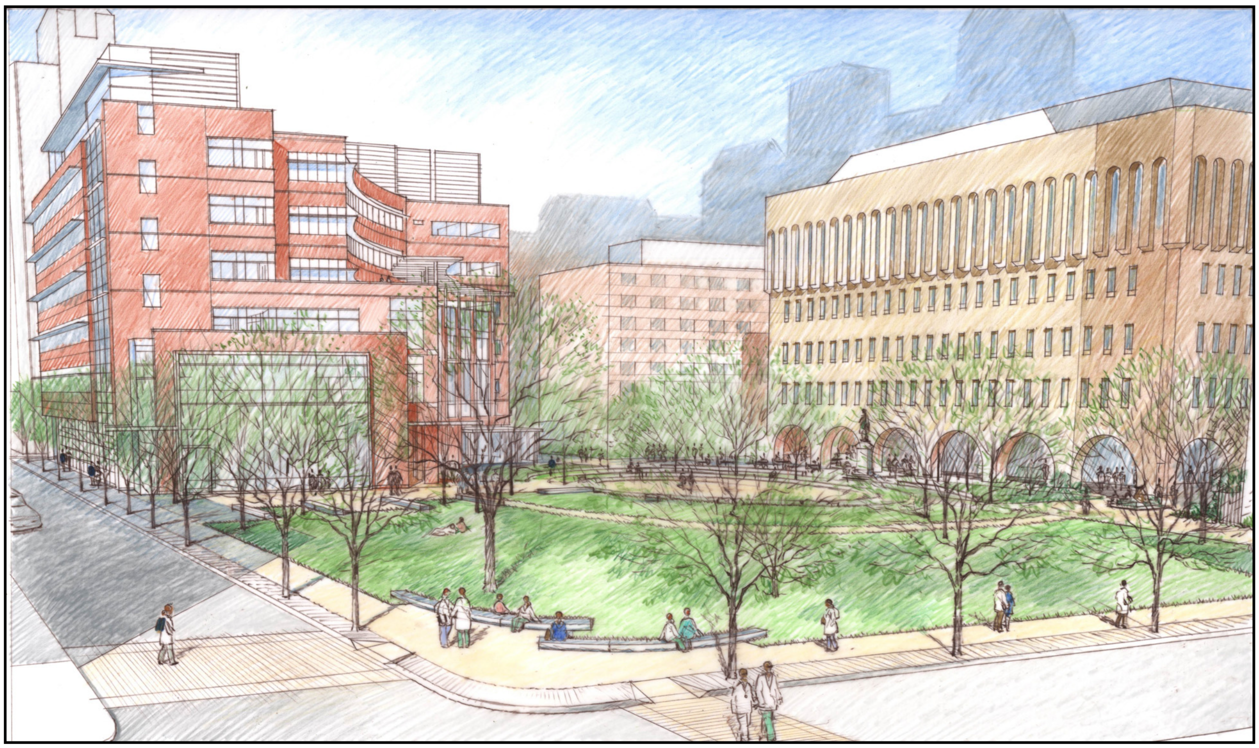
Joshua Kreutzberger
Lighting/Electrical
Spring 2007
Advisor: Dr. Mistrick
Final Report



Dorrance H. Hamilton Building
Philadelphia, PA

Dorrance H. Hamilton Building
Thomas Jefferson University
Philadelphia, PA

PROJECT TEAM

Owner:	Thomas Jefferson University
GC/CM:	P. Agnes Inc.
Architects/Engineers:	Burt Hill
Landscape Architect:	Andropogon Associates
Structural Engineer:	David Chou & Associates Inc.
Lighting Design:	The Lighting Practice
Civil Engineer:	Vollmer Associates LLP
Technology:	RJC Designs Inc.
Project Management:	Dan Bosin Associates LLC & TJU

ARCHITECTURE

- Dorrance H. Hamilton Building will transform the Thomas Jefferson University campus by developing an expansive grassy plaza which will become the new focal point of campus
- The building will house a technologically advanced auditorium, small and large group classrooms, and a two floor clinical skills center featuring virtual diagnostic and surgical suites
- The curved façade features large expanses of glass that will open onto the plaza
- The transparency of the façade carries through the entire ground floor, which allows people on the street to look into the lobby, through the building and out to the plaza

STRUCTURAL

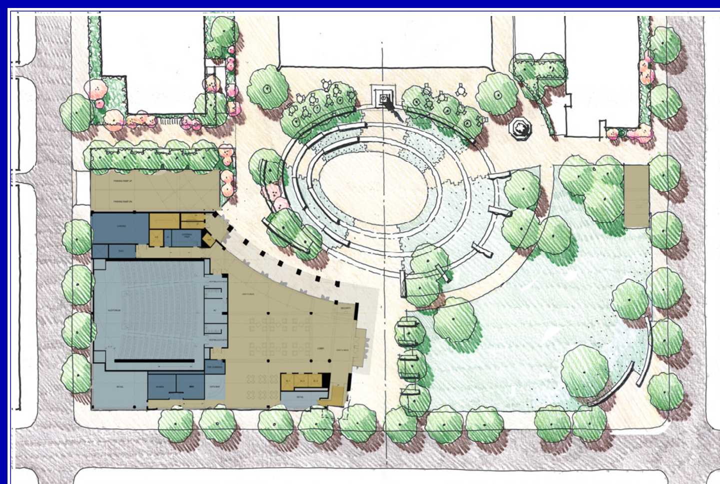
- Foundation consists of concrete footings placed on existing caissons
- 5” Slab-on-Grade for ground floor and parking garage
- Structural steel framing used for most of building

MECHANICAL

- (3) 40,000 cfm AHUs located on mechanical floor
- (1) 480 ton cross-flow cooling tower
- (6) air cooled AC units used for heat removal and environmental control
- (1) 750 cfm and (4) 350 cfm electric unit heaters

BUILDING STATISTICS

- Location:
  1001 Locust Street, Philadelphia, PA 19107
- Number of Floors:
  2 Parking Levels, 6 Floors, Mech. Room
- Square Feet:
  129,000 sq. ft. building w/60,000 sq. ft. plaza
- Occupancy:
  Medical Education
- Start/End Construction:
  October 2005/August 2007
- Project Delivery:
  Guaranteed Maximum Price (GMP)



ELECTRICAL

- 13.2 kV 3 PH parallel service entrance to switchgear
- Uses both 480/277V and 208/120V 3 PH
- 1000 kW, 480Y/277V diesel emergency generator
- 480Y/277V 3PH emergency distribution panel

LIGHTING

- Vast daylighting through building via curved front façade and ribbon windows
- Lobby and classrooms use recessed fluorescent luminaires with some MR16 accent lighting
- Clear Metal Halide for parking area
- Special considerations for emergency rooms

Joshua Kreutzberger
Lighting/Electrical

THESIS EPORTFOLIO: HTTP://WWW.ARCHE.PSU.EDU/THESIS/EPORTFOLIO/2007/PORTFOLIOS/JJK295/

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Executive Summary

The Dorrance H. Hamilton Building is a 129,000 ft^2 medical education building, which is a portion of the Thomas Jefferson University (TJU) campus in Philadelphia, PA. The building is comprised of six stories above grade, plus a mechanical floor, and the roof. The 2 floors of the 215 space parking garage will be located underground.

The final report consists of the lighting depth, electrical depth, mechanical breadth, and the construction management breadth. The lighting depth is the lighting redesign of the following four spaces: plaza, lobby, auditorium, and 5^{th} floor classroom.

The lighting redesign met all of the design criteria, while incorporating an intriguing design into the medical education building. In order to accomplish this task, AGI32 software was utilized in order to analyze luminaire layout, uniformity ratios, and horizontal illuminance calculations.

The electrical depth is comprised of a variety of different tasks, which include the redesign of branch circuits for the four re-lighted spaces, analysis of a central transformer versus distributed transformers, analysis of feeders versus a bus duct spanning to the penthouse, the analysis of a motor control center, and a protective device coordination study. The redesign of the electrical system was compared to the existing system regarding cost analysis, efficiency, and power consumption. The cost analysis is a part of the construction management breadth work.

The mechanical system of the different electrical rooms was analyzed in accordance with the distributed and central transformers. A comparison was done in order to determine the best design alternative between the two. The distributed transformers were once again the obvious choice.

The second breadth area of study was a cost analysis of the existing electrical system versus the redesigned portions of the electrical system. The cost analysis includes the following: central transformer versus distributed transformers and feeders running to each floor versus a main bus duct to penthouse. The cost analysis of the feeder vs. busduct system showed that the busduct was cheaper than the individual feeders. Also, the distributed transformers were cheaper than the central transformer.

Building Information

Architecture

Burt Hill Kosar Rittelmann Associates will transform the Thomas Jefferson University campus with the Dorrance H. Hamilton Building. The medical education complex will include an expansive grassy plaza which will become the new focal point of campus. The building will house a technologically-advanced auditorium, small and large group classrooms and a two-floor clinical skills center featuring virtual diagnostic and surgical suites. The entrance faces the grassy plaza which provides an interaction area among students and professors. Other areas of interaction include common meeting areas on each floor and a rooftop terrace and lounge for special events. The curved façade features large expanses of glass that will open onto the plaza to highlight the "new heart of campus," the Thomas Jefferson University President Robert L. Barchi, M.D., PhD said. The transparency of the façade carries through the entire ground floor, which allows people on the street to look into the lobby, through the building and out to the plaza.

Electrical

The source of the electrical system for the Dorrance H. Hamilton Building starts with the existing 13.2 kV switchgear in the Jefferson Alumni Hall. Two 13.2 kV Philadelphia Electric Company (PECO) feeders supply six existing 13.2 kV feeders. Four of the feeders are to substations in Jefferson Alumni Hall, while the other two feeders will supply the Dorrance H. Hamilton Building. The electrical service is distributed to two 15 kV load interrupter switches integral for the unit substation. From the closed load interrupter switch, the 13.2 kV service is fed through a dry-type transformer rated at 480Y/277 volt, 3 phase, and 2500 kVA. After the 2500 kVA transformer, the service is supplied to the main bus system with TVSS located in Substation No. 1. A 4000 draw amp low voltage circuit breaker protects the main bus. The main distribution panels are located on the parking level P2 and fed up through the building into the electrical room of each floor into sub-distribution panels. From the sub-distribution panels, lighting and receptacle loads are distributed to each floor and served by 150 kVA dry-type transformers and 208Y/120V panelboards.

The emergency power is produced with a 1000 kW, 408Y/277V diesel generator. The generator provides emergency power to the automatic transfer switches of the Life Safety, Elevator, and the Standby Distribution panels.

Lighting

The lighting of the Dorrance H. Hamilton Building mostly consists of recessed fluorescent light sources powered by 277 and 120 volt services. Linear and compact fluorescent recessed fixtures are specified in most of the classrooms and corridors. The main lobby includes vast daylighting via a curved glass façade, fluorescent fixtures and HID sources. Compact fluorescent downlights are utilized in the auditorium along with some of the higher end classrooms. Accent lighting with MR16 and wall wash luminaires provides a striking design and ample illuminance. The plaza area consists of LED strip lighting, HID, and fluorescent sources of light.

Mechanical

A 480-ton cross-flow cooling tower located in the penthouse of the building provides the building will cool air. Along with the cooling tower, six air cooled AC units are employed throughout the building to remove heat and provide environmental control. The building is heated by one 750 cfm and four 350 cfm electric unit heaters located throughout the building. The building also includes three 40,000 cfm air handling units located in the penthouse. Most of the mechanical load is provided with 480 volt, three phase power.

Fire Protection

The building will have manual fire alarm pull stations and an addressable automatic fire detecting device. Alarm signal devices will activate if system detects a fire. The system includes an automatic voice evacuation sequence, a manual voice paging sequence, a device to send an alarm to the University's on-site central monitoring station, sprinkler system tamper switch, smoke detectors in elevator lobbies, machine rooms, and hoist ways, addressable heat detectors, duct mounted smoke detectors, among other items. A supervised, two-way communication system between the fire command center/main fire alarm control panel and the emergency phones throughout the building is also included.

Transportation

There are two passenger elevators and one service elevator in the Dorrance H. Hamilton Building. The passenger elevators serve the ground floor through the sixth floor, where as the service elevator serves the ground floor through the mechanical room on the seventh floor. The elevators run on a 480 volt, three phase system with an automatic transfer switch for switching to emergency power if the normal distribution system shuts down.

Telecommunications

The security system of the building has surveillance television systems, security door access control, and security intrusion detection devices. The security system will provide perimeter security of the areas around the building during off peak hours.

The building has various other communications systems that are to be issued at a later date. These include the nurses call system, sound system, audio visual equipment, and a clock system.

Lighting Depth

Space Introduction

The four spaces for the lighting redesign include the plaza, lobby, auditorium, and the 5th floor sixty-capacity classroom of the Dorrance H. Hamilton Building. The grassy plaza consists of a 60,000 ft^2 courtyard used as a circulation space for the Dorrance H. Hamilton Building, Martin Building, Scott Library & Administration Building, and Orlowitz Residence Hall. The plaza area will also provide students and faculty with an area to enjoy the outdoors.

Upon entering the building through the curved glass façade, one would find themselves in the lobby of the building, which is the second space to be redesigned. The lobby will be mainly used for a circulation space with elevators, stairways, and a small retail space. The lobby also includes the entrance to the third space of redesign, which is the auditorium.

The 300-seat capacity auditorium resides on the first floor of the building, adjacent to the lobby. The auditorium provides a challenging redesign with a 15’ high raked ceiling and 4800 ft^2 of space.

The sixty-capacity classroom is located on the 5th floor of the Dorrance H. Hamilton Building. Some other spaces that accompany the classroom on the fifth floor includes other classrooms, lecture halls, two skills simulation labs, storage rooms, a small lobby, and a library/meeting room. The back wall of the classroom is a curved glass ribbon window, which will have dual/solar blackout shades provided by the owner of the building.

Lighting Design

The lighting design will provide the four spaces with an aesthetically pleasing atmosphere and ample light on the task plane. In order to accomplish this task, the IESNA Lighting Handbook and ASHRAE 90.1 were followed throughout the design process. The spaces were modeled in AutoCAD and exported into AGI32, where the lighting design was finished with various renderings and lighting calculations.

Plaza – Lighting Redesign

Description of Space

The main entrance to the Dorrance H. Hamilton Building faces a grassy plaza where students and faculty can meet and interact informally. The facilities curved façade will feature large expanses of glass that will open on the plaza outside. The transparency of the building carries through the entire ground floor, allowing people on the street to look into the lobby, through the building and out to the plaza. The plaza includes walkways, a statue, seating areas, and an open grass area. The plaza is approximately 60,000 ft^2.

Site Plan

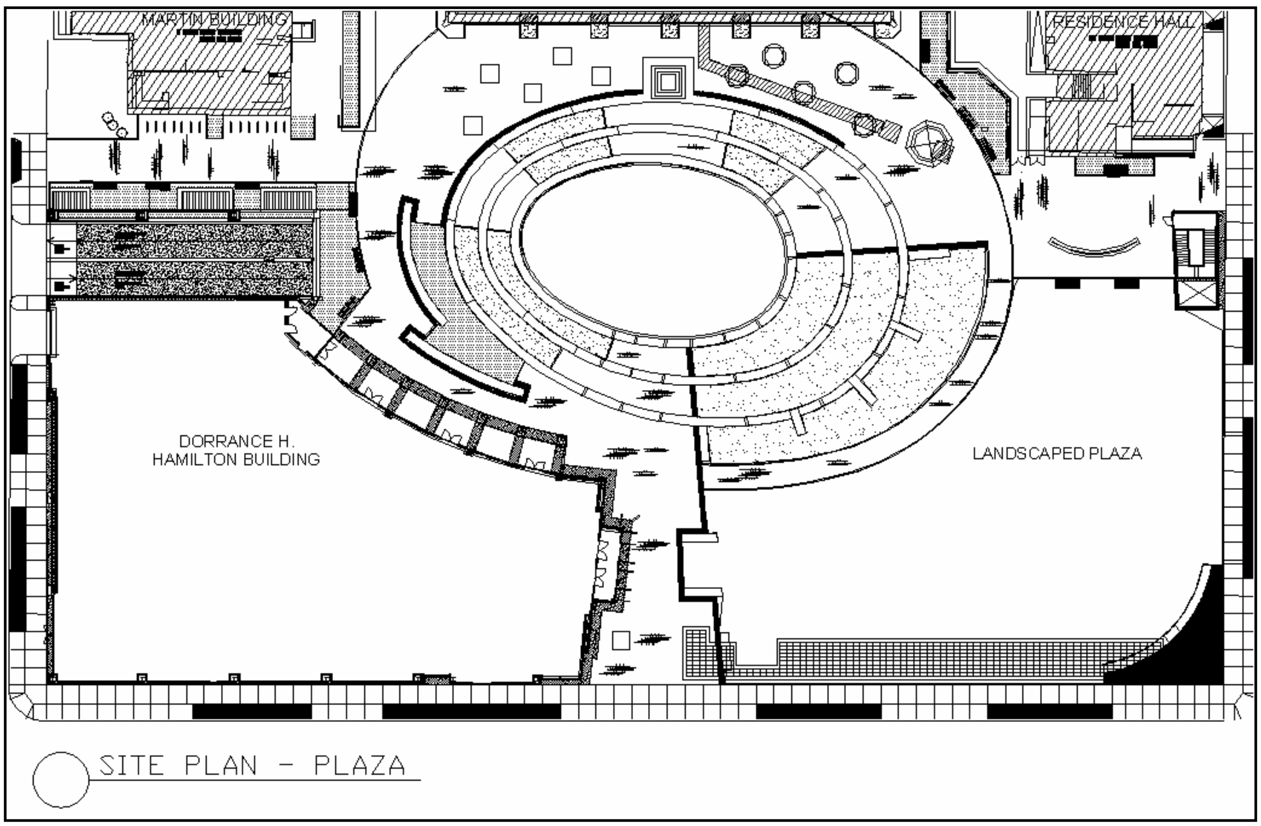


Figure 1: Plaza Site Plan

Design Concept

The design concept of the plaza is to provide sufficient illumination for circulation for buildings surrounding the Dorrance H. Hamilton Building. The main areas of interest are the walkways, stairways, the statue, and seating areas.

Design Criteria

Appearance of Space and Luminaires

The appearance of the space and luminaires is extremely important when lighting a plaza to this new "new heart of campus". The appearance of the space and luminaires has to be aesthetically appealing. The statue, walkways, and seating areas need to be lighted.

Point(s) of Interest

The points of interest in the space include the entrances and exits of buildings, walkways, statue, and grassy plaza. The points of interest will prosper with a higher illuminance due to the fact that they will stand out, such as the entrances and exits to the surrounding buildings, the statue, and walkways. The grassy area of the plaza does not need to be illuminated as high as the other points of interest. A number of luminaires surrounding the space may be a good idea instead of lighting the whole grassy area.

Illuminance (Horizontal)

The IESNA handbook calls for a horizontal illuminance of 5 lux (0.5 fc) for walkways distant from roadways and 6 lux (0.6 fc) for intermediate roadside sidewalks.

Illuminance (Vertical)

The IESNA handbook recommends a vertical illuminance of 1 lux (0.1 fc) for this space. The entrances and exits of the buildings should be at 30 lux (3 fc) for this space.

Power Allowances from ASHRAE 90.1 Standards

The power allowance in Table 9.4.5 of the ASHRAE 90.1 Standards is 0.2 W/ft^2 for the building grounds. The building grounds will include walkways 10 feet wide or greater and plaza areas. For walkways less than 10 feet wide, the power allowance is 1.0 W/ft^2. The main building entrance and exit has a power allowance of 30W/linear foot of door width.

Fixture Schedule

Label	Description	MH	Lamps	Ballast/ Transformer	Watts	Voltage	Mfr.	Catalogue No.
F-A1	18’ High Pole Mounted Area Source 8-Sided Lantern Opal Text Lens with Black Finish	18’	1 – 175 Watt MH	IMH-175-C – Advance - e-Vision Electronic Ballast for MH Lamps	175	277	Allscape	AA-01-22-175MH-E-17-277-OA-BK-PCB
F-A2	6” Diameter Bollard with Spherical Variform Reflector with 42” Overall Height	3.5’	1 – 70 Watt MH	IMH-70-A-BLS-ID - Advance – e-Vision Electronic Ballast for MH Lamps	70	277	Allscape	LL-02-70MH-E-17-277-O-42-BK
F-A3	SP-108 Metric Series Cutoff Step Light Luminaire	2’	2 – 18 Watt CFL	ICF-2S18-H1-LD – Advance – Smartmate Electronic Ballast	36	277	Allscape	SP-108-2(18)CFL-277-BK-PL
F-A4	SL-50 Die-Cast Aluminum Floodlight	1’	1 – 50 Watt MR16	N/A	50	277	Allscape	Sl-50-50LV-MR-16-277-BK-UD
F-A5	BL-49 Cast Aluminum Wall Mount Black Fixture	6’	1 – 70 Watt MH	IMH-70-A-BLS-ID - Advance – e-Vision Electronic Ballast for MH Lamps	70	277	Allscape	BL-49-70MH-277-OP-BK-EMG

Table 1: Plaza Fixture Schedule

Light Loss Factors

The assumed space cleaning period for this space is 12 months and the space has a medium dirt condition. For fixture F-A4, a LLD of 0.80 was assumed for the MR-16 lamp.

Label	Maintenance Category	LLD	RSDD	LDD	BF	LLF
F-A1	V	0.75	-	0.82	1.00	0.62
F-A2	V	0.72	-	0.82	1.00	0.59
F-A3	V	0.85	-	0.82	1.05	0.73
F-A4	V	0.80	-	0.82	-	0.82
F-A5	V	0.72	-	0.82	1.00	0.59

Table 2: Plaza Light Loss Factors

Ballast Information

Label	Type	Ballast Watts	Ballast Factor	Voltage	Max THD %	Mfr.	Catalogue No.
B-A1	Electronic	191	1.00	277	15	Advance – e-Vision	IMH-175-C
B-A2	Electronic	84	1.00	277	18	Advance – e-Vision	IMH-70-A-BLS-ID
B-A3	Electronic - Programmed Start	39	1.05	277	10	Advance – Smartmate	ICF-2S18-H1-LDGE
B-A5	Electronic	84	1.00	277	18	Advance – e-Vision	IMH-70-A-BLS-ID

Table 3: Plaza Ballast Information

Lamp Information

Label	Type	CRI	CCT	Watts	Initial Lumens	Mean Lumens	Mfr.	Ballast
L-A1	GE Constant Color CMH ED17	90	4200	175	12000	9000	GE	IMH-175-C – e-Vision Electronic Ballast for MH Lamps
L-A2	GE Protected Constant Color PulseArc CMH ED17	80	3000	70	5700	4100	GE	IMH-70-A-BLS-ID – e-Vision Electronic Ballast for MH Lamps
L-A3	GE Ecolux Biax T4 CFL	82	4100	18	1200	1020	GE	ICF-2S18-H1-LD – Advance – Smartmate Electronic Ballast
L-A4	GE MR16 – Q50MR16/HIR/CG40	-	3000	50	2600	-	GE	N/A
L-A5	GE Protected Constant Color PulseArc CMH ED17	80	3000	70	5700	4100	GE	IMH-70-A-BLS-ID – e-Vision Electronic Ballast for MH Lamps

Table 4: Plaza Lamp Information

Power Density

Label	Ballast Watts	No. of Fixtures	Total Watts	
F-A1	191	6	1146	
F-A2	84	11	924	
F-A3	39	72	2808	
F-A4	50	28	1400	
F-A5	84	15	1260	
			7538	Watt Total
			41,500	Square Foot Total
			0.18 W/ft^2	

Table 5: Plaza Power Density

Therefore, the power density is slightly below the target IESNA value of 0.20 W/ft^2. The value is conservative because the building entrance and exit values and the walkways less than 10 feet wide are calculated into the total value. The space is at an appropriate illuminance level, so the power density is sufficient. Note: The square foot total of the plaza is 60,000 ft^2; however, the grassy of the plaza is 18,500 ft^2. Therefore, the total square foot total of the plaza is 41,500 ft^2.

Lighting Plan

The lighting site plan for the plaza is too large to view with one drawing. Therefore, the lighting site plan is cut into four sections: lower left, upper left, upper right, and lower right. All of the fixtures are labeled with their respected panelboard location on the drawing. The lights will be controlled by a timer during the year.

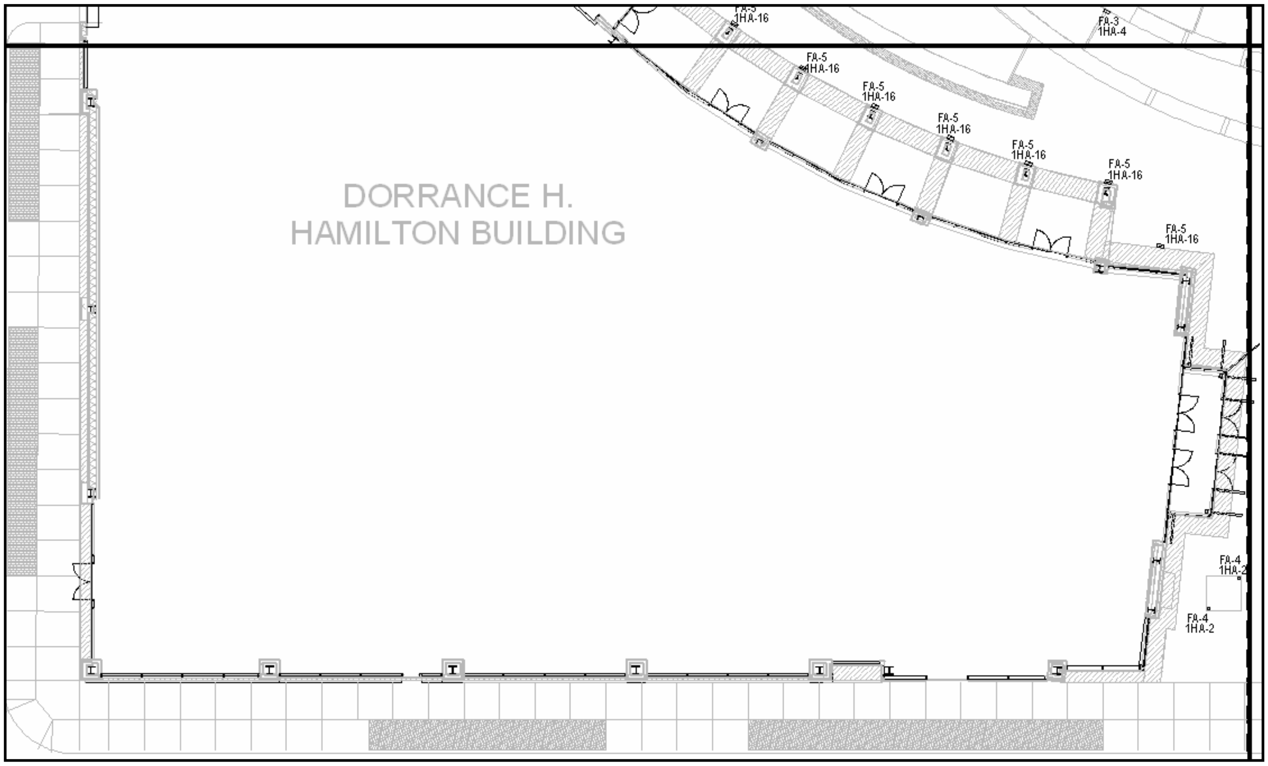


Figure 2: Plaza Lighting Plan (Lower Left)

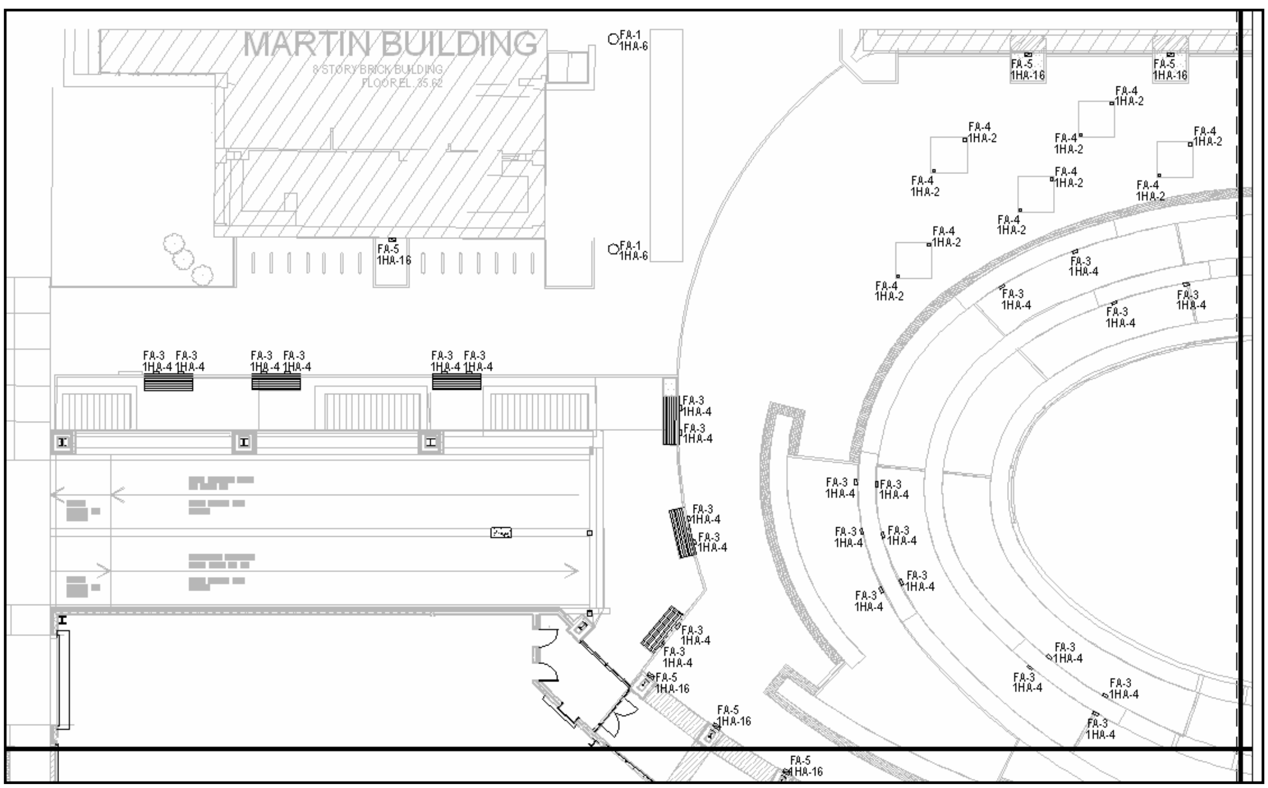


Figure 3: Plaza Lighting Plan (Upper Left)

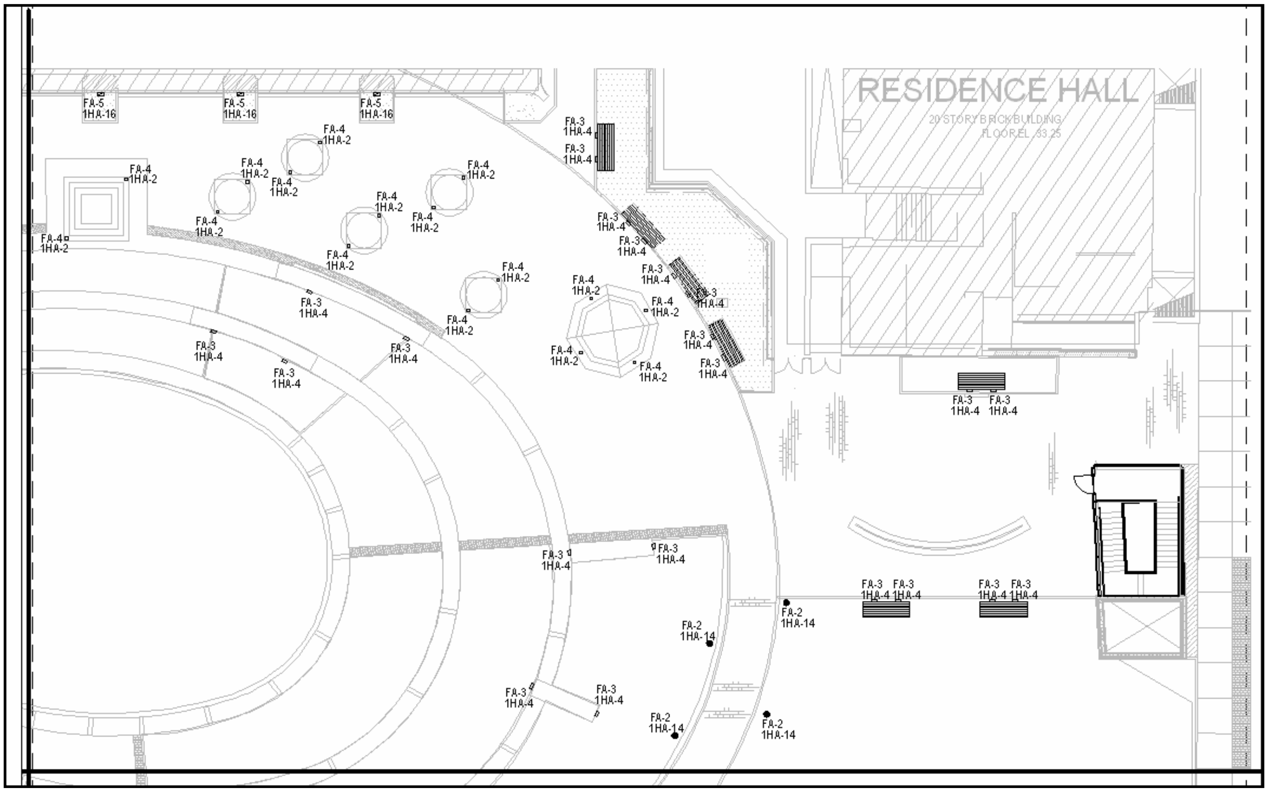


Figure 4: Plaza Lighting Plan (Upper Right)

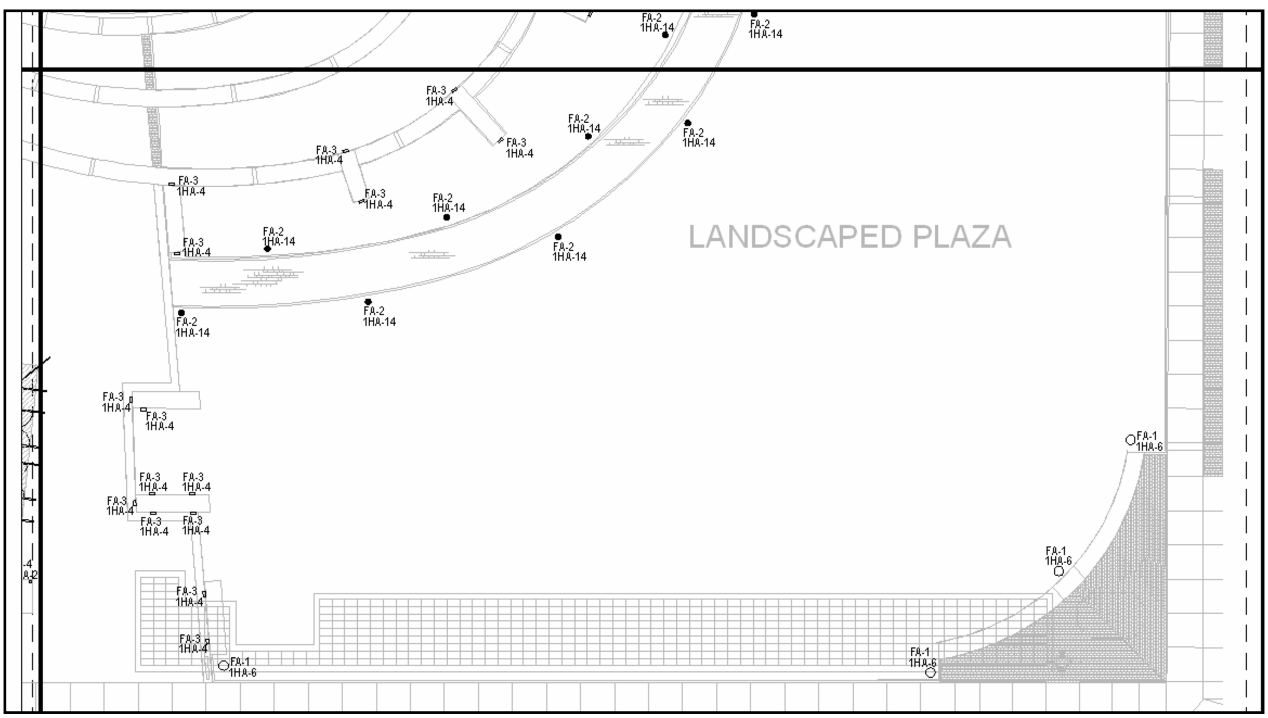
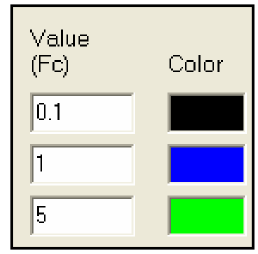


Figure 5: Plaza Lighting Plan (Lower Right)

Isometrics



The isolines from AGI32 were analyzed on the work plane height of 0.0’. The average illuminance throughout the walkways of the plaza was 0.99 fc.

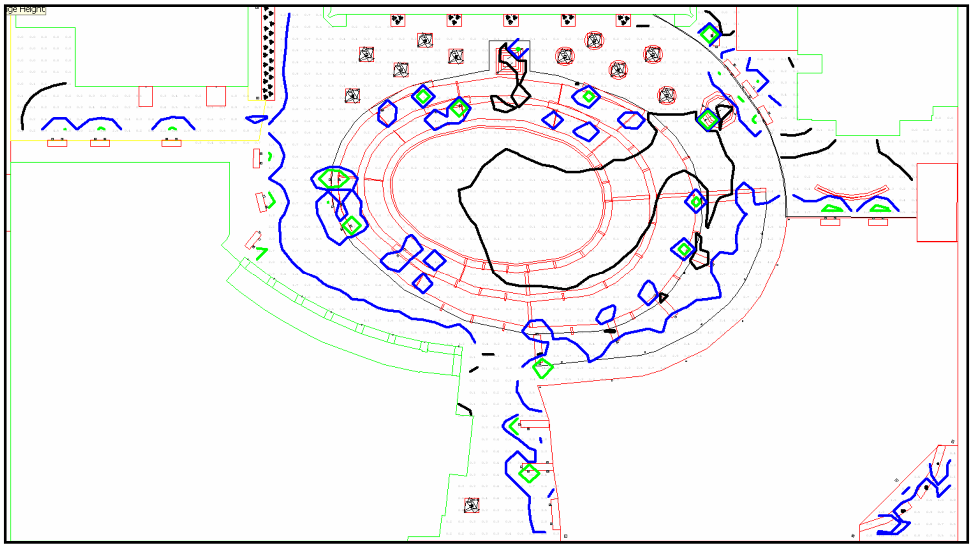


Figure 6: View of Isolines of Plaza

The isolines from AGI32 were analyzed on the work plane height of 0.0’. Figure 7 is a close-up view of the isolines of the center of the plaza.

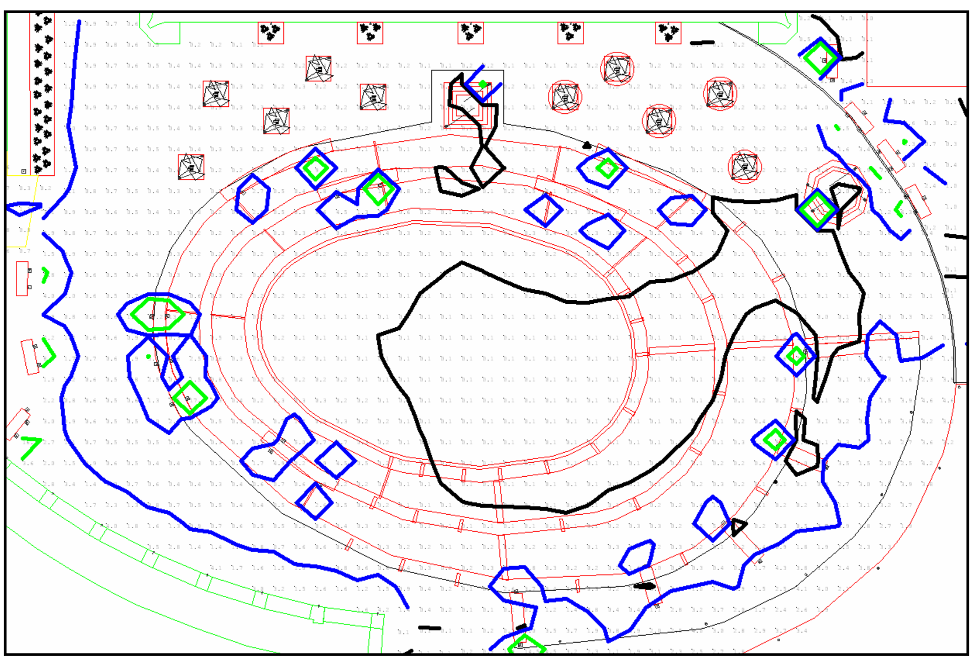


Figure 7: Close-up View of Isolines of Plaza

Conclusion

Overall, the lighting design achieved the space design goals. The step lights were inserted into the various benches around the plaza. The step lights provided the area with a luminaire source without cluttering the space. The middle of the plaza is used for a large tent, so fixtures were not permitted to be placed in the center of the ovals. The walkway closest to the grassy area was illuminated nicely by the bollard fixtures placed along the walkway. Outdoor wall sconces were placed on the columns of the DH Hamilton Building and above the planters of the Scott Library and Administrative Building. The trees, statue, and fountain outside of the Scott Library Building were accentuated by directional spotlights, which provided aesthetic appeal to the space. A few 18' high architectural area source luminaires were used at various places throughout the design.

The average illuminance on the work plane was 0.99 fc, which was high for the IESNA value for a plaza of 0.50 fc. The trees, statue, and fountain were accentuated; therefore, the average illuminance was higher. The power density was 0.16 W/ft^2, which was under the ASHRAE 90.1 Standards of 0.20 W/ft^2 for outdoor walkways/plaza.

Lobby – Lighting Redesign

Description of Space

The lobby is located on the first floor of the building. Upon entering the building through the curved façade that features large expanses of glass, one would find themselves in the lobby of the building. The auditorium entrance would then be straight ahead when in the lobby. The lobby will be mainly used for a circulation space although the space will have plasma screens in it. A small retail space is located in one corner of the lobby and is not included in the lighting redesign. The lobby is 70' wide by 110' long with the ends tapering out to a triangle. This equates to an area of 6,597 ft^2. The two-story height ceiling provides the space with a various options for the lighting design. The ceiling is 15' high were the spaces are not two-stories high.

Floor Plan

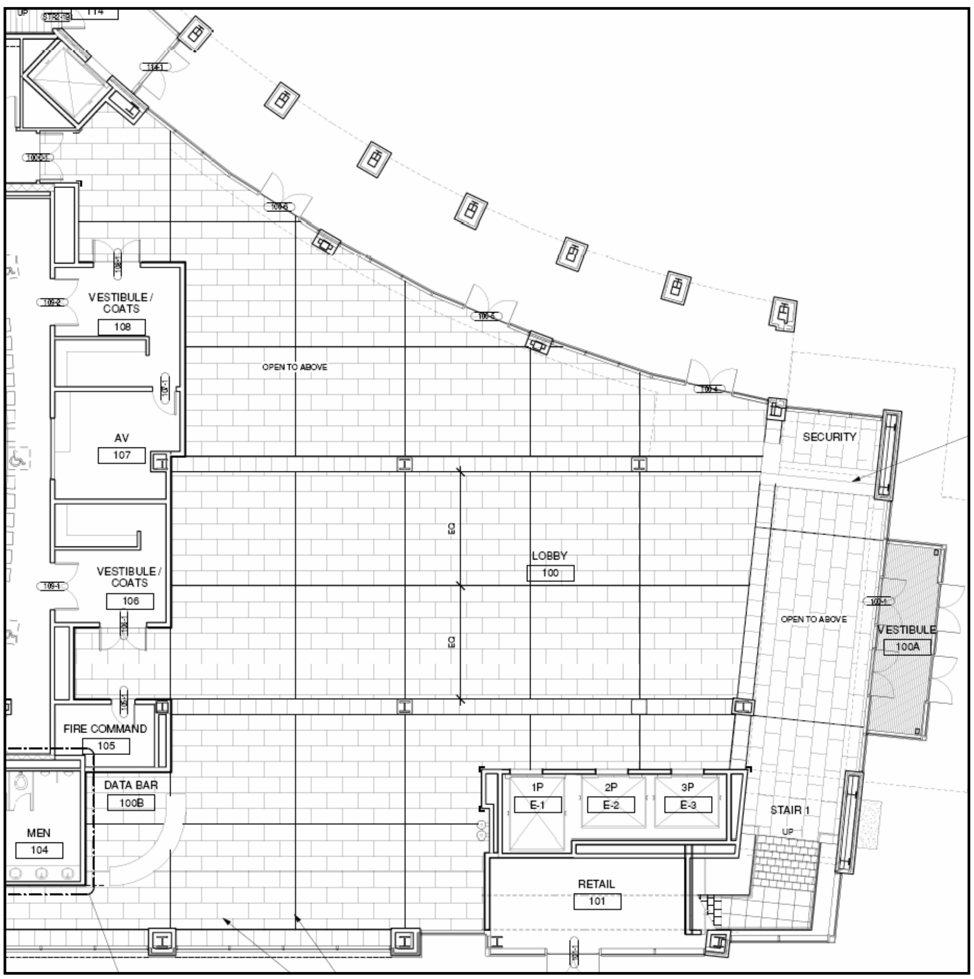


Figure 8: Lobby Floor Plan

Design Concept

The design concept of the lobby is to provide an inviting appeal to the space by adding sparkle and aesthetically pleasing fixtures. The large glass façade provides daylighting into the space, which will provide an opportunity to save on energy. The space is in the middle of the plaza and auditorium, so a smooth transition is necessary between the three spaces. The lighting design should accent the architecture and have a warm CCT for the wood panels used in the space. Attention to the plasma screens is also necessary in the lobby. Since the lobby is only used for circulation, the controls should be simple to use.

Design Criteria

Appearance of Space and Luminaires

The appearance of the space and luminaires is extremely important when lighting the lobby to this “new heart of campus”. The appearance of the space and luminaires has to be aesthetically appealing. The architecture, such as the double height space, columns, and wood paneling, can be highlighted.

Color Appearance (and Color Contrast)

Color appearance can affect visibility and aesthetics. A color rendering index (CRI) of 70 or above is acceptable when dealing with educational facilities; however, a CRI greater than 80 may be needed in order to ensure a pleasant appearance of skin tones.

Daylighting Integration and Control

The space incorporates an expansive curved glass façade on the entire northeast wall. This will be an issue for the use of the VDT on the walls and may cause glare on the screen. The orientation of the plasma screens with respect to the daylighting is used in order to cut down on the directed glare. A daylighting system can be used to limit the amount of energy used in the room during the day. Controls such as a photo sensor and switching can be used to dim the luminaires in the room when daylighting is entering the room.

Luminances of Room Surfaces

User comfort and satisfaction is increased when spaces deliver both direct and diffuse light to the occupant and task. With the number of luminaires in the space and daylighting, the luminances of the room surfaces are assumed to be from direct and diffused light. The special surfaces in the space include the doors of the space, the retail room, and the entrance to the lobby.

Modeling of Faces or Objects

The modeling of faces or objects is somewhat important to a lobby. A CRI of 80 or higher will provide a better skin tone color. Another consideration should be that light will hit the face at all angles. In this space with all the different light sources including daylight, the modeling of faces or objects should not be a problem.

Point(s) of Interest

The points of interest in the space include the entrances, exits, plasma screens, circulation paths, retail space, and security space. The points of interest will prosper with a slightly higher illuminance due to the fact that they will stand out, such as the entrances and exits.

Reflected Glare

The reflected glare in the space will be an issue with the VDT screens in the space. Caution should be used when placing luminaires around the area of the plasma screens.

Source/Task/Eye Geometry

The source/task/eye geometry is somewhat important to a lobby application. The angular relationships between the viewer, the task (VDTs), and the luminaire are frequently critical to task visibility. The luminaires should not be placed in the reflected view of the VDTs.

Sparkle/Desirable Reflected Highlights

The lobby is a good place to add sparkle because it enhances the look of the space. Sparkle should not create reflected glare, but may include some desirable reflected highlights, especially in the double height area of the lobby.

Surface Characteristics

The surface characteristics of the space are somewhat important due to the appearance of the space. The surfaces of the space should be a high gloss, grand looking material. The space should appear to be high class.

Illuminance (Horizontal)

The IESNA handbook calls for a horizontal illuminance of 50 lux (5 fc) on the work plane for circulation.

Illuminance (Vertical)

The IESNA handbook recommends a vertical illuminance of 30 lux (3 fc) for this space. The entrances and exits should have a vertical illuminance of 50 lux (5 fc). Artwork and the directory should have an illuminance of 300 lux (30 fc).

Power Allowances from ASHRAE 90.1 Standards

The power allowance by the space by space method for a lobby is 1.3 W/ft^2.

Reflectances

Ceiling: Gypsum Wallboard Soffits/banding & Armstrong “Optima Vector” #3900, white acoustical ceiling tile

- Assume 90% ceiling reflectance

Walls: Wood Paneling/Painted Gypsum Wallboard

- Assume 50% wall reflectance

Floor: Cotto D’Este Porcelain Tile “Buxy”, Cendre Natural Finish in 2’x2’ and 2’x4’ tiles

- Assume 40% floor reflectance

Fixture Schedule

Label	Description	MH	Lamps	Ballast/ Transformer	Watts	Voltage	Mfr.	Catalogue No.
F-B1	Campbell Pendant with Clear Glass and Sandblasted Stripes	18′	1 – 75 Watt R20	N/A	75	120	Louis Poulsen Lighting	CAM-1/75W/R20 Med-120V-Striped Glass
F-B2	Recessed Compact Fluorescent Downlight/Wallwasher with EvenTone Clear Flange	17′	2 – 26 Watt Triple Tube CFL	ICF-2S26-H1-LD - Advance Smartmate Electronic Programmed Start	52	277	Edison Price Lighting	TRPH 226/7–WW –277–VOL-PS
F-B3	Saturn Maxi Wall Sconce	6.5′	2 – 26 Watt Triple Tube CFL	ICF-2S26-H1-LD - Advance Smartmate Electronic Programmed Start	52	277	Louis Poulsen Lighting	SAW-MAX-2/26W/CF Gx24q-3/4-277V-NAT. PAINT ALUM.
F-B4	41" Dia x 2" Deep Semi-Indirect Area Source with Specular Segmented/White Reflector	12′	4 – 42 Watt CFL & 1 - 38	ICF-2S42-M2-BS – Advance – Smartmate Electronic Programmed Start	168	277	LAM	HR41-4/42-1/382D-HC-CN-62-SGW-SGW-277-ALB/3

Table 6: Lobby Fixture Schedule

Light Loss Factors

The assumed room cleaning period for this room is 6 months and the room is clean. The expected dirt depreciation was calculated at 8%.

$$RCR = [(5)*(H)*(L + W)] / (L)*(W)$$

$$RCR = [(5)*(16'\text{-}8'')*(88' + 75')] / (6597\ ft^2) = 2.06 = 2.1$$

Label	Maintenance Category	LLD	RSDD	LDD	BF	LLF
F-B1	IV	0.88	0.98	0.92	1.00	0.79
F-B2	IV	0.92	0.98	0.92	1.00	0.83
F-B3	II	0.92	0.94	0.96	1.00	0.83
F-B4	VI	0.92	0.90	0.91	0.97	0.73

Table 7: Lobby Light Loss Factors

Ballast Information

Label	Type	Ballast Watts	Ballast Factor	Voltage	Max THD %	Mfr.	Catalogue No.
B-B2	Electronic – Programmed Start	54	1.00	277	10	Advance – Smartmate	ICF-2S26-H1-LD@277
B-B3	Electronic – Programmed Start	54	1.00	277	10	Advance – Smartmate	ICF-2S26-H1-LD@277
B-B4	Electronic – Programmed Start	2 @ 93	0.97	277	10	Advance – Smartmate	ICF-2S42-M2-BS@277

Table 8: Lobby Ballast Information

Lamp Information

Label	Type	CRI	CCT	Watts	Initial Lumens	Mean Lumens	Mfr.	Ballast
L-B1	DuraMax 75W Med 120V R20	80	3000	75	570	500	Philips	N/A
L-B2	ALTO PL-T 26W/830/GX2 4q-3/4P ALTO	82	3000	26	1800	1650	Philips	ICF-2S26-H1-LD - Advance Smartmate Electronic Programmed Start
L-B3	ALTO PL-T 26W/830/GX2 4q-3/4P ALTO	82	3000	26	1800	1650	Philips	ICF-2S26-H1-LD - Advance Smartmate Electronic Programmed Start
L-B4	ALTO PL-T 42W/830/GX2 4q-3/4P ALTO	82	3000	42	3200	2950	Philips	ICF-2S42-M2-BS – Advance – Smartmate Electronic Programmed Start

Table 9: Lobby Lamp Information

Power Density

The power density is slightly below the target IESNA value of 1.3 W/ft^2. The space is at an appropriate illuminance level, so the power density is sufficient.

Label	Ballast Watts	No. of Fixtures	Total Watts	
F-B1	75	22	1650	
F-B2	54	28	1512	
F-B3	54	12	648	
F-B4	224	14	3136	
			6946	Watt Total
			6597	Square Foot Total
			1.05 W/ft^2	

Table 10: Lobby Power Density

Lighting Plan

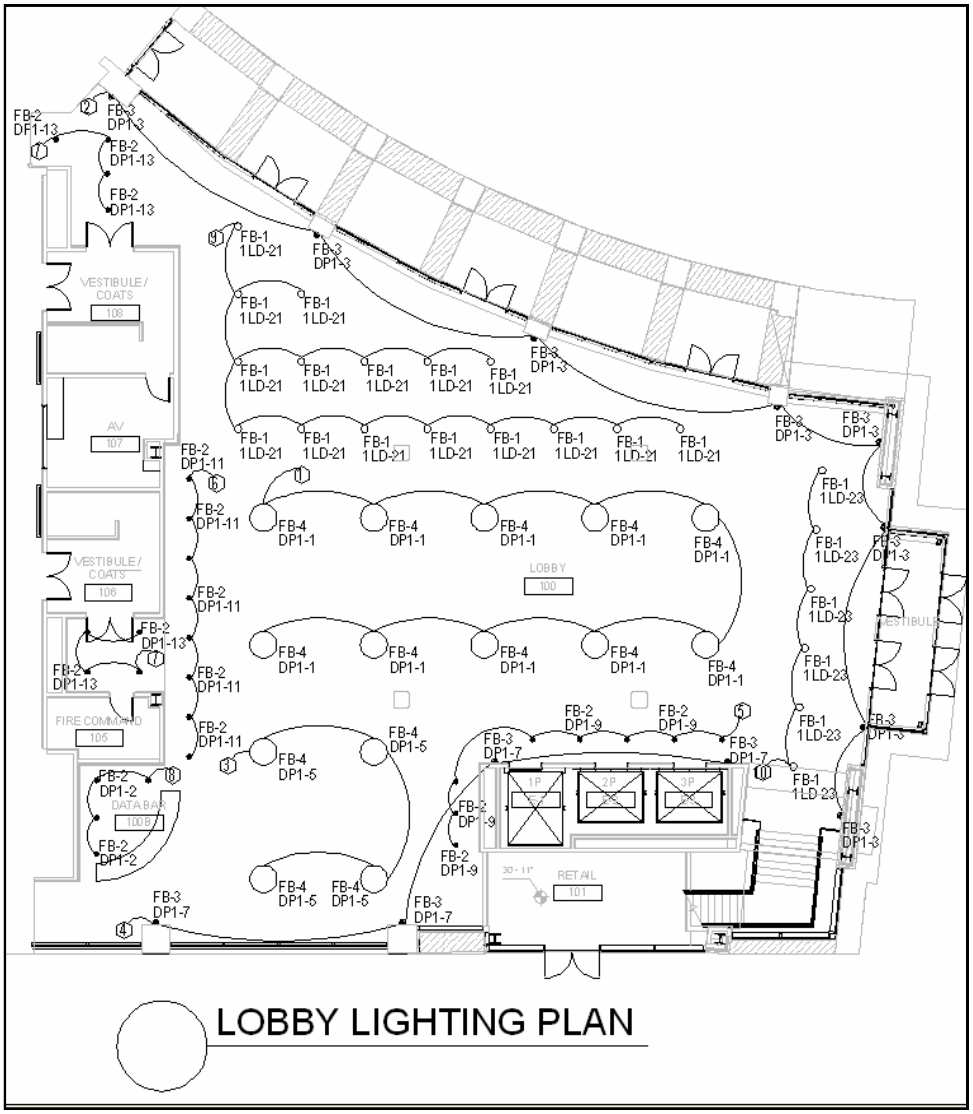


Figure 9: Lobby Lighting Plan

Isometrics

The Isolines from AGI32 were analyzed on the work plane height of 0.0'. The average illuminance throughout the lobby was 21.12 fc. The illuminance value is high for a circulation space, but the space needed a higher illuminance level.

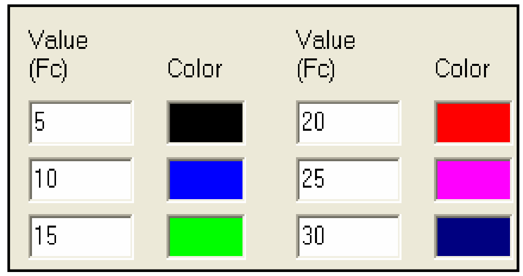


Figure 10: View of Isolines of Lobby

Renderings

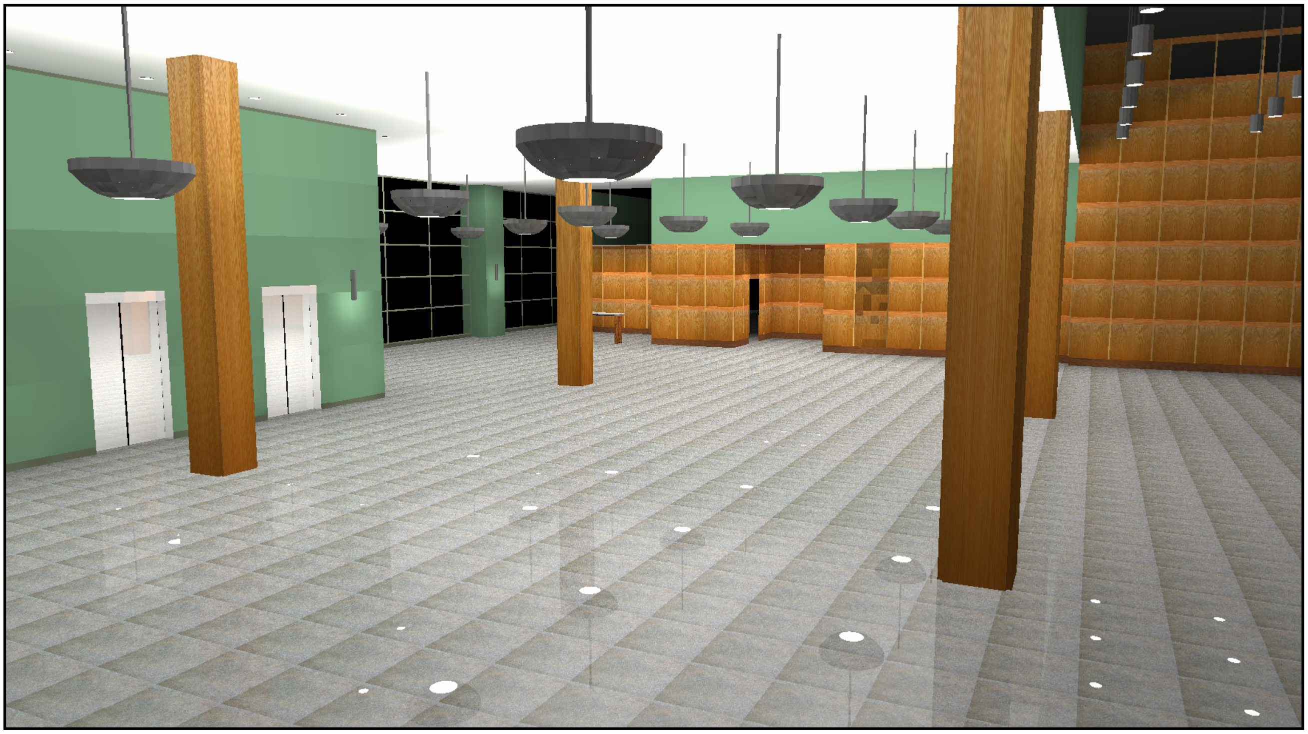


Figure 11: Rendering of Lobby (Vestibule Entrance)

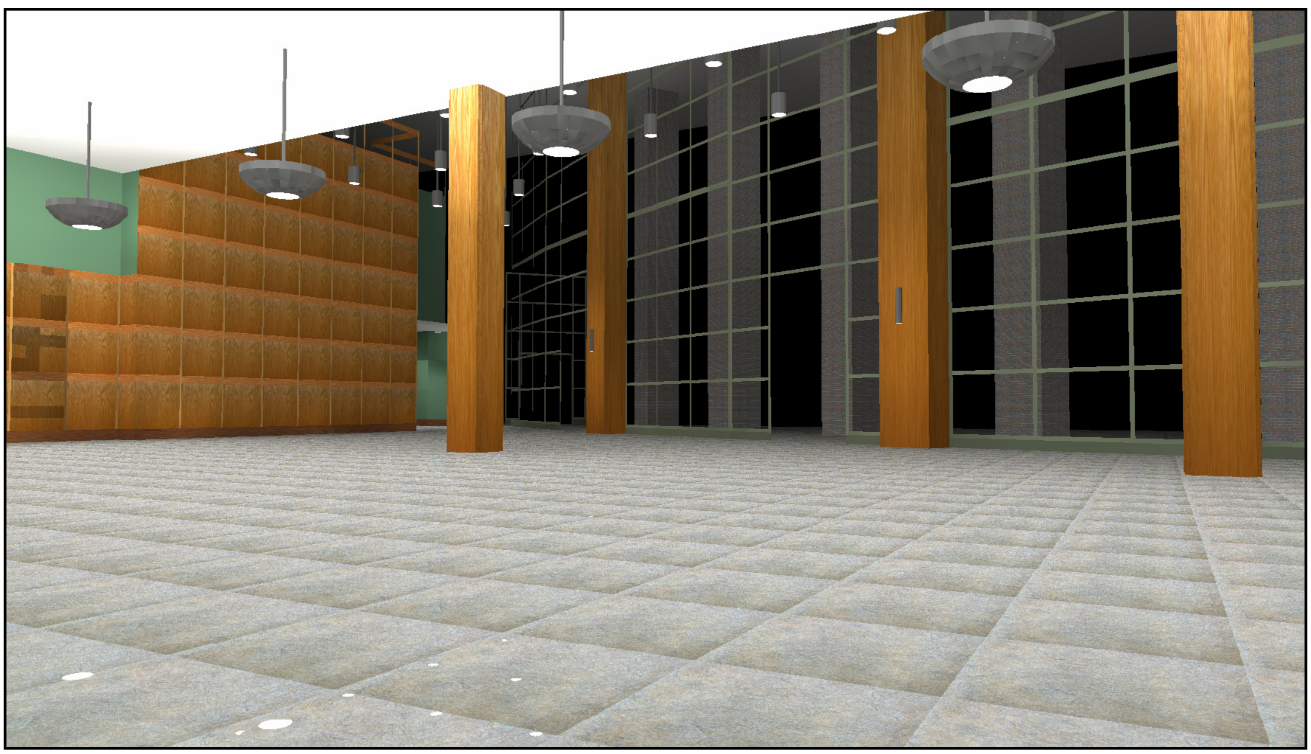


Figure 12: Rendering of Lobby (Elevator Entrance)

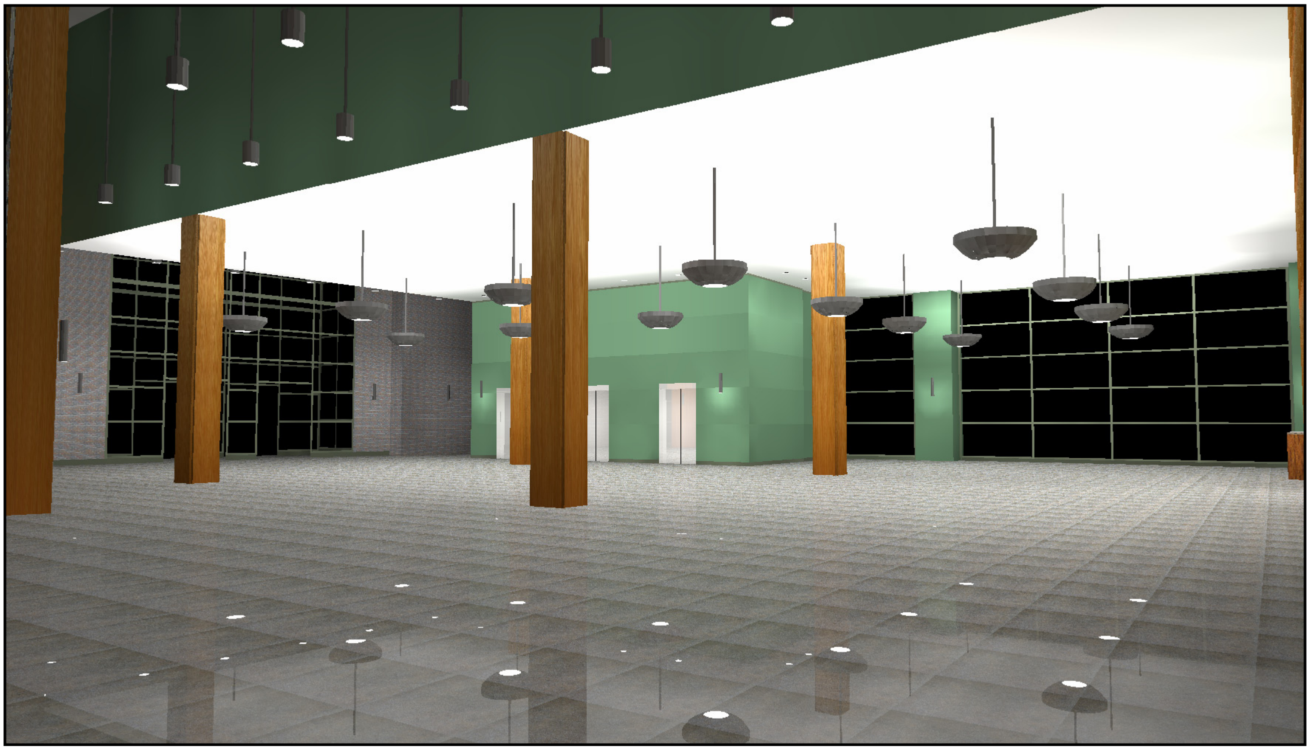


Figure 13: Rendering of Lobby (Glass Façade Entrance)

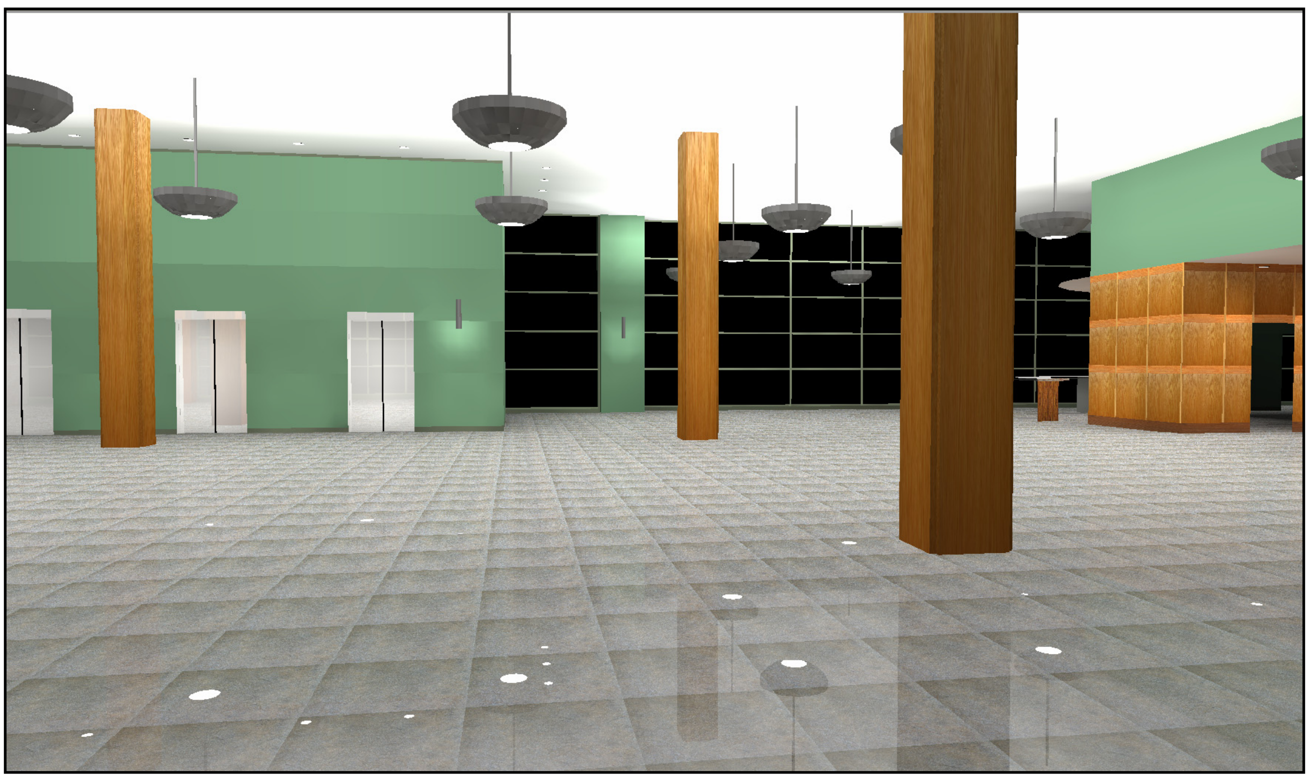


Figure 14: Rendering of Lobby (Glass Façade Entrance)

Pseudo Color Renderings

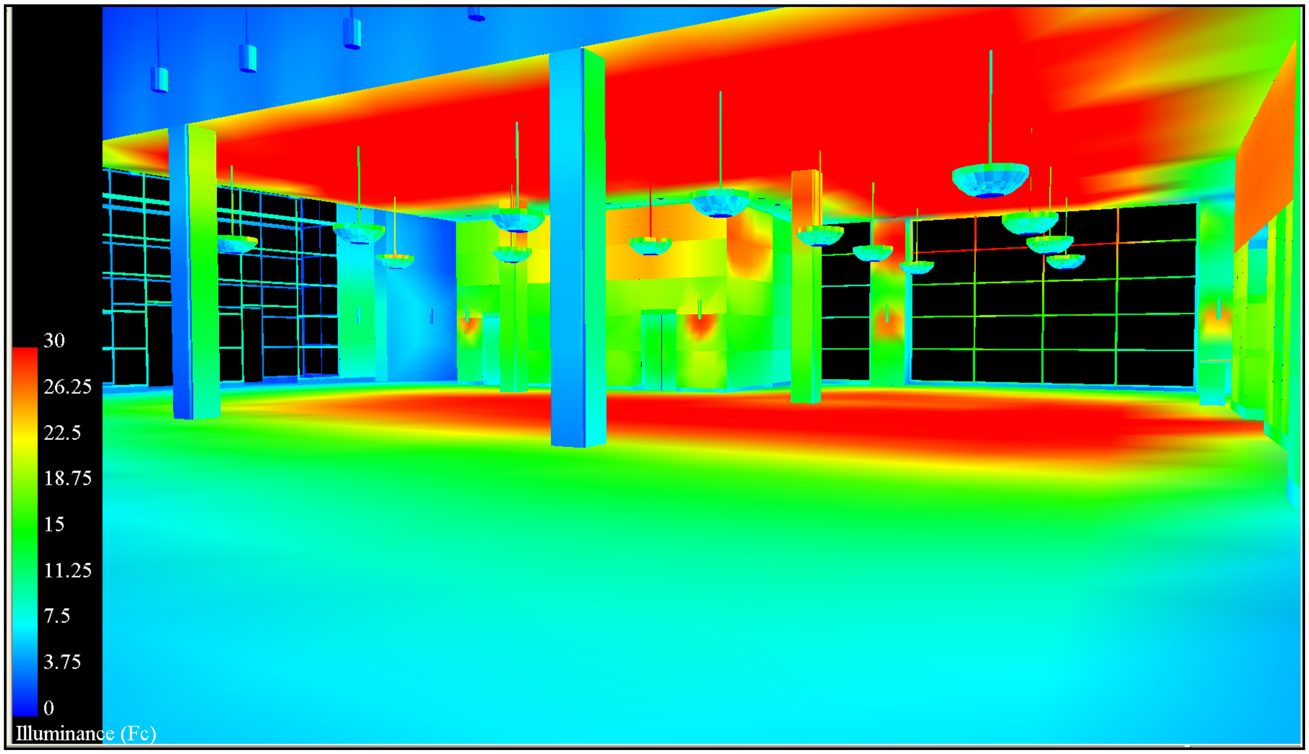


Figure 15: Pseudo Color of Lobby (Glass Façade Entrance)

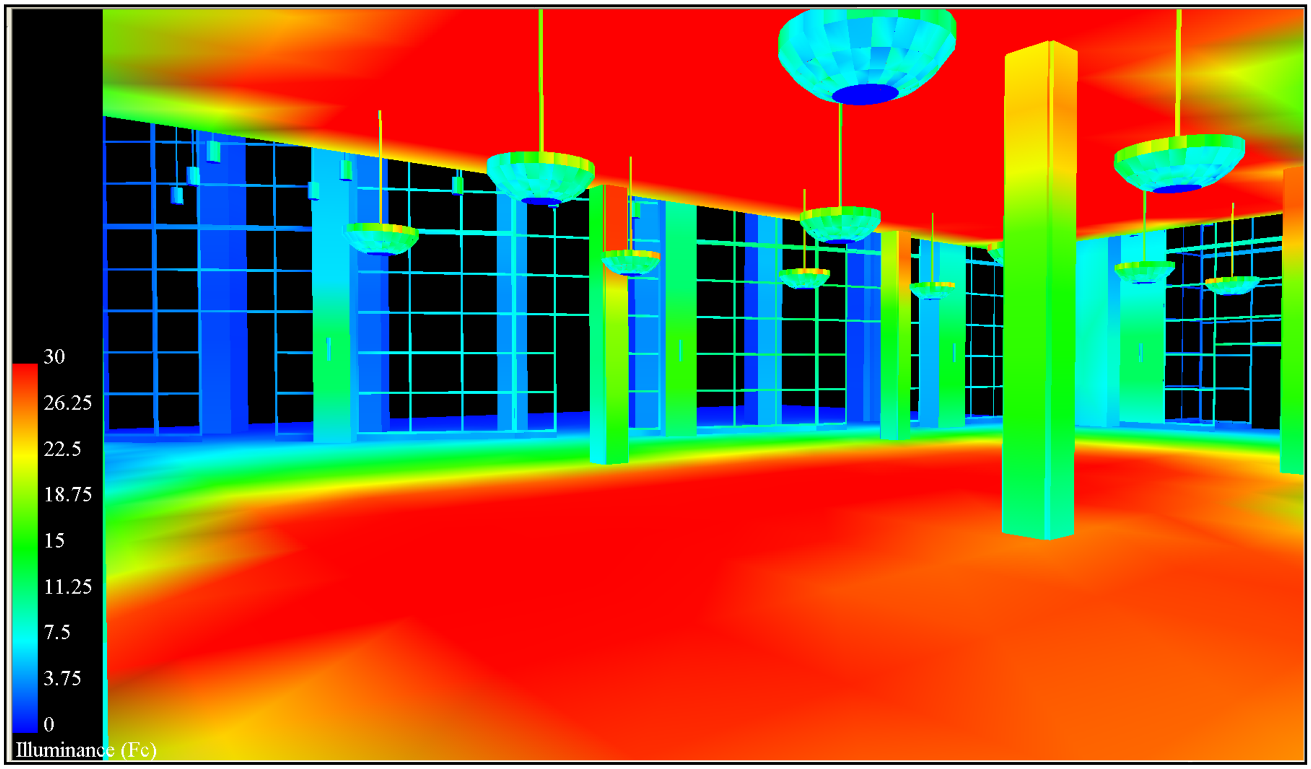


Figure 16: Pseudo Color of Lobby (@ Data Bar)

Conclusion

The lobby has an aesthetically pleasing look with the various high end construction materials and the lighting design. The space achieved all of the design goals by using pendants, recessed downlights, and wall sconces. The average illuminance on the work plane was 21.12 fc, which is above the IESNA value for a lobby/circulation space of 5 fc. However, the power density was 1.05 W/ft^2, which was under the ASHRAE 90.1 Standards of 1.30 W/ft^2 for a lobby.

Auditorium – Lighting Redesign

Description of Space

The 300-seat capacity auditorium resides on the first floor of the building. Upon entering the building through the curved façade that features large expanses of glass, one would find themselves in the lobby of the building. The auditorium entrance would then be straight ahead when in the lobby. The auditorium is used for lectures, demonstrations, film projects, and guest presentations. The tasks will be mainly note-taking, reading, and writing. The dimensions of the auditorium are 70' wide by 77' long by 15' high. This equates to a square footage of approximately 5,412 ft^2.

Floor Plan

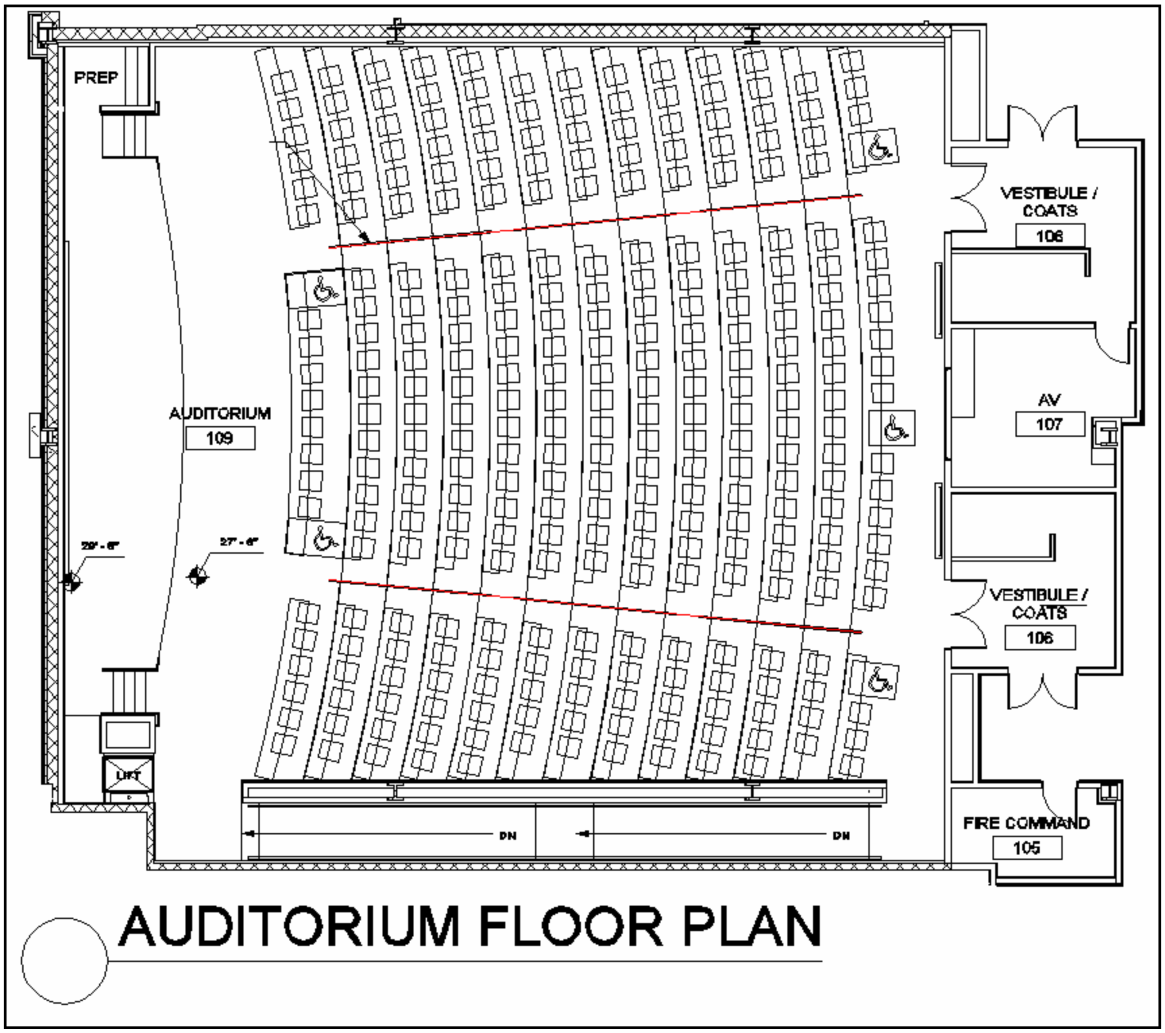


Figure 17: Auditorium Floor Plan

Design Concept

The design concept of the auditorium is to provide various scenes for the different tasks of the space, provide ample task lighting on the desks, and to accent the chalkboard/whiteboard. The space should provide a user friendly control system with the scene selection at the touch of a button. A smooth transition from the lobby will be incorporated into the design.

Design Criteria

Appearance of Space and Luminaires

The appearance of the space and luminaires is somewhat important in the auditorium. The auditorium will hold seminars with special speakers; therefore, the space and luminaires need to be aesthetically pleasing.

Color Appearance (and Color Contrast)

Color appearance can affect visibility and aesthetics. A color rendering index (CRI) of 70 or above is acceptable when dealing with educational facilities; however, a CRI greater than 80 may be needed in order to ensure a pleasant appearance of skin tones. Since the auditorium will have special speakers and guest lecturers, a CRI of 80 or greater will be beneficial. A CCT should be around 3500 K in order to provide a warmer feel to the space.

Light Distribution on Surfaces

Harsh striated patterns of excessive brightness or noticeable shadows should be avoided. Illuminance patterns should correspond with objects of the space. Ceiling and walls should have luminances within a 3:1 ratio. The current layout should not provide a harsh pattern on any surfaces in the space. The walls of the space can be uniform or non-uniform depending on the final design. Acoustical panels are on the upper portion of the wall. Depending on the appearance of the panels, a decision will be made on whether or not to make the light on the walls uniform or non-uniform.

Light Distribution on Task Plane (Uniformity)

Patterns of light on the task plane should be uniform. The desks in the room are used for reading and writing. A non-uniform pattern of light on the work plane would be distracting or confusing. The task illuminance should be higher than the immediate surroundings. With a work plane illuminance that is 1.5 to 3 times higher than those in the surrounding areas will assist in directing the occupants' attention to the task, which is very important in educational facilities. The illuminance of the speaker should also be illuminated greater than the surrounding tasks (approximately 25-30 fc).

Point(s) of Interest

The points of interest in the space include the projection screen and the podium at the front of the space. The projection screen should be a lower illuminance and the podium will prosper with a slightly higher illuminance.

Source/Task/Eye Geometry

Extremely important to a lecture hall is the source/task/eye geometry. The angular relationships between the viewer, the task, and the luminaire are frequently critical to task visibility. This should not be an issue due to the height of the ceiling.

System Control and Flexibility

System control and flexibility is very important due to the different tasks in the space. A couple of different systems include a scene for a projection screen, a guest speaker, lectures, and general reading/writing tasks. Dimming ballasts will be required.

Illuminance (Horizontal)

The IESNA handbook calls for a horizontal illuminance of 50 lux (5 fc) on the work plane for auditoriums; however, the horizontal illuminance of a classroom is 500 lux (50 fc). When the projection screen is in use, a horizontal illuminance of 50 lux (5 fc) on the work plane is needed.

Illuminance (Vertical)

The IESNA handbook recommends a vertical illuminance of 30 lux (3 fc) when the projection screen is in use. The points of interest for vertical illuminance include the chalkboard, the speaker, and the projection screen. Note that the projection screen should be a lower illuminance than the surrounding space.

Power Allowances from ASHRAE 90.1 Standards

The power allowance by the space by space method for a classroom, lecture, or training space is 1.4 W/ft^2.

Reflectances

Ceiling: Sloped Gypsum Wallboard Planes with Fascias to Follow Radius of Seating Tiers

- Assume 90% ceiling reflectance

Walls: Fabric Covered Acoustical Panels/Wood Panels/Painted Gypsum Wallboard

- Assume 50% wall reflectance

Floor: Constantine Commercial Carpet, "Corporate Exchange" 12' W Broadloom; Color T.B.D.

- Assume 20% floor reflectance

Fixture Schedule

Label	Description	MH	Lamps	Ballast/ Transformer	Watts	Voltage	Mfr.	Catalogue No.
F-C1	Concealed Cove-30 System with High-Reflectance White Reflectors	16'	1 – T5HO	REZ-154 – Mark 10 Powerline Electronic Dimming/Programmed Start	54	120	Lite Control Corporation	CC-AI-3024-T5-CWM-TW-2CWQ-277
F-C2	Triples-H 232/7 Recessed CFL Downlight/Wallwasher with EvenTone Clear Reflector	16'	2 – 32 Watt CFL	IZT-2T42-M3-BS@277 – Mark 7 – Electronic Dimming/Programmed Start	64	277	Edison Price Lighting	TRPH 232/7-277-VOL-DM
F-C3	Strip LED Lights for the Stairs	4"	10 – LEDS	Packaged Unit	24	120	Color Kinetics Incorporated	501-000010-00 MEDIUM
F-C4	Obround Wall Mount Luminaire with Specular Aluminum Reflector	11'	2 – F40T8	B-D2 – Advance Electronic/Instant Start Optanium	80	277	LAM Lighting	OB70-2/T8-O-L-WN-8-SGW-277-GLR

Table 11: Auditorium Fixture Schedule

Light Loss Factors

The assumed room cleaning period for this room is 6 months and the room is clean. The expected dirt depreciation was calculated at 8%.

RCR = [(5)*(H)*(L + W)] / (L)*(W)

RCR = [(5)*(15')*(77' + 70')] / (5412 ft^2) = 2.04 = 2.0

Label	Maintenance Category	LLD	RSDD	LDD	BF	LLF
F-C1	VI	0.90	0.90	0.92	1.00	0.75
F-C2	IV	0.83	0.98	0.93	1.00	0.76
F-C3	II	0.70	0.94	0.97	1.00	0.64
F-C4	IV	0.93	0.98	0.93	1.03	0.87

Table 12: Auditorium Light Loss Factors

Ballast Information

Label	Type	Ballast Watts	Ballast Factor	Voltage	Max THD %	Mfr.	Catalogue No.
B-C1	Electronic Dimming/Programmed Start	63	1.00	120	10	Advance – Mark 10 Powerline	REZ-154
B-C2	Mark 7 – Electronic Dimming/Programmed Start	75	1.00	277	10	Advance	IZT-2T42-M3-BS@277
B-C4	Electronic/Instant Start/2-Lamp	81	1.03	277	10	Advance – Optanium	VOP-4P32-SC

Table 13: Auditorium Ballast Information

Lamp Information

Label	Type	CRI	CCT	Watts	Initial Lumens	Mean Lumens	Mfr.	Ballast
L-C1	F54T5/830 HO ALTO TG	85	3000	54	5000	4500	Philips	REZ-154 – Mark 10 Powerline Electronic Dimming/Programmed Start
L-C2	PL-T 32W/830 GX24Q-3/4P	82	3000	32	2400	2000	Philips	IZT-2T42-M3-BS@277 – Mark 7 – Electronic Dimming/Programmed Start
L-C4	F40T8 TL841 ALTO	86	4100	40	3775	3500	Philips	B-D2 – Advance Electronic/Instant Start Optanium

Table 14: Auditorium Lamp Information

Power Density

Label	Ballast Watts	No. of Fixtures	Total Watts	
F-C1	63	42	2646	
F-C2	75	48	3600	
F-C3	24	48	1152	
F-C4	81	7	567	
			7965	Watt Total
			5412	Square Foot Total
			1.47 W/ft²	

Table 15: Auditorium Power Density

Therefore, the power density is slightly above the target IESNA value of 1.4 W/ft^2. If the power density must be lower than 1.4 W/ft2, then the amount of cove luminaires could be reduced in order to obtain the proper power density. The space is at an appropriate illuminance level of approximately 42.3 fc, so the power density is sufficient.

Lighting Plan

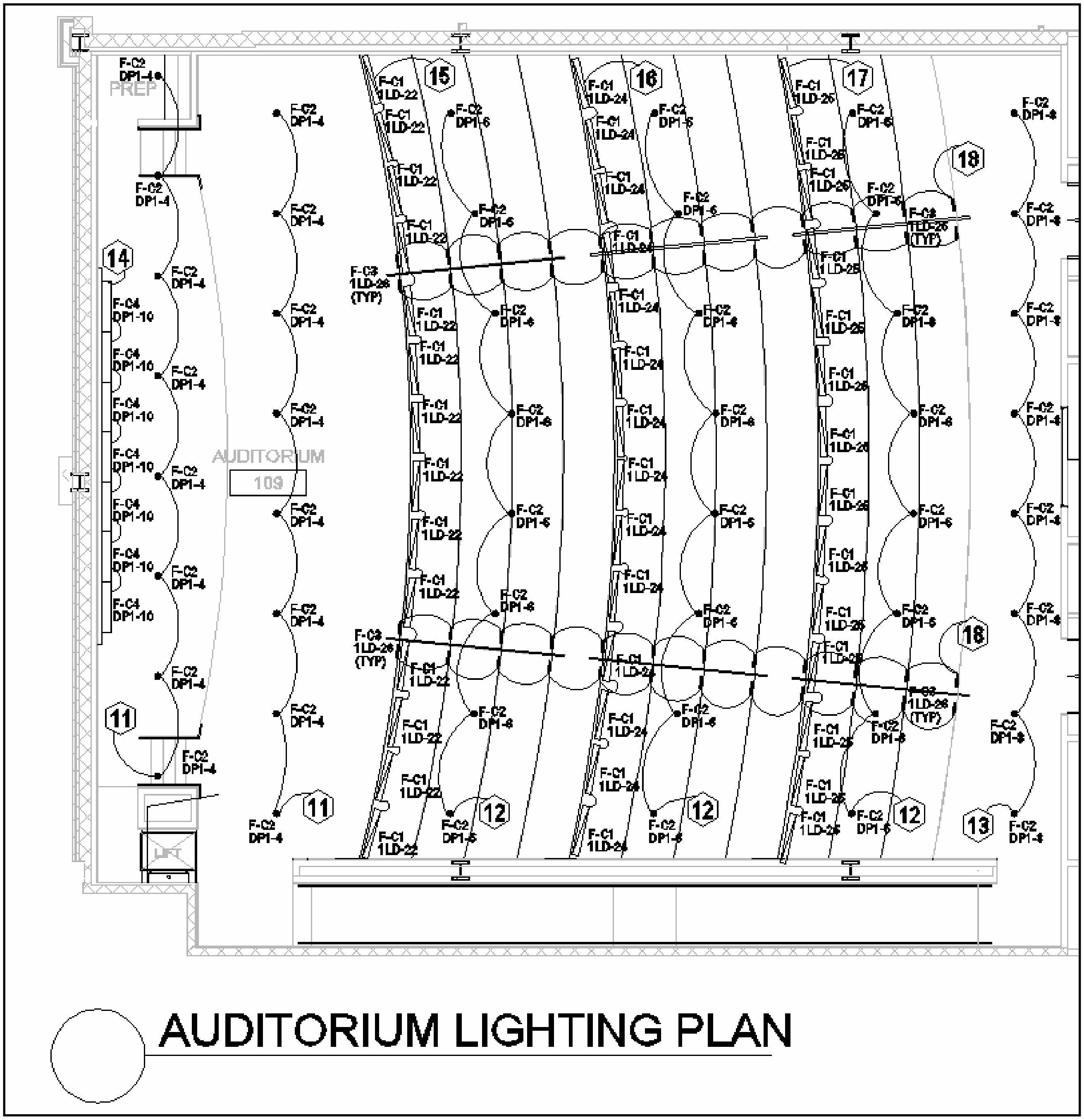


Figure 18: Auditorium Lighting Plan

Lighting Controls

The different zones represent different dimming areas. A Lutron 100 system is being utilized by the DH Hamilton Building. Occupancy sensors are being used as in the previous spaces.

Renderings

Figure 19: Rendering of Auditorium

Figure 20: Rendering of Auditorium

Renderings

Figure 21: Rendering of Auditorium

Figure 22: Rendering of Auditorium

Pseudo Color

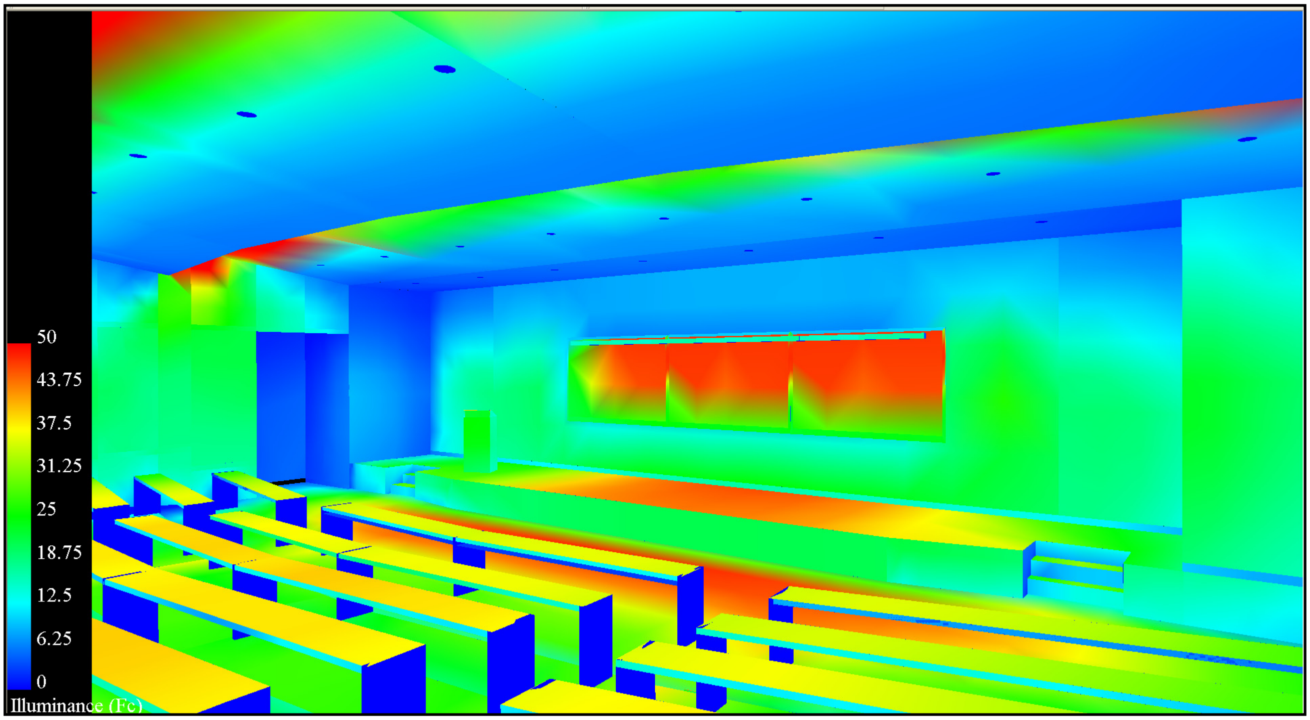


Figure 23: Pseudo Color of Auditorium

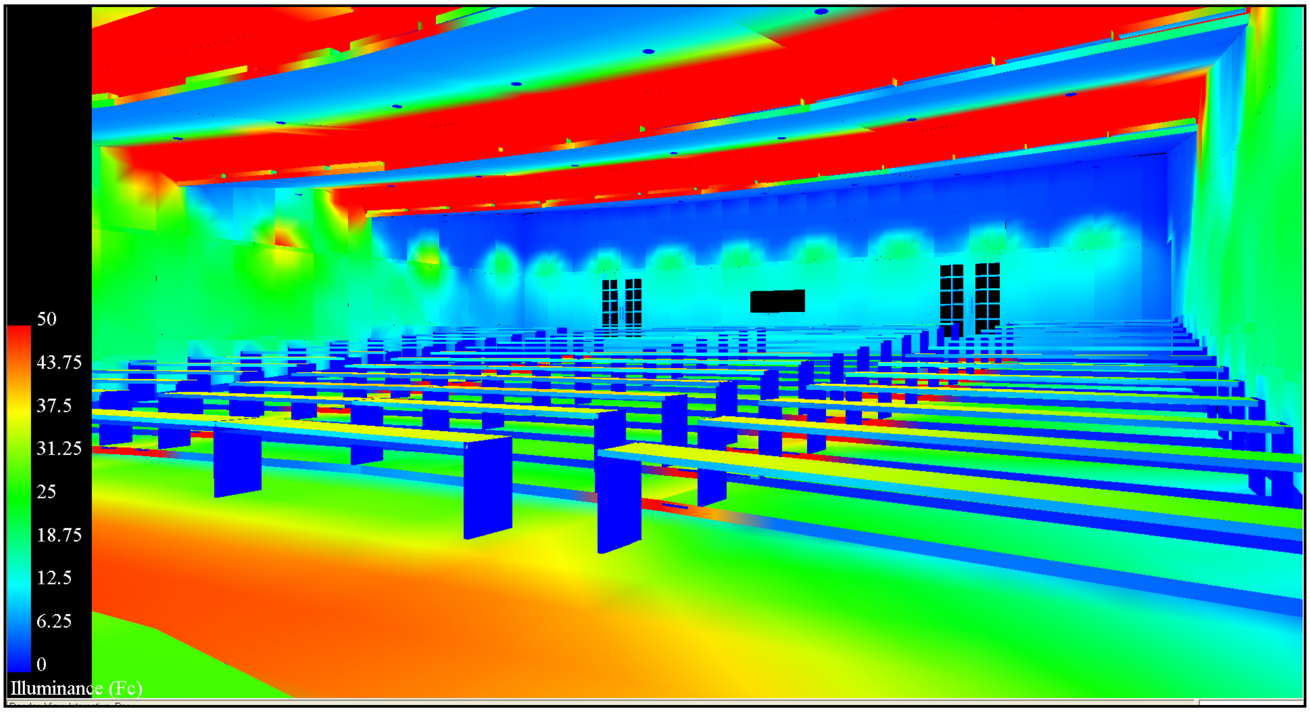


Figure 24: Pseudo Color of Auditorium

Conclusion

The auditorium was the hardest space to provide the lighting design for. The space had a curved ceiling with various heights across the whole ceiling. A curved cove was used throughout the space to achieve some area lighting. The rest of the ambient lighting was done through downlights. The steps have a built in LED strip. Overall, the lighting design achieved the space design goals. The average illuminance on the work plane was 42.3 fc, which is low for the IESNA value for a classroom/lecture space of 50 fc. The power density was 1.47 W/ft^2, which was slightly over the ASHRAE 90.1 Standards of 1.4 W/ft^2 for a classroom/lecture space.

Classroom (505) – Lighting Redesign

Description of Space

The 60-person classroom is located on the fifth floor of the building. The fifth floor of the Dorrance H. Hamilton Building also includes other classrooms, lecture halls, two skills simulation labs, storage rooms, a small lobby, and a library/meeting room. The back wall of the classroom is a curved glass ribbon window, which will have dual/solar blackout shades. The shades will provide the space with a visual display terminal (VDT) friendly environment. The space tasks include note-taking, reading, writing, chalkboard use, and VDT use. The classroom is 32' long by 54' wide by 10' high. This equates to an area of 1728 ft^2.

Floor Plan

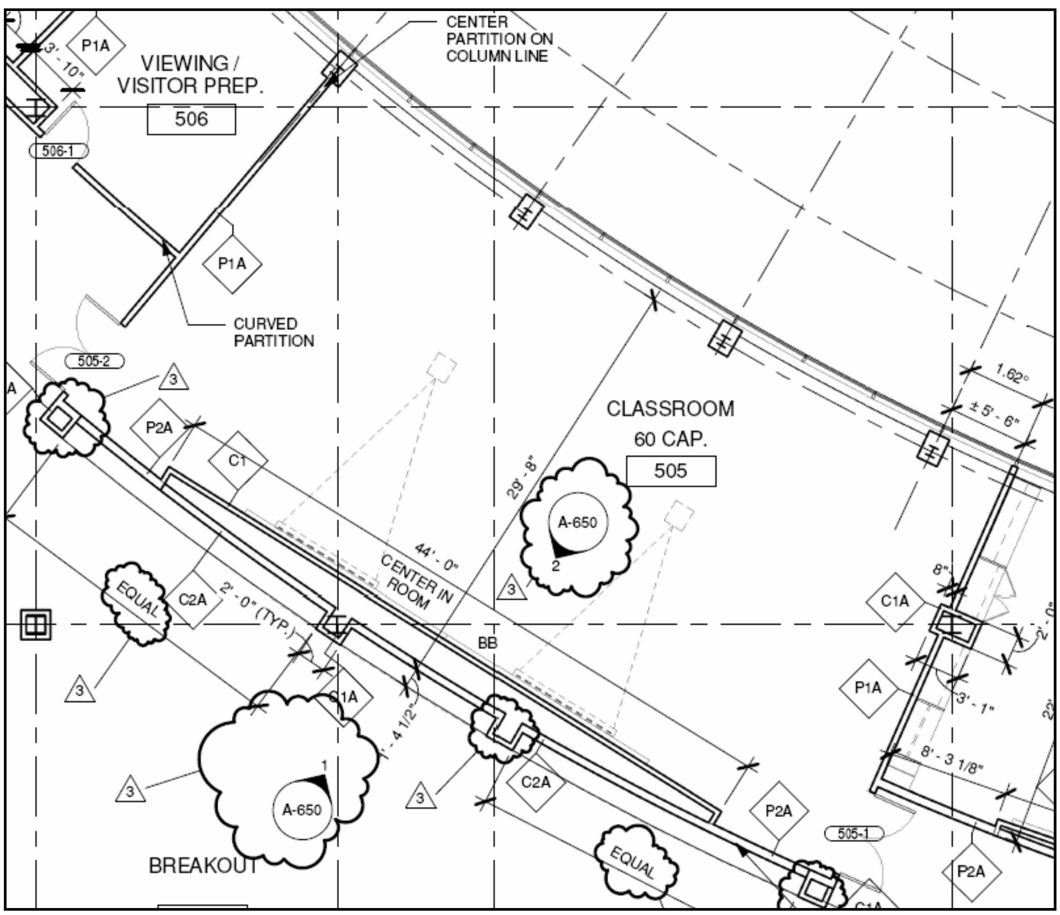


Figure 25: Classroom Floor Plan

Design Concept

The design concept of the classroom is to provide various scenes for the different tasks of the space, provide ample task lighting on the desks, and to accent the chalkboard/whiteboard. The space should be user friendly with only switching to turn the lights on and off. The front row of lights will be on a separate switch in order to provide sufficient lighting for the chalkboard/whiteboard. The 2x2 fixtures throughout the room will provide a sufficient area source of light. A fluorescent wall mounted light will be on top of the chalkboard to provide adequate illuminance.

Design Criteria

Daylighting Integration and Control

The space incorporates a curved ribbon window on the entire rear wall of the room. This will be a design issue during the use of the projector and screen and may even cause glare on the blackboard. Dual/Solar blackout blinds will remedy this potential problem; however, they will also limit the daylight in the space.

Light Distribution on Task Plane (Uniformity)

Patterns of light on the task plane should be uniform. The desks in the room are used for reading and writing, so a non-uniform pattern of light on the task plane would be distracting and/or confusing. In a learning environment, the task plane illuminance should be 1.5 to 3 times higher than those in the surrounding areas in order to assist occupant's attention on the task at hand.

System Control and Flexibility

System control and flexibility are of extreme importance in the space due to the various tasks provided in the classroom. A couple of different scenes of the space include the projection screen, blackboard/whiteboard applications, and general lecture talks. This will be accomplished by the front row of luminaires to be on a separate switch.

Illuminance (Horizontal)

The IESNA Handbook recommends a horizontal illuminance of 500 lux (50 fc) on the task plane for reading and writing tasks. When the projection screen is in use, a horizontal illuminance of 30 lux (3 fc) on the task plane is needed.

Illuminance (Vertical)

The IESNA Handbook recommends a vertical illuminance of 30 lux (3 fc) when the projection screen is in use. The points of interest for vertical illuminance include the chalkboard, the speaker, and the projection screen. Note: The projection screen should be a lower illuminance than the surrounding space.

Power Allowances from ASHRAE 90.1 Standards

The power allowance by the space by space method for a classroom, lecture, or training space is 1.4 W/ft^2 – 1.6 W/ft^2.

Reflectances

Ceiling: Acoustical Ceiling Tile

- Assume 85% ceiling reflectance

Walls: To Be Determined

- Assume 50% wall reflectance

Floor: To Be Determined

- Assume 50% floor reflectance

Fixture Schedule

Label	Description	Lamps	Ballast/ Transformer	Watts	Voltage	Mfr.	Catalogue No.
F-B1	2x2 Parabolic Grid Troffer with Specular Louver Finish	3 – F17T8	B-D1 - Advance Electronic Dimming/Instant Start Mark 10 PowerLine	51	277	Holophane	1-HP-G-N-22-X-N-D33-023-EP-1-2
F-B2	Obround Wall Mount Luminaire with Specular Aluminum Reflector	2 – F40T8	B-D2 – Advance Electronic/Instant Start Optanium	80	277	LAM Lighting	OB70-2/T8-O-L-WN-8-SGW-277-GLR

Table 16: Classroom Fixture Schedule

Light Loss Factors

The assumed room cleaning period for this room is 6 months and the room is clean. The expected dirt depreciation was calculated at 8%.

RCR = [(5)*(H)*(L + W)] / (L)*(W)

RCR = [(5)*(10')*(32' + 54')] / (32')*(54') = 2.49 = 2.5

Label	Maintenance Category	LLD	RSDD	LDD	BF	LLF
F-D1	IV	0.95	0.98	0.93	1.05	0.91
F-D2	IV	0.93	0.98	0.93	1.03	0.87

Table 17: Classroom Light Loss Factors

Ballast Information

Label	Type	Ballast Watts	Ballast Factor	Voltage	Max THD %	Mfr.	Catalogue No.
B-D1	Electronic Dimming/ Instant Start/ 3-Lamp	56	1.05	277	10	Advance – Mark 10 PowerLine	VEZ-3S32-SC
B-D2	Electronic/Instant Start/2-Lamp	81	1.03	277	10	Advance – Optanium	VOP-4P32-SC

Table 18: Classroom Ballast Information

Lamp Information

Label	Type	CRI	CCT	Watts	Initial Lumens	Mean Lumens	Mfr.	Ballast
L-D1	F17T8 TL841 ALTO TG	85	4100	17	1400	1330	Philips	B-D1 - Advance Electronic Dimming/Instant Start Mark 10 PowerLine
L-D2	F40T8 TL841 ALTO	86	4100	40	3775	3500	Philips	B-D2 – Advance Electronic/Instant Start Optanium

Table 19: Classroom Lamp Information

Power Density

Label	Ballast Watts	No. of Fixtures	Total Watts	
F-D1	59	28	1652	
F-D2	81	4	324	
			1976	Watt Total
			1506	Square Foot Total
			1.31 W/ft^2	

Table 20: Classroom Power Density

Therefore, the power density is slightly below the target IESNA value of 1.4 W/ft^2 to 1.6 W/ft^2. The space is at an appropriate illuminance level, so the power density is sufficient.

Lighting Plan

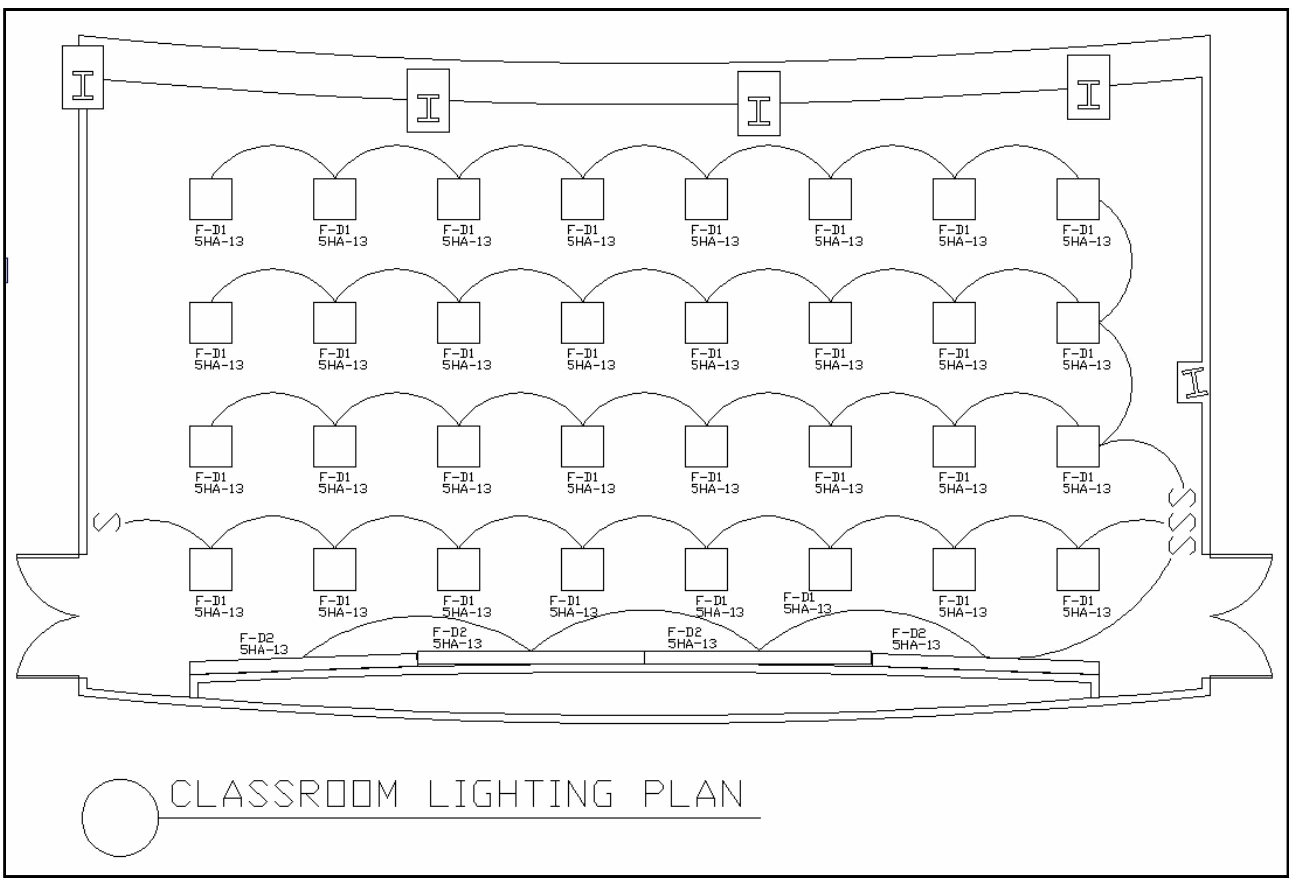


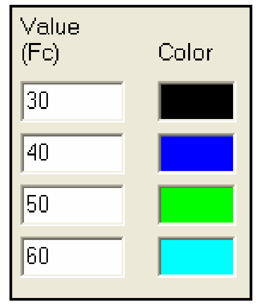
Figure 26: Classroom Lighting Plan

Lighting Controls

The classroom will use two dual technology occupancy sensors due to the size of the classroom. The sensors will be located in two rear corners of the classroom. The sensors can accommodate lower levels of activity without false triggers. Dimming ballasts are specified for use with these lighting controls.

Isometrics

The Isolines from AGI32 were analyzed on the work plane height of 2.5'. The average illuminance throughout the classroom was 49.66 fc.



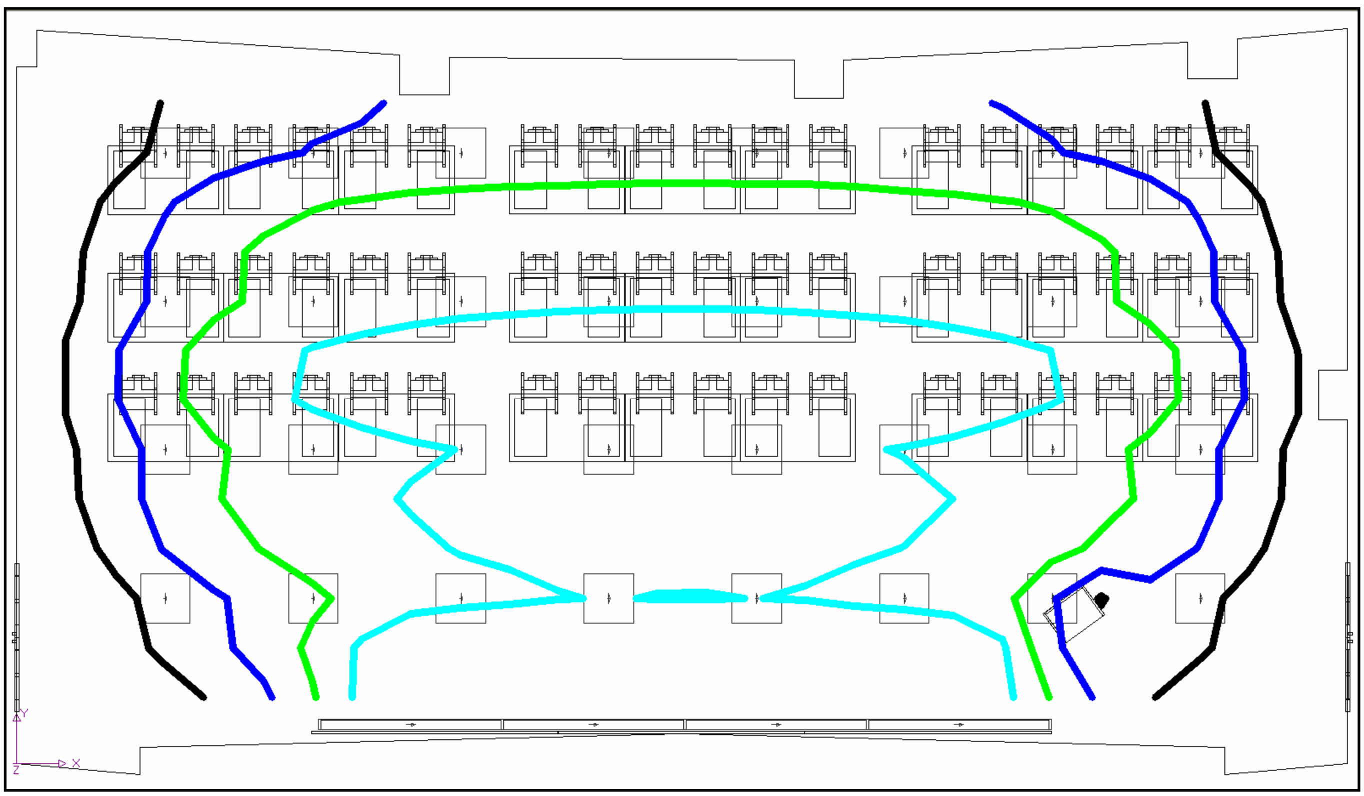


Figure 27: View of Isolines of Classroom

Renderings


Figure 28: Rendering of Classroom


Figure 29: Rendering of Classroom

Conclusion

Overall, the lighting design achieved the space design goals. The 2 by 2 fixtures worked well in accordance with the acoustical tile ceiling grid and provided sufficient light onto the workplane. The average illuminance on the work plane was 49.6 fc, which almost matched the IESNA value for a classroom of 50 fc. The power density was 1.31 W/ft^2, which was under the ASHRAE 90.1 Standards of 1.4 W/ft^2 for a classroom.

Electrical Depth

Electrical Introduction

The current power distribution system provides the building with power; however, an alternative design solution was analyzed. This analysis was done in order to compare the two different systems by cost analysis, efficiency, and power consumption.

The system redesign is comprised of a variety of different tasks, which include the redesign of branch circuits for the four re-lighted spaces, analysis of a central transformer versus distributed transformers, analysis of feeders versus a bus duct spanning to the penthouse, the analysis of a motor control center, and a protective device coordination study. The redesign of the power distribution system was compared to the existing system regarding cost analysis, efficiency, and power consumption. The cost analysis is a part of the construction management breadth work.

The power distribution system was redesigned following the 2005 NEC handbook. The branch circuits were recalculated along with feeders and panelboard schedules for all four areas of the redesign of the lighting systems. A central transformer was utilized instead of distributed transformers on each floor. The elimination of a variety of feeders in place of a bus duct spanning to the penthouse should be an advantageous change to the power distribution system. The installment of a mechanical equipment motor control center was analyzed by calculating the design loads for branch conductors, feeders, and protective devices. Also, a short circuit current calculation was investigated for a single-path through the distribution system.

Branch Circuit Redesign – Plaza

Original Panelboard 1LA - Plaza

PANEL NAME	VOLTAGE INFORMATION				PANEL INFORMATION						FEEDER INFORMATION	
1LA	VOLTAGE	120/208			BUSS		150A				FROM	1DPA
MOUNTING: SURFACE	PHASE	3			MAIN/MLO		MLO				TYPE	NORMAL
LOCATION: 1ST FLOOR	WIRE	4			AIC RATING		10 kA				SIZE	SEE RISER ON E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
RCPT 112	900	12		20A-1P	1	A----	2	20A-1P		12	500	RELAY PANEL LP-1
RCPT 110	180	12		20A-1P	3	--B--	4	20A-1P		12	1080	RCPT 112B
RCPT 110	540	12		20A-1P	5	---C	6	20A-1P		12	100	UH LOADING DOCK
GFI WP	360	12		20A-1P	7	A----	8	20A-1P		12	1000	PLASMA SCREEN
RCPT 100,100C,111	900	12		20A-1P	9	--B--	10	20A-1P				SPARE
COLUMN RCPT 100	720	12		20A-1P	11	---C	12	20A-1P		12	360	EXTERIOR LED LIGHTS
COLUMN RCPT 100	720	12		20A-1P	13	A----	14	20A-1P		12	200	EXTERIOR CAMERA
ICE MACHINE	1000	12		20A-1P	15	--B--	16	20A-1P		12	500	COFFEE
GARBAGE DISPOSAL	1000	12		20A-1P	17	---C	18	20A-1P		12	1500	FOOD CARTS
REFRIGERATOR	1000	12		20A-1P	19	A----	20	20A-1P		12	1500	FOOD CARTS
DISHWASHER, 110	6126	#3	1.25"	80A-2P	21	--B--	22	20A-1P				SPARE
	6126				23	---C	24	20A-1P				SPARE
RCPT METERS, 112A	500	12		20A-1P	25	A----	26	20A-1P				SPARE
SPACE AND PROVISION					27	--B--	28					SPACE AND PROVISION
SPACE AND PROVISION					29	---C	30					SPACE AND PROVISION
SPACE AND PROVISION					31	A----	32					SPACE AND PROVISION
SPACE AND PROVISION					33	--B--	34					SPACE AND PROVISION
SPACE AND PROVISION					35	---C	36					SPACE AND PROVISION
AUTO DOOR, 112	829	12		20A-3P	37	A----	38					SPACE AND PROVISION
	829				39	--B--	40					SPACE AND PROVISION
	829				41	---C	42					SPACE AND PROVISION

NOTES:
1. PROVIDE 200% NEUTRAL

Figure 30: Original Panelboard – Plaza

New Panelboard 1LA – Plaza

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W	PANEL TAG: 1LA	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 150A	PANEL LOCATION: Room 112B - Electrical Room	OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1DPA
SIZE/TYPE MAIN: 150A/3P C/B	PANEL MOUNTING: SURFACE	

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
RCPT	Room 112	900	20A/1P	1	*			2	20A/1P	500	-	RELAY PANEL LP-1
RCPT	Room 110	180	20A/1P	3		*		4	20A/1P	1080	Room 112B	RCPT
RCPT	Room 110	540	20A/1P	5			*	6	20A/1P	100	-	UH LOADING DOCK
GFI WP	-	360	20A/1P	7	*			8	20A/1P	1000	-	PLASMA SCREEN
RCPT	Rm 100, 111	900	20A/1P	9		*		10	20A/1P	0	-	SPARE
COLUMN RCPT	Room 100	720	20A/1P	11			*	12	20A/1P	0	-	SPARE
COLUMN RCPT	Room 100	720	20A/1P	13	*			14	20A/1P	200	-	EXT. CAMERA
ICE MACHINE	-	1000	20A/1P	15		*		16	20A/1P	500	-	COFFEE
ARBAGE DISPOSA	-	1000	20A/1P	17			*	18	20A/1P	1500	-	FOOD CARTS
REFRIGERATOR	-	1000	20A/1P	19	*			20	20A/1P	1500	-	FOOD CARTS
DISHWASHER	-	6126	80A/2P	21		*		22	20A/1P	0	-	SPARE
DISHWASHER	-	6126	80A/2P	23			*	24	20A/1P	0	-	SPARE
RCPT METERS	Room 112A	500	20A/1P	25	*			26	20A/1P	0	-	SPARE
SPACE & PROV.	-	0		27		*		28		0	-	SPACE & PROV.
SPACE & PROV.	-	0		29			*	30		0	-	SPACE & PROV.
SPACE & PROV.	-	0		31	*			32		0	-	SPACE & PROV.
SPACE & PROV.	-	0		33		*		34		0	-	SPACE & PROV.
SPACE & PROV.	-	0		35			*	36		0	-	SPACE & PROV.
AUTO DOOR	Room 112	829	20A/3P	37	*			38		0	-	SPACE & PROV.
AUTO DOOR	Room 112	829	20A/3P	39		*		40		0	-	SPACE & PROV.
AUTO DOOR	Room 112	829	20A/3P	41			*	42		0	-	SPACE & PROV.

CONNECTED LOAD (KW) - A	7.51	TOTAL DESIGN LOAD (KW)	24.55
CONNECTED LOAD (KW) - B	10.62	POWER FACTOR	0.88
CONNECTED LOAD (KW) - C	10.82	TOTAL DESIGN LOAD (AMPS)	77

Figure 31: New Panelboard – Plaza

Feeder Size – Plaza

Feeder Size – Panelboard 1LA	
Calculated Design Load	77.4 A
Feeder Protection Size	80 A
Sets	1
Wire Size	
Phase	#4 AWG
Neutral	2/0 AWG
Ground	#8 AWG
Wire Area	
Each Phase	0.0824"
All Phase	0.2472"
Neutral	0.2223"
Ground	0.0366"
Total Area	0.5061"
Conduit Size	1 ¼"
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾" conduit 200% Neutral

Table 21: Feeder Size – Plaza

Original Panelboard 1HA - Plaza

PANEL NAME	VOLTAGE INFORMATION				PANEL INFORMATION						FEEDER INFORMATION	
1HA	VOLTAGE	277/480			BUSS		200A				FROM	BDPA
SURFACE	PHASE	3			MAIN/MLO		MLO W/SUBFEED LUGS				TYPE	NORMAL
LOCATION: 1ST FLOOR	WIRE	4			AIC RATING		25 kA				SIZE	SEE RISER ON E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
LIGHTING	2776	12		20A-1P	1	A----	2	20A-1P		#12	1300	SITE LGT, WEST PLAZA
LIGHTING	2648	12		20A-1P	3	--B--	4	20A-1P		#12	800	TREE LGT, WEST PLAZA
LIGHTING	2960	12		20A-1P	5	---C	6	20A-1P		#12	1295	SITE LGT @SCOTT
LIGHTING	1824	12		20A-1P	7	A----	8	50A-3P	1"	#6	5466	PANEL DP1
LIGHTING	1710	12		20A-1P	9	--B--	10				5466	
LIGHTING	3162	12		20A-1P	11	---C	12				5466	
VAV'S	2424	#12		20A-1P	13	A----	14	20A-1P		#12	1780	SITE LGT, EAST PLAZA
VAV'S	1224	#12		20A-1P	15	--B--	16	20A-1P		#12	1300	TREE LGT, EAST PLAZA
PARK SIGNS	*2200*	#12		20A-1P	17	---C	18	20A-1P				SPARE
SPARE				20A-1P	19	A----	20	20A-1P				SPARE
SPARE				20A-1P	21	--B--	22	20A-1P				SPARE
SPARE				20A-1P	23	---C	24	20A-1P				SPARE
SPARE				20A-1P	25	A----	26	20A-1P				SPARE
SPARE				20A-1P	27	--B--	28	20A-1P				SPARE
SPARE				20A-1P	29	---C	30	20A-1P				SPARE
SPACE AND PROVISION					31	A----	32					SPACE AND PROVISION
SPACE AND PROVISION					33	--B--	34					SPACE AND PROVISION
SPACE AND PROVISION					35	---C	36					SPACE AND PROVISION
SPACE AND PROVISION					37	A----	38					SPACE AND PROVISION
SPACE AND PROVISION					39	--B--	40					SPACE AND PROVISION
SPACE AND PROVISION					41	---C	42					SPACE AND PROVISION
NOTES:												

Figure 32: Original Panelboard – Plaza

New Panelboard 1HA – Plaza

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 200A SIZE/TYPE MAIN: 200A/3P C/B	PANEL TAG: 1HA PANEL LOCATION: Room 112B - Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 25K OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD BDPA

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	-	2776	20A/1P	1	*			2	20A/1P	1400	Plaza	LIGHTING
LIGHTING	-	2648	20A/1P	3		*		4	20A/1P	2808	Plaza	LIGHTING
LIGHTING	-	2960	20A/1P	5			*	6	20A/1P	1146	Plaza	LIGHTING
LIGHTING	-	1824	20A/1P	7	*			8	50A/3P	5466	-	PANEL DP1
LIGHTING	-	1710	20A/1P	9		*		10	50A/3P	5466	-	PANEL DP1
LIGHTING	-	3162	20A/1P	11			*	12	50A/3P	5466	-	PANEL DP1
VAV'S	-	2424	20A/1P	13	*			14	20A/1P	924	Plaza	LIGHTING
VAV'S	-	1224	20A/1P	15		*		16	20A/1P	1260	Plaza	LIGHTING
PARK SIGNS	-	2200	20A/1P	17			*	18	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	19	*			20	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	21		*		22	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	23			*	24	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPARE
SPACE & PROV.	-	0		31	*			32		0	-	SPACE & PROV.
SPACE & PROV.	-	0		33		*		34		0	-	SPACE & PROV.
SPACE & PROV.	-	0		35			*	36		0	-	SPACE & PROV.
SPACE & PROV.	-	0		37	*			38		0	-	SPACE & PROV.
SPACE & PROV.	-	0		39		*		40		0	-	SPACE & PROV.
SPACE & PROV.	-	0		41			*	42		0	-	SPACE & PROV.
CONNECTED LOAD (KW) - A		14.81								TOTAL DESIGN LOAD (KW)		34.67
CONNECTED LOAD (KW) - B		15.12								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		14.93								TOTAL DESIGN LOAD (AMPS)		44

Figure 33: New Panelboard – Plaza

Feeder Size – Plaza

Feeder Size – Panelboard 1HA	
Calculated Design Load	44.1 A
Feeder Protection Size	45 A
Sets	1
Wire Size	
Phase	#8 AWG
Neutral	#8 AWG
Ground	#10 AWG
Wire Area	
Each Phase	0.0366"
All Phase	0.1098"
Neutral	0.0366"
Ground	0.0211"
Total Area	0.1675"
Conduit Size	¾"
Remarks:	Based on Copper Wire, 75ºC, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾" conduit 100% Neutral

Table 22: Feeder Size – Plaza

Branch Circuit Redesign – Lobby

Original Panelboard - Lobby

PANEL NAME	VOLTAGE INFORMATION				PANEL INFORMATION					FEEDER INFORMATION		
DP1	VOLTAGE	277/480			BUSS		125A			FROM		1HA
MOUNTING: SURFACE	PHASE	3			MAIN/MLO		MLO W/SUBFEED LUGS			TYPE		NORMAL
LOCATION: 1ST FLOOR	WIRE	4			AIC RATING		14 kA			SIZE		SEE RISER E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
LOBBY ZONE 1	420	#12		20A-1P	1	A----	2	20A-1P		#12	240	LOBBY ZONE 9
LOBBY ZONE 2	2760	#12		20A-1P	3	--B--	4	20A-1P		#12	240	LOBBY ZONE 10
LOBBY ZONE 3	480	#12		20A-1P	5	---C	6	20A-1P		#12	2240	AUDITORIUM ZONE 11
LOBBY ZONE 4	1200	#12		20A-1P	7	A----	8	20A-1P		#12	1088	AUDITORIUM ZONE 12
LOBBY ZONE 5	450	#12		20A-1P	9	--B--	10	20A-1P		#12	1500	AUDITORIUM ZONE 13
LOBBY ZONE 6	810	#12		20A-1P	11	---C	12	20A-1P		#12	900	AUDITORIUM ZONE 14
LOBBY ZONE 7	400	#12		20A-1P	13	A----	14	20A-1P		#12	300	AUDITORIUM ZONE 15
LOBBY ZONE 8	660	#12		20A-1P	15	--B--	16	20A-1P		#12	300	AUDITORIUM ZONE 16

NOTES:
1. DIMMING PANEL PROVIDED WITH DIMMING SYSTEM.

Figure 34: Original Panelboard – Lobby

New Panelboard – Lobby

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 125A
SIZE/TYPE MAIN: 125A/3P C/B

PANEL TAG: DP1
PANEL LOCATION: ROOM 112B - ELECTRICAL
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14 K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1HA

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING ZONE 1	Lobby	2240	20A/1P	1	*			2	20A/1P	216	Lobby	LIGHTING ZONE 8
LIGHTING ZONE 2	Lobby	432	20A/1P	3		*		4	20A/1P	2240	Auditorium	LIGHTING ZONE 11
LIGHTING ZONE 3	Lobby	896	20A/1P	5			*	6	20A/1P	1088	Auditorium	LIGHTING ZONE 12
LIGHTING ZONE 4	Lobby	216	20A/1P	7	*			8	20A/1P	1500	Auditorium	LIGHTING ZONE 13
LIGHTING ZONE 5	Lobby	432	20A/1P	9		*		10	20A/1P	900	Auditorium	LIGHTING ZONE 14
LIGHTING ZONE 6	Lobby	432	20A/1P	11			*	12	20A/1P	300	Auditorium	LIGHTING ZONE 15
LIGHTING ZONE 7	Lobby	432	20A/1P	13	*			14	20A/1P	300	Auditorium	LIGHTING ZONE 16
		0		15		*		16		0		
		0		17			*	18		0		
		0		19	*			20		0		
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		
CONNECTED LOAD (KW) - A		4.90							TOTAL DESIGN LOAD (KW)			13.95
CONNECTED LOAD (KW) - B		4.00							POWER FACTOR			0.96
CONNECTED LOAD (KW) - C		2.72							TOTAL DESIGN LOAD (AMPS)			18

Figure 35: New Panelboard – Lobby

Feeder Size – Lobby

Feeder Size – Panelboard DP1	
Calculated Design Load	17.6 A
Feeder Protection Size	20 A
Sets	1
Wire Size	
Phase	#12 AWG
Neutral	#12 AWG
Ground	#12 AWG
Wire Area	
Each Phase	0.0133”
All Phase	0.0399”
Neutral	0.0133”
Ground	0.0133”
Total Area	0.0665”
Conduit Size	¾"
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾” conduit 100% Neutral

Table 23: Feeder Size Lobby

Original Panelboard – Lobby

PANEL NAME	VOLTAGE INFORMATION				PANEL INFORMATION						FEEDER INFORMATION	
1LD	VOLTAGE	120/208			BUSS			100A			FROM	1DPA
MOUNTING: SURFACE	PHASE	3			MAIN/MLO			MLO			TYPE	NORMAL
LOCATION: 1ST FLOOR	WIRE	4			AIC RATING			10 kA			SIZE	SEE RISER ON E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
COLUMN RECEPTS	1440	12		20A-1P	1	A----	2	20A-1P		12	900	WIREWAY: LOBBY
COLUMN RECEPTS	1440	12		20A-1P	3	--B--	4	20A-1P		12	720	WIREWAY: LOBBY
PROJECTOR: LOBBY	1000	12		20A-1P	5	---C	6	20A-1P		12	540	RECEPTS
MOTORIZED SCREEN	500	12		20A-1P	7	A----	8	20A-1P		12	500	SENSORS: RESTROOM
A V EQUIPMENT	1000	12		20A-1P	9	--B--	10	20A-1P		12	500	SENSORS: RESTROOM
PLASMA SCREEN	*1000*	12		20A-1P	11	---C	12	20A-1P		12	540	RESTROOM GFI
PLASMA SCREEN	1000	12		20A-1P	13	A----	14	20A-1P		12	250	LUTRON SYSTEM, 100
EWC GFI	500	12		20A-1P	15	--B--	16	20A-1P		12	1395	FCU'S, 100A
EWC GFI	500	12		20A-1P	17	---C	18	20A-1P		12	540	RCPT, 101
ELEVATOR PIT	540	12		20A-1P	19	A----	20	20A-1P		*12*	*1000*	*PLASMA SCREEN*
SPARE				20A-1P	21	--B--	22					SPACE AND PROVISION
SPARE				20A-1P	23	---C	24					SPACE AND PROVISION
SPARE				20A-1P	25	A----	26					SPACE AND PROVISION
SPACE AND PROVISION					27	--B--	28					SPACE AND PROVISION
SPACE AND PROVISION					29	---C	30					SPACE AND PROVISION
SPACE AND PROVISION					31	A----	32					SPACE AND PROVISION
SPACE AND PROVISION					33	--B--	34					SPACE AND PROVISION
SPACE AND PROVISION					35	---C	36					SPACE AND PROVISION
SPACE AND PROVISION					37	A----	38					SPACE AND PROVISION
SPACE AND PROVISION					39	--B--	40					SPACE AND PROVISION
SPACE AND PROVISION					41	---C	42					SPACE AND PROVISION
NOTES: 1. PROVIDE 200% NEUTRAL												

Figure 36: Original Panelboard – Lobby

New Panelboard – Lobby

PANELBOARD SCHEDULE		
VOLTAGE: 208Y/120V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 100A/3P C/B	PANEL TAG: 1LD PANEL LOCATION: ROOM 112B - ELECTRICAL PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1DPA

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
COLUMN RCPTS	LOBBY	1440	20A/1P	1	*			2	20A/1P	900	LOBBY	WIREWAY: LOBBY
COLUMN RCPTS	LOBBY	1440	20A/1P	3		*		4	20A/1P	720	LOBBY	WIREWAY: LOBBY
ROJECTOR: LOBB	LOBBY	1000	20A/1P	5			*	6	20A/1P	540	-	RECEPTS
OTORIZED SCREE	LOBBY	500	20A/1P	7	*			8	20A/1P	500	-	SENSORS: RR
AV EQUIPMENT	LOBBY	1000	20A/1P	9		*		10	20A/1P	500	-	SENSORS: RR
PLASMA SCREEN	LOBBY	1000	20A/1P	11			*	12	20A/1P	540	-	RESTROOM GFI
PLASMA SCREEN	LOBBY	1000	20A/1P	13	*			14	20A/1P	250	100	LUTRON SYSTEM
EWC GFI	LOBBY	500	20A/1P	15		*		16	20A/1P	1395	100A	FCU'S
EWC GFI	LOBBY	500	20A/1P	17			*	18	20A/1P	540	100	RCPT
ELEVATOR PIT	LOBBY	540	20A/1P	19	*			20	20A/1P	1000	LOBBY	PLASMA SCREEN
LIGHTING ZONE 9	LOBBY	1200	20A/1P	21		*		22	20A/1P	0	-	SPACE & PROV
LIGHTING ZONE 10	LOBBY	450	20A/1P	23			*	24	20A/1P	0	-	SPACE & PROV
SPARE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	31	*			32	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	33		*		34	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	35			*	36	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	37	*			38	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	39		*		40	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	41			*	42	20A/1P	0	-	SPACE & PROV

CONNECTED LOAD (KW) - A	6.13	TOTAL DESIGN LOAD (KW)	19.40
CONNECTED LOAD (KW) - B	6.76	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C	4.57	TOTAL DESIGN LOAD (AMPS)	60

Figure 37: New Panelboard – Lobby

Feeder Size – Lobby

Feeder Size – Panelboard 1LD	
Calculated Design Load	59.8 A
Feeder Protection Size	60 A
Sets	1
Wire Size	
Phase	#6 AWG
Neutral	#6 AWG
Ground	#10 AWG
Wire Area	
Each Phase	0.0507"
All Phase	0.1521"
Neutral	0.0507"
Ground	0.0211"
Total Area	0.2239"
Conduit Size	¾"
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾" conduit 100% Neutral

Table 24: Feeder Size Lobby

Branch Circuit Redesign – Auditorium

Original Panelboard - Auditorium

PANEL NAME	VOLTAGE INFORMATION					PANEL INFORMATION					FEEDER INFORMATION	
DP1	VOLTAGE	277/480				BUSS	125A				FROM	1HA
MOUNTING: SURFACE	PHASE	3				MAIN/MLO	MLO W/SUBFEED LUGS				TYPE	NORMAL
LOCATION: 1ST FLOOR	WIRE	4				AIC RATING	14 kA				SIZE	SEE RISER E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
LOBBY ZONE 1	420	#12		20A-1P	1	A----	2	20A-1P		#12	240	LOBBY ZONE 9
LOBBY ZONE 2	2760	#12		20A-1P	3	--B--	4	20A-1P		#12	240	LOBBY ZONE 10
LOBBY ZONE 3	480	#12		20A-1P	5	---C	6	20A-1P		#12	2240	AUDITORIUM ZONE 11
LOBBY ZONE 4	1200	#12		20A-1P	7	A----	8	20A-1P		#12	1088	AUDITORIUM ZONE 12
LOBBY ZONE 5	450	#12		20A-1P	9	--B--	10	20A-1P		#12	1500	AUDITORIUM ZONE 13
LOBBY ZONE 6	810	#12		20A-1P	11	---C	12	20A-1P		#12	900	AUDITORIUM ZONE 14
LOBBY ZONE 7	400	#12		20A-1P	13	A----	14	20A-1P		#12	300	AUDITORIUM ZONE 15
LOBBY ZONE 8	660	#12		20A-1P	15	--B--	16	20A-1P		#12	300	AUDITORIUM ZONE 16

NOTES:
1. DIMMING PANEL PROVIDED WITH DIMMING SYSTEM.

Figure 38: Original Panelboard – Auditorium

New Panelboard – Auditorium

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 125A
SIZE/TYPE MAIN: 125A/3P C/B

PANEL TAG: DP1
PANEL LOCATION: Room 112B - Electrical
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14 K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1HA

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING ZONE 1	Lobby	2240	20A/1P	1	*			2	20A/1P	216	Lobby	LIGHTING ZONE 8
LIGHTING ZONE 2	Lobby	432	20A/1P	3		*		4	20A/1P	1200	Auditorium	LIGHTING ZONE 11
LIGHTING ZONE 3	Lobby	896	20A/1P	5			*	6	20A/1P	1800	Auditorium	LIGHTING ZONE 12
LIGHTING ZONE 4	Lobby	216	20A/1P	7	*			8	20A/1P	500	Auditorium	LIGHTING ZONE 13
LIGHTING ZONE 5	Lobby	432	20A/1P	9		*		10	20A/1P	567	Auditorium	LIGHTING ZONE 14
LIGHTING ZONE 6	Lobby	432	20A/1P	11			*	12	20A/1P	0	-	SPARE
LIGHTING ZONE 7	Lobby	432	20A/1P	13	*			14	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	15		*		16	20A/1P	0	-	SPARE
	-	0		17			*	18		0	-	
	-	0		19	*			20		0	-	
	-	0		21		*		22		0	-	
	-	0		23			*	24		0	-	
	-	0		25	*			26		0	-	
	-	0		27		*		28		0	-	
	-	0		29			*	30		0	-	
	-	0		31	*			32		0	-	
	-	0		33		*		34		0	-	
	-	0		35			*	36		0	-	
	-	0		37	*			38		0	-	
	-	0		39		*		40		0	-	
	-	0		41			*	42		0	-	

CONNECTED LOAD (KW) - A	3.60	TOTAL DESIGN LOAD (KW)	11.24
CONNECTED LOAD (KW) - B	2.63	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	3.13	TOTAL DESIGN LOAD (AMPS)	14

Figure 39: New Panelboard – Auditorium

Feeder Size – Auditorium

Feeder Size – Panelboard DP1	
Calculated Design Load	14.3 A
Feeder Protection Size	15 A
Sets	1
Wire Size	
Phase	#12 AWG
Neutral	#12 AWG
Ground	#12 AWG
Wire Area	
Each Phase	0.0133”
All Phase	0.0399”
Neutral	0.0133”
Ground	0.0133”
Total Area	0.0665”
Conduit Size	¾”
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾” conduit 100% Neutral

Table 25: Feeder Size Auditorium

Original Panelboard - Auditorium

PANEL NAME	VOLTAGE INFORMATION				PANEL INFORMATION						FEEDER INFORMATION	
DP2	VOLTAGE	277/480			BUSS		125A				FROM	DP1
MOUNTING: SURFACE	PHASE	3			MAIN/MLO		MLO				TYPE	NORMAL
LOCATION: 1ST FLOOR	WIRE	4			AIC RATING		14 kA				SIZE	SEE RISER E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
AUDITORIUM ZONE 17	300	#12		20A-1P	1	A----	2	20A-1P		#12	150	AUDITORIUM ZONE 21
AUDITORIUM ZONE 18	960	#12		20A-1P	3	--B--	4	20A-1P		#12	150	AUDITORIUM ZONE 22
AUDITORIUM ZONE 19	300	#12		20A-1P	5	---C	6	20A-1P				SPARE
AUDITORIUM ZONE 20	550	#12		20A-1P	7	A----	8	20A-1P				SPARE
NOTES: 1. DIMMING PANEL PROVIDED WITH DIMMING SYSTEM.												

Figure 40: Original Panelboard – Auditorium

New Panelboard – Auditorium

Some of the fixtures used in the auditorium were 208/120; therefore, the panelboard 1LD was utilized. The panelboard DP2 is unnecessary and will not be used.

Original Panelboard - Auditorium

PANEL NAME	VOLTAGE INFORMATION					PANEL INFORMATION					FEEDER INFORMATION	
1LD	VOLTAGE	120/208				BUSS		100A			FROM	1DPA
MOUNTING: SURFACE	PHASE	3				MAIN/MLO		MLO			TYPE	NORMAL
LOCATION: 1ST FLOOR	WIRE	4				AIC RATING		10 kA			SIZE	SEE RISER ON E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
COLUMN RECEPTS	1440	12		20A-1P	1	A----	2	20A-1P		12	900	WIREWAY: LOBBY
COLUMN RECEPTS	1440	12		20A-1P	3	--B--	4	20A-1P		12	720	WIREWAY: LOBBY
PROJECTOR: LOBBY	1000	12		20A-1P	5	---C	6	20A-1P		12	540	RECEPTS
MOTORIZED SCREEN	500	12		20A-1P	7	A----	8	20A-1P		12	500	SENSORS: RESTROOM
A V EQUIPMENT	1000	12		20A-1P	9	--B--	10	20A-1P		12	500	SENSORS: RESTROOM
PLASMA SCREEN	*1000*	12		20A-1P	11	---C	12	20A-1P		12	540	RESTROOM GFI
PLASMA SCREEN	1000	12		20A-1P	13	A----	14	20A-1P		12	250	LUTRON SYSTEM, 100
EWC GFI	500	12		20A-1P	15	--B--	16	20A-1P		12	1395	FCU'S, 100A
EWC GFI	500	12		20A-1P	17	---C	18	20A-1P		12	540	RCPT, 101
ELEVATOR PIT	540	12		20A-1P	19	A----	20	20A-1P		*12*	*1000*	*PLASMA SCREEN*
SPARE				20A-1P	21	--B--	22					SPACE AND PROVISION
SPARE				20A-1P	23	---C	24					SPACE AND PROVISION
SPARE				20A-1P	25	A----	26					SPACE AND PROVISION
SPACE AND PROVISION					27	--B--	28					SPACE AND PROVISION
SPACE AND PROVISION					29	---C	30					SPACE AND PROVISION
SPACE AND PROVISION					31	A----	32					SPACE AND PROVISION
SPACE AND PROVISION					33	--B--	34					SPACE AND PROVISION
SPACE AND PROVISION					35	---C	36					SPACE AND PROVISION
SPACE AND PROVISION					37	A----	38					SPACE AND PROVISION
SPACE AND PROVISION					39	--B--	40					SPACE AND PROVISION
SPACE AND PROVISION					41	---C	42					SPACE AND PROVISION

NOTES:
1. PROVIDE 200% NEUTRAL

Figure 41: Original Panelboard – Auditorium

New Panelboard – Auditorium

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 100A/3P C/B

PANEL TAG: 1LD
PANEL LOCATION: ROOM 112B - ELECTRICAL
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: SEE RISER ON E602

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
COLUMN RCPTS	LOBBY	1440	20A/1P	1	*			2	20A/1P	900	LOBBY	WIREWAY: LOBBY
COLUMN RCPTS	LOBBY	1440	20A/1P	3		*		4	20A/1P	720	LOBBY	WIREWAY: LOBBY
ROJECTOR: LOBB	LOBBY	1000	20A/1P	5			*	6	20A/1P	540	-	RECEPTS
OTORIZED SCREE	LOBBY	500	20A/1P	7	*			8	20A/1P	500	-	SENSORS: RR
AV EQUIPMENT	LOBBY	1000	20A/1P	9		*		10	20A/1P	500	-	SENSORS: RR
PLASMA SCREEN	LOBBY	1000	20A/1P	11			*	12	20A/1P	540	-	RESTROOM GFI
PLASMA SCREEN	LOBBY	1000	20A/1P	13	*			14	20A/1P	250	100	LUTRON SYSTEM
EWC GFI	LOBBY	500	20A/1P	15		*		16	20A/1P	1395	100A	FCU'S
EWC GFI	LOBBY	500	20A/1P	17			*	18	20A/1P	540	100	RCPT
ELEVATOR PIT	LOBBY	540	20A/1P	19	*			20	20A/1P	1000	LOBBY	PLASMA SCREEN
LIGHTING ZONE 9	LOBBY	1200	20A/1P	21		*		22	20A/1P	756	AUDITORIUM	LIGHTING ZONE 15
IGHTING ZONE 10	LOBBY	450	20A/1P	23			*	24	20A/1P	756	AUDITORIUM	LIGHTING ZONE 16
IGHTING ZONE 17	AUDITORIUM	756	20A/1P	25	*			26	20A/1P	1152	AUDITORIUM	LIGHTING ZONE 18
SPACE & PROV	-	0	20A/1P	27		*		28	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	29			*	30	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	31	*			32	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	33		*		34	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	35			*	36	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	37	*			38	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	39		*		40	20A/1P	0	-	SPACE & PROV
SPACE & PROV	-	0	20A/1P	41			*	42	20A/1P	0	-	SPACE & PROV

CONNECTED LOAD (KW) - A	8.04	TOTAL DESIGN LOAD (KW)	23.67
CONNECTED LOAD (KW) - B	7.51	POWER FACTOR	0.91
CONNECTED LOAD (KW) - C	5.33	TOTAL DESIGN LOAD (AMPS)	72

Figure 42: New Panelboard – Auditorium

Feeder Size – Auditorium

Feeder Size – Panelboard 1LD	
Calculated Design Load	72.3 A
Feeder Protection Size	80 A
Sets	1
Wire Size	
Phase	#4 AWG
Neutral	#4 AWG
Ground	#8 AWG
Wire Area	
Each Phase	0.0824"
All Phase	0.2472"
Neutral	0.0824"
Ground	0.0366"
Total Area	0.3662"
Conduit Size	1"
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾" conduit 100% Neutral

Table 26: Feeder Size Auditorium

Branch Circuit Redesign – Classroom

Original Panelboard - Classroom

PANEL NAME	VOLTAGE INFORMATION				PANEL INFORMATION						FEEDER INFORMATION	
5HA	VOLTAGE	277/480			BUSS		200A				FROM	4HA
SURFACE	PHASE	3			MAIN/MLO		MLO W/SUBFEED LUGS				TYPE	NORMAL
LOCATION OF PANEL	WIRE	4			AIC RATING		25 kA				SIZE	SEE RISER ON E602
LOCATION/ITEM	LOAD WATTS	WIRE	COND	BREAKER	CKT	PHS	CKT	BREAKER	COND	WIRE	LOAD WATTS	LOCATION/ITEM
LIGHTING	2430	12		20-1P	1	A----	2	20A-1P		12	4008	VAV'S
LIGHTING	2750	12		20-1P	3	--B--	4	20A-1P		12	2616	VAV'S
LIGHTING	1650	12		20-1P	5	---C	6	20A-1P		12	2000	CORRIDOR LIGHTING
LIGHTING	2462	12		20-1P	7	A----	8	20A-1P		12	2000	CORRIDOR LIGHTING
LIGHTING	1884	12		20-1P	9	--B--	10	20A-1P				SPARE
LIGHTING	2288	12		20-1P	11	---C	12	20A-1P				SPARE
LIGHTING	1706	12		20-1P	13	A----	14	20A-1P				SPARE
LIGHTING	2336	12		20-1P	15	--B--	16	20A-1P				SPARE
SPARE				20A-1P	17	---C	18	20A-1P				SPARE
SPARE				20A-1P	19	A----	20	20A-1P				SPARE
SPARE				20A-1P	21	--B--	22	20A-1P				SPARE
SPARE				20A-1P	23	---C	24	20A-1P				SPARE
SPARE				20A-1P	25	A----	26	20A-1P				SPARE
SPARE				20A-1P	27	--B--	28	20A-1P				SPARE
SPARE				20A-1P	29	---C	30	20A-1P				SPARE
SPACE AND PROVISION					31	A----	32					SPACE AND PROVISION
SPACE AND PROVISION					33	--B--	34					SPACE AND PROVISION
SPACE AND PROVISION					35	---C	36					SPACE AND PROVISION
SPACE AND PROVISION					37	A----	38					SPACE AND PROVISION
SPACE AND PROVISION					39	--B--	40					SPACE AND PROVISION
SPACE AND PROVISION					41	---C	42					SPACE AND PROVISION
NOTES:												

Figure 43: Original Panelboard – Classroom

New Panelboard – Classroom

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W					PANEL TAG: 5HA				MIN. C/B AIC: 25 K			
SIZE/TYPE BUS: 200A					PANEL LOCATION: Room 513A - Electrical				OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 4HA			
SIZE/TYPE MAIN: 200A/3P C/B					PANEL MOUNTING: SURFACE							
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	Room 514	2430	20A/1P	1	*			2	20A/1P	4008	-	VAV'S
LIGHTING	Room 515	2750	20A/1P	3		*		4	20A/1P	2616	-	VAV'S
LIGHTING	Room 512	1650	20A/1P	5			*	6	20A/1P	2000	Corridor	CORRIDOR LIGHT
LIGHTING	Room 509	2462	20A/1P	7	*			8	20A/1P	2000	Corridor	CORRIDOR LIGHTS
LIGHTING	Room 508	1884	20A/1P	9		*		10	20A/1P	0	-	SPARE
LIGHTING	Room 504/511	2288	20A/1P	11			*	12	20A/1P	0	-	SPARE
LIGHTING	Room 505	1976	20A/1P	13	*			14	20A/1P	0	-	SPARE
LIGHTING	Lobby (5th Floor	2336	20A/1P	15		*		16	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	17			*	18	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	19	*			20	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	21		*		22	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	23			*	24	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPARE
SPACE & PROV.	-	0		31	*			32		0	-	SPACE & PROV.
SPACE & PROV.	-	0		33		*		34		0	-	SPACE & PROV.
SPACE & PROV.	-	0		35			*	36		0	-	SPACE & PROV.
SPACE & PROV.	-	0		37	*			38		0	-	SPACE & PROV.
SPACE & PROV.	-	0		39		*		40		0	-	SPACE & PROV.
SPACE & PROV.	-	0		41			*	42		0	-	SPACE & PROV.
CONNECTED LOAD (KW) - A		12.88								TOTAL DESIGN LOAD (KW)		33.84
CONNECTED LOAD (KW) - B		9.59								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		5.94								TOTAL DESIGN LOAD (AMPS)		43

Figure 44: New Panelboard – Classroom

Feeder Size – Classroom

Feeder Size – Panelboard 5HA	
Calculated Design Load	43.0 A
Feeder Protection Size	45 A
Sets	1
Wire Size	
Phase	#8 AWG
Neutral	#8 AWG
Ground	#10 AWG
Wire Area	
Each Phase	0.0366"
All Phase	0.1098"
Neutral	0.0366"
Ground	0.0211"
Total Area	0.1675"
Conduit Size	¾ "
Remarks:	Based on Copper Wire, 75ºC, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾" conduit 100% Neutral

Table 27: Feeder Size - Classroom

Branch Circuit Redesign – Conclusion

Throughout the redesign of the branch circuits, all of the panelboards either stayed the same size or were smaller. I eliminated panelboard DP2 from the auditorium because the fixtures that were used in the auditorium were only found on 208/120 volt panelboards. The 2005 National Electric Code and the ASHRAE 90.1 Standards were used throughout the lighting and electrical branch circuit redesign. Please see attached CD for spreadsheets of all panelboards mentioned above.

Central Transformer vs. Distributed Transformers

Introduction

The DH Hamilton Building is serviced from the Philadelphia Electric Company (PECO). The 13.2 kV service is fed through a dry-type transformer rated at 480Y/277 volt, 3 phase, and 2500 kVA. After the 2500 kVA transformer, the service is supplied to the main bus system with TVSS located in Substation No. 1. A 4000 draw amp low voltage circuit breaker protects the main bus. The main distribution panels are located on the parking level P2 and fed up through the building into the electrical room of each floor into sub-distribution panels. From the sub-distribution panels, lighting and receptacle loads are distributed to each floor and served by 150 kVA dry-type transformers and 208Y/120V panelboards.

These 150 kVA dry-type transformers are the distributed transformers. The DH Hamilton Building has five distributed transformers throughout the building. The following analysis will provide the original design power riser diagram and single line diagram along with the new design. Note the drawings are only partial drawings. I have also included the original transformer schedule and the new transformer schedule. A cost analysis is done in the construction management breadth.

Central Transformer Size

A conservative power factor of 0.85 and a demand factor of 1.00 were assumed for panelboards 1DPA, 2DPA, 3DPA, 4DPA, and 5DPA. The total calculated design load was calculated using the panelboard schedule spreadsheet. The distribution panelboard for the secondary side of the transformer is 3000A with room for growth with the sixth floor of the DH Hamilton Building. The conduit size and wire size were found on the feeder schedule on the original drawings. The sizes were not changed due to the redesign of the lighting. The wire size was found by using the table for the DH Hamilton Building. This table is the feeder schedule for the building, but it goes by the protection size.

Calculated Design Load	
Panelboard 1DPA	570.6 A
Panelboard 2DPA	495.1 A
Panelboard 3DPA	418.6 A
Panelboard 4DPA	426.1 A
Panelboard 5DPA	516.4 A
Total Calculated Design Load	2426.8 A

Table 28: Calculated Design Load

Central Transformer Size	
Calculated Design Load	2426.8 A
Feeder Protection Size	2500 A
Wire Size (From DH Hamilton Feeder Schedule)	(5) 4" Conduit each with (3) 500 kCmil & (1) #4/0 Ground
Transformer	
kVA	874.29 kVA
Size	1000 kVA
Secondary Protection	2500 A
Primary Protection	1600 A
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾" conduit 100% Neutral Dry type transformers with primary and secondary feeders exceeding 25 feet

Table 29: Central Transformer Size

Original Electrical Single-Line Diagram - Partial

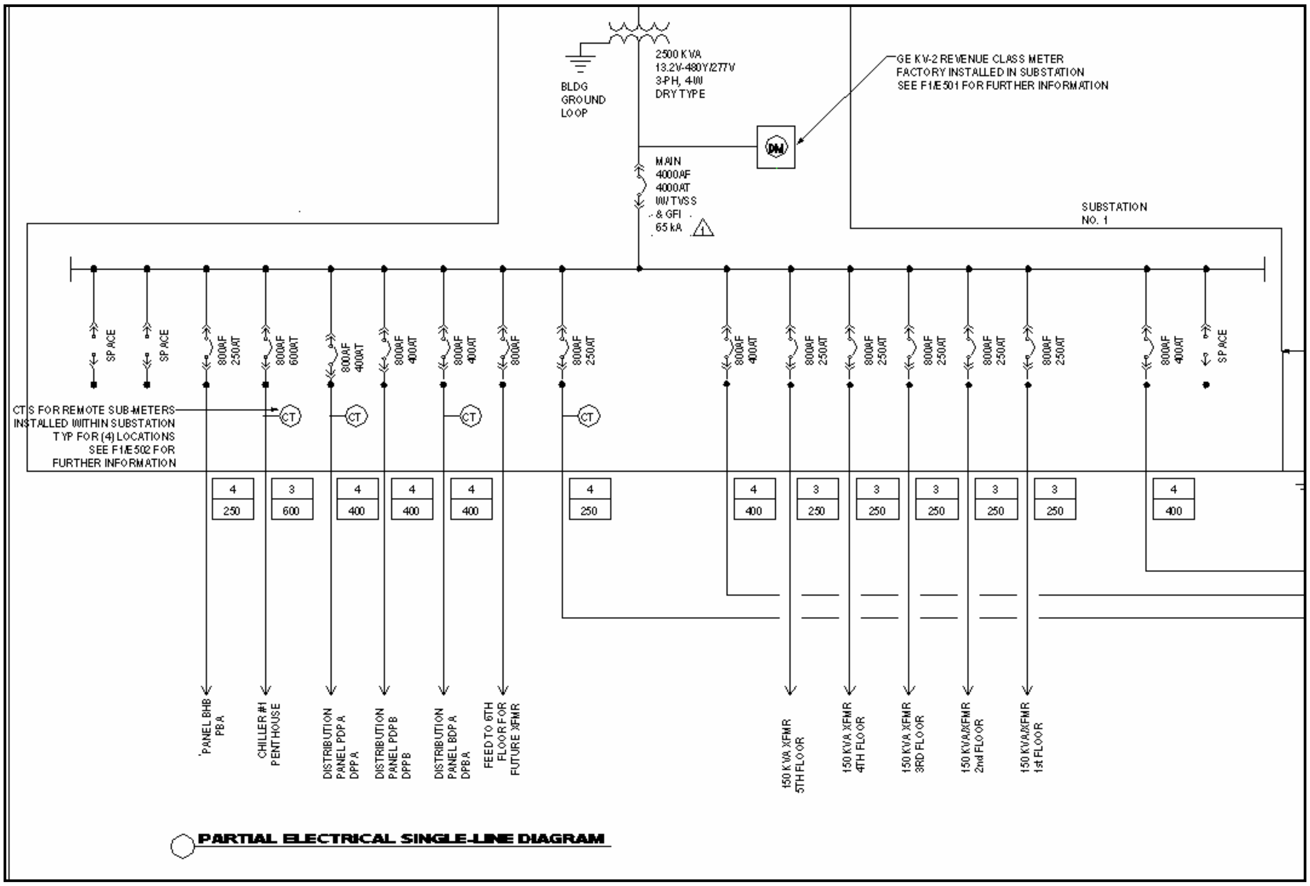


Figure 45: Original Electrical Single-Line Diagram - Partial

New Electrical Single-Line Diagram - Partial

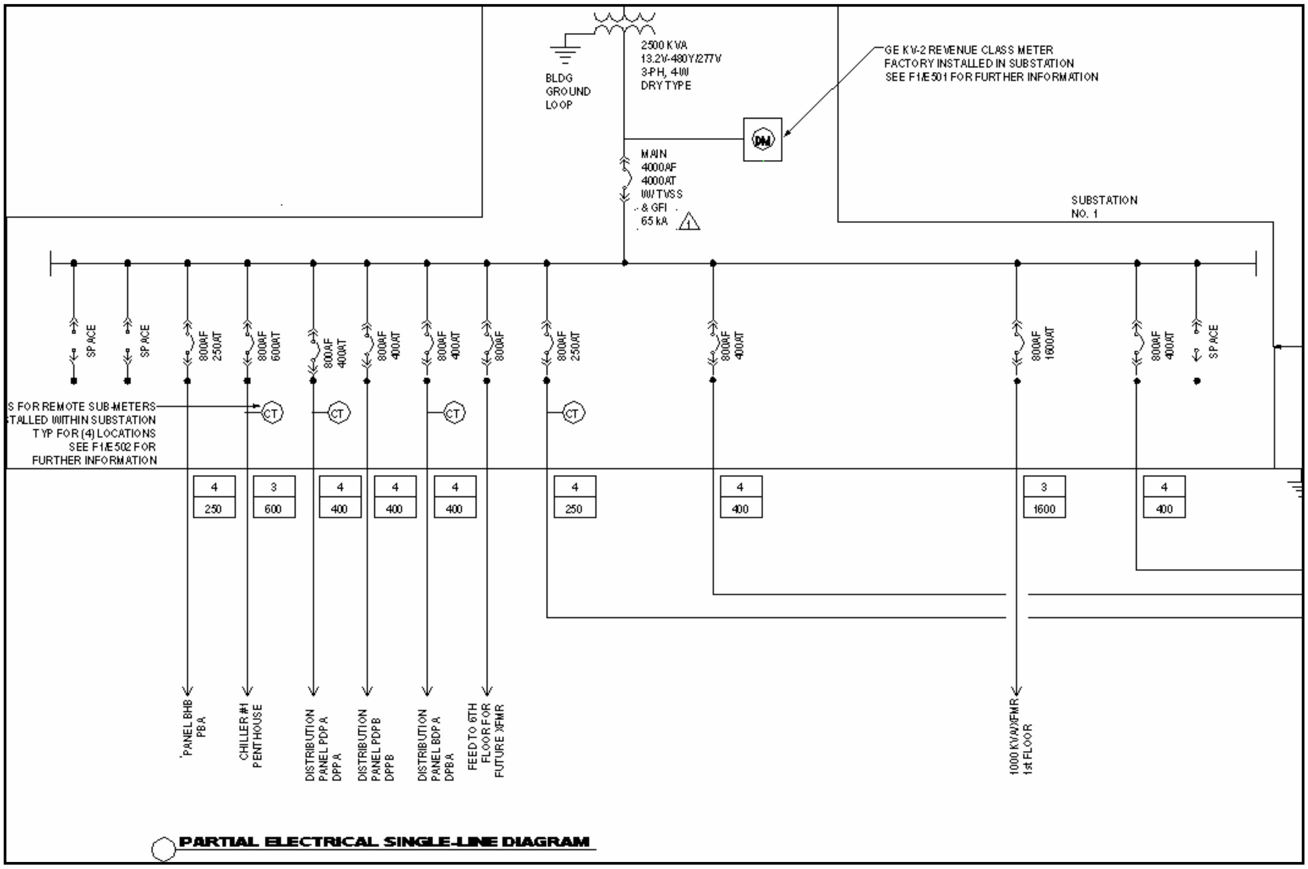


Figure 46: New Electrical Single-Line Diagram - Partial

Original Electrical Riser Diagram – Partial

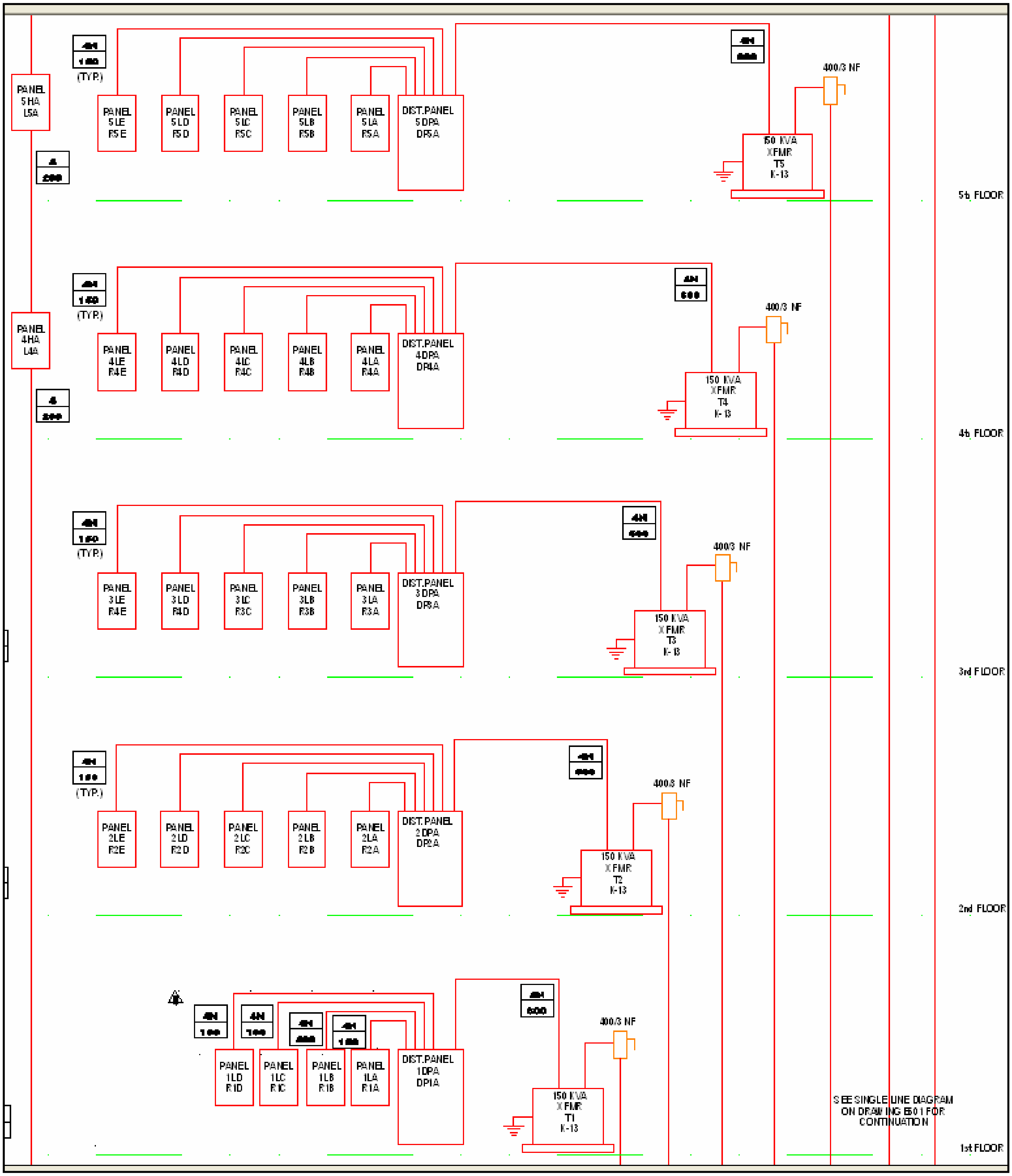


Figure 47: Original Electrical Riser Diagram - Partial

New Electrical Riser Diagram – Partial

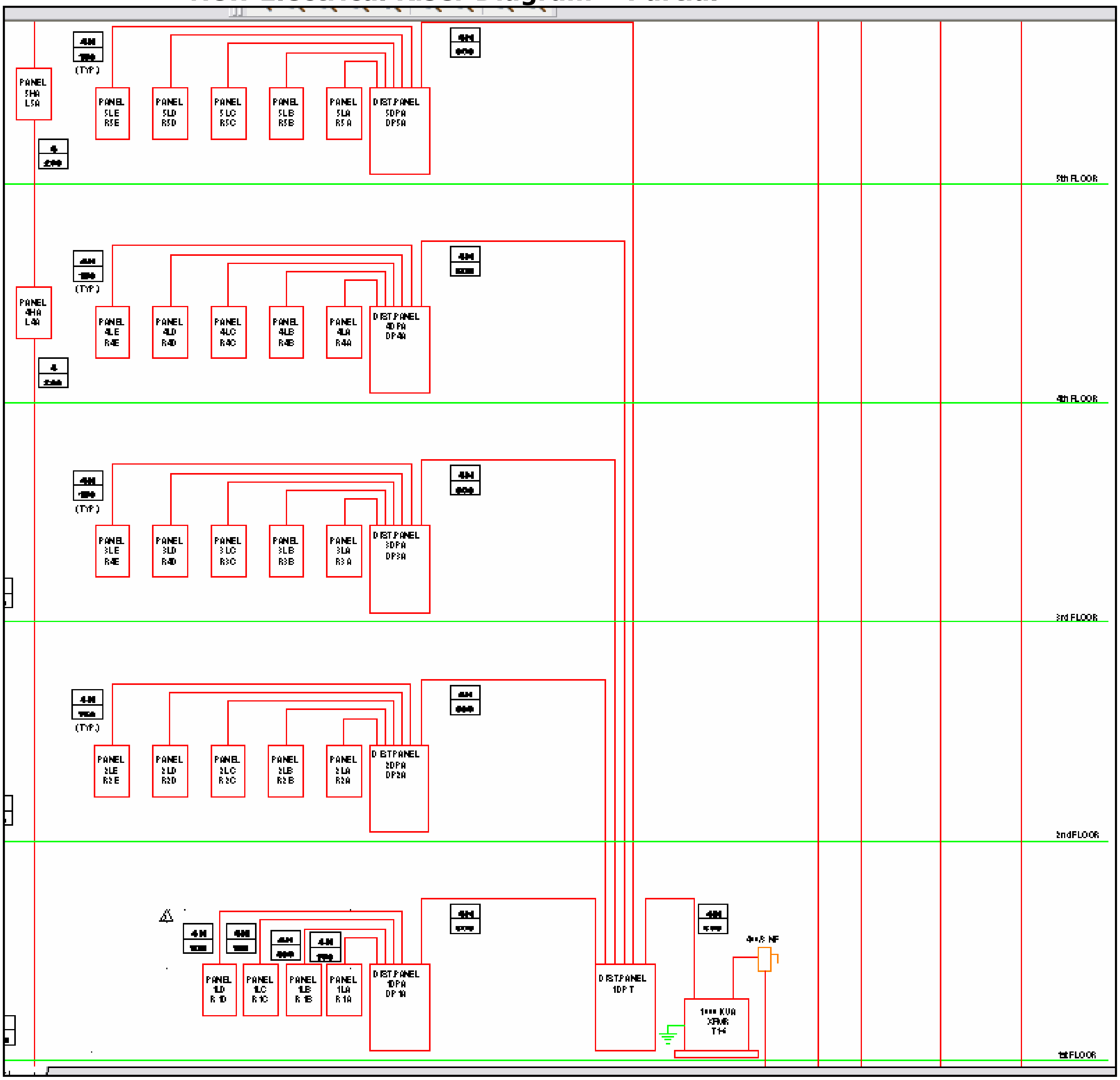


Figure 48: New Electrical Riser Diagram - Partial

Original Transformer Schedule

Transformer Schedule								
Tag	**Primary Voltage**	**Secondary Voltage**	**Size (kVA)**	**Type**	**Temp. Rise**	**Taps**	**Mounting**	**Remarks**
MAIN	13,200V,3PH,3W	480Y/277V,3PH,4W	2500	DRY TYPE	115ºC	N/A	PAD MOUNTED TO FLOOR	N/A
TBA	480V,3PH,3W	208Y/120V,3PH,4W	45	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
T1	**480V,3PH,3W**	**208Y/120V,3PH,4W**	**150**	**DRY TYPE**	**150ºC**	**(4) 2.5%**	**PAD MOUNTED TO FLOOR**	**K-13 RATED**
T2	**480V,3PH,3W**	**208Y/120V,3PH,4W**	**150**	**DRY TYPE**	**150ºC**	**(4) 2.5%**	**PAD MOUNTED TO FLOOR**	**K-13 RATED**
T3	**480V,3PH,3W**	**208Y/120V,3PH,4W**	**150**	**DRY TYPE**	**150ºC**	**(4) 2.5%**	**PAD MOUNTED TO FLOOR**	**K-13 RATED**
T4	**480V,3PH,3W**	**208Y/120V,3PH,4W**	**150**	**DRY TYPE**	**150ºC**	**(4) 2.5%**	**PAD MOUNTED TO FLOOR**	**K-13 RATED**
T5	**480V,3PH,3W**	**208Y/120V,3PH,4W**	**150**	**DRY TYPE**	**150ºC**	**(4) 2.5%**	**PAD MOUNTED TO FLOOR**	**K-13 RATED**
T6	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
TP	480V,3PH,3W	208Y/120V,3PH,4W	30	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
LTBA	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
STBA	480V,3PH,3W	208Y/120V,3PH,4W	45	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	K-13 RATED
STBB	480V,3PH,3W	208Y/120V,3PH,4W	30	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
TL1A	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
ST4	480V,3PH,3W	208Y/120V,3PH,4W	45	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
LPA	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
STPA	480V,3PH,3W	208Y/120V,3PH,4W	30	DRY TYPE	150ºC	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A

NOTES:

1. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
2. TRANSFORMERS 45 KVA AND SMALLER MAY BE FLOOR, WALL, OR TRAPEZE MOUNT AT THE OPTION OF THE CONTRACTOR.

KEY: A/N = AS NOTED

Table 30: Original Transformer Schedule

New Transformer Schedule

Transformer Schedule								
Tag	Primary Voltage	Secondary Voltage	Size (kVA)	Type	Temp. Rise	Taps	Mounting	Remarks
MAIN	13,200V,3PH,3W	480Y/277V,3PH,4W	2500	DRY TYPE	115°C	N/A	PAD MOUNTED TO FLOOR	N/A
TBA	480V,3PH,3W	208Y/120V,3PH,4W	45	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
T1-61	**480V,3PH,3W**	**208Y/120V,3PH,4W**	**1000**	**DRY TYPE**	**150°C**	**(1) - 3.5%**	**PAD MOUNTED TO FLOOR**	**N/A**
T6	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150°C	() 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
TP	480V,3PH,3W	208Y/120V,3PH,4W	30	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
LTBA	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
STBA	480V,3PH,3W	208Y/120V,3PH,4W	45	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	K-13 RATED
STBB	480V,3PH,3W	208Y/120V,3PH,4W	30	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
TL1A	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
ST4	480V,3PH,3W	208Y/120V,3PH,4W	45	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
LPA	480V,3PH,3W	208Y/120V,3PH,4W	15	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
STPA	480V,3PH,3W	208Y/120V,3PH,4W	30	DRY TYPE	150°C	(4) 2.5%	FLOOR, WALL, OR TRAPEZE MOUNT	N/A
Notes:								
1. Refer to specifications for additional requirements.								
2. Transformers 45 kVA and smaller may be floor, wall, or trapeze mount at the option of the contractor.								
Key: A/N = As Noted								

Table 31: New Transformer Schedule

Cost Analysis

The cost analysis is part of the construction management breadth; however, it is included in the tables below. The cost analysis is based on THWN copper wire rated at 75°C, IMC conduit, a maximum of 500 kCmil Wire, and a minimum of ¾" conduit. As you can see by the tables below, the cost of the distributed transformer system is $215,987, while the central transformer system is $240,107.

Distributed Transformer Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Transformers				
150 kVA D-Type, K-13 Rated	5.0	EA	16900.00	84,500.00
Copper Feeders (THWN)				
#4 AWG, Stranded	10.3	CLF	229.00	2,347.25
Size 1/0, Stranded	5.5	CLF	450.00	2,466.00
250 kCmil, Stranded	30.8	CLF	925.00	28,443.75
500 kCmil, Stranded	27.4	CLF	1625.00	44,525.00
Conduit (IMC)				
2-1/2"	1025.0	LF	27.00	27,675.00
4"	548.0	LF	47.50	26,030.00
TOTAL				**$215,987.00**
Remarks	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 32: Distributed Transformer Estimate

Central Transformer Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Transformers				
1000 kVA D-Type Transformer	1.0	EA	43200.00	43,200.00
Copper Feeders (THWN)				
#4 AWG, Stranded	0.9	CLF	229.00	201.52
Size 1/0, Stranded	13.4	CLF	450.00	6,021.00
250 kCmil, Stranded	2.6	CLF	925.00	2,442.00
500 kCmil, Stranded	66.9	CLF	1625.00	108,712.50
Distribution Panelboards 4-Wire, 120/208V, 3000 Amp	1.0	EA	15975.00	15,975.00
Conduit (IMC)				
2-1/2"	88.0	LF	27.00	
4"	1338.0	LF	47.50	63,555.00
TOTAL				**$240,107.02**
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 33: Central Transformer Estimate

Conclusion

Overall, the central transformer system is not recommended due to the overall cost. The central transformer is 109% the cost of the five distributed transformers. The central transformer will save on square footage for the space, but the transformer cost is higher than the five distributed transformers. The recommendation is to keep the original design with the distributed transformers.

Feeders vs. BusDuct

Introduction

The DH Hamilton Building is serviced from the Philadelphia Electric Company (PECO). The main distribution panels are located on the parking level P2 and fed up through the building into the electrical room of each floor into sub-distribution panels with feeders. From the sub-distribution panels, lighting and receptacle loads are distributed to each floor and served by 150 kVA dry-type transformers and 208Y/120V panelboards.

The feeders running from the parking level P2 to the penthouse are going to be replaced by a busduct. The following analysis will provide the original design power riser diagram and single line diagram along with the new design. Note the drawings are only partial drawings. The original full drawings are located on the CPEP website. A cost analysis is done in the construction management breadth.

Calculated Design Load

A conservative power factor of 0.85 and a demand factor of 1.00 were assumed for panelboards 1DPA, 2DPA, 3DPA, 4DPA, and 5DPA. An additional 20% growth was assumed for the future of floor six. Currently, floor six is an empty space and a future load will be placed on the floor. The total calculated design load was calculated using the panelboard schedule spreadsheet. The conduit size and wire size were found on the feeder schedule on the original drawings. The sizes were not changed due to the redesign of the lighting. The wire size was found by using the table for the DH Hamilton Building. This table is the feeder schedule for the building, but it goes by the protection size.

Calculated Design Load	
Panelboard 1DPA	570.6 A
Panelboard 2DPA	495.1 A
Panelboard 3DPA	418.6 A
Panelboard 4DPA	426.1 A
Panelboard 5DPA	516.4 A
Panelboard 6DPA (Future)	485.4 A
Total Calculated Design Load	2912.2 A
Busduct Design Load	600 A

Table 34: Calculated Design Load

Original Electrical Single-Line Diagram - Partial

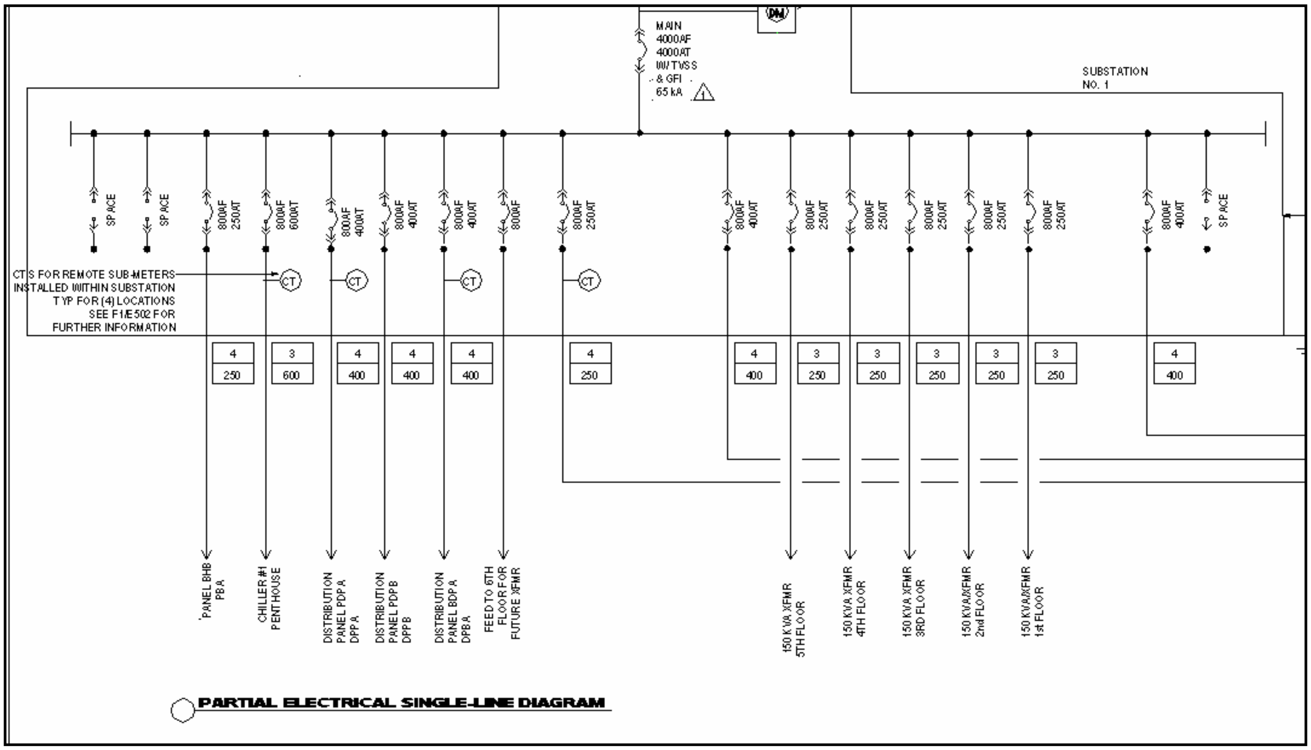


Figure 49: Original Electrical Single-Line Diagram - Partial

New Electrical Single-Line Diagram - Partial

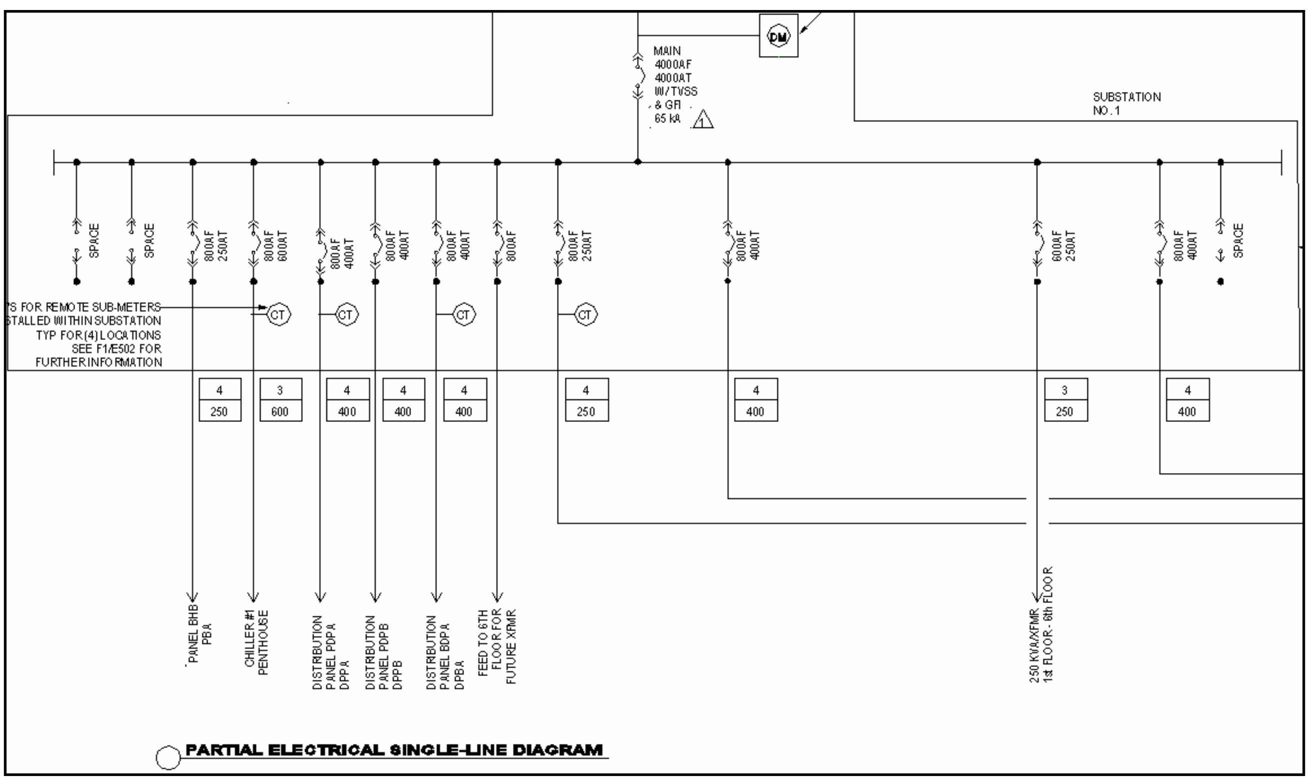


Figure 50: New Electrical Single-Line Diagram - Partial

Original Electrical Riser Diagram – Partial

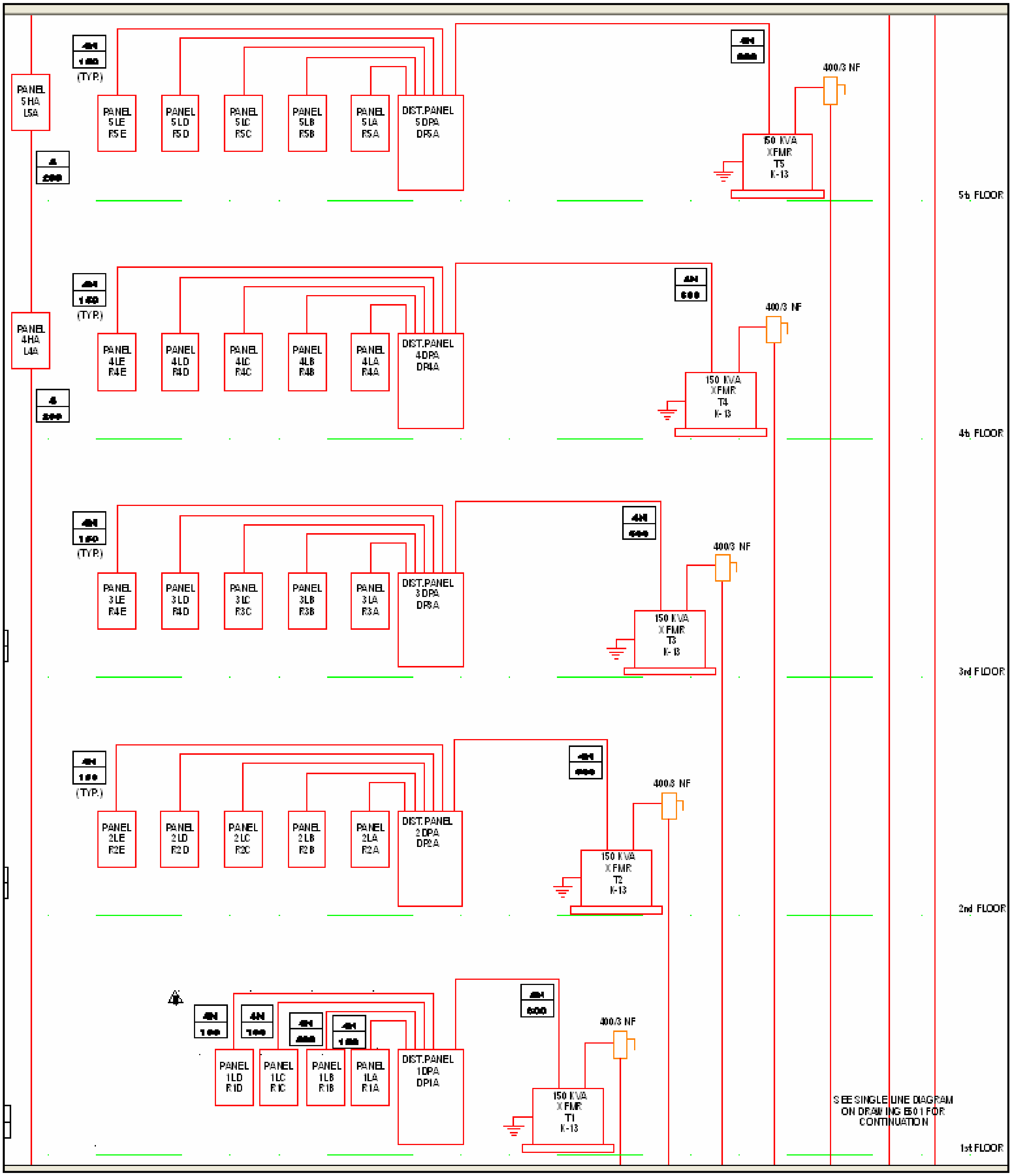


Figure 51: Original Electrical Riser Diagram - Partial

New Electrical Riser Diagram – Partial

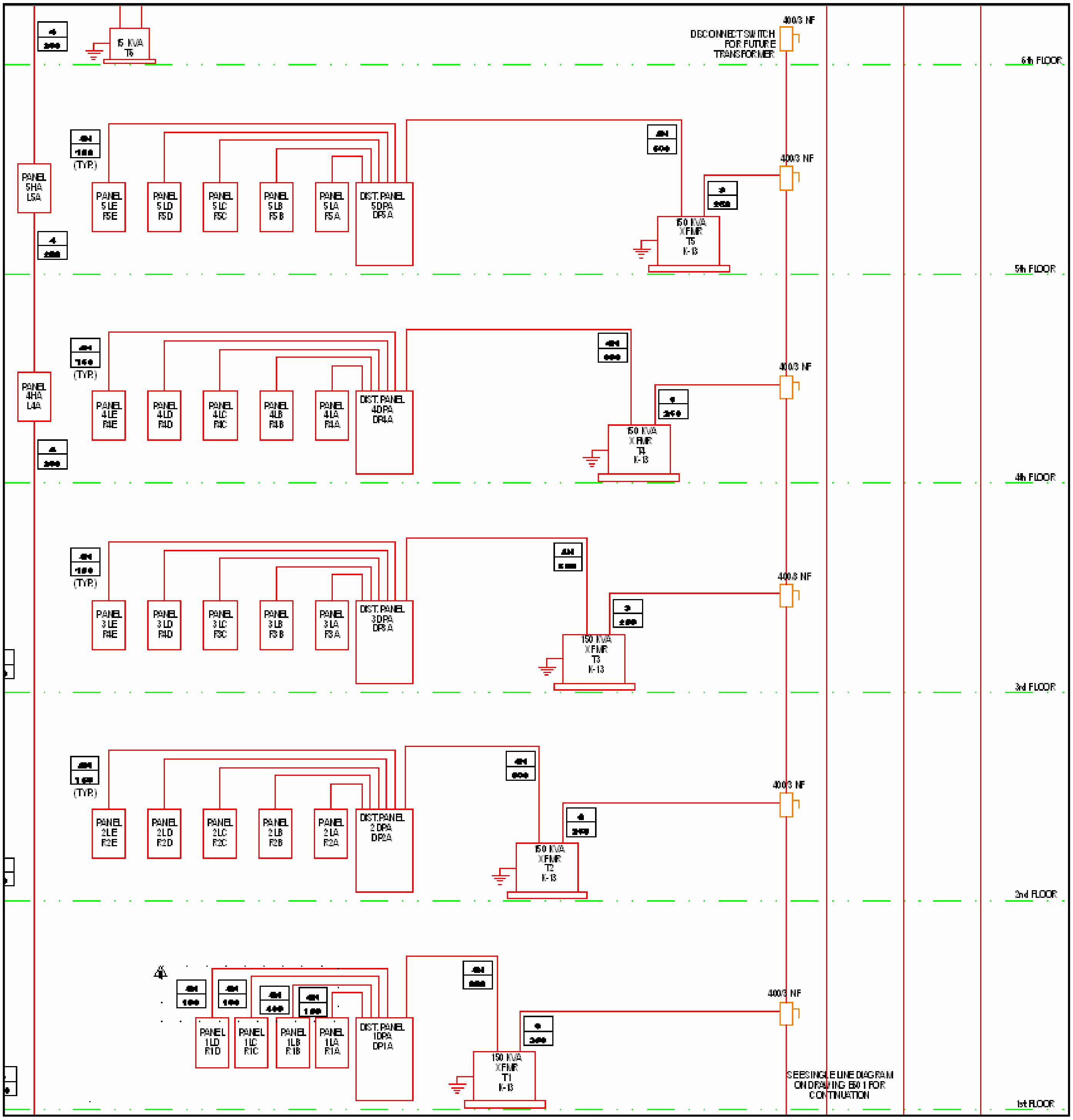


Figure 52: New Electrical Riser Diagram - Partial

Cost Analysis

The cost analysis is part of the construction management breadth; however, it is included in the tables below. The cost analysis is based on THWN copper wire rated at 75°C, IMC conduit, a maximum of 500 kCmil Wire, and a minimum of ¾" conduit. As you can see by the tables below, the cost of the system with only feeders is $59,606, while the cost of the system with the busduct is $55,098.

Feeder Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Copper Feeders (THWN)				
#4 AWG, Stranded	10.5	CLF	229.00	2,393.05
250 kCmil, Stranded	31.4	CLF	925.00	28,998.75
Conduit (IMC)				
2-1/2"	1045.0	LF	27.00	28,215.00
TOTAL				**$59,606.80**
Remarks	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 35: Feeder Estimate

Busway Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Indoor/Plug-in Busduct				
Copper Busduct - 600A	220.0	LF	210.00	46,200.00
Feeders				
#4 AWG	1.6	CLF	229.00	357.24
250 kCmil	4.7	CLF	925.00	4,329.00
Conduit (IMC)				
2-1/2"	156.00	LF	27.00	4,212.00
TOTAL				**$55,098.24**
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 36: Busway Estimate

Conclusion

Overall, the busduct is recommended due to the overall cost. The busduct is 92% the cost of the individual feeders. The feeder system used 1045’ of (3) 250 kCmil & (1) #4G in 2-1/2” conduit. This equates to $59,606 for the system. The busduct system used 220’ of vertical copper 600 A busduct and 156’ of (3) 250 kCmil & (1) #4G in 2-1/2” conduit. This equates to $55,098 for the system. The recommendation is to switch to the busduct instead of the individual feeders.

Motor Control Center

Introduction

The motor control center design consists of the analysis and design of one major mechanical equipment motor control center and associated feeder. A schedule will be provided along with the calculation tables of design loads for branch conductors, feeders, and protective devices. The DH Hamilton Building motor control center will consist of the three AHU motors, the two AHU return fans, two roof supply fans, two garage exhaust fans, the chiller pump, spare chiller pump, and the cooling tower pump.

Motor Control Center Loads

Tag	Equipment Type	Voltage	Phase	Power	Full Load Amps	Power Factor	Load (kVA)
AHU-1	AHU	460 V	3	75 HP	96 A	0.90	71.83
AHU-2	AHU	460 V	3	75 HP	96 A	0.90	71.83
AHU-3	AHU	460 V	3	75 HP	96 A	0.90	71.83
RF-1	AHU Return Fan	460 V	3	50 HP	65 A	0.90	48.64
RF-2	AHU Return Fan	460 V	3	50 HP	65 A	0.90	48.64
SF-3	Stairwell Pressure Fan	460 V	3	20 HP	27 A	0.90	20.20
SF-4	Stairwell Pressure Fan	460 V	3	20 HP	27 A	0.90	20.20
EF-7	Garage Exhaust Fan	460 V	3	30 HP	40 A	0.90	29.93
EF-8	Garage Exhaust Fan	460 V	3	30 HP	40 A	0.90	29.93
P-1	Chiller Pump	460 V	3	40 HP	52 A	0.90	38.91
P-2	Spare Pump	460 V	3	40 HP	52 A	0.90	38.91
P-3	Cooling Tower Pump	460 V	3	40 HP	52 A	0.90	38.91

Table 37: Motor Control Center Loads

The table above states the motor control center schedule. The loads and the NEMA starter sizes are all shown in the above table. The types of fans are variable frequency drive (VFD) and full voltage, non-reversing (FVNR).

Motor Control Center Schedule

Equipment	Motor Type	Power	NEMA Starter Size	# X Spaces	Type of VFD	FLA	Demand Factor	Total Amps
AHU-1	VFD	75 HP	4	12X	SVX9000	71.83	1.25	89.79
AHU-2	VFD	75 HP	4	12X	SVX9000	71.83	1.00	71.83
AHU-3	VFD	75 HP	4	12X	SVX9000	71.83		71.83
RF-1	VFD	50 HP	3	12X	SVX9000	48.64		48.64
RF-2	VFD	50 HP	3	12X	SVX9000	48.64		48.64
SF-3	FVNR	20 HP	2	1X	N/A	20.20		20.20
SF-4	FVNR	20 HP	2	1X	N/A	20.20		20.20
EF-7	FVNR	30 HP	3	2X	N/A	29.23		29.23
EF-8	FVNR	30 HP	3	2X	N/A	29.23		29.23
P-1	VFD	40 HP	3	7X	SVX9000	38.91		38.91
P-2	VFD	40 HP	3	7X	SVX9000	38.91		38.91
P-3	VFD	40 HP	3	7X	SVX9000	38.91		38.91
Total Design Load								546.32

Table 38: Motor Control Center Schedule

Since the design load is 546 Amps, 600 amp busduct is needed to supply the motor control center. A 600-amp busduct will need 6X number of spaces for a bottom cable entry with four cables per phase.

Therefore, I need a total of 93 X number of spaces. Since there are 12X spaces per section, I will need 8 sections. Since this is a rather large motor control center, a spare section is going to be added, which makes the total to be 9 sections. The final dimensions of the motor control center are 16” deep, 90” high, and 180” long. The penthouse will have enough room to house this huge motor control center.

Motor Control Center Size

Motor Control Center	
Calculated Design Load	546.32 A
Feeder Protection Size	600 A
Wire	(2) sets of 250 kCmil & (1) #1 Ground
Conduit	3 ½”
Secondary Protection	600 A
Primary Protection	700 A
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kcmil wire Minimum ¾” conduit 100% Neutral Dry type transformers with primary and secondary feeders exceeding 25 feet

Table 39: Motor Control Center Size

Motor Control Center Layout

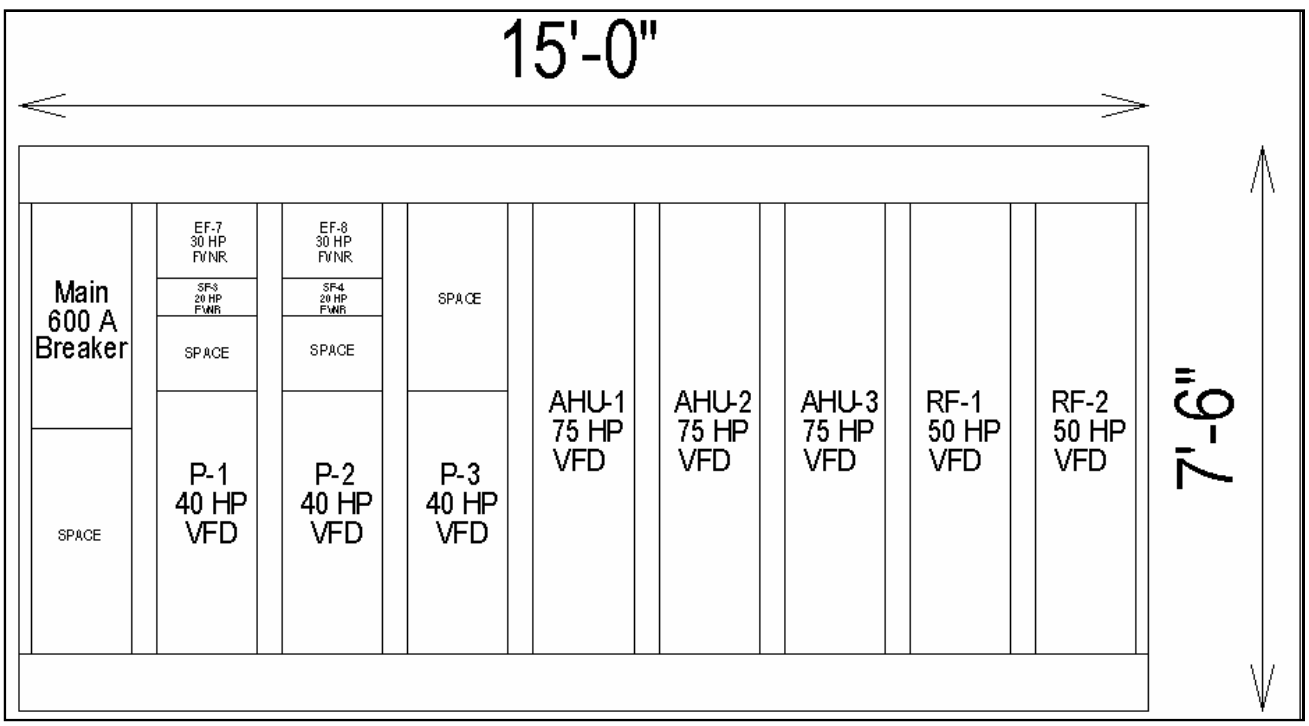


Figure 53: Motor Control Center Layout

Conclusion

The motor control center will provide an adequate space saver in the mechanical room of the DH Hamilton Building. All motors over 20 HP were put into the motor control center. This should provide the motor starters with the correct amperage to start and also the variable frequency drive system for the air handling unit motors, the return fan motors, and the pumps. The motor control center would be an addition to the DH Hamilton Building that would be recommended.

Short Circuit Analysis

Introduction

The short circuit analysis will conduct a brief protective device study that addresses a single-path through the distribution system.

Protective Device Coordination

The protective device coordination was performed on the 100 amp circuit breaker of panelboard 1LD, the 600 amp main distribution panelboard 1DPA, and the 800 amp circuit breaker off of the main buss. The circuit breaker time/current curves are on the pages following the conclusion.

Short Circuit Calculations

The short circuit calculations cannot be completed because the utility information is unattainable from the Thomas Jefferson University.

Conclusion

All of the systems were coordinated by overlaying the devices upstream of the device before itself. Therefore, the single-path through the distribution system is coordinated.

Panelboard 1LD - 100 Amp Trip Curve

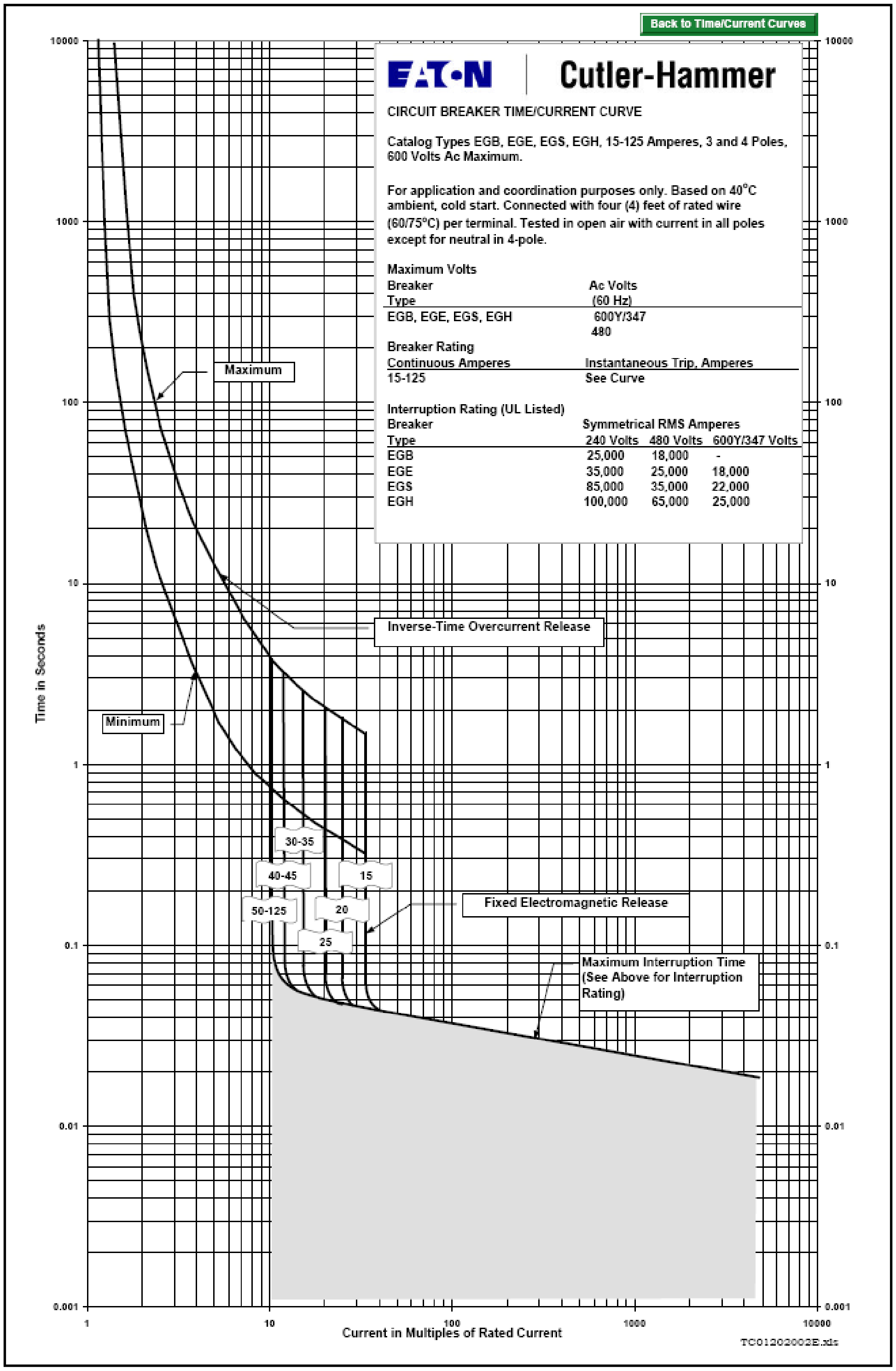


Figure 54: 100 Amp Trip Curve

Panelboard 1DPA – 400 Amp Trip Curve

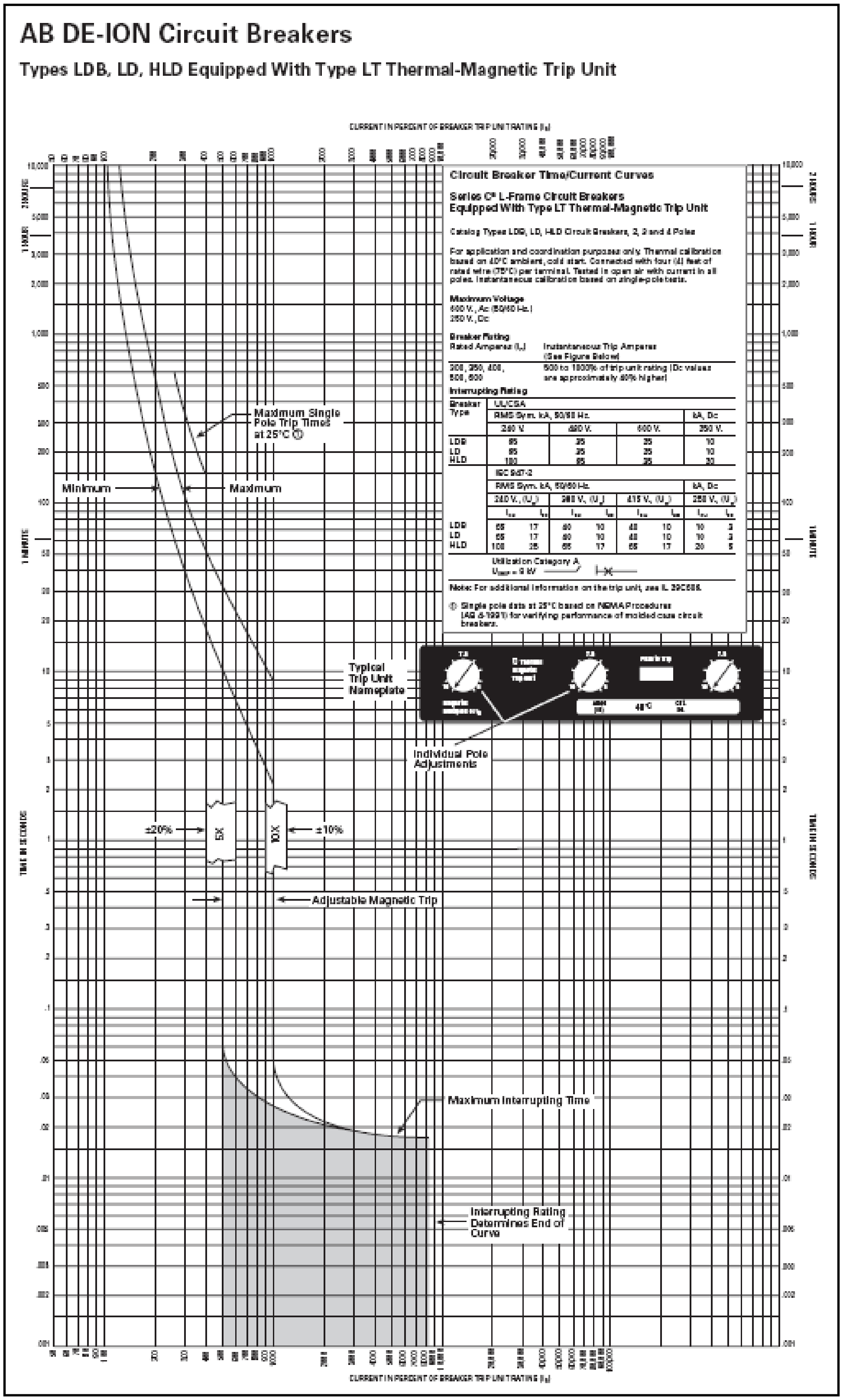


Figure 55: 400 Amp Trip Curve

Feeder - 800 Amp Trip Curve

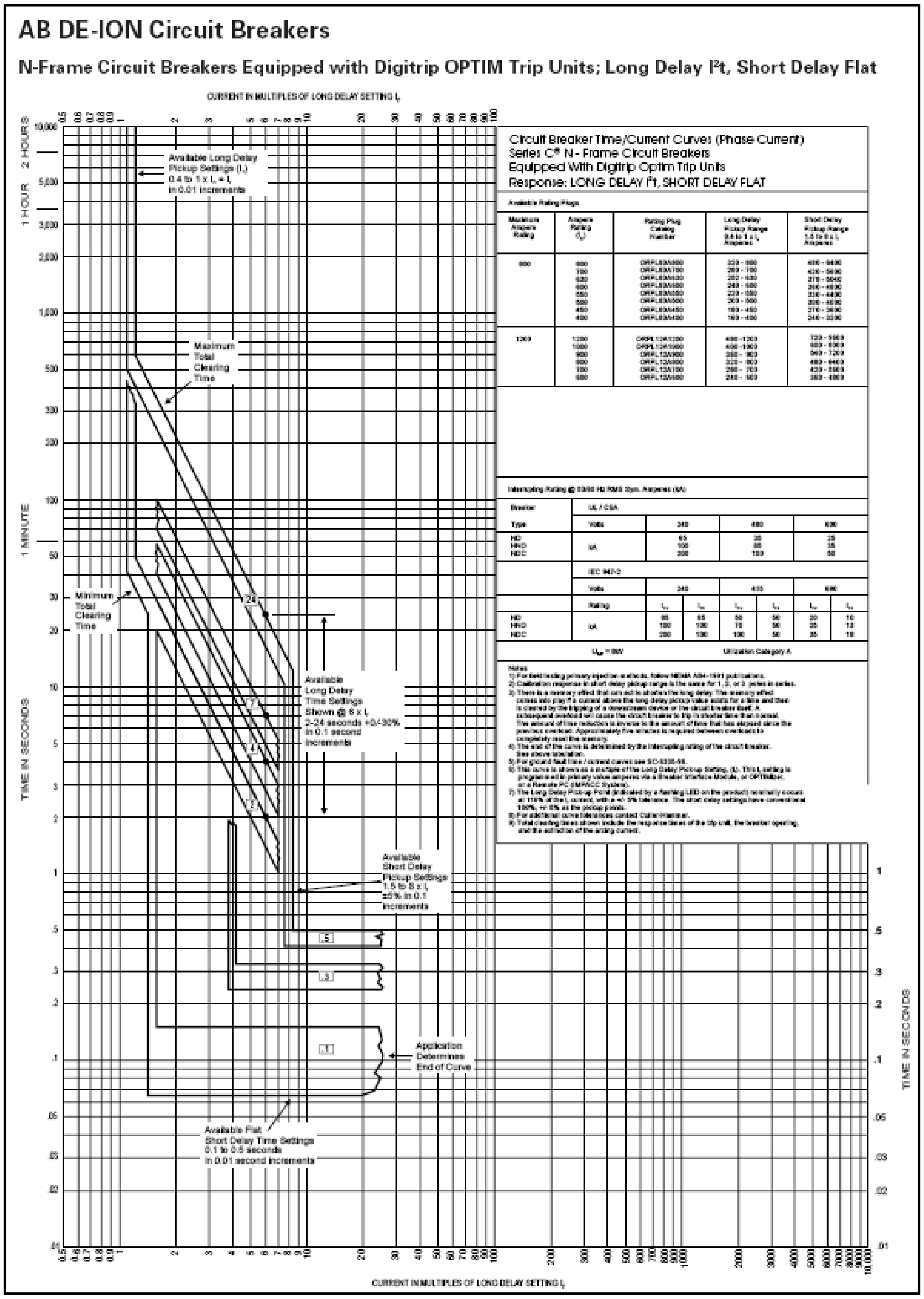


Figure 56: 800 Amp Trip Curve

Construction Management Breadth

Introduction

The construction management breadth is a cost analysis of the existing electrical system versus the redesigned portions of the electrical system. The cost analysis will include the following: central transformer versus distributed transformers and feeders running to each floor versus a main bus duct to the penthouse.

Cost Analysis – Distributed vs. Central Transformers

The cost analysis is part of the construction management breadth; however, it is included in the tables below. The cost analysis is based on THWN copper wire rated at 75°C, IMC conduit, a maximum of 500 kCmil Wire, and a minimum of ¾" conduit. As you can see by the tables below, the cost of the distributed transformer system is $215,987, while the central transformer system is $240,107.

Distributed Transformer Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Transformers				
150 kVA D-Type, K-13 Rated	5.0	EA	16900.00	84,500.00
Copper Feeders (THWN)				
#4 AWG, Stranded	10.3	CLF	229.00	2,347.25
Size 1/0, Stranded	5.5	CLF	450.00	2,466.00
250 kCmil, Stranded	30.8	CLF	925.00	28,443.75
500 kCmil, Stranded	27.4	CLF	1625.00	44,525.00
Conduit (IMC)				
2-1/2"	1025.0	LF	27.00	27,675.00
4"	548.0	LF	47.50	26,030.00
TOTAL				**$215,987.00**
Remarks	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 40: Distributed Transformer Estimate

Central Transformer Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Transformers				
1000 kVA D-Type Transformer	1.0	EA	43200.00	43,200.00
Copper Feeders (THWN)				
#4 AWG, Stranded	0.9	CLF	229.00	201.52
Size 1/0, Stranded	13.4	CLF	450.00	6,021.00
250 kCmil, Stranded	2.6	CLF	925.00	2,442.00
500 kCmil, Stranded	66.9	CLF	1625.00	108,712.50
Distribution Panelboards 4-Wire, 120/208V, 3000 Amp	1.0	EA	15975.00	15,975.00
Conduit (IMC)				
2-1/2"	88.0	LF	27.00	
4"	1338.0	LF	47.50	63,555.00
TOTAL				**$240,107.02**
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 41: Central Transformer Estimate

Conclusion

Overall, the central transformer system is not recommended due to the overall cost. The central transformer is 106% the cost of the five distributed transformers. The central transformer will save on square footage for the space, but the transformer cost is higher than the five distributed transformers. The recommendation is to keep the original design with the distributed transformers.

Cost Analysis – Feeders vs. Busduct

The cost analysis is part of the construction management breadth; however, it is included in the tables below. The cost analysis is based on THWN copper wire rated at 75^{o}C, IMC conduit, a maximum of 500 kCmil Wire, and a minimum of ¾" conduit. As you can see by the tables below, the cost of the system with only feeders is $59,606, while the cost of the system with the busduct is $55,098.

Feeder Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Copper Feeders (THWN)				
#4 AWG, Stranded	10.5	CLF	229.00	2,393.05
250 kCmil, Stranded	31.4	CLF	925.00	28,998.75
Conduit (IMC)				
2-1/2"	1045.0	LF	27.00	28,215.00
TOTAL				**$59,606.80**
Remarks	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 42: Feeder Estimate

Busway Estimate				
Item	Quantity	Units	Cost (Inc. O&P)	Total Cost
Indoor/Plug-in Busduct				
Copper Busduct - 600A	220.0	LF	210.00	46,200.00
Feeders				
#4 AWG	1.6	CLF	229.00	357.24
250 kCmil	4.7	CLF	925.00	4,329.00
Conduit (IMC)				
2-1/2"	156.00	LF	27.00	4,212.00
TOTAL				**$55,098.24**
Remarks:	Based on Copper Wire, 75°C, THWN insulation IMC Conduit Maximum 500kCmil Wire Miniumum 3/4" Conduit 100% Neutral			

Table 43: Central Transformer Estimate

Conclusion

Overall, the busduct is recommended due to the overall cost. The busduct is 92% the cost of the individual feeders. The feeder system used 1045' of (3) 250 kCmil & (1) #4G in 2-1/2" conduit. This equates to $59,606 for the system. The busduct system used 220' of vertical copper 600 A busduct and 156' of (3) 250 kCmil & (1) #4G in 2-1/2" conduit. This equates to $55,098 for the system. The recommendation is to switch to the busduct system instead of the individual feeders.

Mechanical Breadth

Introduction

The mechanical breadth is an analysis of the required cfm in the electrical rooms on floors one through five. This analysis is based on the distributed and central transformers. I will size the cfm for the distributed transformers and the central transformers. This will show the amount of cfm is needed with and without a 150 kVA transformer in the electrical room.

Heat Gain for Transformers

Tag	Floor	kVA	Heat Gain (Btu/hr)	CFM
T-1	1	150	2700	125
T-2	2	150	2700	125
T-3	3	150	2700	125
T-4	4	150	2700	125
T-5	5	150	2700	125
T1-6	**1**	**1000**	**18000**	**833**
NOTE:	Assume power factor = 0.90 Q = 1.08*CFM*Delta T Assume Delta T = 20 degrees			

Table 44: Heat Gain for Transformers

Conclusion

Therefore, the total CFM added to the electrical rooms by the distributed transformers is 625 cfm. The central transformer adds 833 cfm to the space. This only proves once again that the distributed transformers are the best possible solution to the DH Hamilton Building design.

References

Lighting/Electrical

National Electric Code 2005

The IESNA Lighting Handbook

ASHRAE 90.1 Standards

Eaton’s Conprehensive Consultant Resource

Electrical Systems in Buildings, S. David Hughes

Acknowledgments

Design Firms

The Lighting Practice – especially Julie Panassow and Emad Hasan, for sponsoring my senior thesis by providing the building information, construction documents, and specifications.

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Thank you for the support over the past couple of months while I worked on my thesis project. I truly appreciate each and every one of you. Thanks to my girlfriend, *Amanda Nickol*, for being there for me.

Again, thank you to everyone that helped me on this project.

Appendix – Lighting and Electrical Cutsheets