South Nassau Communities Hospital North Addition

Oceanside, New York

AE Senior Thesis Final Report

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All files located on P Drive folder CAS Thesis

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Oceanside, New York

Carl Speroff

Lighting/Electrical Option

Project Team

Owner: South Nassau Communities Hospital
Architect: Cannon Design
Engineers: Cannon Design
Communications: Gene Burton & Associates
Civil Engineer: Cameron Engineering & Associates
Construction Manager: Bovis Lend Lease
General Contractor: KLMK Group

Building Statistics

Occupancy Type: Group I-2, Group A-3
Building Area: 160,000 SF
Number of Stories: 5 (All above grade)
Dates of Contruction: December 2003 - May 2005
Actual Construction Cost: $64,100,000
Delivery Method: Guarenteed Maximum Price

Architecture

- Creates a new modern image while accentuating strengths of existing historical building
- Façade composed of brick, Indian sandstone, and glazing
- Central conservatory serves as a transition between lobby and existing hospital
- 108 new medical rooms
- 300 seat auditorium

Structure

- Foundation consists of spread footings with grade beams
- Ground floor is covered by 5" slab on grade
- Upper floors compsed of 3 ¼" min. lightweight concrete over 2" composite metal decking
- Floors supported by steel framing with a W18x40 typical beam size
- Lateral forces supported by braced framing

Lighting / Electrical

- Primary service at 5 kV stepped down to 480Y/277V, 3Ph, 4W secondary
- 480Y/277V transformed down to 208Y/120V, 3Ph, 4W as necessary
- Three 750 kW and one 400 kW 480Y/270V emergency generators serve existing hospital and new addition
- Luminaire types include fluorescent, metal halide, and halogen lamps

Mechanical

- Steam provided by existing boiler plant
- 750-ton liquid cooled centrifugal chiller
- Four rooftop air handling units with a total capacity of 90,000 CFM serve floors one through four
- Microprocessor based direct digital controls (DDC) energy management system

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Executive Summary

The North Addition of the South Nassau Communities Hospital was completed in 2005 and provides an additional 108 medical / surgical beds, LDRs (Labor/Delivery/Recovery), an obstetrical suite, a behavioral health unit, offices, and a 300 seat auditorium to the existing complex. Designed to accentuate the strengths of the existing historical building, the North Addition serves as a welcoming entrance and helps to create a modern image for the hospital.

The main goal of this report was to research the existing lighting and electrical design of four spaces within the North Addition of the South Nassau Communities Hospital. This analysis focuses on four different types of spaces: a large work space (a second floor nurse's station), a special purpose space (the auditorium and conference center), a circulation space (the main entrance lobby), and an outdoor space (the courtyard adjacent to the conservatory). The inspiration for the lighting design came from the owners desire to create a modern image for the hospital, one which is representative of the advanced healthcare that will be available without having to travel into the city. This vision was the basis for a design that not only enhances the hospitals modern image, but also creates a welcoming environment for both new and returning visitors.

IESNA illuminance recommendations and ASHRAE Standard 90.1 Energy code requirements were used to help guide the redesign of the lighting system. The existing lighting design was examined in detail and the results for each space are presented within the report. In general, the lighting design for each of the four spaces is adequate; however changes can be made to enhance the quality of the lighting design from both an aesthetic and energy consumption standpoint.

To accommodate the changes in the electrical design, the existing electrical design was altered. Changes were made to the branch circuits for all spaces in which the lighting design was changed. In addition to these changes, two electrical depth studies were performed. These studies include the design of a motor control center for the new equipment in the power plant as well as an analysis of the cost associated with increasing feeder size compared to the cost of energy lost through voltage drop.

Two breadth topics related to both the owner's vision and the lighting design were also completed. The existing courtyard was redesigned as part of an architecture and landscape architecture breadth to create a welcoming and relaxing environment that serves as an extension of the adjacent conservatory. It was also determined that in order to provide a fresh and updated image that creates a strong first impression, the design of the lobby should be altered to closer match the architect's original vision. In addition to minor architectural changes, the diffusers which created harsh linear lines in the lobby were sized and relocated as part of a mechanical breadth.

The following report provides the details, process, and conclusions of the yearlong study as well as the proposed designed solutions which exhibits functional and aesthetic performance and creates a building which enhances the owner's modern and dignified vision for the hospital.

Acknowledgements

I would like to thank the following people for their support and assistance throughout senior thesis:

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Building Statistics

Summary

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Building Name | South Nassau Communities Hospital North Addition

Location | Oceanside, New York

Building Occupant | South Nassau Communities Hospital

Occupancy Type | Institutional (Group I-2), Assembly (Group A-3)

Size | 160,000 SF

Stories | 5 (all above grade)

Project Team

Owner | South Nassau Communities Hospital
Architect | Cannon Design
Engineers | Cannon Design
Communications Consultant |
Civil Engineer |
Construction Manager | Bovis Lend Lease
General Contractor | KLMK Group

Dates of Construction | December 2003 – May 2005

Cost | $64,100,000

Project Delivery Method | Guaranteed Maximum Price

Architecture

Completed in May 2005, the North Addition of the South Nassau Communities Hospital provides an additional 108 medical / surgical beds, LDRs (Labor/Delivery/Recovery), an obstetrical suite, a behavioral health unit, offices, and a 300 seat auditorium to the existing complex. Designed to accentuate the strengths of the existing historical building, the North Addition serves as a welcoming entrance and helps to create a modern image for the hospital. The exterior of the addition is divided into two main volumes. By using brick and traditional fenestration, the rectilinear volume serves as a tribute to the hospital's history. Glass curtain walls and Indian sandstone enhance the elevated curved volume that creates a new gateway for the facility and incorporates all public functions including the auditorium, gift shop, and main lobby. A central conservatory or atrium functions as an extension of the main lobby and acts as a transition between the new facility and South Nassau's history. Filled with abundant natural light, the conservatory provides a relaxing environment with access to outdoor courtyards. Waiting lounges overlook the space and elevated bridges pass through the conservatory and link the two buildings.

Hospitality was a key theme in the design of interior spaces. As a result, many elements and areas open to each other both physically and visually. Warm neutral colors and wood comprise a finish palette derived from the materials and colors of the building's exterior and help to create warm and welcoming spaces.

Applicable Codes and Zoning Requirements

- Applicable Codes
    - Building Code of New York State, May 2002
    - NY State Hospital Code, NYCRR Part 712, revised 1998
    - NFPA 101, Life Safety Code, 2000
    - NFPA 99, Health Care Facilities, 2000
    - Americans With Disabilities Act Accessibility Guidelines
- Zoning
    - Researching exact zoning classification. Requirements as outlined on drawings are below.
    - Minimum Zoning Requirements
        - Minimum Lot Area: 6000 SF
        - Maximum Building Area: 30% (147,721 SF)
        - Maximum Building Height: 3 stories / 45 feet
- Historical Requirements: None

Building Enclosure

The façade of the rectilinear volume is comprised of medium and dark iron spot brick with a smooth finish, painted aluminum, and Low-E clear vision insulated PPG Solar Ban 60 glazing. Painted shadow boxes and sandblasting are used between floors to conceal the plenum space. For the curved volume, garnet sandstone surrounds a curtain wall containing the combination of PPG Solar Ban 60 glazing and painted aluminum mullions. A curtain wall system consisting of silver painted aluminum and 9/16" clear laminated glass with a cool white vinyl interlayer surrounds the conservatory. The roofing is composed of fully adhered EPDM membrane with tapered insulation.

Sustainability Features

While LEED certification was not incorporated into the design of the North Addition, several sustainable features were included in the design. Low-E glazing was used throughout the building to maximize the amount of natural light without significantly increasing cooling loads. Indoor air quality is especially important since the building functions as a hospital. As a result the HVAC system was designed to ensure optimal ventilation and indoor air quality.

Construction

Construction of the North Addition of the South Nassau Communities Hospital began in December 2003 and was completed in May 2005. The construction manager on the project was Bovis Lend Lease. The project delivery method was guaranteed maximum price, and the actual construction cost of the project was $64,100,000.

Electrical

Power is distributed at 5 kV to the existing hospital by the Village of Rockville Centre. The North Addition is served by a 5kV switch via an underground duct bank that is connected to new 5kV switchgear located on the corner of Oceanside Road and Oswald Court. The new switchgear is rated at 2,000 kVA, 5 kV, 3Ph, 5W primary and 480Y/277V, 3Ph, 4W secondary. Designed to provide the reliability and flexibility required in hospitals, the secondary power distribution consists of 480V, 3PH, 4W which provides service to lighting and equipment loads and is transformed down to 208Y/120V, 3Ph, 4W when necessary to provide power to receptacles and other equipment. A new 900 kW pad-mounted 480Y/277V diesel powered emergency generator was added to distribute emergency power for the new addition. As required by code, the secondary distribution system is separated into the following branches:

Normal:	Provides normal power to a majority of the facility loads that are not essential to hospital functions. Loads include general lighting, receptacle loads, and miscellaneous equipment.
Life Safety:	Provides continuous power via normal power or emergency generator for lighting and communications equipment related to the safety of building occupants. Loads include egress illumination, fire alarm systems, and paging systems.
Critical:	Provides continuous power via normal power or emergency generator for areas and equipment of the hospital essential to patient care. Loads include lighting, nurse call systems, and certain receptacles in areas such as nurse's stations and medicine preparation areas.
Equipment:	Provides continuous power via normal power or emergency generator for critical patient care and hospital functions. Loads include sump pumps, surgical HVAC, and elevators.
Fire Pump:	Provides continuous power via normal power or emergency generator for a fire pump to ensure water pressure.

Lighting

In general, the lighting design was guided by the desire to provide high quality light that enhances architectural features, improves occupant safety, and conserves energy. Recessed and pendant mounted linear fluorescent fixtures are used throughout the space in conjunction with compact fluorescent and metal halide downlights. Halogen downlights are also used primarily as accent lighting in select spaces. Special high color rendering lamps are used in special areas such as critical care. In spaces such as offices and storage areas, occupancy sensors provide energy efficient controls. Daylighting is utilized in the lobby, conservatory, offices, and patient rooms. Spaces were designed to meet IESNA recommended illuminance levels and code requirements.

Mechanical

An existing boiler plant consisting of three 8500 lb/hr and one 20,000 lb/hr high pressure steam dual fired boilers provides heating for the existing hospital and the North Addition. A new 750 ton centrifugal chiller handles the cooling loads for the building. The building utilizes a variable air volume system. A total of seven air handling units provide heating, cooling, and ventilation to the new building. AHU-1 and AHU-2, with a capacity of 24,600 cfm each, serve levels 1 through 4 of the east wing. Levels 1 through 4 of the west wing are served by AHU-3 and AHU-4, each with a capacity of 19,800 cfm. Humidification steam from the existing plant feeds dispersion grids located in the each air handling unit. HVAC equipment is equipped with direct digital controls and is integrated into a central workstation.

Structural

The primary structure of the North Addition is supported by spread footings with grade beams. A 5" slab on grade reinforced with steel fibers sits on top of 6" of crushed stone and makes up the ground floor. Steel framing with a W18x40 typical beam size supports a floor system composed of a composite slab using lightweight concrete on top of a 20-gage 2" galvanized metal deck. A 1½" deep wide rib steel roof deck spans between steel beams and supports roof and snow loads. Lateral forces are supported by braced and moment framing.

Fire Protection

The fire alarm system is a based upon a LAN hardware package that utilizes a solid state, microprocessor-based, analog/addressable monitoring and control system. The system employs peer-to-peer token ring network topology over common bus data communication lines between field processing units and network display units. The system includes a central processor unit, annunciator panels, field processing units, firefighter's emergency telephone communications, peripheral detection, smoke and heat detectors, speakers, and manual pull stations. The fire alarm system is tied into the main fire alarm panel located in the existing panel.

Transportation

Three hydraulic powered passenger elevators and two service elevators provide access to all floors of the new addition. All elevators have a rated load of 4500 pounds and have a rated speed of 125 feet per minute. There are a total of three stairwells that serve each floor of the building. One is adjacent to the elevator lobby opposite the elevator shaft. There is also one stairwell at either end of the building.

Communication Systems

The telecommunications system was extended from the existing hospital into the new addition and runs back to the main telecom / computer room in the existing hospital. Voice and data closets house telecom copper, fiber optic, and coax patch panels. The nurse call system provides communication between master stations and sub stations via audio and or visual signaling. A code blue system provides audible and visual alarms via dome lights at the nurse call master stations within each departments as well as the hospital's telephone switchboard room where an operator can provide assistance. A code blue emergency button is located at each critical care patient bed.

Large Workspace | Second Floor Nurse's Station

Existing Conditions

Description

Located throughout the hospital, the nursing stations are the center of activity for the surrounding area. The stations serve as a central monitoring location for nurses as well as an area for doctors and nurses to communicate and organize patient information. Visitors and patients also use the nurse's stations to request information. The nurse's station to be studied in this report is located in the West wing of the second floor. Two corridors surround the station, which is positioned in the center of the surrounding patient rooms. Custom workstations provide areas for computer usage in addition to drawer and file space. Specific dimensions, plans, and materials for this space are detailed below.

Area

830 SF

Dimension

Approximately 30' x 27', with a ceiling height of 9'-6".

Materials

Nurse's Station Materials and Finishes Schedule					
Abbreviation	**Finish Type**	**Object**	**Manufacturer**	**Color**	**Reflectance**
ACT-1	Ceiling Tile	Ceiling	Armstrong	White	0.90[b]
PL-3	Plastic Laminate	Desk Top	Formica (933-58)	White-Matte	0.93[c]
SOS-2	Surface	Desk Side	Trespa (Varitop)	Amber (Matte)	0.30[c]
VCT-2	Vinyl Composite Tile	Floor	Azrock	White	0.82[c]
VWB-1	Vinyl Wall Base	Wall	Roppe	Taupe	0.20[c]
W-3	Wood	Wall	Crown Veneer	Cherry	0.20[a]
WPG-1	Wall Guard	Wall	C/S Group	Dark grey	0.15[c]
WPP-1	Wall Panel	Wall	C/S Group	Light beige	0.43[c]

Table 1: Materials and Finishes for Large Workspace

[a] Reflectance values not available. Assumed from Table 8.5, *Architectural Lighting Design*, Gary R. Steffy, 2008.

[b] Value obtained from manufacturer's data.

[c] Reflectance values not available. Assumed from manufacturer's sample imported into AGI32.

Floor Plans, Elevations, and Images

Figure 1: Photograph of Nurses' Station

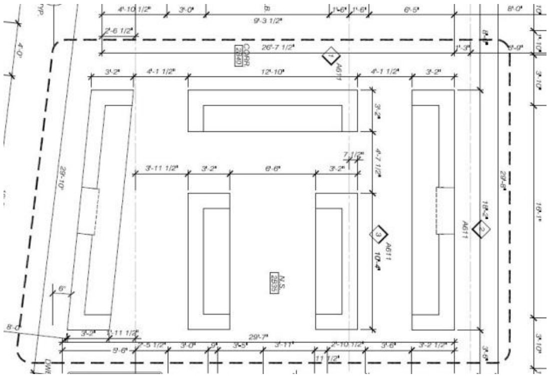


Figure 2: Nurses' Station floor plan

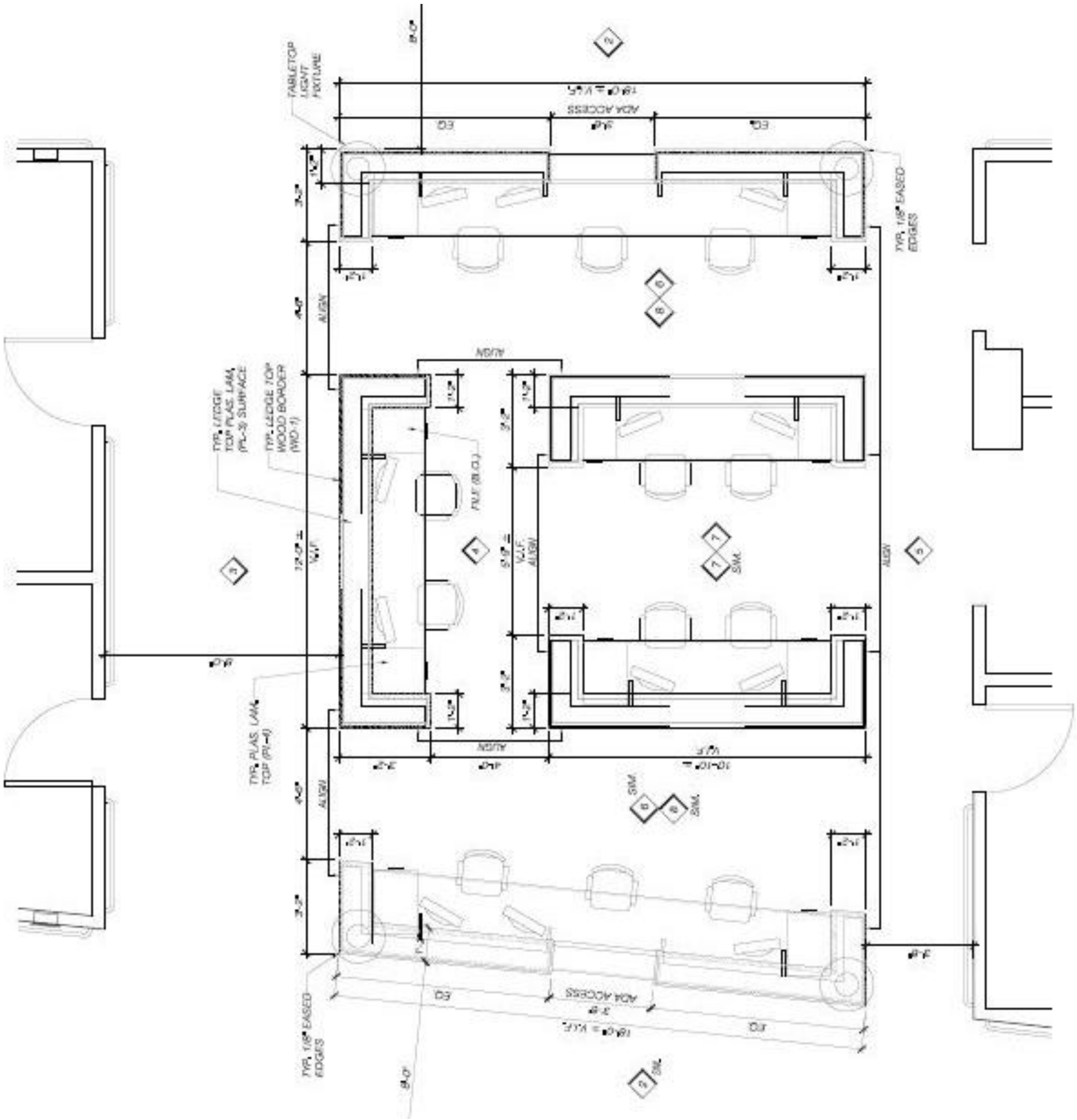


Figure 3: Nurses Station and surrounding area

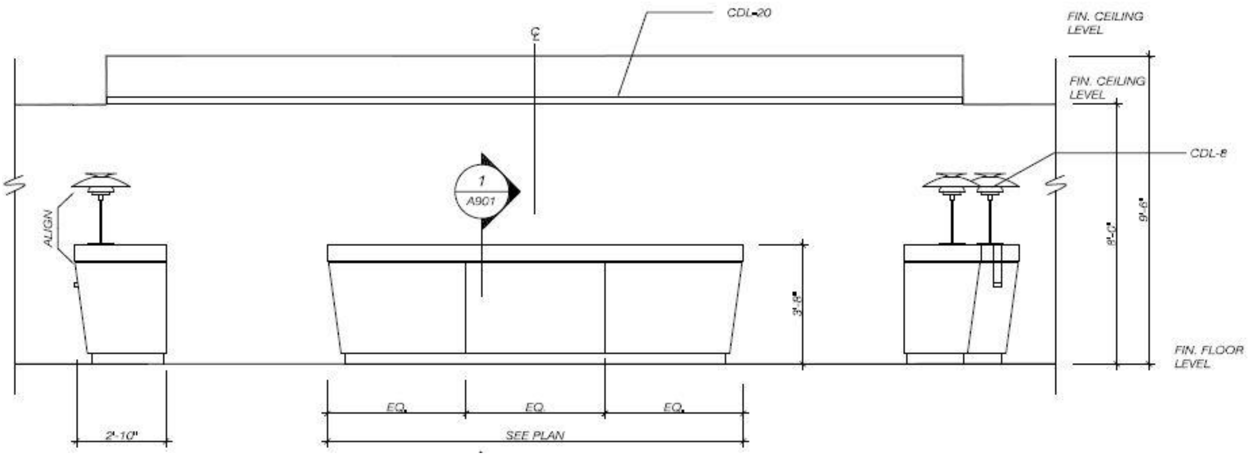


Figure 4: Nurses Station elevation

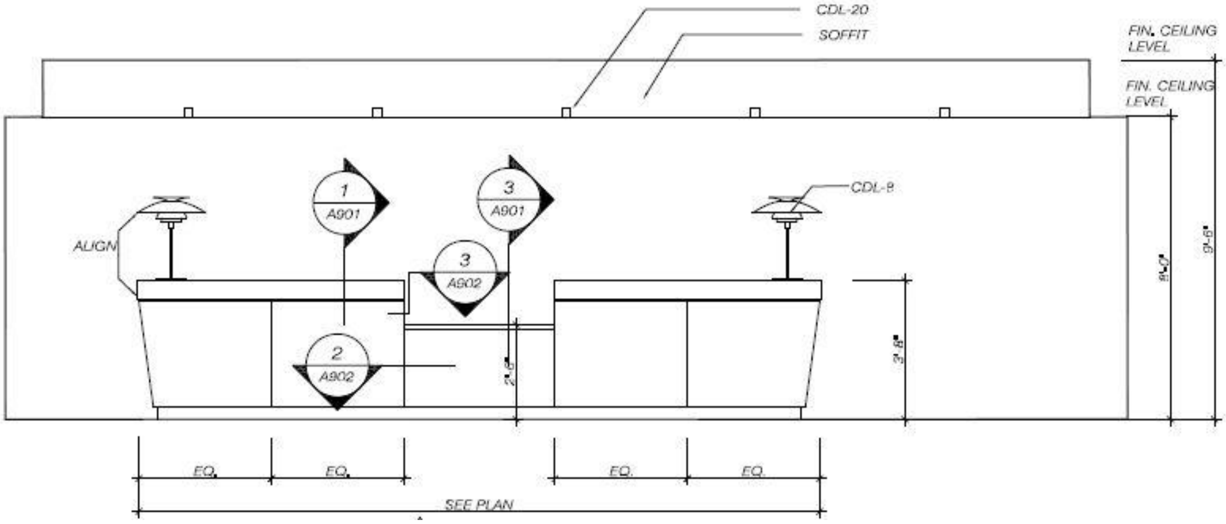


Figure 5: Nurses' Station elevation

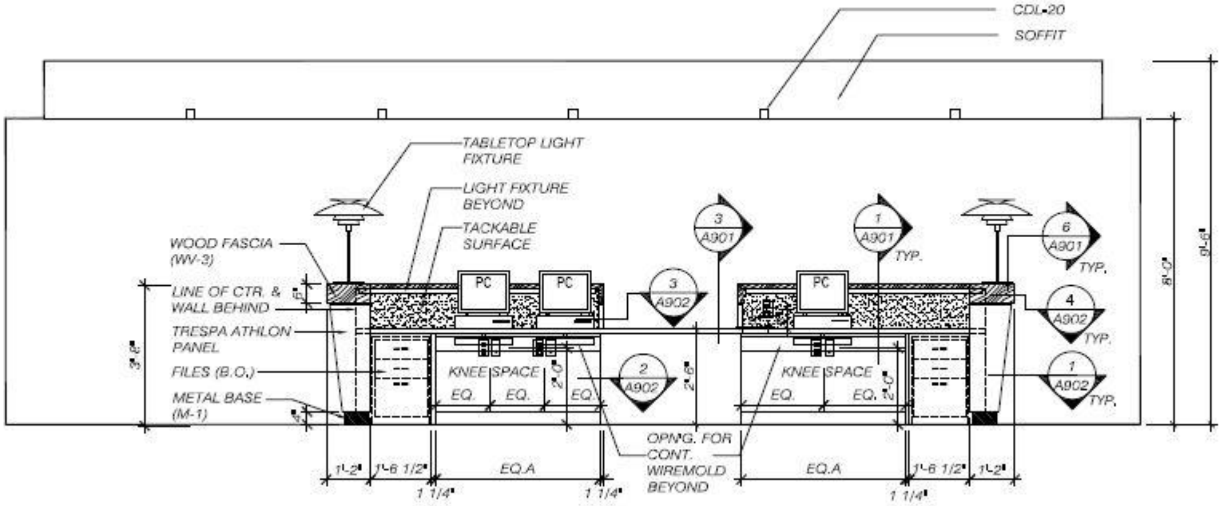


Figure 6: Nurses' Station elevation

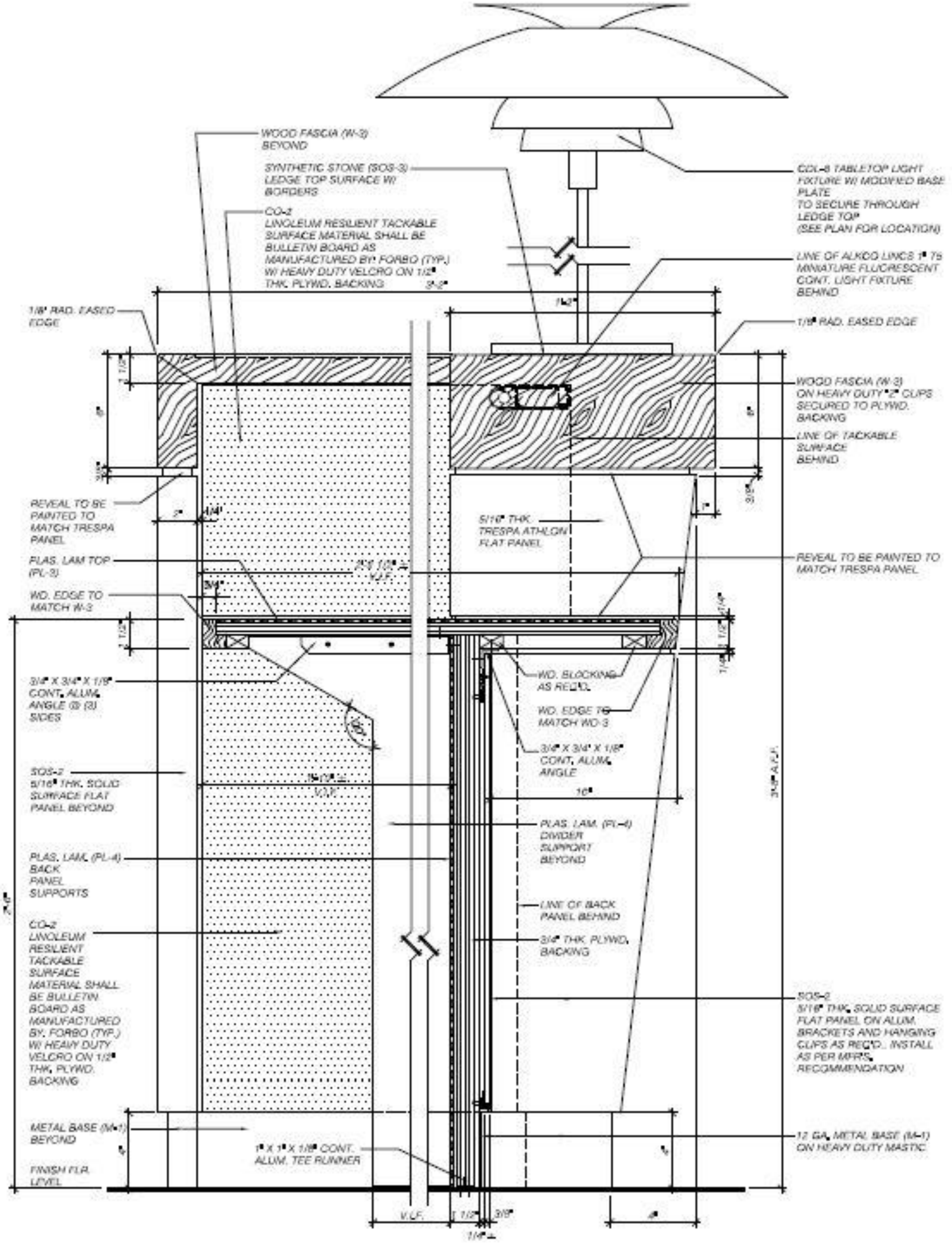


Figure 7: Nurses' Station typical desk section

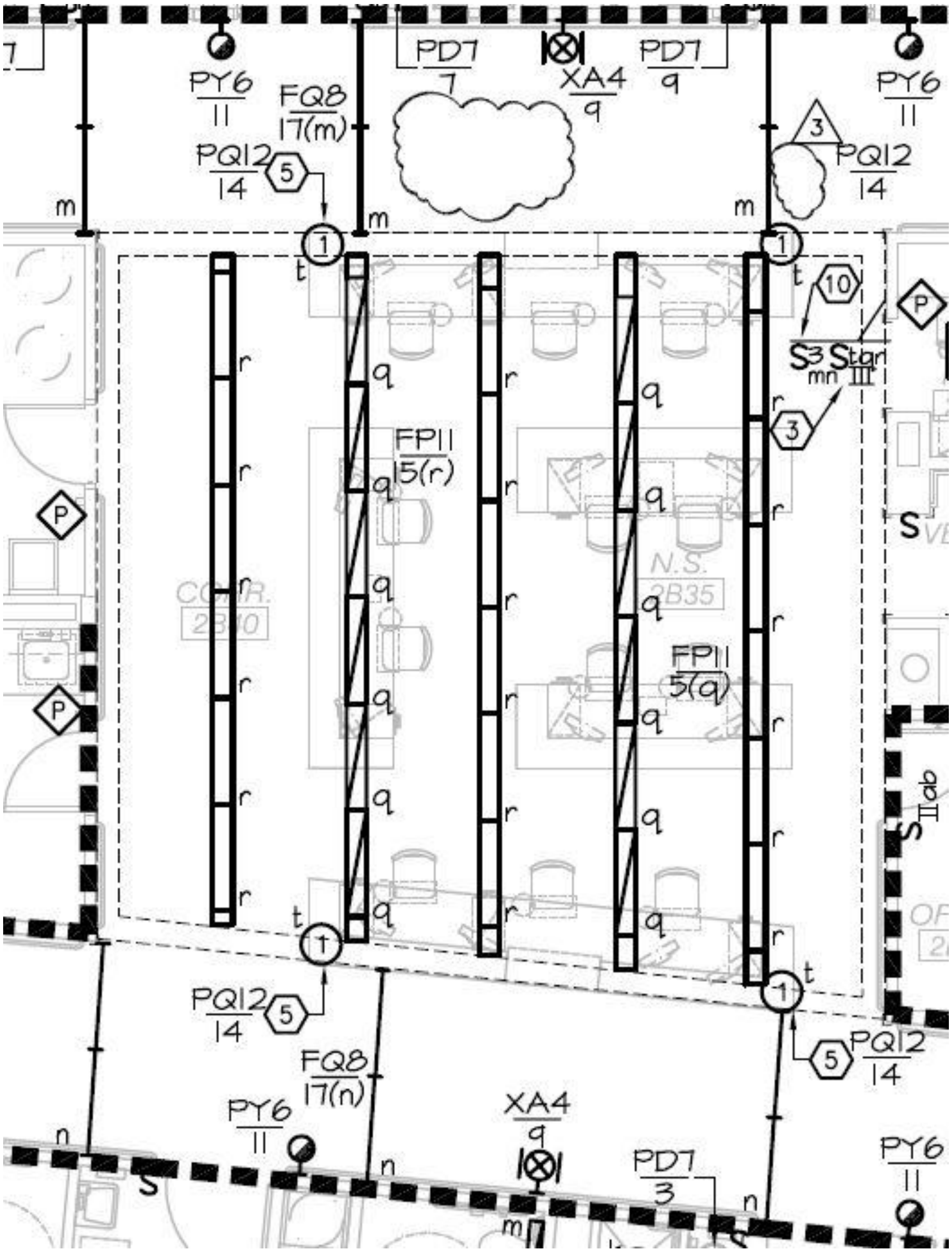


Figure 8: Nurses' Station existing lighting plan

Existing Lighting Equipment

The lighting for the nurse’s station consists primarily of indirect fluorescent lighting (FP11) above the work area. Decorative luminaires (PQ12) with incandescent lamps anchor the corners of the workstation. Under-cabinet fluorescent luminaires (shown in Figure 7) provide additional task lighting on the work plane. Although not part of the lighting for the nurse’s station, luminaires used in the corridors add to the illuminance levels in the nurse’s station. Corridor lighting is achieved primarily by cove lighting which uses a cove lighting fixture (FQ8) with a fluorescent source. A recessed linear fluorescent wall sconce (PY6) provides additional light to the space. Switching for the surrounding hallway lighting is located in the nurse’s station. The switching of luminaires for the nurse’s station allows alternating rows of the indirect luminaires to be switched on and off. Separate switching is also provided for the decorative desk luminaires.

Existing Lighting in Nurse’s Station and Surrounding Corridor							
Type	**Quantity**	**Input Watts**	**Location**	**Mounting**	**Manufacturer**	**Lamp Type**	**Notes**
FP11	30	30	Nurse’s Station	Ceiling Pendant	Gammalux GB44U Series	(1) GE F28T5/835	Custom color Extruded aluminum lens Aircraft cable
PQ12	4	100	Nurse’s Station	Desk Surface	Louis Polsen PH 80 Table Series	(1) 100W A Lamp	White opal acrylic shade
-	-	-	Nurse’s Station	Desk Surface	Alkco Lincs 1”	(1) T5	Not listed in lighting documents
FQ8	12	55	Corridor	Cove	Ledalite 3808T02EN	(2) GE F32T8/835	Dust cover 20 GA. C.R.S. White
PY6	4	37	Corridor	Recessed Sconce	Se’lux M100 Series	(1) (GE) F28T5/835	White flush end Satine lens

Table 2: Existing luminaires for Nurses' Station

Design Criteria and Considerations

Summary

The following sections list important design criteria and considerations for the nurse’s station. Criteria listed include recommended illuminance values as well as power requirements. The final design will strive to meet all design criteria listed, and all existing conditions will be measured against these criteria. All issues listed under considerations come from the IESNA Lighting Handbook in addition to special design issues that relate to this space and project. While many design issues should be considered, the list provided below summarizes the most important issues for this application.

Design Criteria

Table 3 shows recommended illuminance levels specifically for nursing stations. However, individual tasks that are likely to be performed in the area should also be considered. These tasks as well as recommended illuminance values are listed in Table 4. Table 5 and Table 6 summarize lighting power densities according to ASHRAE and the New York State Building Code.

IESNA Illumination Recommendations for Nursing Stations		
Area	**Illuminance**	
	Horizontal	**Vertical**
General Illuminance	30 fc	5 fc
Desk Illuminance	50 fc	10 fc

Table 3: IESNA Illumination Recommendations

IESNA Illumination Recommendations for Tasks		
Task	**Illuminance**	
	Horizontal	**Vertical**
Reading: VDT Screens	3 fc	3 fc
Reading: Keyboard	30 fc	-
Reading: #2 Pencil	30 fc	-
Reading: Ball point pen	30 fc	-
Reading: 8 – 10 point font	30 fc	-

Table 4: IESNA Illumination Recommendations

ASHRAE 90.1-2007 Lighting Power Densities Allowance	
Space Type	**LPD, W/ft^2**
Hospital	1.2
Nursing Station	1.0

Table 5: ASHRAE Lighting Power Densities Allowance

New York State Building Code Lighting Power Requirements	
Space Type	**LPD, W/ft^2**
Hospital	1.2
Nursing Station	1.0

Table 6: Building Code of New York State Lighting Power Requirements

Additional Power Requirements and Allowances:

- New York State Building Code requires that each area required to have a manual control shall also have a control that allows the occupant to reduce the connected lighting load in a reasonably uniform pattern by at least 50%. Corridors and areas controlled by occupancy sensors are exempt. This reduction may be achieved in the following ways:
    - Controlling all lamps and luminaires
    - Dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps
    - Switching the middle lamps independently of the outer lamps

  - Switching each luminaire or each lamp
- ASHRAE allows tradeoffs among spaces provided that the total installed interior lighting power does not exceed the interior lighting power allowance.
- For spaces where decorative lighting is installed in addition to the general lighting, an additional 1.0 W/ft^2 is allowed for the space.

When comparing Table 3 and Table 2, the recommended illuminance values are about the same. An illuminance of 50 fc on the desk and 30 fc in the surrounding area would be appropriate for this space. When comparing allowable lighting power densities, the requirements for the state of New York and ASHRAE are identical. In addition to the design criteria listed, there are many design considerations that must be taken into account. These considerations are summarized in the following section.

Design Considerations

Color Appearance

Appropriate color rendering is critical in nurse's stations. Nurses and doctors must be able to diagnose patients based on visual observation as well as correctly identify medicine that may be similar in color, shape, and size. As a result, lamps with high CRI should be used and decorative luminaires that may alter color should be avoided.

Modeling of Faces and Objects

As mentioned earlier, the nurse's station is the center of activity on patient floors. There are numerous interactions between doctors, nurses, patients, and visitors, and as a result the ability to read and interpret facial expressions is critical to effective communication. Direct downlight that creates harsh facial shadows should be avoided.

Psychological Impression

The nurse's station is the center of activity. Doctors, nurses, patients, and visitors will be performing multiple tasks and frequently moving through a relatively small area. A lighting design that evokes a sense of spaciousness while provide a pleasant workplace will help to make the space feel less confined.

Direct and Reflecting Glare

Direct glare can be distracting to the occupants performing tasks commonly performed in the space such as reading and writing of charts as well as the use of computer screens and should be avoided if possible. Reflected glare could be an issue depending on VDTs used in the area. Almost all of the materials in the area have a matte finish that will reduce reflected glare. The best lighting design will minimize vertical illuminance in the occupant's field of view. Additionally, luminaire luminances should not be greater than 100 times the luminance of surrounding areas. Design solutions include illuminating the ceiling in addition to the task plane.

Appearance of Space and Luminaires

Hospitals are often designed to look modern and clean. The lighting design can assist in meeting these goals by utilizing a clean and uniform layout that reduces visual clutter. Luminaires that are sleek and clean should be chosen to accentuate the hospital's modern design. The surrounding patient rooms should have little to no direct view of the luminaires to eliminate unwanted glare or light.

Light Distribution

Patterns of light on surfaces and the task plane can affect task visibility, comfort, and perception. As a result, the spacing and light distribution of luminaires should be carefully analyzed. Excessive brightness and shadows should be avoided. The task illuminance should be higher than the surroundings to draw attention to the task.

Controls

As outlined in the design criteria, New York State Building Code requires additional controls for the space. The lighting system for the space should also be flexible. The system should be able to operate at higher illuminance levels during the day and lower levels at night to avoid disturbing patients who are sleeping. Since the space lacks natural light, daylight sensors are not a feasible option. Motion sensors could be used, however the lighting will likely always remain on since the will be a constant flow of occupants through the space.

Flicker

Flicker and strobe can create an undesirable work environment. Luminaires that utilize light sources prone to flickering should be avoided. High frequency electronic ballasts should also be used to eliminate flicker.

Daylighting Integration and Control

Daylighting integration and control are important from an energy conservation standpoint; however for this particular space daylight integration is not feasible due to the lack of natural light in the area.

Evaluation and Critique

Summary

The nursing station functions simply as a workspace, and this is mirrored in the lighting design of the space. As shown in Figure 1, the indirect luminaires provide a uniform illuminance on the work plane while helping to add to the modern image of the hospital. The uplight from the luminaires compliments the cove lighting in the corridor, while the thin linear shape of the fixture works well with the wall sconces. The linearity also follows the lighting design used throughout most space in the building.

Lamp selection is consistent throughout the space. Fluorescent lamps with CRIs in the 80's and CCTs of 3500 give the space a warm feel while rendering colors pretty well. The design of the controls allows alternating rows of luminaires to be switched separately, achieving the New York State Building Code requirement that lighting be able to switch to 50% output. Even with switching, dimming may have been a better option as it would have allowed more control of the space and since task lighting is available at the desks.

While the aesthetics work well with the architectural design, the performance and feel of the space are a different story. The use of indirect fixtures creates an almost shadow free environment, and without direct downlighting in the space, the space feels almost hazy. A combination of indirect lighting with downlights and some wall washing could have been used to create a more pleasant space.

The nurse's station was one of two spaces analyzed using AGI32, and based on the calculation results, the nurse's station exceeds all criteria presented in Table 2 through Table 5. Table 6 shows a comparison of the recommended and existing illuminance and power density values.

Criteria Comparison for Nurse's Station		
Criteria	**Recommended**	**Existing**
General Horizontal Illuminance @ 2.5'(fc)	30	63
General Vertical Illuminance (fc)	5	77
Desk Horizontal Illuminance @ 2.5' (fc)	50	63
Desk Vertical Illuminance (fc)	10	77
LPD (W/ft^2)	1.0	1.07

Table 7: Comparison of existing and recommended illuminance levels

As Table 7 shows, the existing illuminance values greatly exceed those recommended by IESNA. A more detailed breakdown of the AGI calculation results is shown in Table 9 and Figures 9 through 12. Calculations were run using the light loss factors outlined in Table 10 and Table 11. It should be noted that calculations for the nurse's station were run with corridor luminaires on, since that best simulates the working condition. This could be one reason why illuminance values in the space are so high. Lighting power density calculations, summarized in Table 8, were conducted using only the luminaires above the nurse's station (FP11). The existing LPD exceeds the recommendations of both ASHRAE and New York State, however, if the extra 1.0 W/ft^2 for decorative lighting is applied, the lighting design passes requirements. The existing lighting design, which includes indirect lighting in addition to task lighting for the work plane, seems excessive, especially when additional light from the surrounding corridor is considered. The lighting redesign should create a more pleasant space that adheres to the criteria presented.

Lighting Power Density for Nurse's Station			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
FP11	30	30	900

Total Watts:	900
Total Area (ft^2):	840
LPD (W/ft^2):	1.07

Table 8: Lighting power density calculation for existing design

Illuminance Values for Nurse's Station

Horizontal Illuminance Work Plane	
Average Illuminance (fc)	62.68
Maximum Illuminance (fc)	86.10
Minimum Illuminance (fc)	10.30
Maximum : Minimum	8.36
Average : Minimum	6.09

Vertical Illuminance at 4'	
Average Illuminance (fc)	77.76
Maximum Illuminance (fc)	91.80
Minimum Illuminance (fc)	49.00
Maximum : Minimum	1.87
Average : Minimum	1.59

Table 9: Summary of AGI32 calculations for nurses' station

Luminaire Light Loss Factors for Nurse's Station									
Type	**Cleaning Interval**	**LDD Case**	**Initial Lumens**	**Design Lumens**	**LLD**	**LDD**[a]	**RSDD**[b]	**BF**	**Total LLF**
FP11	Clean, 6 mo.	X	2900	2660	0.92	0.92	0.98	0.96	0.796

Table 10: Light loss factors for nurses' station luminaries

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

Luminaire Light Loss Factors for Corridor									
Type	**Cleaning Interval**	**LDD Case**	**Initial Lumens**	**Design Lumens**	**LLD**	**LDD**[a]	**RSDD**[b]	**BF**	**Total LLF**
FQ8	Clean, 6 mo.	X	2800	2660	0.95	0.92	0.98	0.88	0.754
PY6	Clean, 6 mo.	W	2900	2660	0.92	0.93	0.98	0.96	0.801

Table 11: Light loss factors for corridor luminaries

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

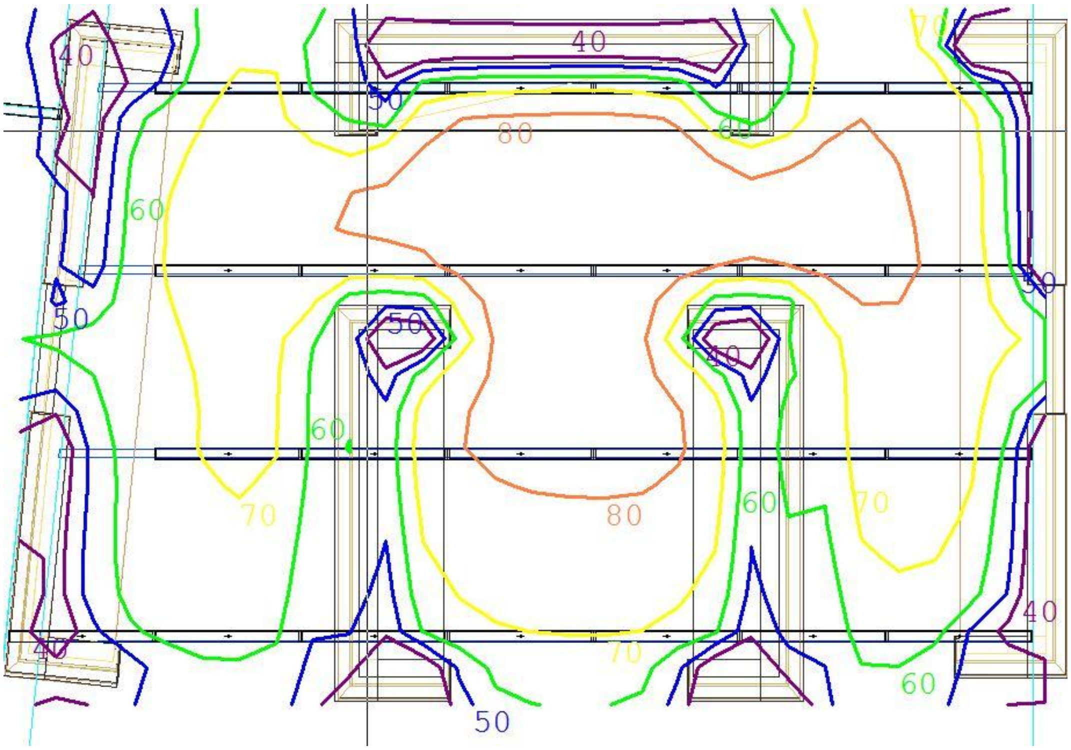


Figure 9: Iso lines for horizontal illuminance values for nurses' station

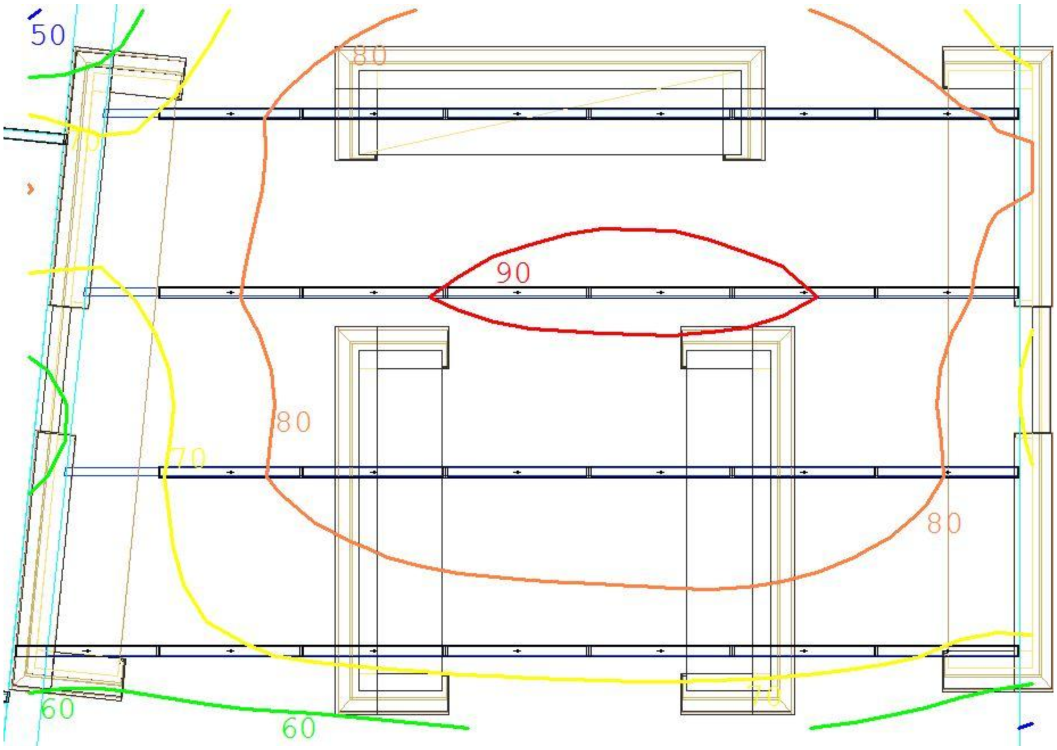


Figure 10: Iso lines of vertical illuminance values for nurses' station

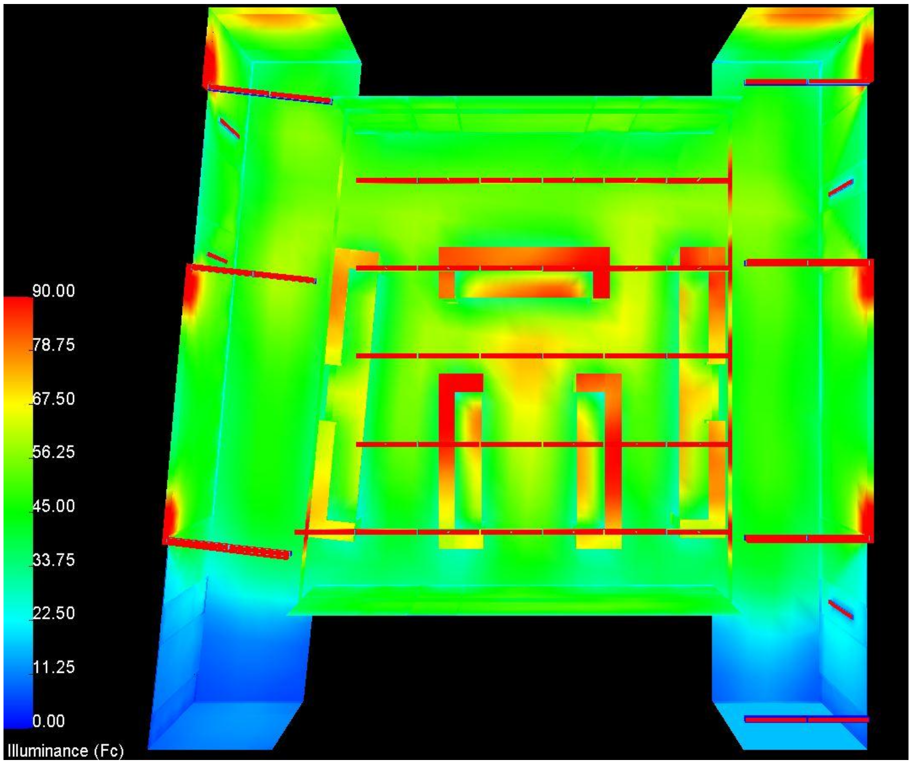


Figure 11: Pseudo color rendering of nurses' station

Figure 12: AGI32 rendering of nurses' station

Schematic Design

Summary

The main goal for the new lighting design is to create a comfortable working environment while creating a modern image and improving the aesthetics of the space. Since the space is located between two hallways, and is rather small, lighting will be used to create an impression of spaciousness in the space. The indirect pendants were removed to reduce visual clutter in the space and to give the space a more spacious feel by eliminating the false ceiling created by the bottom of the pendants. The spacious feeling is also enhanced with ceiling illumination from cove lighting and peripheral illumination from wall slots. The peripheral lighting also helps to create a relaxing environment for the workers. To meet illumination recommendations for the workspace, downlights will be added above the work area. Task lighting should also be considered if additional illumination is needed on the work plane.

Figure 13: Schematic lighting design for nurses' station

Figure 14: Schematic lighting design for nurses' station

Professional Comments from Lutron Presentation

Lee Brandt:

- Think about the nurses. Maybe they don't want to have the station dark at night.
- Don't be too concerned with glare on computer screens. This applies more to older screens
- Could build a cove and not light it. Could also build shallow cove and light with low wattage LEDs to create a glow on the ceiling.
- Could use direct/indirect pendants to keep light focused above the central working area.

Mike Barber

- To do what you want will be tough from an energy perspective.
- Some nurses do like it darker at night.
- Dig deeper into the idea of hospitals as healing spaces.

Luke Tigue

- Concur that coves will get you out of the allocated energy budget.
- Anything you can do to reduce clutter is good since hospital spaces like this tend to be quite cluttered.

Lighting Solution

Overview

Key concepts from the schematic design were carried over into the final design. The pendants were removed to eliminate ceiling clutter and make the space feel taller. Cove lighting was not implemented because of power density requirements, however by eliminating the pendants the plane created by the bottom of the pendants is removed and the area above the workspace feels taller and more open. Linear fluorescent lamps were located in an 8" wall slot to illuminate the walls in the front and back of the space. The added illuminance adds to the spacious feel of the area while also creating a relaxing environment. The addition of peripheral lighting also helps to create a strong contrast between the edge of the ceiling and the wall and complements the linear architecture of the space. LED downlights were used to meet the general illuminance recommendations for the space. The use of LED sources helped the design meet the power density requirements for the space because of their low power consumption. The overall combination of peripheral lighting and general downlighting help to create a more relaxing space. The design also creates a livelier environment by eliminating the haziness created by the indirect lighting of the original design.

In addition to creating an aesthetically pleasing lighting design, a goal of the lighting design was to incorporate ways in which light exposure, or more appropriately, optical radiation, can be used to positively affect human health and productivity. As part of the M.A.E. requirements, the biological effects of optical radiation on humans were researched. This research, which is provided in detail in the M.A.E. section of this report, was applied specifically to nurses working under night shift conditions in the space.

Nurses and doctors often work long hours without sleep or work on schedules that make a regular sleep cycle difficult. These working conditions can lead to a decrease in alertness and can lead to errors that could be potentially life threatening to patients and the workers themselves. A desired outcome of the research was to devise a lighting system that would increase worker productivity, increase worker alertness, and help adjust the circadian rhythms of night shift workers. Based on this research, it was determined that a ten to fifteen minute exposure of 20 – 50 fc of short wavelength radiation heavily saturated in the 480nm region would help improve alertness and adjust the circadian rhythms of night shift workers.

To achieve this lighting design, a custom fixture with royal blue and 4100K white LEDs was specified and is to be mounted just under the top shelf of the workstations, approximately 3.5’ above the floor and approximately 1’ above the work plane. The white LEDs have a lens which allows the light to illuminate the work plane while minimizing direct glare, while the blue LEDs have a 30° beam spread which allows for the recommended 20 – 50 fc of short wavelength to be delivered to a worker seated at a desk in the nurses’ station. A CCT of 4100K was used for the task lighting in the space as well as the both the slot and downlighting in the space. This CCT was specified because it is a relatively comfortable CCT to work under and contains a higher concentration of short wavelength energy than warmer sources.

The tables, renderings, schedules, and lighting plans on the following pages convey the final design for this space.

Renderings

Figure 15: AGI32 rendering of final lighting design for nurses' station

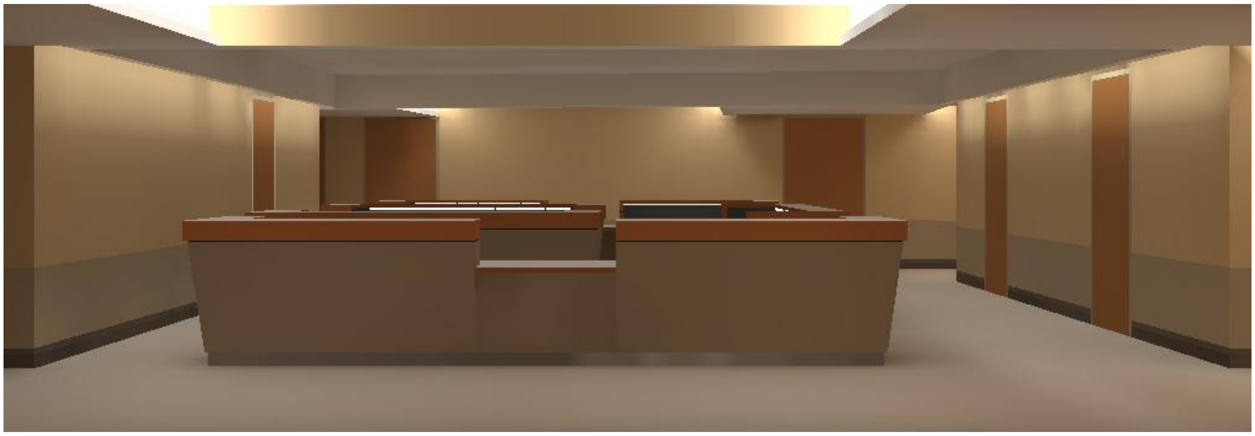


Figure 16: AGI32 rendering of final lighting design for nurses' station

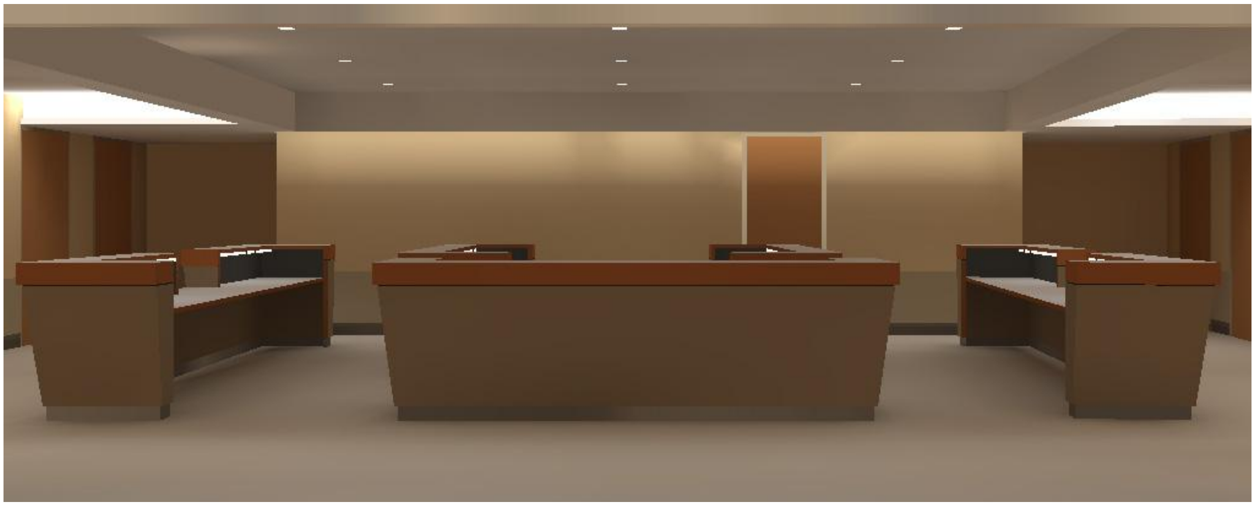


Figure 17: AGI32 Rendering of final lighting design for nurses' station

Figure 18: AGI32 rendering of final light design for nurses' station

Figure 19: AGI32 rendering of final light design for nurses' station

Lighting Plan

See Appendix A for lighting plans, construction details, and control diagrams.

Luminaire Schedule

LUMINAIRE SCHEDULE								
TAG	IMAGE	MANUFACTURER/CATALOG #	DECRIPTION	LAMP	VOLT	BALLAST / POWER SUPPLY	WATT	LOCATION
NA		Focal Point / focus3-1T8-1C-277-S-RC	High performance slot mounted open wall washing luminaire. 81% luminaire effeciency. Aluminum reflector with steel housing.	(1) 25W F32T8 4100K, 85 CRI; (1)	277	GE132-MVPS-N electronic program/rapid start ballast.	24	Recessed mounting in slot 8'-0" A.F.F.
NB		Lightolier / Calculite-C4X4L05-40K-W-CCL-FT	4.5" square recessed LED fixture. LED module with royal blue LEDs with remote phosphor. Wide beam. Dimmable. Tested in accordance with LM79	LED Module 4000K, CRI 78	277	Integral driver	10	Recessed mounting in ceiling 9'-6" A.F.F. See dwgs for additional details.
NC		Color Kinetics/ ColorGraze Powercore - Custom	Surface mount LED fixture. Channel 1 & 3 4000K White LEDs w/ 90° x 60° assymetric lens. Channel 2 royal blue LEDs w/ 30° x 60° lens.	(8) 4000K LEDs, (4) Royal Blue LEDs per 1' length	120	Advance 120V LED Driver LED-120A-0012V-50-F. Input 75W.	35	Mounted under desk in nurses station, 3'-6" A.F.F. See dwgs for additional details.

Table 12: Nurses' station luminaire schedule

Control Scheme

The lighting in the nurses' station is controlled primarily through switching located in the adjacent break room. Luminaire type NB is controlled separately from luminaire type NA via two switches in the break room. Luminaire type NC is controlled with a Color Kinetics Light System Manager. The light system manager allows the circadian lighting system (the blue light component of luminaire NC) to be programmed to turn on and off and preset times. The system also allows for fine tuning of the circadian lighting system, allowing the blue LEDs to be dimmed to different levels based on the desired level of optical radiation at eye level. The Light System Manager also allows the task lighting component of Luminaire type NC to be controlled independently of the circadian lighting system. Each workstation can have up to four programmed scenes for task lighting, allowing for a total of eight task lighting scenes per desk. These scenes include one scene with the maximum output for the task lighting and three scenes that deliver lower illuminance levels on the work plane. These scenes are to be programmed into the light system manager and will be controlled through a keypad placed at each desk.

Performance

Performance was measured through calculations in AGI32 and 3D Studio Max. Material reflectance values were the same as those detailed in the Materials section. Performance was measured against IESNA and ASHRAE recommendations documented earlier. Light loss factors were also calculated for each luminaire in the space.

Luminaire Light Loss Factors for Courtyard								
Luminaire Designation	**Cleaning Interval**	**LDD Case**	**Initial Lumens**	**Design Lumens**	**LLD**	**LDD[a]**	**BF**	**Total LLF**
NA	Clean, 12 mo.	W	2500	2350	0.94	0.91	0.86	0.73
NB	Clean, 12 mo.	W	1800	1620	0.80	0.91	1.0	0.73
NC	Clean, 12 mo.	W	2500	2425	0.80	0.91	1.0	0.73

Table 13: Light loss factors for nurses' station luminaires

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

[c] Assumed LED lamp lumen depreciation.

Lighting Power Density for Lobby			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
NA	13	24	312
NB	12	10	120
NC	25	35	875

Total Watts:	1307
Total Area (ft^2):	840
LPD (W/ft^2):	1.55
Allowable (W/ft^2):	1.0

Table 14: Lighting power density calculation

The lighting design outlined above does not meet ASHRAE or New York State power requirements of 1.0 W/SF. This is due to the additional luminaires used for the circadian lighting system. ASHRAE and the state of New York does not make any provisions for lighting that benefits human health, however it is reasonable to expect that the circadian lighting system could be an exception to the power requirements similar to the exceptions afforded to decorative lighting. Under the assumption that, like decorative lighting, the circadian lighting system is allowed an additional 1.0 W/SF, the designed lighting power density of 1.55 W/SF would fall under the required 2.0 W/SF. If this assumption is not made, the additional 0.55 W/SF can be covered by tradable watts from other spaces.

IESNA Illumination Recommendations for Nursing Station		
Area	**Avg. Horizontal Illuminance**	
	Target	**Design**
General Horizontal @ 2.5’	30 fc	31 fc
General Vertical	5 fc	10 fc
Desk Horizontal @ 2.5’	50 fc	48 fc
Desk Vertical	10 fc	10 – 45 fc
Circadian Vertical	20 – 50 fc	25 – 45 fc

Table 15: Comparison of designed and recommended illuminance values

The illuminance values in the nurses’ station all meet the designated criteria. General vertical illumination was not measured; however the vertical illuminance at the desk meets requirements, so the general vertical illuminance is also met. Vertical illuminance was measured at 3.5’ above the work plane facing the desk. The average general illuminance given was measured at the floor, so it is reasonable to assume the recommended illuminance levels are met at 2.5’ above the floor. Figure 20 shows desktop illuminance under general lighting conditions with luminaires NA and NB on but with task luminaire NC switched off. Figure 21 shows desktop illuminance with task lighting at full output. Pseudo color renderings below show the illuminance values in more detail. Figure 22 shows general lighting switched on with the circadian lighting system at full output. The circadian lighting systems’ contribution to the vertical illuminance can be seen by the line of illuminance values. With the circadian system at full output, the average vertical illuminance at eye level is approximately 60 fc. Without the circadian lighting system, the vertical illuminance is an average of 15 fc, slightly higher than the recommended value of 10 fc.

Figures 24 through 27 show the contribution of the circadian and task lighting independent of light from luminaires NA and NB. Figure 24 shows that the task lighting alone delivers an average of 30 fc to the work plane. Figure 25 shows that the circadian system delivers an average of 45 fc of short wavelength light to eye level. This is slightly higher than the desired 30 fc, but falls between the 20 – 50 fc that was determined to be effective at shifting our circadian system and improving alertness. Figure 26 shows that an average vertical illuminance of 35 fc can be achieved by dimming the royal blue LEDs to 80% output, while Figure 27 shows that an average of 25 fc can be achieved by dimming to 60% output. This shows that dimming can be used to tailor the amount of optical radiation administered. This allows flexibility in the lighting design as additional research and studies are completed.

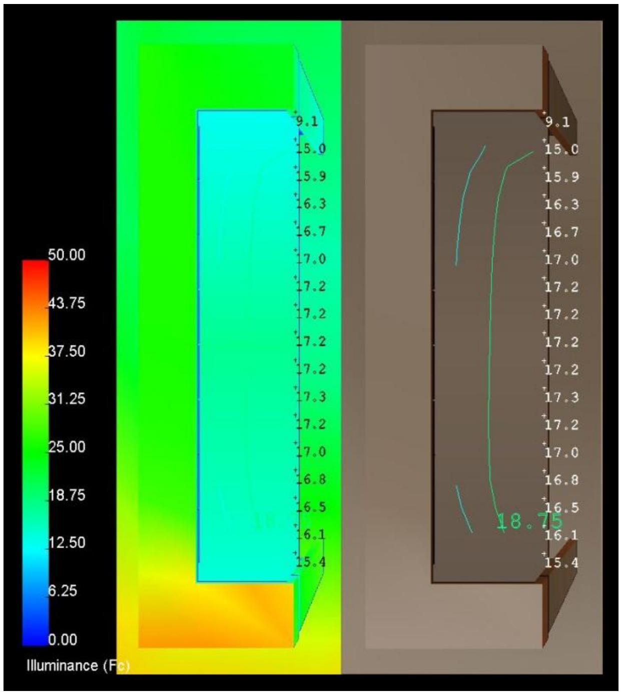


Figure 20: Desktop illuminance – General Lighting

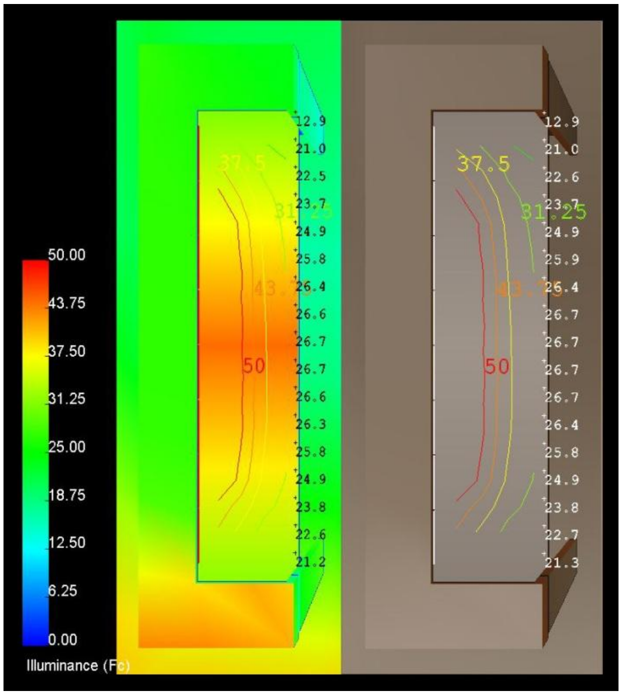


Figure 21: Desktop illuminance - Task lighting

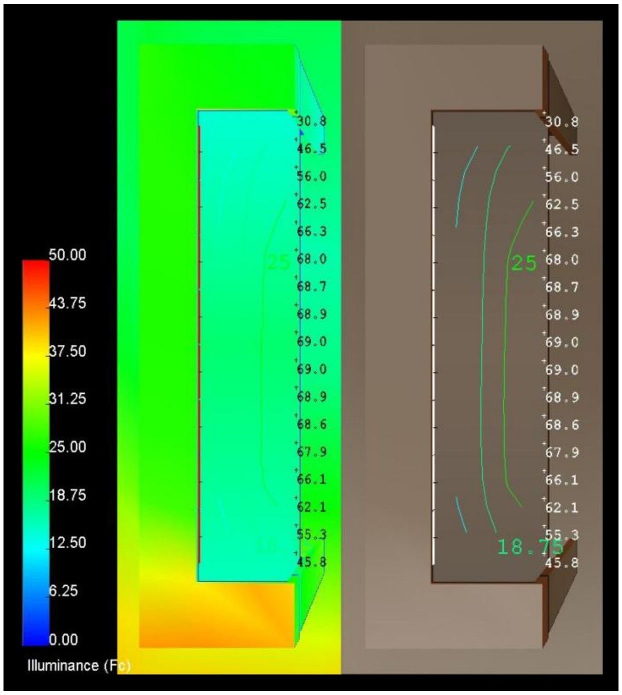


Figure 22: Desktop illuminance - Circadian lighting 100%

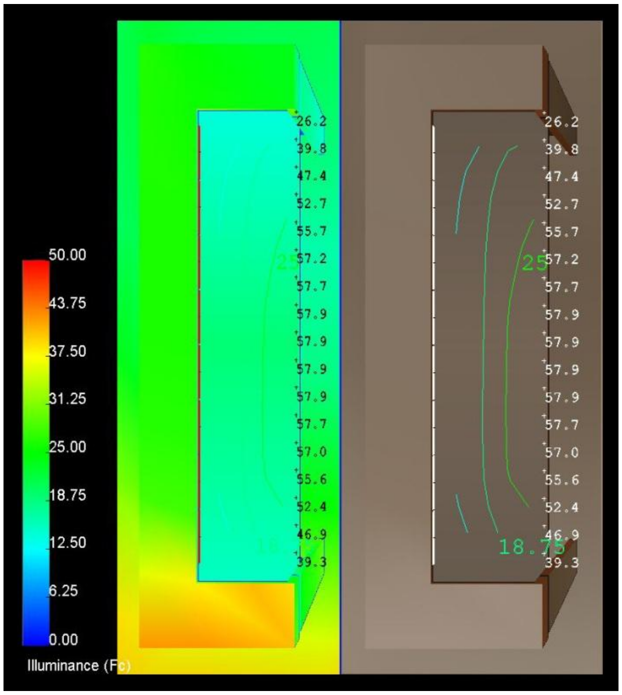


Figure 23: Desktop illuminance - Circadian lighting 80%

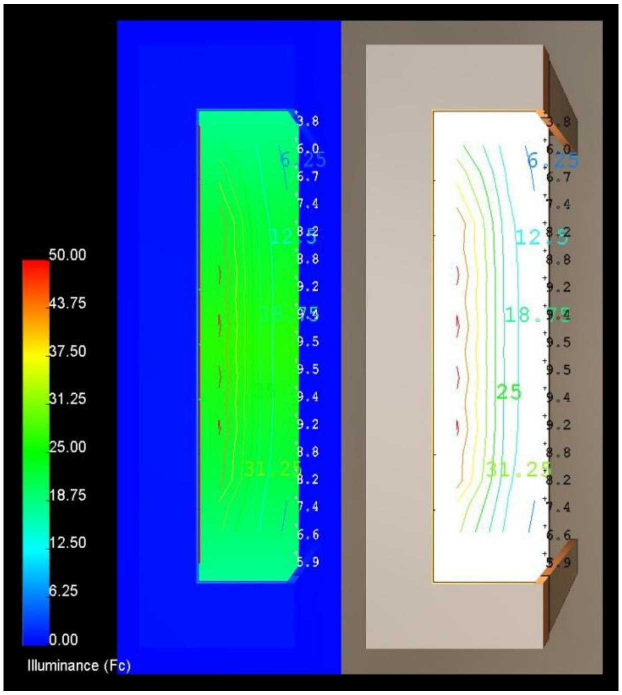


Figure 24: Desktop illuminance - Task Lighting

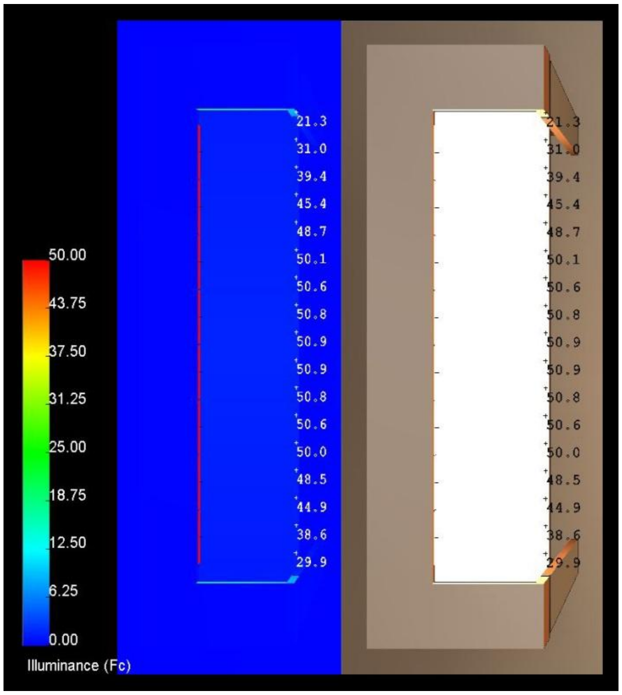


Figure 25: Desktop illuminance – Circadian lighting 100%

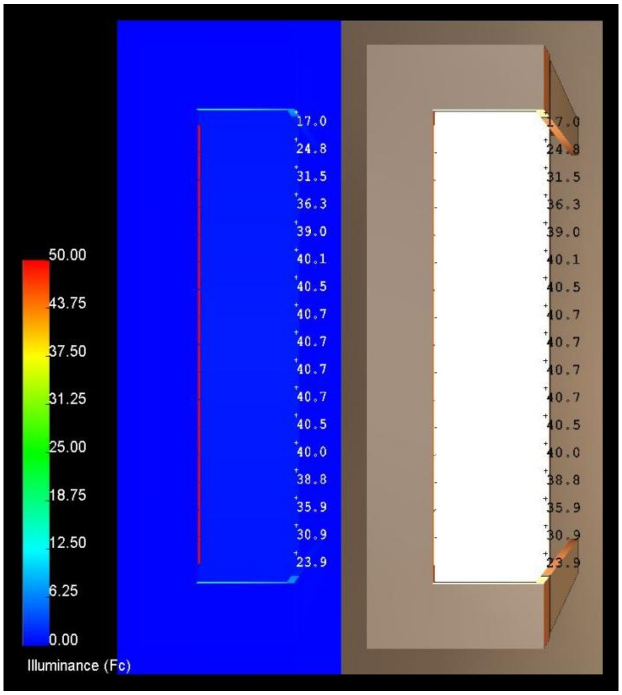


Figure 26: Desktop illuminance - Circadian lighting 80%

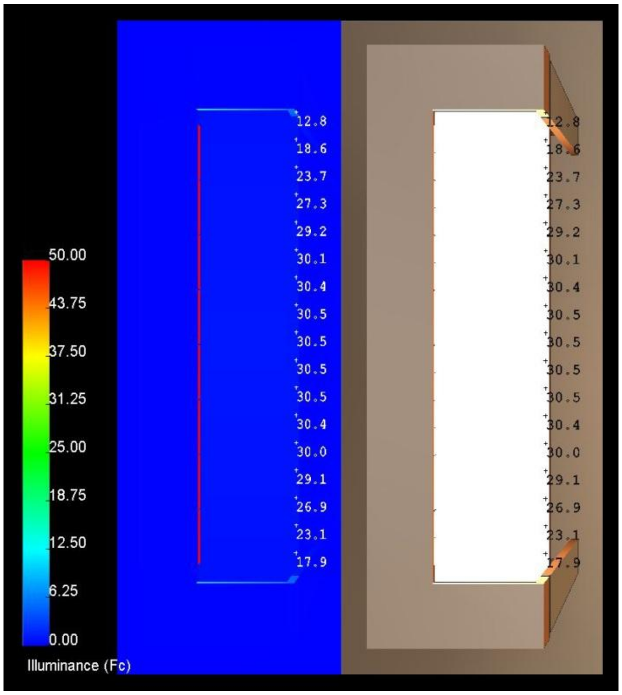


Figure 27: Desktop illuminance - Circadian lighting 60%

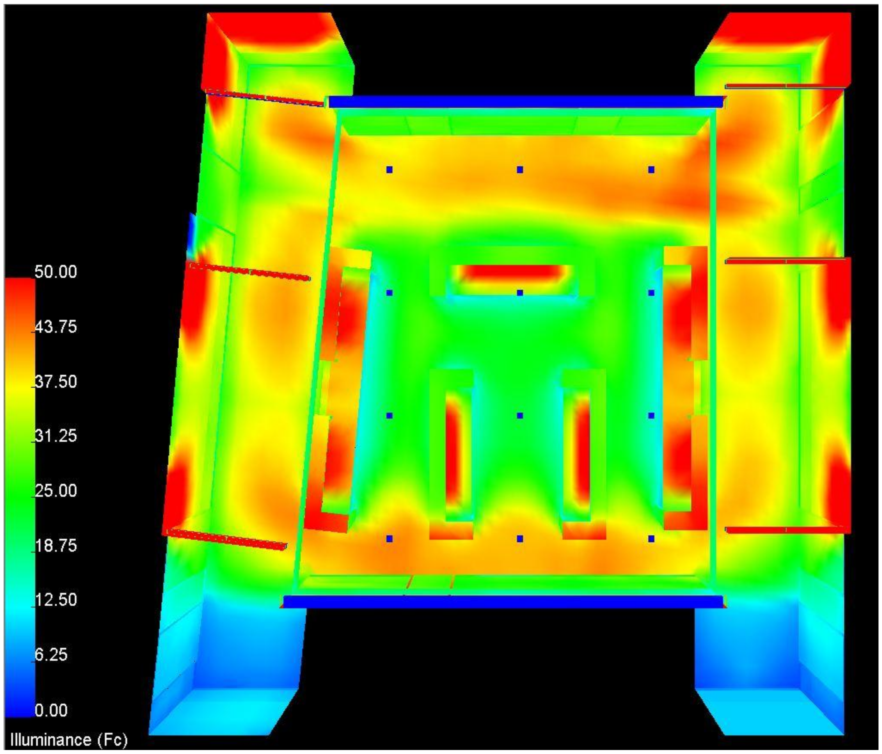


Figure 28: Pseudo color rendering of illuminance levels in nurses' station

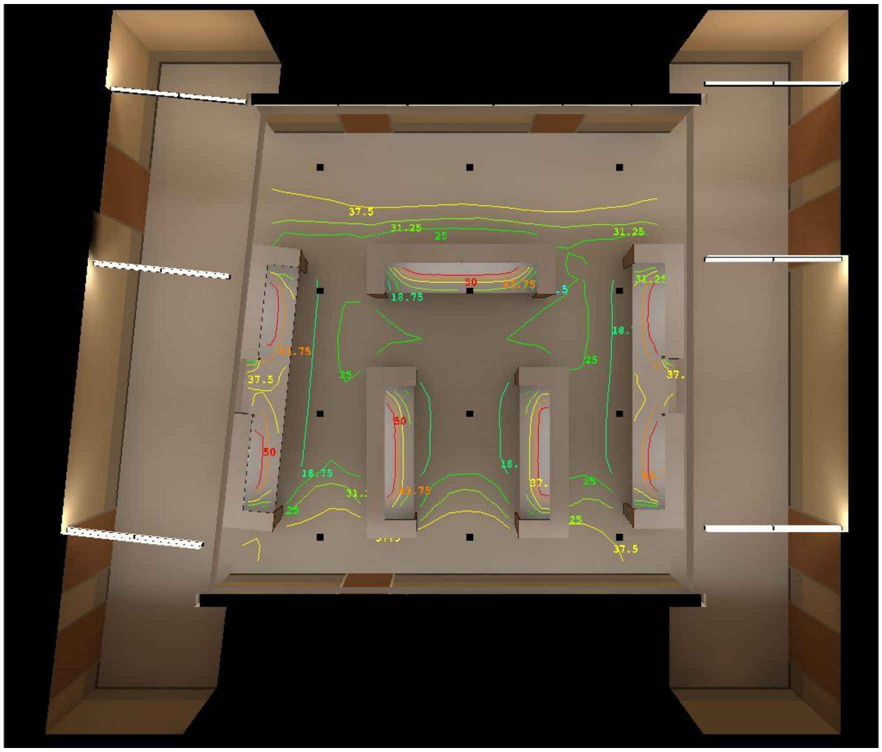


Figure 29: Iso lines of illuminance levels in nurses' station

The original design considerations for the space were also met using the following methods:

Summary of Considerations for Nurses' Station		
Considerations	**Recommended**	**Design**
Appearance of Space and Luminaires	Minimize clutter, uniform layout. Design should complement space.	Slot lighting illuminates walls adding visual interest. Ceiling clutter eliminated by replacing pendants with uniformly arranged downlights.
Psychological Impression	Relaxing, spacious.	Peripheral lighting adds reflected light into the space create a relaxing environment. Illuminated walls also help to expand the space, creating a spacious feeling.
Modeling of Faces	Avoid harsh shadows	Lighting uniformly arranged to avoid direct downlighting and harsh shadows. Slot and task lighting reduce the amount of downlighting.
Controls	Space should be flexible	Light System Manager allows for flexible control of task lighting system.
Glare	Avoid direct glare	Direct glare avoided with the exception of circadian lighting system, which requires direct glare for exposure. Luminance of luminaire less than 100X surroundings.
Color Appearance	Good color rendering.	High CRI LEDs enhance color rendering and allows for color discrimination.
Light Distribution	Avoid patterns, draw attention to task.	Uniform light levels on walls, floor, and work plane. No scalloping. Higher illuminance levels are used to draw attention to work plane.

Table 16: Summary of design consideration for nurses' station

Summary

The lighting in the nursing station was designed to reduce clutter, enhance the modern image of the hospital, and create a comfortable and safe working environment. Ceiling clutter was eliminated by replacing the existing pendants with LED downlights. A selection of modern equipment and uniform layout of the lighting helps to create a modern image for the space. Slot lighting is used to help add contrast and interest to the surfaces in the space and to create both a relaxing and spacious environment. Perimeter lighting also helps to define the boundaries of the space while creating contrast between the walls and ceiling.

The circadian lighting design meets the goals set forth at the beginning of the design process. The specification of royal blue LEDs ensures that short wavelength optical radiation close to the desired 480 nm will be administered to occupants in the space. The specified control system can be used to program the circadian lighting system to slowing increase output to the desired level for ten to fifteen minutes every hour. The controls system also allows for the output of the system to be adjusted in the event that future research dictates a change in the duration or amount of exposure to optical radiation.

The lighting design exceeds the ASHRAE requirement of 1.0 W/SF in this space due to the power consumption of the luminaires used for the circadian and task lighting. Under the assumption that, like decorative lighting, the circadian lighting system is allowed an additional 1.0 W/SF, the designed lighting power density of 1.55 W/SF would fall under the required 2.0 W/SF. If this assumption is not made, the additional 0.55 W/SF can be covered by tradable watts from other spaces.

In addition to all power requirements, the lighting design meets all recommended illuminance values in the space. General recommendations for the space were achieved through the use of LED downlights above the space, while task specific target values are met through the use of the task lighting component luminaire type NC.

Special Purpose Space | Auditorium

Existing Conditions

Description:

The auditorium is located adjacent to the main lobby on the ground floor. Designed to function as an auditorium as well as a small conference center, the space can be divided into three separate rooms and can be used for public functions as well as to host more formal events. The main projector screen is located on the front wall of the auditorium. Visual tasks will vary depending on the function of the space. As a conference center, visual tasks will likely include reading and writing, but could also include viewing presentations. Minimizing glare and producing good facial rendering on the speaker will be important to consider when designing the lighting for a presentation space. The auditorium is roughly in the shape of an ellipse with the wall serving as an interesting architectural element in the space. Specific dimensions, plans, and materials for this space are detailed below.

Area

2700 SF

Dimension

Approximately 75’ x 40’, with a ceiling height of 16’.

Materials:

Auditorium Materials and Finishes Schedule					
Abbreviation	**Finish Type**	**Object**	**Manufacturer**	**Color**	**Reflectance**
ACT-3	Ceiling Tile	Ceiling	Decoustics	White,Claro	0.90[b]
CPT-2	Carpet	Floor	Atlas	Light Brown	0.23[c]
FWC-1	Fabric wall	Wall	Texaa	Orce rouge 390	0.08[c]
W-2	Wood	Doors	Crown Veneer	Walnut	0.10[a]
W-6	Wood	Wall	Crown Veneer	Match FWC-1	0.08[c]

Table 17: Materials and finishes for Auditorium

[a] Reflectance values not available. Assumed from Table 8.5, *Architectural Lighting Design*, Gary R. Steffy, 2008.

[b] Value obtained from manufacturer’s data.

[c] Reflectance values not available. Assumed from manufacturer’s sample imported into AGI32.

Floor Plans, Elevations, and Images

Figure 30: Photograph of Auditorium

Figure 31: Photograph of Auditorium entrance

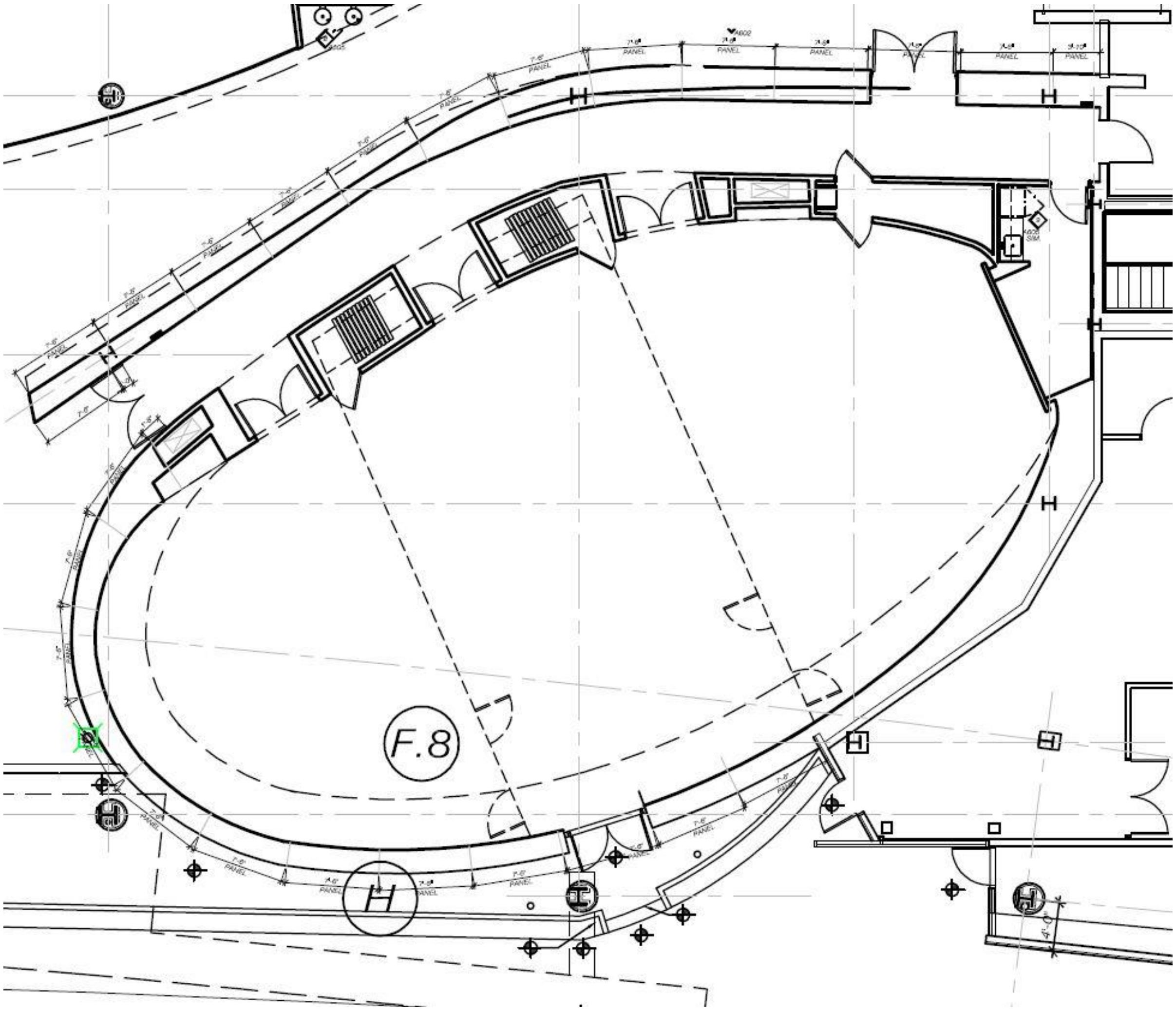


Figure 32: Auditorium floor plan

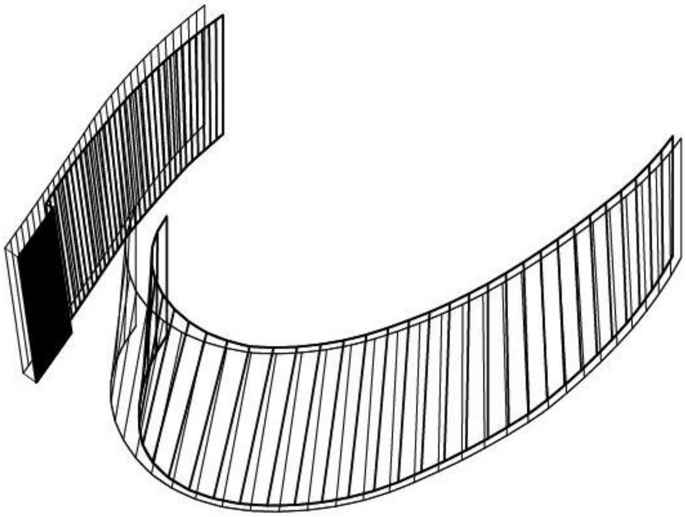


Figure 33: Auditorium wall shape

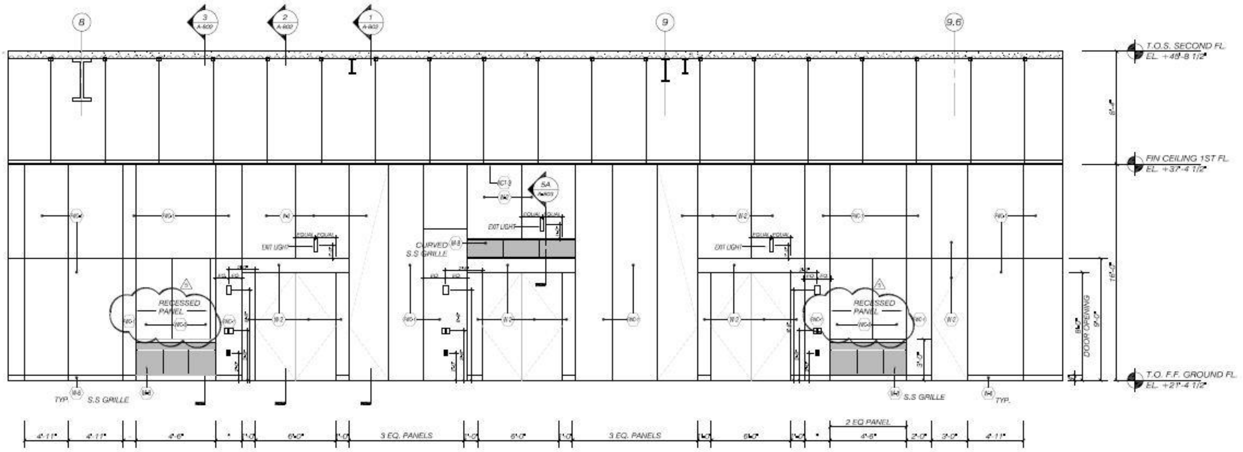


Figure 34: Elevation of Auditorium entrance

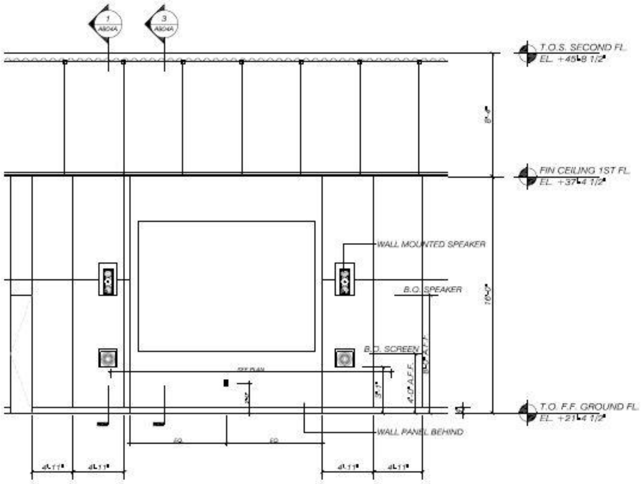


Figure 35: Elevation of Auditorium front

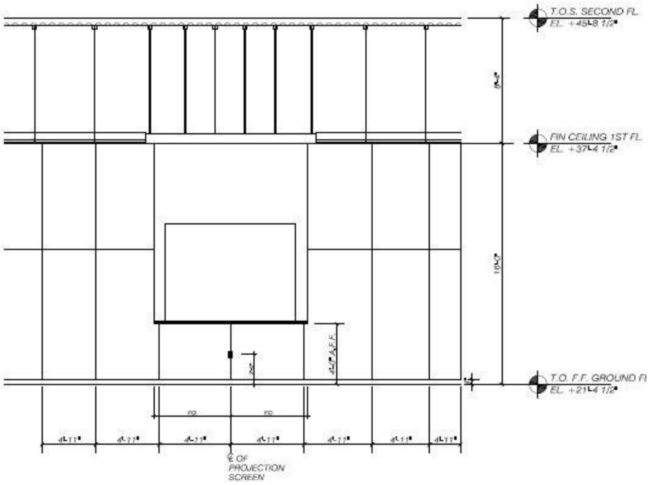


Figure 36: Elevation of Auditorium back

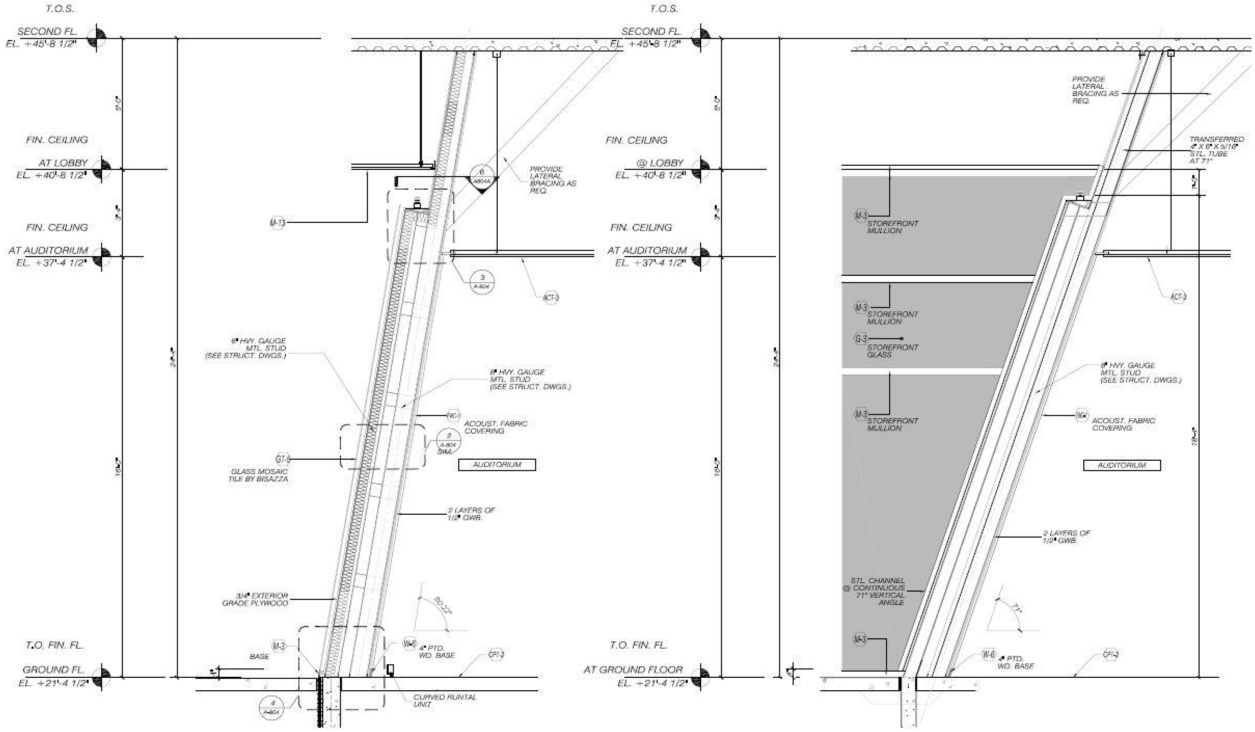


Figure 37: Auditorium wall sections

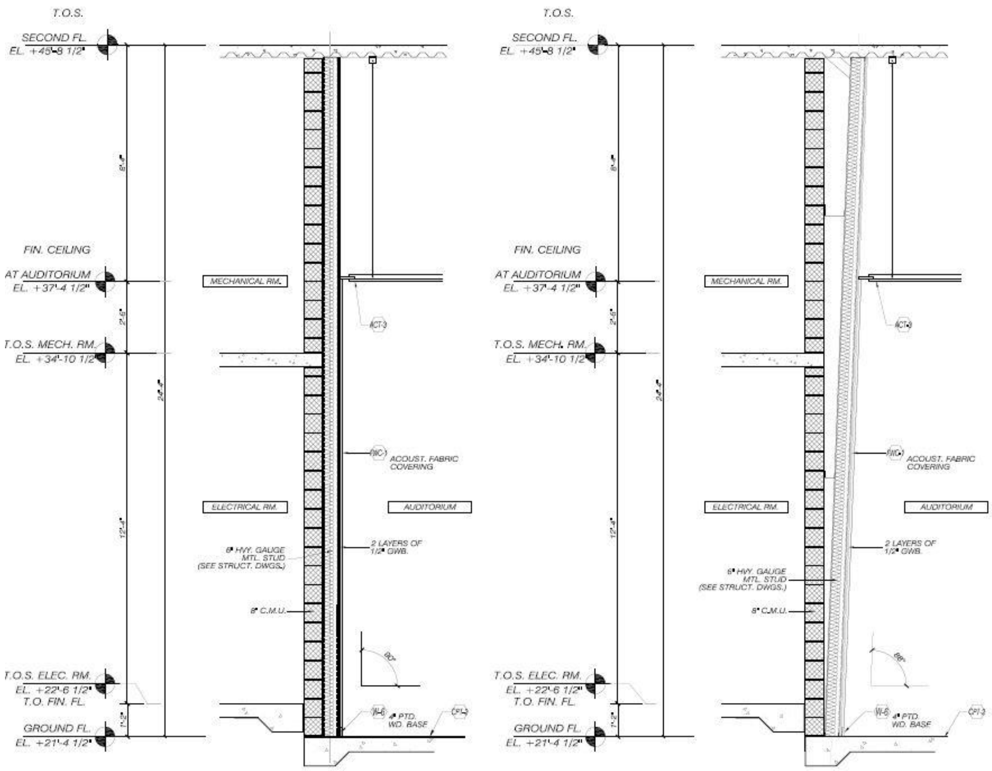


Figure 38: Auditorium wall sections

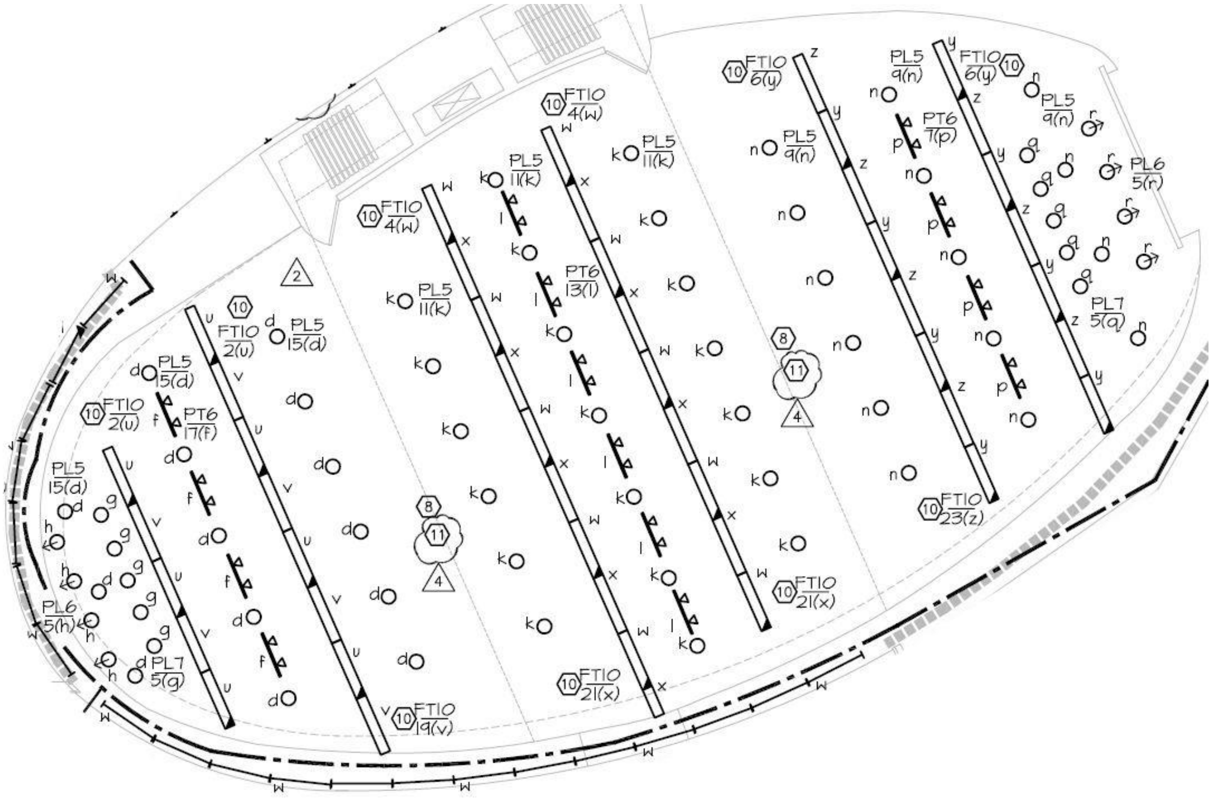


Figure 39: Auditorium existing lighting plan

Existing Lighting Conditions

The lighting in the auditorium was designed to cater to the multiple functions of the space. There are two primary lighting systems; recessed linear fluorescent luminaires and recessed-can halogen downlights, both of which help to define the ceiling grid in the space. The linear fluorescents (FT10) run parallel to the front wall of the auditorium and the linear diffusers in the ceiling. The recessed halogen downlights (PL5) are located between diffusers. Recessed circular wall washers (PL6) with halogen lamping are used in the front and rear of the auditorium to illuminate the wall. The front and rear of the auditorium also contains additional recessed circular halogen downlights (PL7) to provide lighting to be used in the event of a presentation or lecturer. Three rows of halogen track lighting (PT6) are also used in the space. The lighting in the auditorium is dimmable and is controlled by a Lutron Graphic Eye 4000 Series Dimming Panel. The fluorescent lighting is switched to allow alternating luminaires in a row to be controlled separately. To allow the auditorium to function as three separate spaces, the lighting systems are switched to allow each space to be controlled separately.

Existing Lighting for Auditorium							
Type	Quantity	Input Watts	Location	Mounting	Manufacturer	Lamp Type	Notes
FT10	46	120	Auditorium	Ceiling Recessed DL	Linear Lighting RC68-D2-ET5HO	(2) GE F54T5HO/835	Mounted in cont. row Specular parabolic louvers
PL5	49	75	Auditorium	Ceiling Recessed DL	Zumtobel Spec 3 Series	(1) 75W/MR16 NFL 25 Degree	4” aperture Integral mag. 120V/12V tran. Alzak reflector
PL6	8	75	Auditorium	Ceiling Recessed WW	Zumtobel Spec 3 Series	(1) 75W/MR16 NFL 25 Degree	4” aperture Integral mag. 120V/12V tran. Alzak reflector, lens
PL7	16	75	Auditorium	Ceiling Recessed DL	Zumtobel Spec 3 Series	(1) 75W/MR16 NFL 25 Degree	4” aperture Integral mag. 120V/12V tran. Alzak reflector, frosted lens
PT6	10	75	Auditorium	Ceiling Track	Lighting Services Inc. 216 Series	(1) 75W/MR16 NFL 25 Degree	Single circuit track Integral elec. 75W trans.

Table 18: Existing luminaires for Auditorium

Design Criteria and Considerations

Summary:

The following sections list important design criteria and considerations for the auditorium. Criteria listed include recommended illuminance values as well as power requirements. The final design will strive to meet all design criteria listed, and all existing conditions will be measured against these criteria. All issues listed under considerations come from the IESNA Lighting Handbook in addition to special design issues that relate to this space and project. While many design issues should be considered, the list provided below summarizes the most important issues for this application.

Design Criteria:

Table 19 shows recommended illuminance levels specifically for auditoriums. However, individual tasks that are likely to be performed in the area should also be considered. These tasks as well as recommended illuminance values are listed in Table 20. Table 21 and Table 22 summarize lighting power densities according to ASHRAE and the New York State Building Code.

IESNA Illumination Recommendations for Auditoriums		
Task	**Illuminance**	
	Horizontal	**Vertical**
Assembly	10 fc	-
Social Activity	5 fc	3 fc
Meeting	30 fc	5 fc
Video Conference	50 fc	30 fc

Table 19: IESNA Illumination Recommendations

IESNA Illumination Recommendations for Tasks		
Task	**Illuminance**	
	Horizontal	**Vertical**
Reading: VDT Screens	3 fc	3 fc
Reading: Keyboard	30 fc	-
Reading: #2 Pencil	30 fc	-
Reading: Ball point pen	30 fc	-
Reading: 8 – 10 point font	30 fc	-

Table 20: IESNA Illumination Recommendations

ASHRAE 90.1-2007 Lighting Power Densities Allowance	
Space Type	**LPD, W/ft^2**
Hospital	1.2
Conference / Multipurpose	1.3

Table 21: ASHRAE Lighting Power Densities Allowance

New York State Building Code Lighting Power Requirements	
Space Type	**LPD, W/ft^2**
Hospital	1.2
Conference / Multipurpose	1.3

Table 22: Building Code of New York State Lighting Power Requirements

Additional Power Requirements and Allowances:

- New York State Building Code requires that each area required to have a manual control shall also have a control that allows the occupant to reduce the connected lighting load in a reasonably uniform pattern by at least 50%. Corridors and areas controlled by occupancy sensors are exempt. This reduction may be achieved in the following ways:
    - Controlling all lamps and luminaires
    - Dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps
    - Switching the middle lamps independently of the outer lamps
    - Switching each luminaire or each lamp
- ASHRAE allows tradeoffs among spaces provided that the total installed interior lighting power does not exceed the interior lighting power allowance.
- For spaces where decorative lighting is installed in addition to the general lighting, an additional 1.0 W/ft^2 is allowed for the space.

When comparing Table 19 and Table 20, the recommended illuminance values are about the same. An average illuminance of 30 fc, with a higher illuminance value of 50 fc in selected areas such as the front of the auditorium, would be appropriate for this space. Controls should be used to lower the illuminance levels when the space functions more as an auditorium than a conference center. When comparing allowable lighting power densities, the requirements for the state of New York and ASHRAE are identical. In addition to the design criteria listed, there are many design considerations that must be taken into account. These considerations are summarized in the following section.

Design Considerations:

Appearance of Space and Luminaires

The auditorium is a unique space. The lighting design should complement the space and should have a clean design. The auditorium will most likely host important functions and the lighting design should help the space give a good impression. Visual clutter should be minimized, and luminaires should be arranged in a uniform layout to eliminate areas of greater brightness that may distract occupants.

Direct and Reflecting Glare

Direct glare can be distracting to the occupants performing tasks commonly performed in the space. Direct glare from luminaires can cause discomfort and can make it difficult for occupants to focus on a presenter, projection screen, and other points of interest. The best lighting design will minimize vertical illuminance in the occupant's field of view. Additionally, luminaire luminances should not be greater than 100 times the luminance of surrounding areas.

Modeling of Faces and Objects

Since the auditorium can function as a presentation space, the modeling of the presenter's face and presented objects are very important. The ability to read and interpret the facial expressions of the presenter is critical to effective communication. Direct downlight that creates harsh facial shadows should be avoided.

Controls

As outlined in the design criteria, New York State Building Code requires additional controls for the space. The lighting system for the space should also be flexible. The system needs to be able to cater uses ranging from a private social function to a public conference. The space can also be divided in to three spaces, and the lighting design should be similar throughout each space and should be controlled separately. Dimming controls should be utilized in the space.

Psychological Impression

The multiple functions of the auditorium create a unique opportunity to explore multiple psychological impressions. When hosting private social functions, the space should feel private, with low levels of direct downlight and higher illuminance levels on the walls. When functioning as a conference center, the space should feel public and spacious and should allow visual clarity.

Color Appearance

Appropriate color rendering in the auditorium is important. Since social interactions occur in the space, the lighting design should render skin tones properly. The bright red walls and wood tones in the space should also be rendered correctly to ensure the architect’s vision for the space is achieved.

Flicker

Flicker and strobe can create an undesirable work environment. Luminaires that utilize light sources prone to flickering should be avoided. High frequency electronic ballasts should also be used to eliminate flicker.

Light Distribution

Patterns of light on surfaces and the task plane can affect task visibility, comfort, and perception. As a result, the spacing and light distribution of luminaires should be carefully analyzed. Excessive brightness and shadows should be avoided. The task illuminance should be higher than the surroundings to draw attention to the task.

Evaluations and Critique

Summary

The multiple functions of the auditorium are evident when looking at the lighting design of the space. The strong linear lines created by the fluorescent lights compliments the ceiling grid and give the space a public feeling, but takes away from the unique shape of the ceiling and the space. The recessed cans with halogen lamping help to create a warmer, more private feeling for the space and works well with the materials used in the space. The wall washers at the front and rear of the room can be used to draw attention to the projection screen; however the scallops produced by the luminaires make the screen difficult to view. The halogen track lighting provides a more flexible lighting system that can be changed as needed.

Lamp selection is somewhat consistent throughout the space. Fluorescent lamps with CRIs in the 80’s and CCTs of 3500 are used in all fluorescent luminaires in the space. The recessed cans and track lighting use 75 watt halogen lamps with a 25 degree beam spread and provide good color rendering. When the systems are used separately, the colors in the space are consistent. However when used together, there is noticeable color difference between the fluorescent and incandescent sources, which is expected. The Lutron dimming panel used to control the luminaires provides great flexibility in the space. All luminaires can be dimmed, and the linear strips, recessed cans, and track lighting can be switched separately. Each of these systems can also be controlled separately in each of the three divided spaces. The design of the controls also allows alternating linear luminaires to be switched separately.

The auditorium was the second space calculated using AGI32, and based on the calculation results, the auditorium exceeds all criteria presented in Table 19 through Table 22. Table 23 and Table 24 shows a comparison of the recommended and existing illuminance and power density values.

Criteria Comparison for Auditorium with Fluorescent Lighting			
Criteria	**Recommended**	**Existing @ 2.5’**	**Existing @ 0’**
Assembly Horizontal Illuminance (fc)	10	86	80
Social Horizontal Illuminance (fc)	5	86	80
Meeting Horizontal Illuminance (fc)	30	86	80
Video Conf. Horizontal Illuminance (fc)	50	86	80
LPD (W/ft^2)	1.3	2.04	2.04

Table 23: Comparison of existing and recommended illuminance values

Criteria Comparison for Auditorium with Incandescent Lighting			
Criteria	**Recommended**	**Existing @ 2.5’**	**Existing @ 0’**
Assembly Horizontal Illuminance (fc)	10	29	28
Social Horizontal Illuminance (fc)	5	29	28
Meeting Horizontal Illuminance (fc)	30	29	28
Video Conf. Horizontal Illuminance (fc)	50	29	28
LPD (W/ft^2)	1.3	2.02	2.02

Table 24: Comparison of existing and recommended illuminance values

Table 23 shows that the illuminance levels from the fluorescent lighting system greatly exceed those recommended by the IESNA. While the switching of these fixtures can reduce the illuminance on the floor and work plane, the most the fluorescent system should provide with all fixtures on is 50 fc. As shown in Table 24, the calculated illuminance value of the incandescent lighting meet the IESNA recommendation of 30 fc for a meeting space, but exceeds the recommended values for assembly and social events. It should be noted that dimming allows all luminaires to be adjusted; however dimming the luminaires to reach a recommended maximum illuminance is not acceptable.

A more detailed breakdown of the AGI calculation results is shown in Table 25 and Figures 41 through 46. Calculations were run using the light loss factors outlined in Table 22. Calculations were run with for three scenarios; fluorescent lighting only, halogen lighting only, and all lighting. Lighting power density calculations, summarized in Table 25, were conducted using all luminaires in the space. Independent lighting system power densities are shown in Table 23 and Table 24. The existing combined LPD exceeds the recommendations of both ASHRAE and New York State with the extra 1.0 W/ft^2 for decorative lighting applied. When looking at the systems separately, they also exceed the recommended LPD of 1.3 W/ft^2. The current lighting design is extremely flexible and works well aesthetically with the space, but exceeds recommended illuminance and LPD values.

Lighting Power Density for Nurse's Station			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
FT10	46	120	5520
PL5	49	75	3675
PL6	8	75	600
PL7	16	75	1200
PT6	10	75	750

Total Watts:	11,745
Total Area (ft^2):	2700
LPD (W/ft^2):	4.35

Table 25: Lighting power density calculation

Calculated Illuminance Values for Auditorium

Fluorescent Lighting		Halogen Lighting	
Horizontal Illuminance Work Plane		**Horizontal Illuminance Work Plane**	
Average Illuminance (fc)	86.45	Average Illuminance (fc)	29.32
Maximum Illuminance (fc)	153.00	Maximum Illuminance (fc)	89.00
Minimum Illuminance (fc)	26.10	Minimum Illuminance (fc)	3.30
Maximum : Minimum	5.85	Maximum : Minimum	26.97
Average : Minimum	3.31	Average : Minimum	8.88
Horizontal Illuminance Floor		**Horizontal Illuminance Floor**	
Average Illuminance (fc)	80.94	Average Illuminance (fc)	28.53
Maximum Illuminance (fc)	123.00	Maximum Illuminance (fc)	72.50
Minimum Illuminance (fc)	36.20	Minimum Illuminance (fc)	3.50
Maximum : Minimum	3.40	Maximum : Minimum	20.71
Average : Minimum	2.24	Average : Minimum	8.15
Vertical Illuminance Front Wall		**Vertical Illuminance Front Wall**	
Average Illuminance (fc)	27.58	Average Illuminance (fc)	14.36
Maximum Illuminance (fc)	46.50	Maximum Illuminance (fc)	31.90
Minimum Illuminance (fc)	8.50	Minimum Illuminance (fc)	4.80
Maximum : Minimum	5.74	Maximum : Minimum	6.65
Average : Minimum	3.24	Average : Minimum	2.99

Table 26: Summary of AGI32 calculations for auditorium

Luminaire Light Loss Factors for Auditorium									
Luminaire Designation	**Cleaning Interval**	**LDD Case**	**Initial Lumens**	**Design Lumens**	**LLD**	**LDD**[a]	**RSDD**[b]	**BF**	**Total LLF**
FT10	Clean, 12 mo.	W	5000	4600	0.92	0.93	0.96	1.0	0.821
PL5	Clean, 12 mo.	W	NA	NA	0.95[c]	0.93	0.96	1.0	0.848
PL6	Clean, 12 mo.	W	NA	NA	0.95[c]	0.93	0.96	1.0	0.848
PL7	Clean, 12 mo.	W	NA	NA	0.95[c]	0.93	0.96	1.0	0.848
PT6	Clean, 12 mo.	W	NA	NA	0.95[c]	0.93	0.96	1.0	0.848

Table 27: Light loss factors for auditorium luminaries

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

[c] Halogen lamp lumen depreciation calculated using Figure 6-20 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

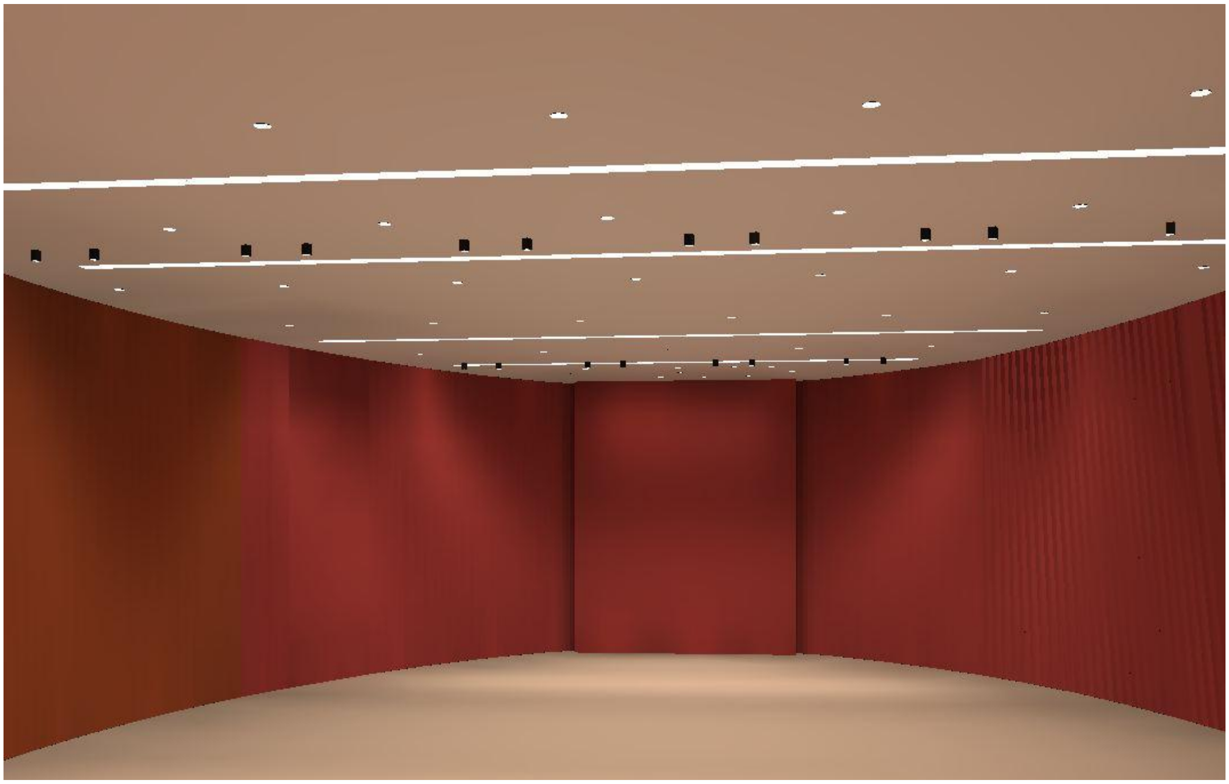


Figure 40:AGI32 rendering of auditorium existing lighting design

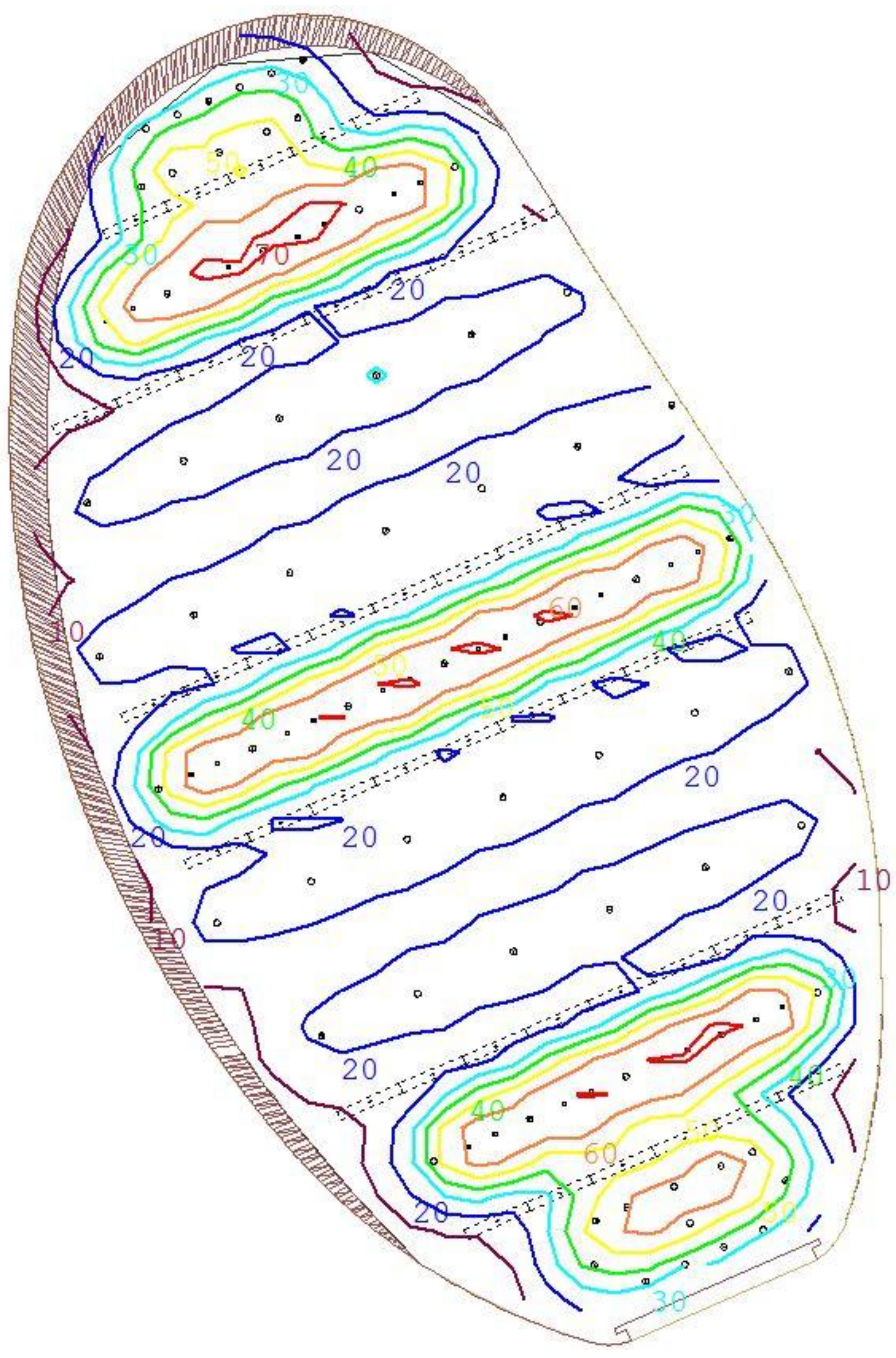


Figure 41: Iso lines of floor horizontal illuminance from incandescent light for auditorium

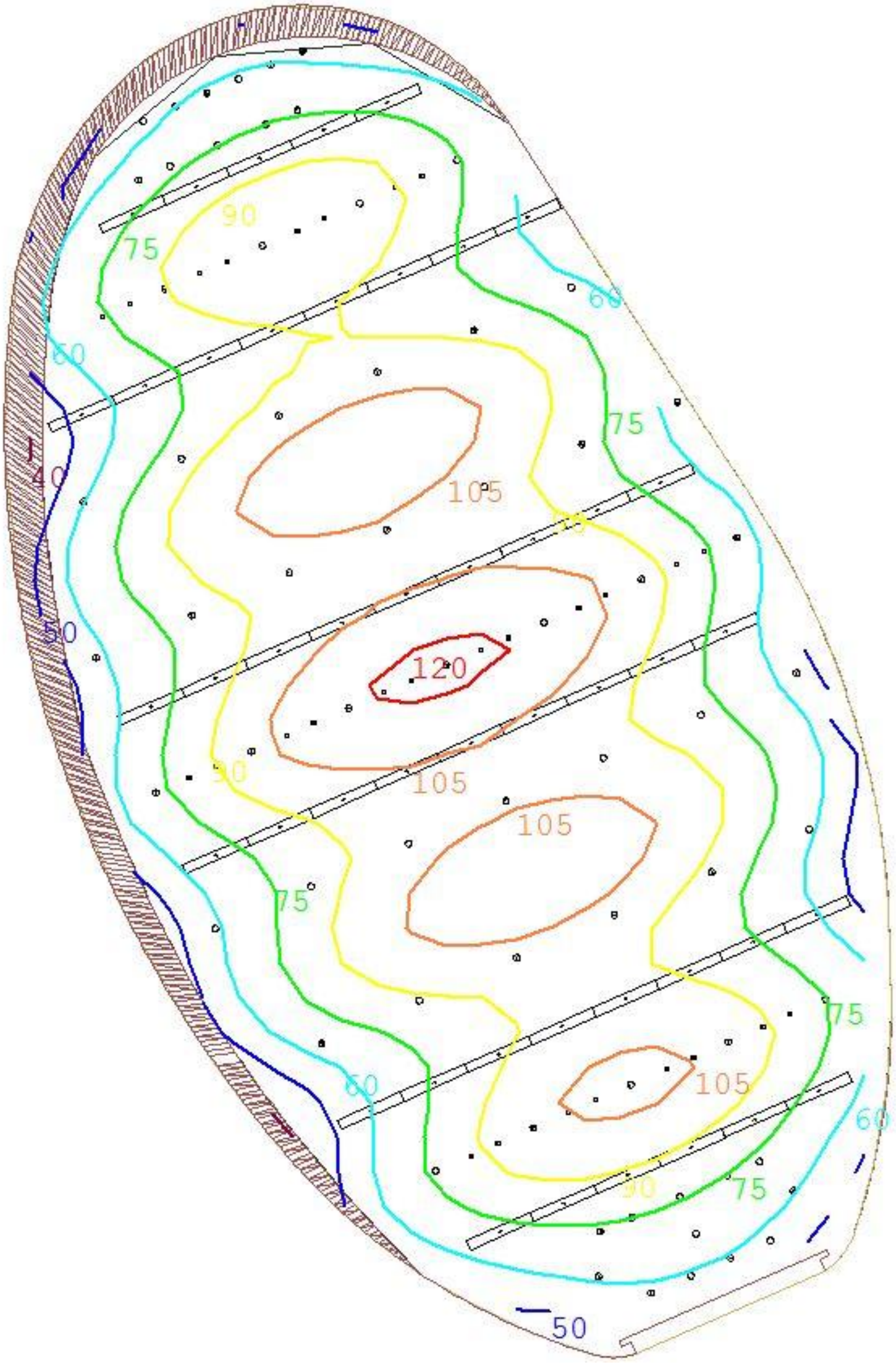


Figure 42: Iso lines of floor illuminance from fluorescent lights for auditorium

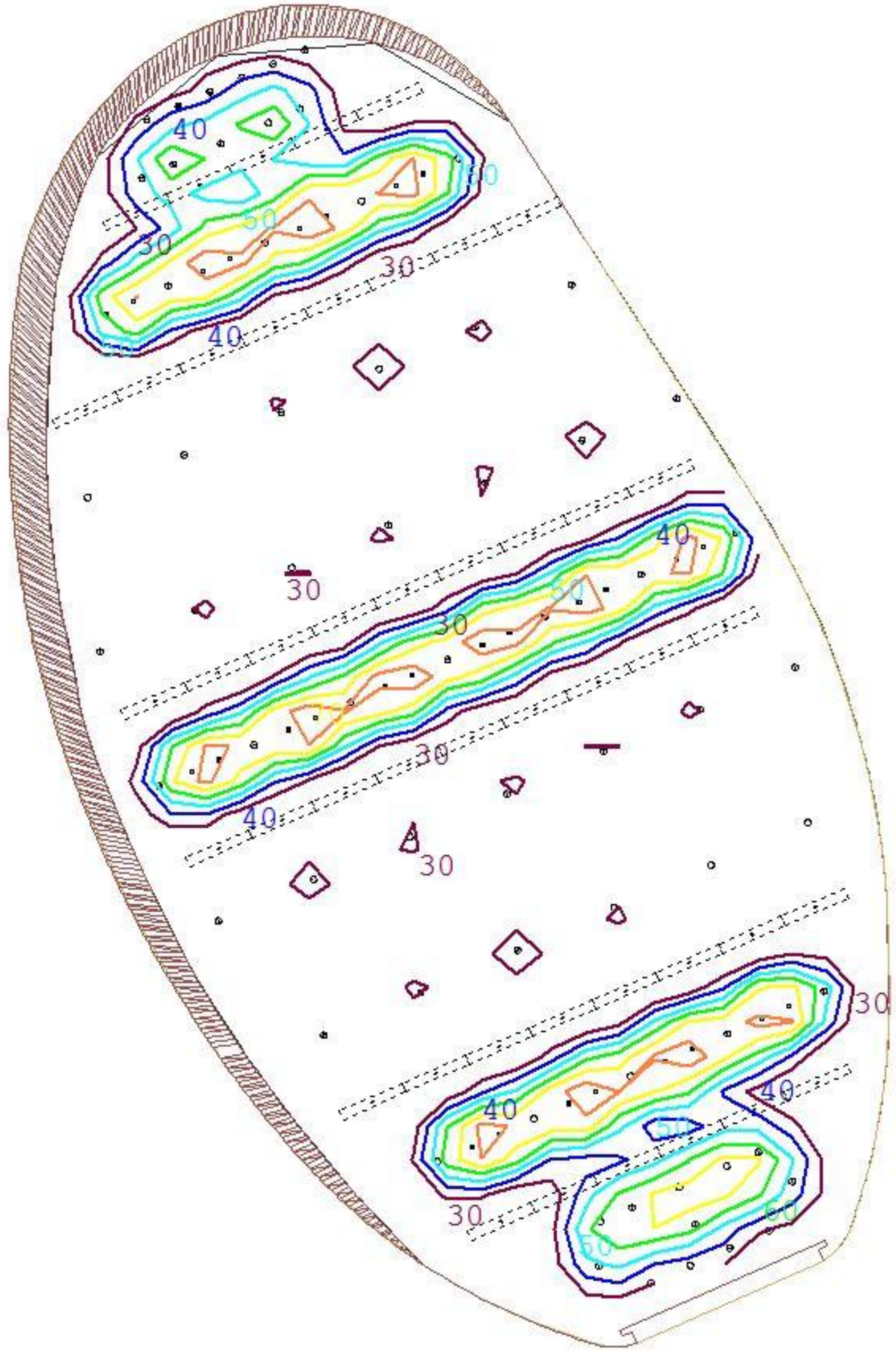


Figure 43: Iso lines of work plane horizontal illuminance from incandescent lights for auditorium

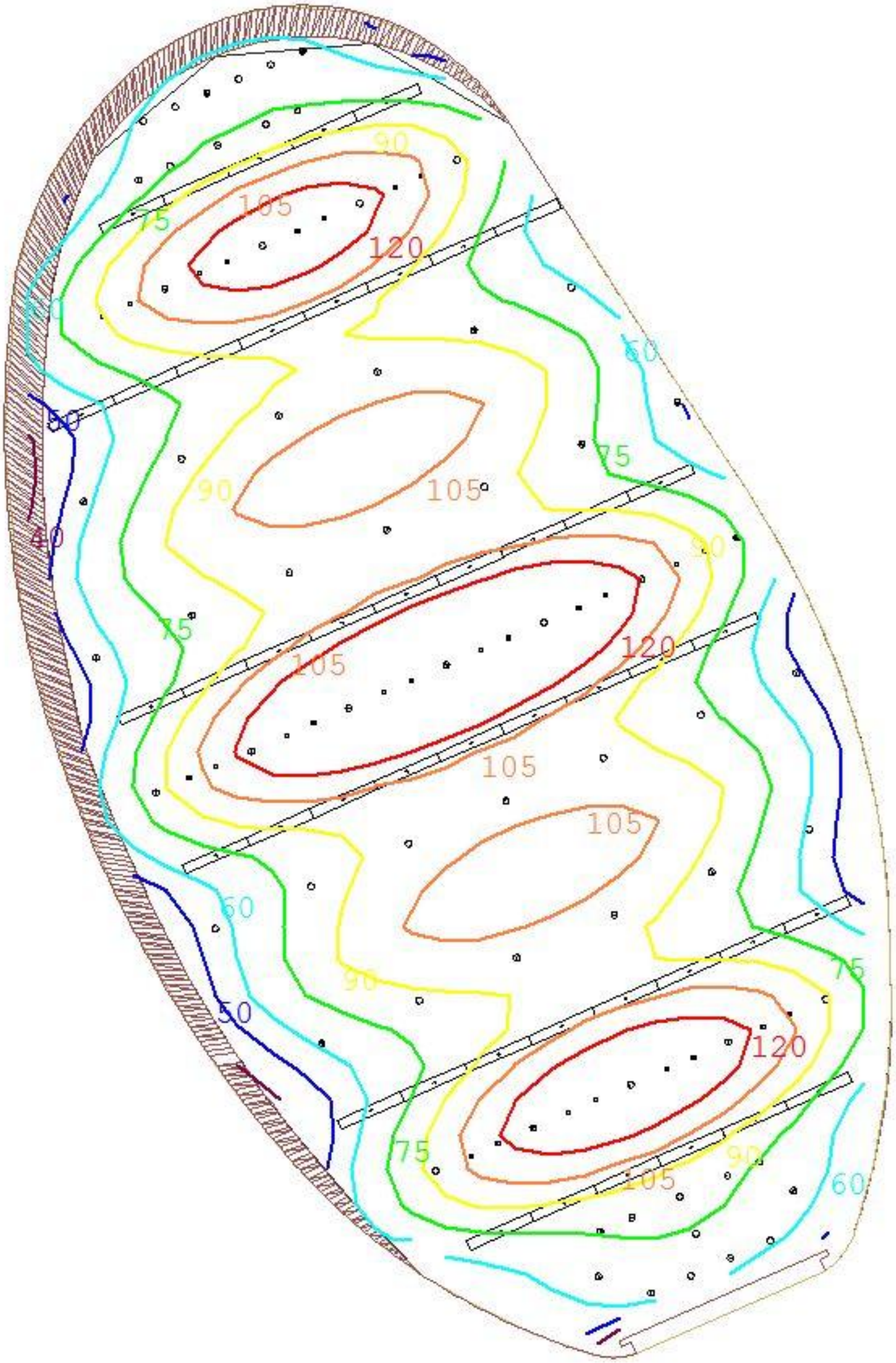


Figure 44: Iso lines of work plane illuminance from fluorescent lights for auditorium

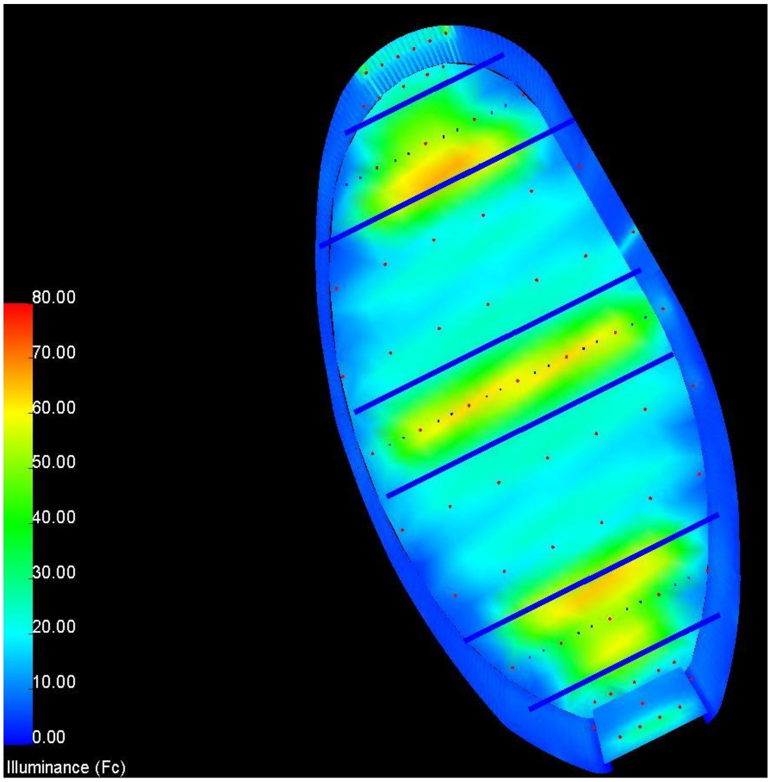


Figure 45: Pseudo color rendering of auditorium floor with incandescent lighting

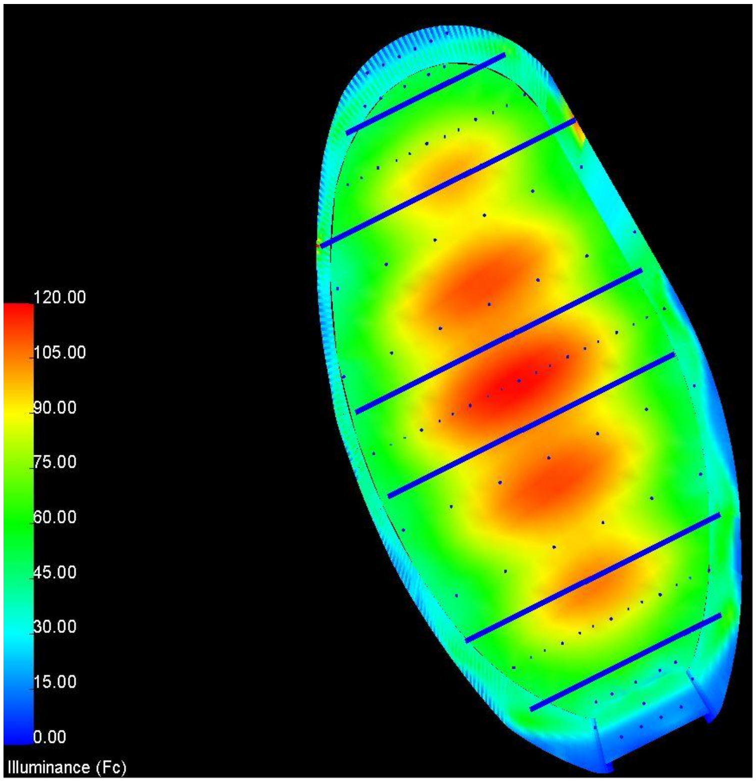


Figure 46: Pseudo color rendering of auditorium floor with fluorescent lighting

Schematic Design

Summary

The proposed lighting design will aim to create a flexible environment that can be used for a wide range of low key and public functions. Flynn impressions will be studied and used to create a space that can feel both intimate and public depending on the function of the space. Lighting will be added in the form of a slot or cove to help define the ceiling and create contrast between the ceiling and walls. Luminaires will be incorporated into the wall to help highlight the unique shape of the space. Downlights will be used to provide the recommended illuminance levels on the floor and work plane.

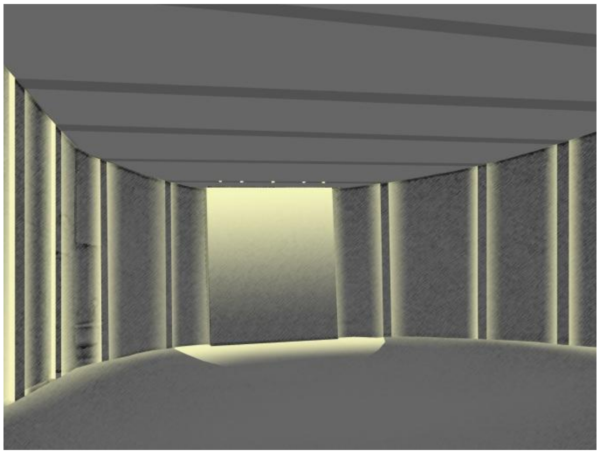


Figure 47: Schematic lighting design 1 – Private

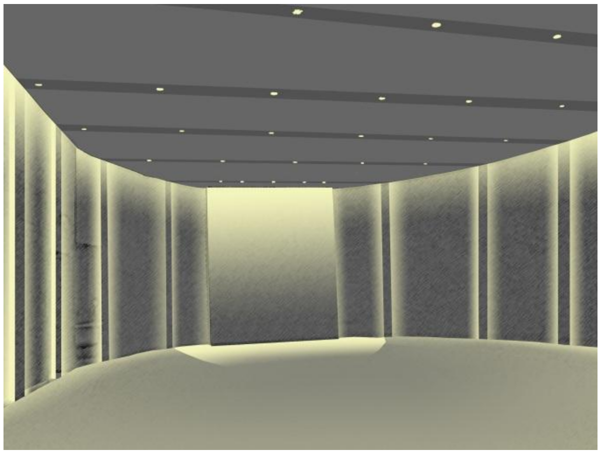


Figure 48: Schematic lighting design 1 - Public

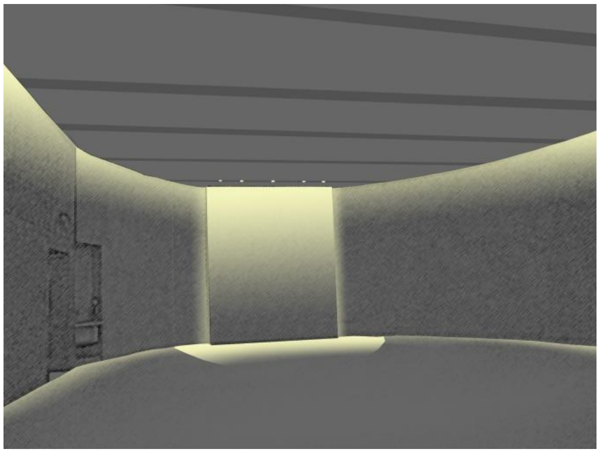


Figure 49: Schematic Lighting Design 2 – Private

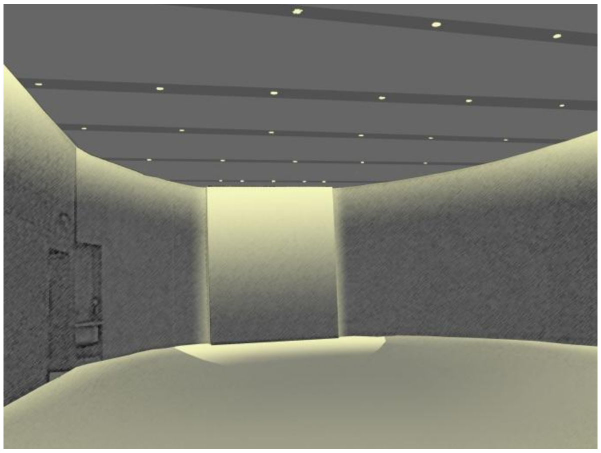


Figure 50: Schematic lighting design 2 - Public

Professional Comments from Lutron Presentation

Lee Brandt:

- Talked about wall, but then showed lighting solutions. How does this work?

Mike Barber

- Choice of lighting the wall from the surface is interesting since it is complex and could be accentuated.
- Look at a solution with hardware located in the ceiling.

Luke Tigue

- Probably will not be able to light wall from above
- How will the divides make sense with the lighting design?
- Existing design with ceiling stripes is chaotic. The oval shape gets lost when it is divided with two lines of light.

Lighting Solution

Overview

The second schematic design served as the basis of the final design. Slot mounted linear LED luminaires along the perimeter of the ceiling are used to highlight the surface of the wall and enhance the shape of the room by providing contrast between the ceiling and walls. The use of peripheral lighting also helps to create a relaxing environment. When the overhead lighting is dimmed, emphasis is placed on the walls as opposed to occupants in the floor area. LED downlights were used to provide adequate lighting levels on the floor and work plane. LED sources were used for perimeter and downlighting to achieve power density requirements. A CCT of 3000K was used for both fixtures to compliment the warm colors of the materials used in the space. All luminaires are controlled through a Lutron Grafik Eye system which allows independent control of the divided spaces and full control of all luminaires in the space when the dividers are not in use. The tables, renderings, schedules, and lighting plans on the following pages convey the final design for this space.

Renderings

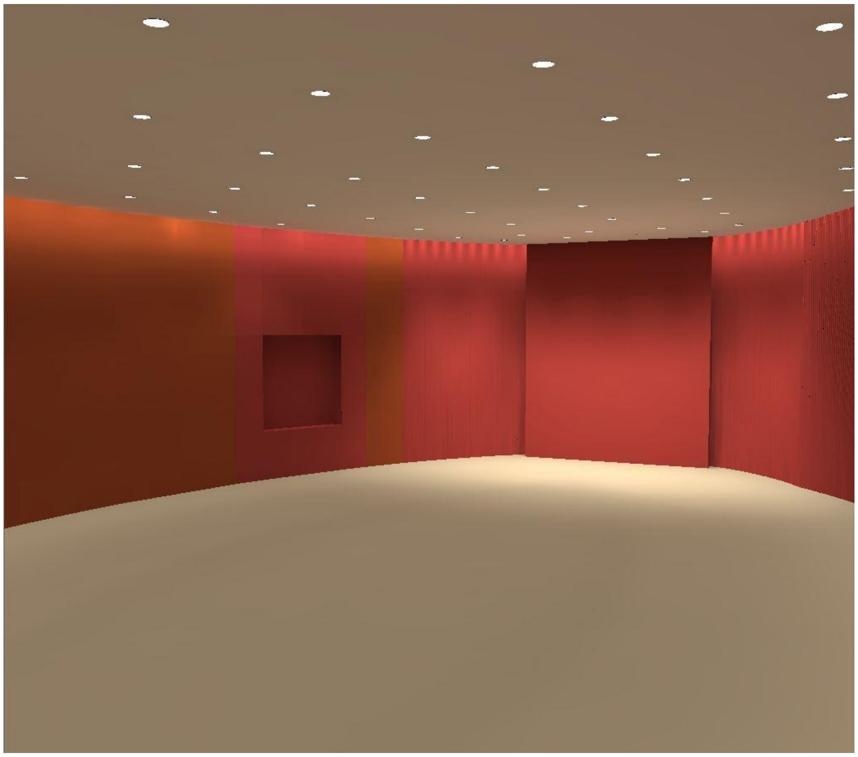


Figure 51: AGI32 rendering of Auditorium lighting design - Assembly Scene

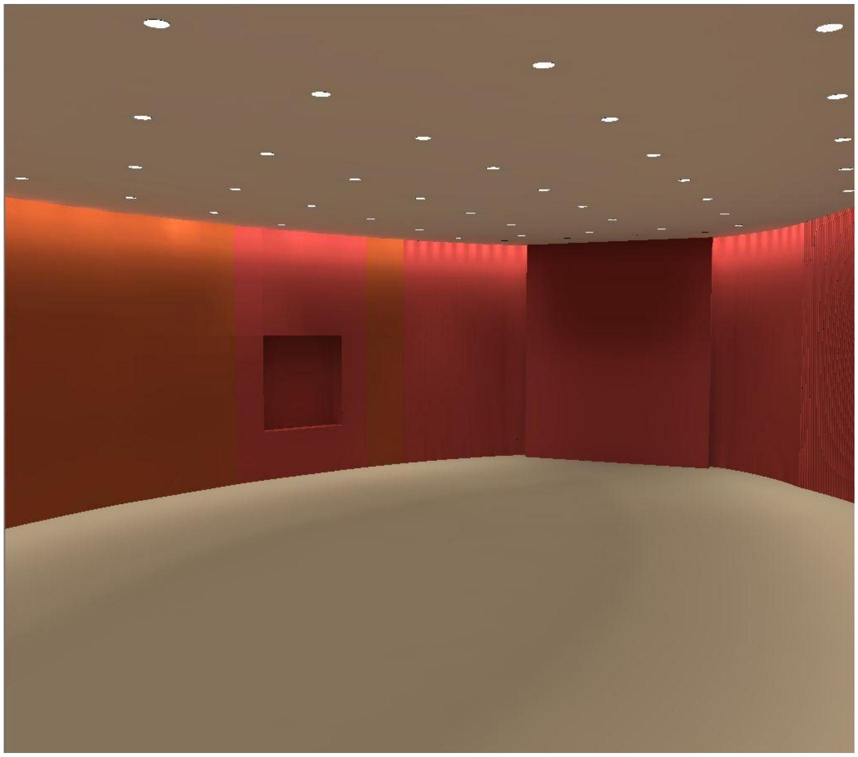


Figure 52: AGI32 rendering of Auditorium lighting design - Social Scene

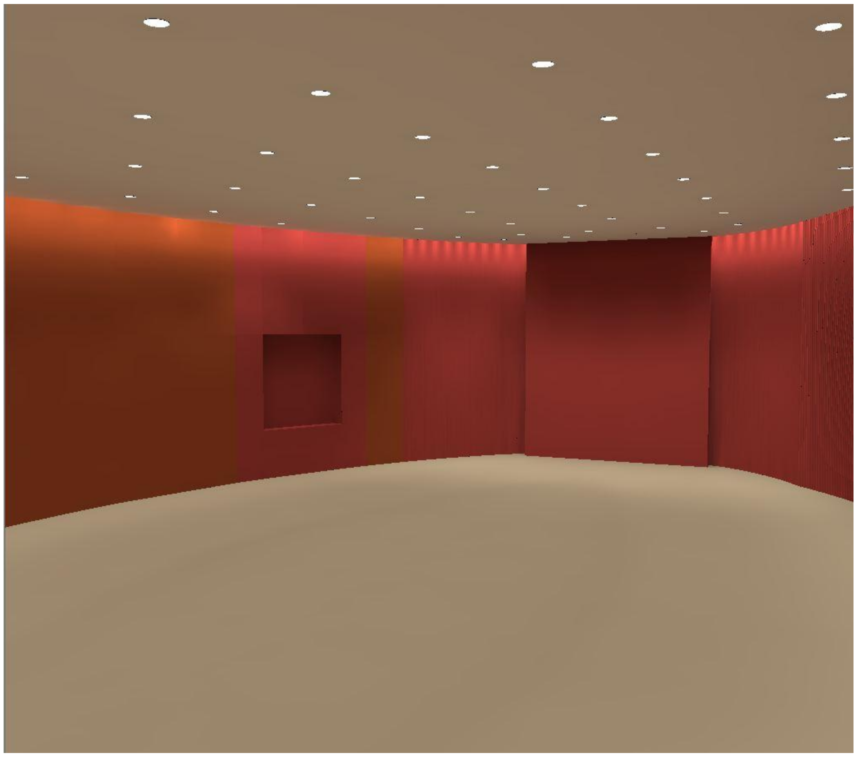


Figure 53: Rendering of Auditorium lighting design - Meeting Scene

Lighting Plans

See Appendix A for lighting plans, construction details, and control diagrams.

Luminaire Schedule

LUMINAIRE SCHEDULE								
TAG	IMAGE	MANUFACTURER/CATALOG #	DECRIPTION	LAMP	VOLT	BALLAST / POWER SUPPLY	WATT	LOCATION
AA		Lightolier / Calculite-C6L15DL-30K-W-CCL-FT	6" diameter recessed LED fixture. LED module with royal blue LEDs with remote phosphor. Wide beam. Dimmable. Tested in accordance with LM79	LED Module 3000K, CRI 78	120	Integral driver	27	Recessed mounting in ceiling 15'-6" A.F.F. See dwgs for additional details.
AB		Lightolier / Calculite-C6L20DL-30K-W-CCL-FT	6" diameter recessed LED fixture. LED module with royal blue LEDs with remote phosphor. Wide beam. Dimmable. Tested in accordance with LM79	LED Module 3000K, CRI 78	120	Integral driver	39	Recessed mounting in ceiling 15'-6" A.F.F. See dwgs for additional details.
AC		Lightolier / Calculite-C6L20DL-30K-M-CCL-FT	6" diameter recessed LED fixture. LED module with royal blue LEDs with remote phosphor. Medium beam. Dimmable. Tested in accordance with LM79	LED Module 3000K, CRI 78	120	Integral driver	39	Recessed mounting in ceiling 15'-6" A.F.F. See dwgs for additional details.
AD		Color Kinetics/ eWFuse Powercore - 523-000065-05	1' length linear LED grazing fixture. LED module with warm white LEDs. 10° x 30° beam angle. Tested in accordance with LM79	LED Module 3000K, CRI 83	120	Integral driver	13.5	Recessed mounting in slot 16'-0" A.F.F. Mount parallel to wall surface.

Table 28: Auditorium Luminaire Schedule

Control Scheme

A main goal for the control system in the auditorium is to provide flexible lighting to accommodate the wide range of functions that can occur in the space. A Lutron Grafik Eye system with up to 16 programmable scenes was used to create flexibility in the space. There are three preset scenes for each of the three divided spaces, and three preset scenes for the space as a whole. The meeting scene allows for high light levels required in conference settings while the assembly scene allows for presentations with higher illuminance levels on the stage area and lower levels in the seating area. The third scene is intended for social settings, with low illuminance levels in the main event area and higher illuminance levels on the walls surrounding the space. Table 29 describes the control zones and scenes for the full space in more detail. The three divided spaces would be controlled with similar scene settings. Additional information on the control system and equipment can be found in the electrical portion and the appendices of the report.

Auditorium Lighting Scene Settings			
	Scene 1	**Scene 2**	**Scene 3**
Label	Meeting	Assembly	Social
Description	General lighting levels for conferences	Lecture mode with emphasis on stage area	Low illuminance levels ideal for entertaining
Control Zone	**Dimming Level (% of Full Output)**		
a	100	100	15
b	100	100	15
c	100	30	15
d	75	25	25
g	100	30	15
h	75	25	25
r	100	30	15
s	100	30	15
t	0	0	0
u	75	25	25

Table 29: Auditorium lighting scene settings

Performance

Performance was measured through calculations in AGI32 and 3D Studio Max. Material reflectance values were the same as those detailed in the Materials section. Performance was measured against IESNA and ASHRAE recommendations documented earlier. Light loss factors were also calculated for each luminaire in the space.

Luminaire Light Loss Factors for Courtyard								
Luminaire Designation	**Cleaning Interval**	**LDD Case**	**Initial Lumens**	**Design Lumens**	**LLD**	**LDD**[a]	**BF**	**Total LLF**
AA	Clean, 12 mo.	W	1500	-	0.80[c]	0.91	1.00	0.73
AB	Clean, 12 mo.	W	2000	-	0.80[c]	0.91	0.95	0.77
AC	Clean, 12 mo.	W	2000	-	0.80[c]	0.91	0.99	0.87
AD	Clean, 12 mo.	W	602	-	0.80[c]	0.91	0.99	0.58

Table 30: Light loss factors for auditorium luminaires

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

[c] Assumed LED lamp lumen depreciation.

Lighting Power Density for Lobby			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
AA	52	27	1404
AB	6	39	234
AC	12	39	468
AD	180	13.5	2484

Total Watts:	4590
Total Area (ft^2):	2700
LPD (W/ft^2):	1.7
Allowable (W/ft^2):	2.3

Table 31: Lighting power density calculation

Considering luminaire types AA, AB, and AC as general lighting, the lighting design meets ASHRAE and New York State power requirement of 1.3 W/SF with additional wattage available to be traded with other spaces. Luminaires AD was designed to highlight the unique wall in the space and can be considered decorative lighting, which would raise the total power requirement in the space to 2.3 W/SF. Compared to both values, the lighting design meets the power density requirements in the space.

IESNA Illumination Recommendations for Auditorium – Assembly Setting			
Area	**Avg. Horizontal Illuminance**		
	Target	**Design @ 2.5’**	**Design @ 0’**
Stage	50 fc	36.46 fc	34.23 fc
Seating	10 fc	13.05 fc	11.41 fc

Table 32: Comparison of designed and recommended illuminance values for assembly scene

IESNA Illumination Recommendations for Auditorium – Meeting Setting			
Area	**Avg. Horizontal Illuminance**		
	Target	**Design @ 2.5’**	**Design @ 0’**
Stage	50 fc	49.67 fc	47.67
Seating	30 fc	35.51 fc	34.79

Table 33: Comparison of designed and recommended illuminance values for meeting scene

IESNA Illumination Recommendations for Auditorium – Social Setting			
Area	**Avg. Horizontal Illuminance**		
	Target	**Design @ 2.5’**	**Design @ 0’**
Stage	5 fc	7.53 fc	6.88 fc
Seating	5 fc	7.32 fc	6.88 fc

Table 34: Comparison of designed and recommended illuminance values for social scene

The illuminance values in the auditorium all meet the designated criteria. The recommended 50 fc for a meeting setting was applied to the stage area in the front and back of the room. The 50 fc recommendation was also applied to the stage area in the assembly setting, but the lighting design only achieved an average of 36 fc. This was deemed acceptable since the lighting levels in the seating area are lower, therefore the contrast between the stage and seating area will be high. The average lighting levels for a social setting are slightly above the recommended values, but this is because the perimeter lighting was dimmed to a higher level to allow for perimeter lighting and emphasis on the wall. The Pseudo color renderings below show give a better representation of the average illuminance values in the different areas of the auditorium.

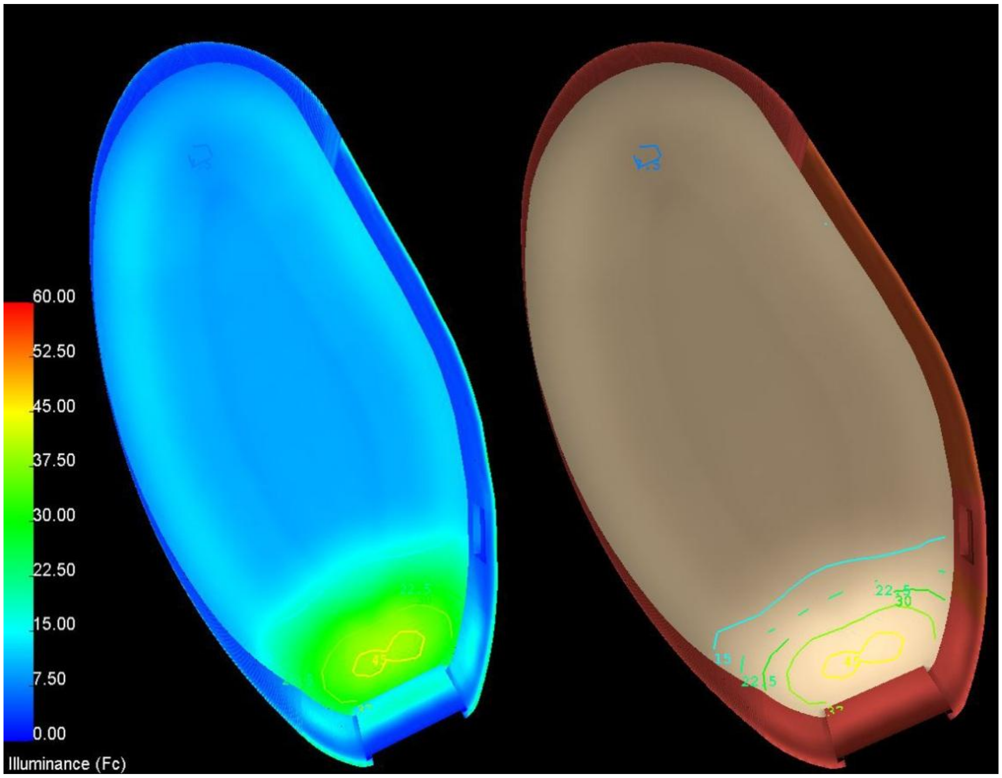


Figure 54: Pseudo color rendering and iso lines of illuminance levels in auditorium - Assembly Scene

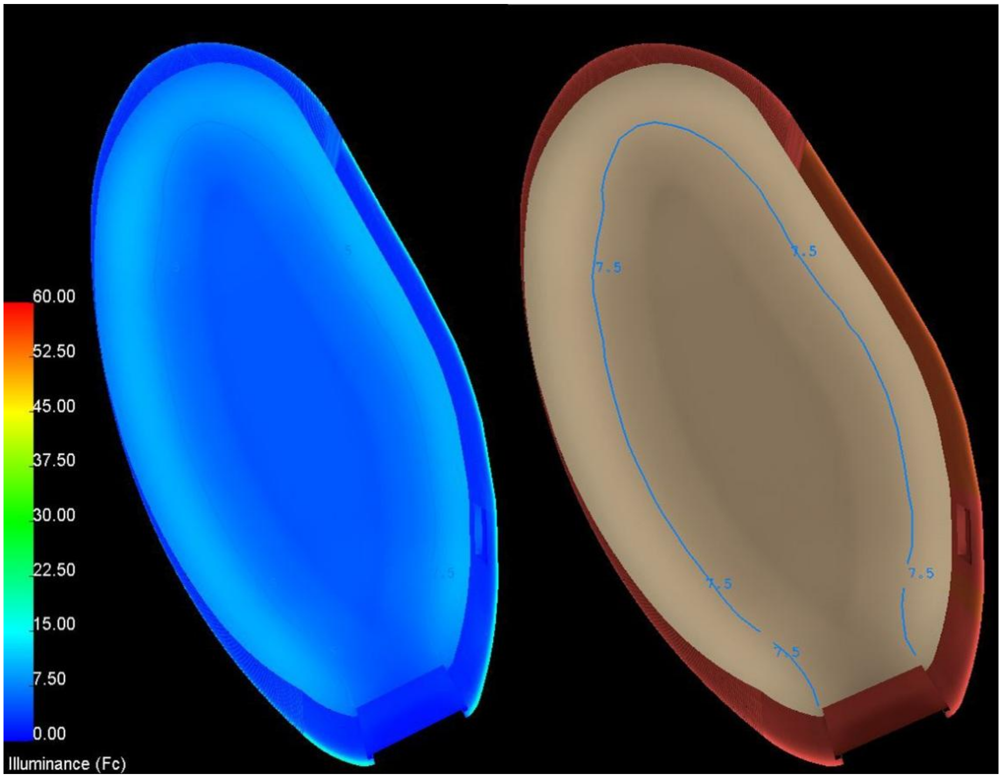


Figure 55: Pseudo color rendering and iso lines of illuminance levels in auditorium - Social Scene

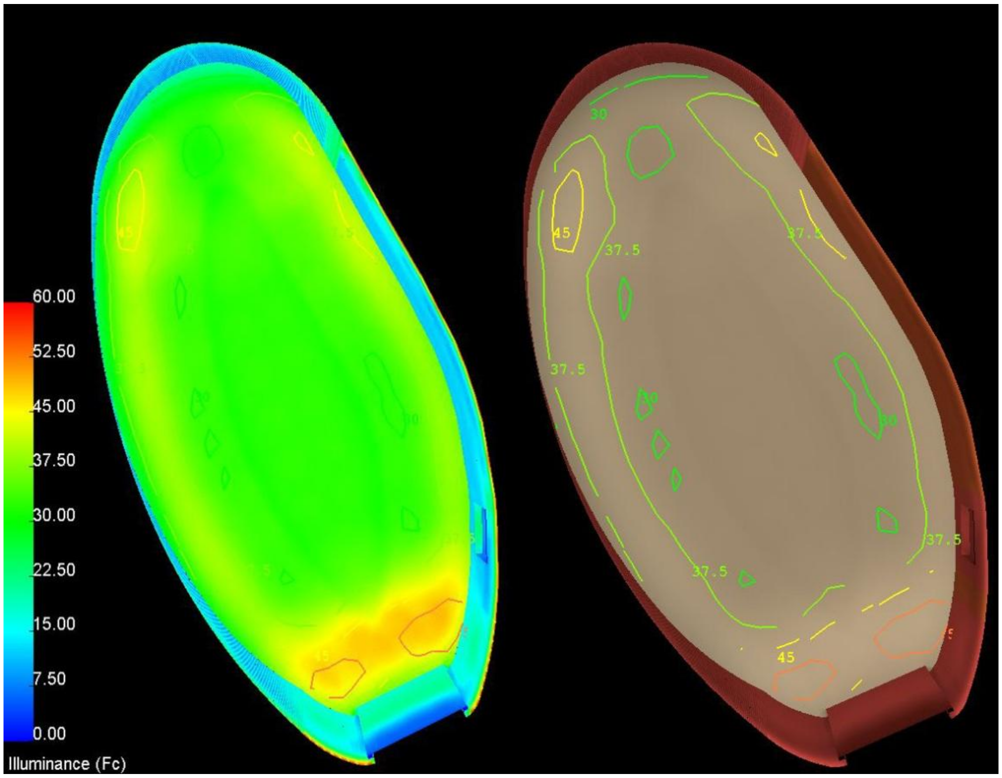


Figure 56: Pseudo color rendering and iso lines of illuminance level in auditorium - Meeting Scene

The original design considerations for the space were also met using the following methods:

Summary of Considerations for Auditorium		
Considerations	**Recommended**	**Design**
Appearance of Space and Luminaires	Minimize clutter, uniform layout. Design should complement space.	Slot lighting illuminates walls and enhances shape of space. Lines of light replaced with uniform and clean arrangement of downlights.
Psychological Impression	Welcoming, relaxing, private and public.	Peripheral lighting and warm CCTs create a relaxing environment. Flexible controls allows for public and private lighting scenes.
Modeling of Faces	Avoid harsh shadows	Stage lighting uniformly arranged to avoid direct downlighting and harsh shadows
Controls	Space should be flexible	Lutron Grafik Eye system used to allow for flexible control of each individual section and the space as a whole.
Glare	Avoid direct glare	Peripheral lighting adds illuminant to perimeter reducing the need for high output downlighting. The use of LED with remote phosphor used in place of a high glare source.
Color Appearance	Good color rendering.	Warm CCTs compliment warm tones in the space while high CRI LEDs enhance color rendering.
Light Distribution	Avoid patterns, draw attention to task.	Uniform light levels on walls, floor, and stage area. No scalloping. Higher illuminance levels are used to draw attention to stage and to the unique wall in the space.

Table 35: Summary of Design Considerations

Summary

The lighting in the auditorium was designed to be flexible and enhance the space. Ceiling clutter was eliminated be replacing the existing linear fluorescent downlights with a uniform downlighting layout. The uniform layout and perimeter lighting also help to create a modern image for the space. Lighting is used to accentuate the architecture by highlighting unique elements in the space such as the auditorium wall. Perimeter lighting helps to define the boundaries of the space while creating contrast between the walls and ceiling. This contrast also helps to define the unique oval shape of the space. The perimeter lighting also helps to make the space feel more relaxing and is used to draw attention to the walls and away from the main seating and gathering area.

The lobby is also intended to be flexible. The use of a Lutron Grafik Eye system allows for three different scenes in each of the three divided spaces in addition to the space as a whole. Combined with dimmable LEDs, the controls system allows the criteria for multiple functions and activities to be addressed with one lighting design.

ASHRAE allows for 1.3 W/SF in this space. An additional 1.0 W/SF can be applied for decorative lighting, bring the total allowable power density in the space to 2.3 W/SF. With the additional allowance for decorative lighting applied to the perimeter lighting, the design comes in under the power budget at 1.7 W/SF. The substitution of the incandescent downlighting in the original design with newer lower wattage LEDs was a significant reason for the reduction in power density and also allowed for decorative elements such as the perimeter lighting to be employed in the design

In addition to all power requirements, the lighting design meets or slightly exceeds all recommended illuminance values in the space.

Circulation Space | Main Lobby

Existing Conditions

Description

Upon entering the lobby, occupants are greeted by the reception desk located to their left. The lobby serves as a transition and circulation space between the elevator lobby, conservatory, and auditorium. The walkway on the second floor overlooks the double storied space. A small seating area placed around large support columns provides a relaxing space to wait. Natural materials such as stone and wood decorate the walls, and the outside of the auditorium is an important architectural feature in the space. Specific dimensions, plans, and materials for this space are detailed below.

Area

Approximately 6500 SF

Dimensions

Main Lobby: Approximately 95’ x 53’, with a ceiling height of 19’-4”.
Corridor adjacent to auditorium: Approximately 54’ x 15’, with a ceiling height of 19’-4”.
Security: Approximately 18’ x 9’, with a ceiling height of 8’-0”.

Materials

Lobby Materials and Finishes Schedule					
Abbreviation	**Finish Type**	**Object**	**Manufacturer**	**Color**	**Reflectance**
ACT-3	Ceiling Tile	Ceiling	Decoustics	White	0.90[c]
CPT-1	Carpet	Floor	Atlas	Sorrel, IT11	0.23[d]
GT-5	Glass Tile	Wall	Bisazza	Brown	0.04[d]
M-1	Metal	Wall	PPG	Champagne	0.65[b]
M-3	Metal	Wall	Milgo / Bufkin	Stainless Steel	0.60[b]
M-9	Metal	Wall	Zahner	Stainless Steel	0.65[b]
P-1	Paint	Wall	Benjamin Moore	Ivory	0.60[d]
PL-9	Plastic Laminate	Wall	Abet Laminati	Silver	0.47[d]
S-2	Stone	Wall	Vetter Stone	Veined Pink	0.41[d]
TZ-2	Terrazzo	Floor	Nat. Terrazzo	Beige	0.55[d]
W-1	Wood	Wall	Crown Veneer	Anegre	0.30[a]
Abbreviation	**Finish Type**	**Object**	**Manufacturer**	**Color**	**Transmittance**
G-3	Glazing	Glazing	PPG	Clear	.90[c]
G-9	Glazing	Glazing	Bendheim	White-Polished	.20[b]

Table 36: Materials and finishes for circulation space

[a] Reflectance values not available. Assumed from Table 8.5, *Architectural Lighting Design*, Gary R. Steffy, 2008.

[b] From Figure 1-36, *IESNA Lighting Handbook*, 2000, IESNA

[c] Value obtained from manufacturer’s data.

[d] Reflectance values not available. Assumed from manufacturer sample imported into AGI32.

Floor Plans, Elevations, and Images

Figure 57: Photograph of lobby seating

Figure 58: Photograph of Auditorium exterior

Figure 59: Photograph of Auditorium Lobby

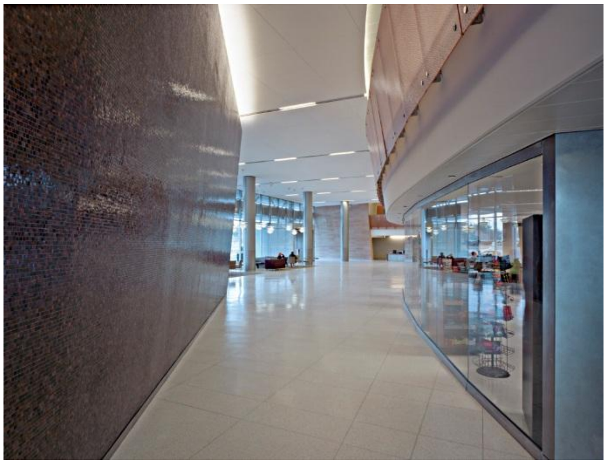


Figure 60: Photograph of Lobby Corridor

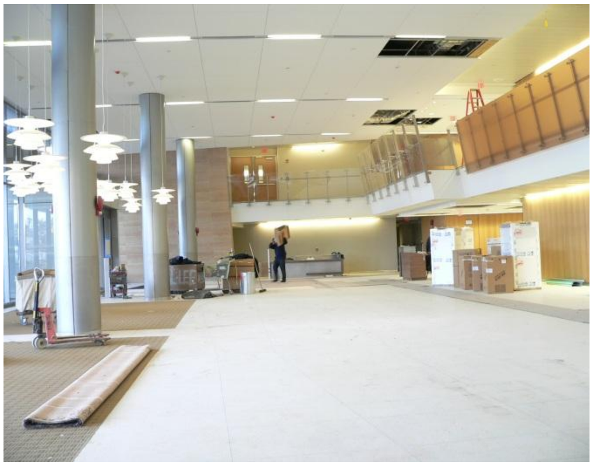


Figure 61: Photograph of reception area

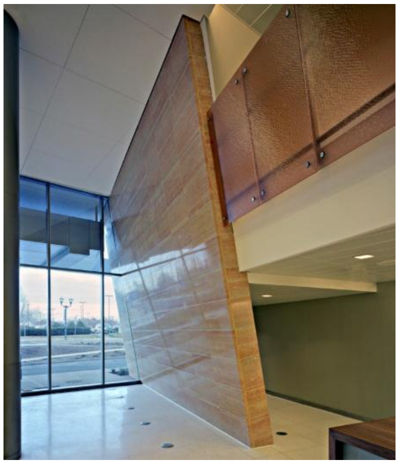


Figure 62: Stone wall at reception area

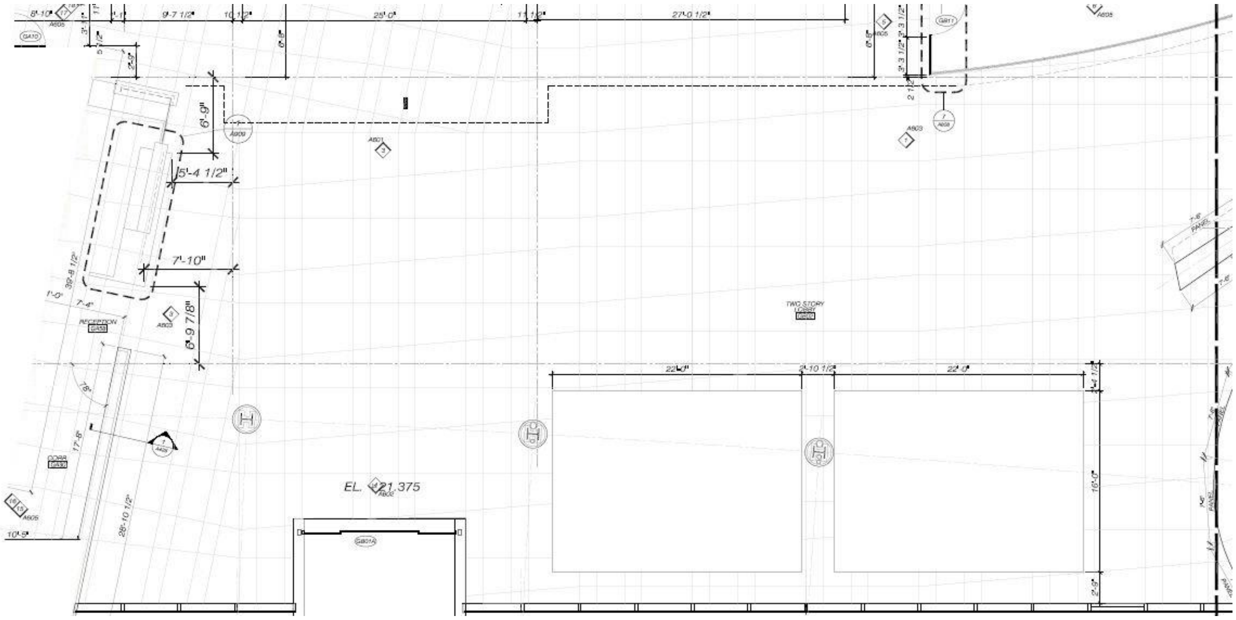


Figure 63: Main lobby floor plan

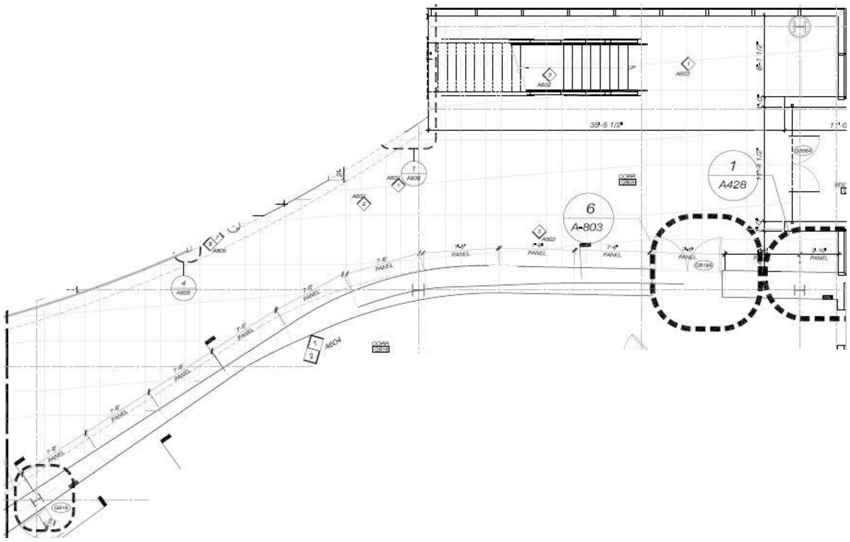


Figure 64: Auditorium lobby and corridor floor plan

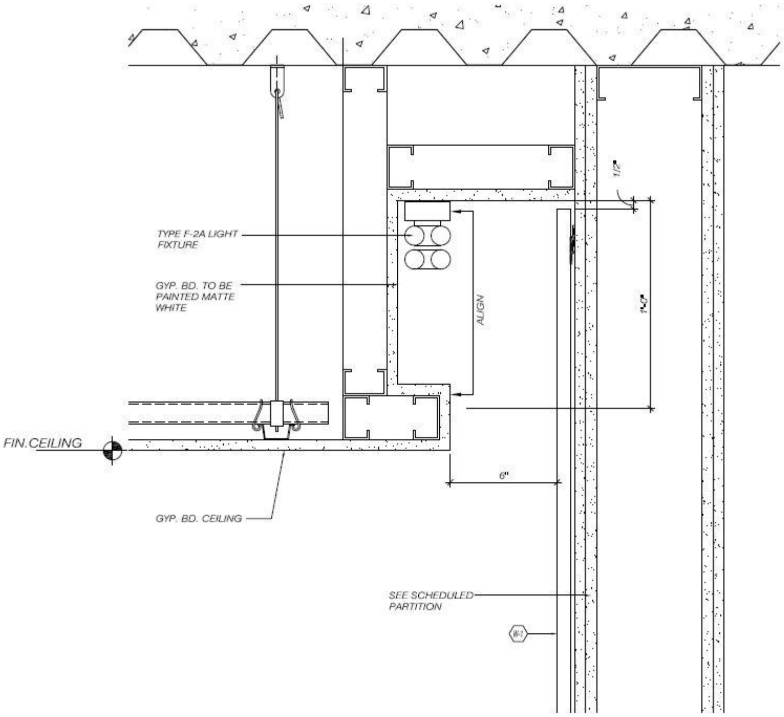


Figure 65: Typical lobby cove detail

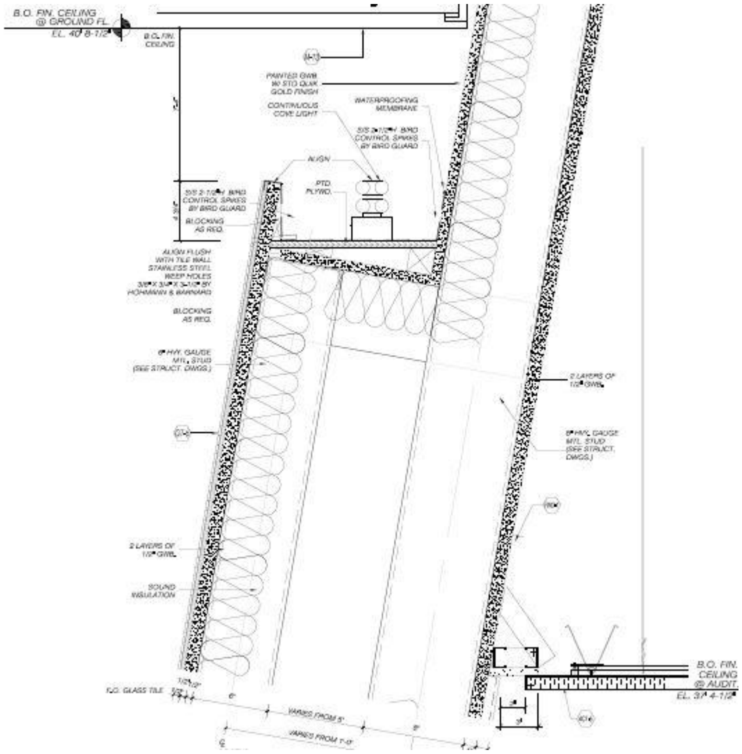


Figure 66: Typical cove detail at Auditorium wall

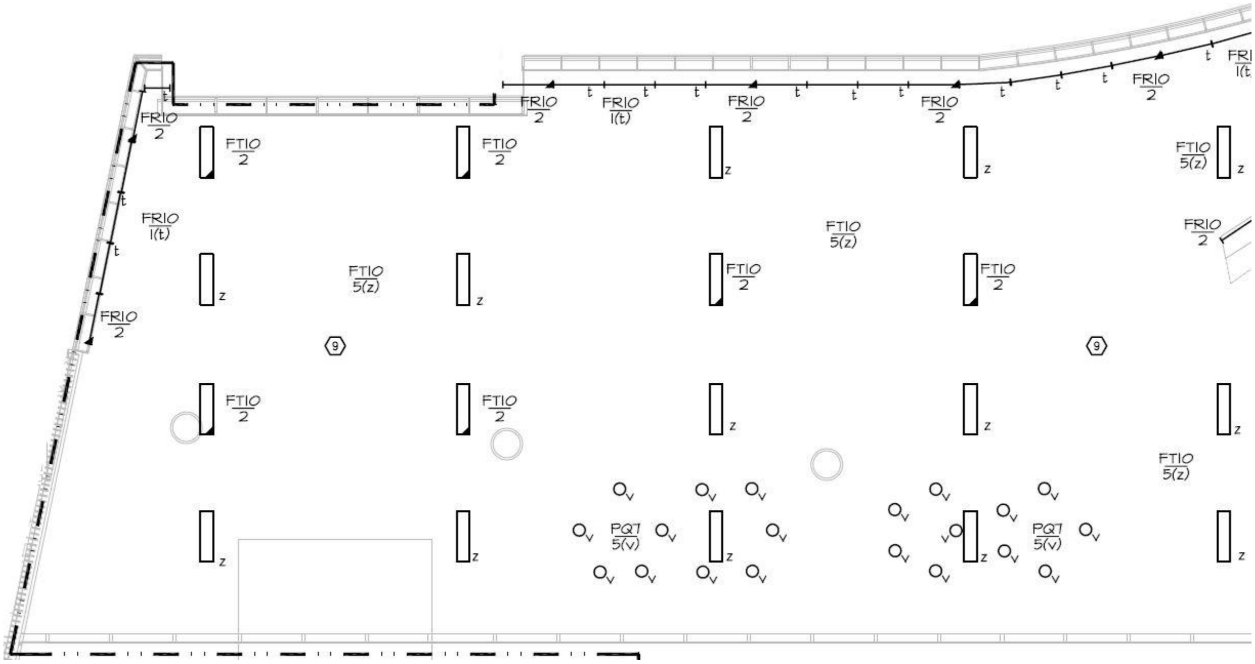


Figure 67: Main lobby existing lighting plan

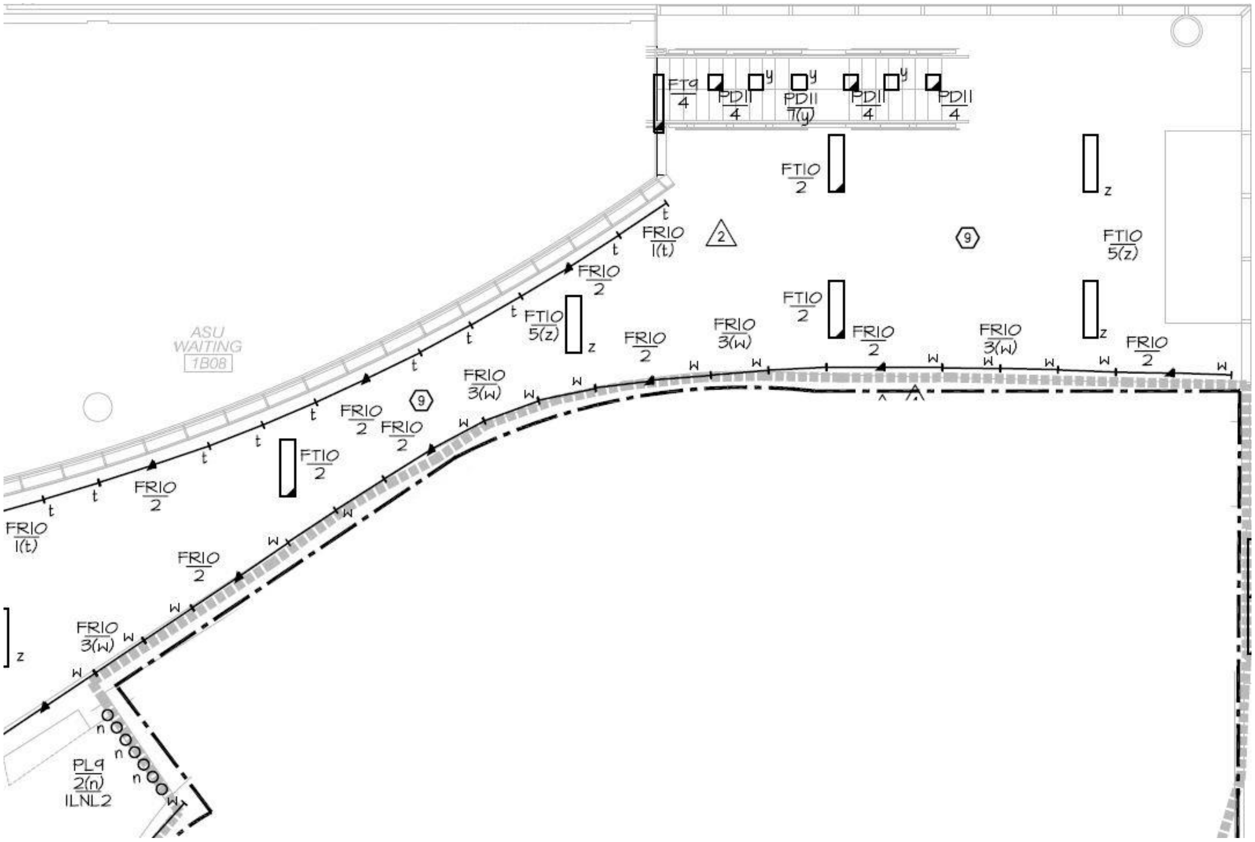


Figure 68: Auditorium lobby and corridor existing lighting plan

Existing Lighting Conditions

The general lighting in the lobby comes from recessed linear fluorescent 1' x 4' luminaires (FT10) located in the ceiling. Decorative fluorescent cove lighting (FR10) is used along the top of the exterior wall of the auditorium as well as to define the walkway on the first floor. The typical mounting for this luminaire is shown in Figure 38. A similar fixture (FR9) mounted in a wall slot is used to graze the wall behind the reception desk as well as the wood paneling near the elevator lobby. The stone wall next to the left of the reception desk is illuminated from the floor by recessed metal halide floodlights (PX15) that are flush with the lobby floor. Additional lighting is provided above the reception desk with recessed CFL downlights (PD9) in a square aperture. A similar fixture (PD11) with metal halide lamping is used in the auditorium lobby above the stairway to the first floor shown in Figure 31. Decorative pendants (PQ7) with ceramic metal halide lamps are used above the seating area. Each lighting system is switched separately and is controlled from the reception desk.

Existing Lighting for Main Lobby

Type	Quantity	Input Watts	Location	Mounting	Manufacturer	Lamp Type	Notes
FT10	25	120	Lobby	Ceiling Recessed DL	Linear Lighting RC68-D2-ET5HO	(2) GE F54T5HO/835	Mounted in cont. row Specular parabolic louvers
FR9	16	80	Lobby	Ceiling Slot WG	Celestial Lighting UBL 5000 BXO	(2) 40W BIAX CFL per 40”	Low profile Overlapping “ramped” socket Continuous length of cove
FR10	36	80	Lobby	Surface Cove	Celestial Lighting UBL 5000 BXO	(2) 40W BIAX CFL per 40”	Low profile Overlapping “ramped” socket Continuous length of cove
PD9	4	46	Lobby Reception	Ceiling Recessed DL	Kurt Versen H8643	(1) 42W CFL	6” square aperture Matte silver finish
PD11	6	48	Auditorium Lobby Stair	Ceiling Recessed DL	Kurt Versen H8402-SC	(1) 39W MH PAR20	4 1/2” square aperture Matte silver finish
PQ7	20	48	Lobby Seating	Ceiling Pendant DL	Louis Polsen PH6 Series	(1) 39W CMH T6 840	White Remote ballast in canopy
PX15	5	48	Lobby Reception	Floor Recessed	HP^2-CO^2	(1) 35W MH PAR20FL	Remote ballast Stainless steel face plate 30 degree flood

Table 37: Existing luminaires for Main Lobby

Design Criteria and Considerations

Summary

The following sections list important design criteria and considerations for the main lobby. Criteria listed include recommended illuminance values as well as power requirements. The final design will strive to meet all design criteria listed, and all existing conditions will be measured against these criteria. All issues listed under considerations come from the IESNA Lighting Handbook in addition to special design issues that relate to this space and project. While many design issues should be considered, the list provided below summarizes the most important issues for this application.

Design Criteria

Table 38 shows recommended illuminance levels specifically for the lobby. However, individual tasks that are likely to be performed in the area should also be considered. These tasks as well as recommended illuminance values are listed in Table 39. Table 40 and Table 41 summarize lighting power densities according to ASHRAE and the New York State Building Code.

IESNA Illumination Recommendations for Main Lobby

Area	Illuminance	
	Horizontal	Vertical
Lobby	5 fc	3 fc
General Waiting Area	10 fc	3 fc
Reading in Waiting Area	30 fc	5 fc
Corridors / Stairs	5 fc	-
Reception	50 fc	30 fc

Table 38: IESNA Illumination Recommendations

IESNA Illumination Recommendations for Tasks

Task	Illuminance	
	Horizontal	Vertical
Reading: VDT Screens	3 fc	3 fc
Reading: Keyboard	30 fc	-
Reading: #2 Pencil	30 fc	-
Reading: Ball point pen	30 fc	-
Reading: 8 – 10 point font	30 fc	-
Reading: Glossy magazines	30 fc	-

Table 39: IESNA Illumination Recommendations

ASHRAE 90.1-2007 Lighting Power Densities Allowance	
Space Type	**LPD, W/ft^2**
Hospital	1.2
Lobby	1.3

Table 40: ASHRAE Lighting Power Densities Allowance

New York State Building Code Lighting Power Requirements	
Space Type	**LPD, W/ft^2**
Hospital	1.2
Lobby	1.3

Table 41: Building Code of New York Lighting Power Requirements

Additional Power Requirements and Allowances:

- ASHRAE allows tradeoffs among spaces provided that the total installed interior lighting power does not exceed the interior lighting power allowance.
- For spaces where decorative lighting is installed in addition to the general lighting, an additional 1.0 W/ft^2 is allowed for the space.

When comparing Table 38 and Table 39, the recommended illuminance values for a waiting area and reception area are about the same as the recommended illuminance levels for the various tasks that will be performed in this space. An average illuminance of 5 - 10 fc, with a higher illuminance value of 30 fc for reading related tasks in the waiting area and a value of 50 fc at the reception desk, would be appropriate for this space. When comparing allowable lighting power densities, the requirements for the state of New York and ASHRAE are identical. In addition to the design criteria listed, there are many design considerations that must be taken into account. These considerations are summarized in the following section.

Design Considerations

Appearance of Space and Luminaires

When entering the hospital, the lobby gives the first impression. Proper lighting design that enhances the architecture can help significantly in giving a favorable impression. The lighting design should complement the space and should have a clean design. Since the lobby functions primarily as a circulation space, how the lighting design guides the occupant through the space is an important consideration. Uniform layouts with straight lines can be used to guide occupants to a particular area, while a less uniform layout may encourage a more random movement through the space.

Psychological Impression

As described above, the impression of the space important. Visitors should feel comfortable and relaxed upon entering the hospital. Direct downlighting should be avoided. In the seating area and the main lobby in general, an occupant should feel relaxed. This impression can be achieved through lighting by the use of non-uniform peripheral luminances.

Modeling of Faces and Objects

The modeling of faces at the reception area and entrance to the building are very important. The ability of staff and security to read and interpret the facial expressions of occupants entering the building is critical to effective communication and safety. Direct downlight that creates harsh facial shadows should be avoided above the reception desk.

Daylighting Integration and Control

Daylighting integration and control are important from an energy conservation standpoint and should be used in the lobby area due to the availability of natural light near the seating area. Photosensors should be used to control luminaires in close proximity to the glazing. Proper glazing and shading should be used to block direct glare from the sun.

Direct and Reflecting Glare

Direct glare can be distracting to the occupants performing tasks commonly performed in the space. Direct glare from luminaires can cause discomfort and can make it difficult for occupants to circulate through the space. Direct views of lamps sources should be avoided as much as possible. Additionally, luminaire luminances should not be greater than 100 times the luminance of surrounding areas.

Color Appearance

Appropriate color rendering in the lobby is important. Since social interactions occur in the space, the lighting design should render skin tones properly. The natural materials used throughout the space should also be rendered correctly to ensure the architect’s vision for the space is achieved.

Light Distribution

Patterns of light on surfaces and the task plane can affect task visibility, comfort, and perception. As a result, the spacing and light distribution of luminaires should be carefully analyzed. Excessive brightness and shadows should be avoided. The task illuminance should be higher than the surroundings to draw attention to the task. The luminance ratio between the presenter or projection screen and the surrounding walls should be carefully considered. Between the task and remote surface, the luminance ratio should not exceed 10:1.

Flicker

Flicker and strobe can create an undesirable environment. Luminaires that utilize light sources prone to flickering should be avoided. High frequency electronic ballasts should also be used to eliminate flicker.

Shadows

Shadows can interfere with tasks as well as set a mood for a space. A dark corridor or area of the lobby can deter occupants from circulating through the area. Point sources tend to created harsher shadows while linear sources tend to produce softer shadows.

Evaluation and Critique

Summary

The lighting design for the lobby is adequate for the space, but could be designed better. The strong linear lines created by the fluorescent lights work well with the sharp edges of the architecture but create a sense of forced circulation in an open lobby where movement should flow more freely. The cove lighting in the space works well along the second floor walkway by adding a line of light that helps to define the curve. However when used along the auditorium wall, the lighting system creates undesirable "hot spots" across the top of the wall. A luminaire that is angled or is mounted in a way that shoots light across the ceiling would have created a more desirable effect. Additionally, no attempt was made to actually high light the auditorium wall itself. Slot mounted luminaires could have achieved a similar effect as the existing design while highlighting the exterior walls of the auditorium.

Aside from the cove lighting on the auditorium wall, decorative lighting is used well is the space. The in-ground fixtures draw attention to the stone wall next to the reception desk. In the seating area, the pendants help to scale down the space and provide additional lighting for tasks performed in the area. The use of slot mounted fixtures along the walls help to define boundary between the wall and ceiling, but not without creating a line of noticeably higher illuminance at the top of the wall. A fixture that sends light down the wall in a more uniform matter would have created a better effect.

Since the fluorescent lighting used in the lobby is the same fixture used in the auditorium, based on the relatively low amount of luminaires in the lobby I would assume that the lighting levels are closer to the IESNA recommended levels than in the auditorium. However, since the nurse's station and auditorium were severely overdesigned, it is likely that the illuminance levels in the lobby exceed recommendations. The lighting power density for the lobby is 1.01 W/ft^2, which is well under the 1.3 W/ft^2 required by ASHRAE and New York.

Lighting Power Density for Lobby			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
FT10	25	120	3000
FR9	16	80	1280
FR10	36	80	600
PD9	4	46	184
PD11	6	48	288
PQ7	20	48	960
PX15	5	48	240

Total Watts:	6552
Total Area (ft^2):	6500
LPD (W/ft^2):	1.01

Table 42: Lighting power density calculation

Schematic Design

Summary

The main goal for the new lighting design is to build on the architect's original vision of the space, as shown in Figure 69. This vision was used to create schematic designs shown in Figures 70 through 75 that eliminated ceiling clutter and the hard horizontal lines created by the existing lighting in the space. In addition to building on this initial vision, the goal is to create a lasting impression for visitors to the hospital. Patients and visitors should be impressed with this space, and should feel comfortable in choosing South Nassau with their health. As a result it is extremely important the lobby not only feel welcoming, but also feel modern. Illuminating the walls and ceilings of the space gives the impression of spaciousness and helps to give the lobby a sense of grandeur. Decorative slot lighting and wall washing help to enhance the architecture by creating the impression of a floating ceiling and illuminating significant architectural elements in the space, such as the auditorium and stone wall near the main entrance. Cove lighting is used to encourage movement through the lobby and elevator lobby, while the darker ceiling and low pendants help create a relaxing and subdued seating area nearby.

Figure 69: Original rendering of main lobby, Courtesy of Cannon Design

Figure 70: Schematic Lighting Design 1

Figure 71: Schematic Lighting Design 1

Figure 72: Schematic Lighting Design 2

Figure 73: Schematic Lighting Design 2

Figure 74: Schematic Lighting Design 3

Figure 75: Schematic Lighting Design 3

Professional Comments from Lutron Presentation

Lee Brandt:

- Second concept for lobby reinforced architecture the best.

Luke Tigue

- Lobby concepts are good, try to use one view. Use original design considerations to help make decision between scenarios.

Lighting Solution

Overview

Key concepts from the schematic design were carried over into the final design. The second schematic design served as the basis of the final design. The pedestrian areas were highlighted using cove mounted low wattage linear LED luminaires create contrast between the ceiling above the pedestrian walkways and the surrounding areas, and is intended to guide occupants through the space. Linear LED luminaires were used because of the small size and ability to provide adequate light levels in the curved areas of the space. Recessed ceiling mounted downlights with compact fluorescent lamps were used to meet the recommended illuminance values. These were chosen over ceramic metal halide lamps because their restrike time does not meet emergency lighting requirements. Ceramic metal halides were specified above the reception desk because of the superior color rendering ability and relatively low wattage. Linear LED wall washers mounted in an 8” slot are used to highlight the walls throughout the space, create contrast between the ceiling and walls, and give the appearance of a floating ceiling. A custom ceramic frit pattern, shown in Figure 81 was designed and specified for the upper glazing in the lobby to create the wall washing effect on the glazing. Custom cylindrical pendants were specified for the seating area. The luminaires use a low output fluorescent T8 lamp to create a glow from the luminaire and create an architectural element in the space. Ceramic metal halide MR16 lamps are mounted in the bottom of the luminaire to provide the required illuminance values for the seating area. The height of the bottom of the luminaire vary between 8’ and 10’ and help to shrink the height of the space within the seating area, giving a more private and relaxing feel while still complementing the height of the overall space. Due to the warm tones of the wood paneling and stone throughout the space, lamps with a CCT of 3000K were specified for this space. The tables, renderings, schedules, and lighting plans on the following pages convey the final design for this space.

Renderings

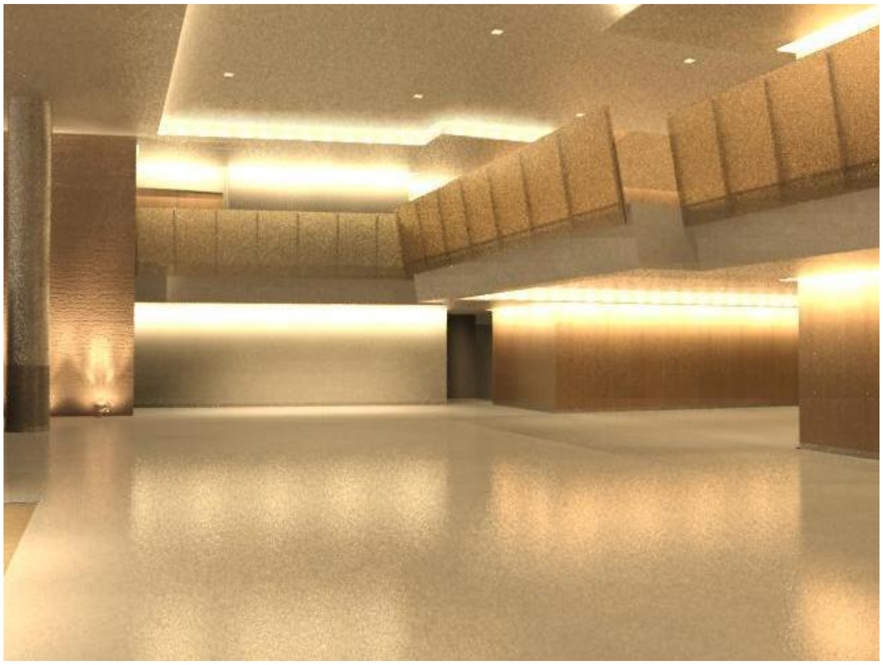


Figure 76: 3DS Max rendering of lobby lighting design

Figure 77: 3DS Max rendering of lobby lighting design

Figure 78: 3DS Max rendering of lobby lighting design

Figure 79: 3DS Max rendering of lobby lighting design

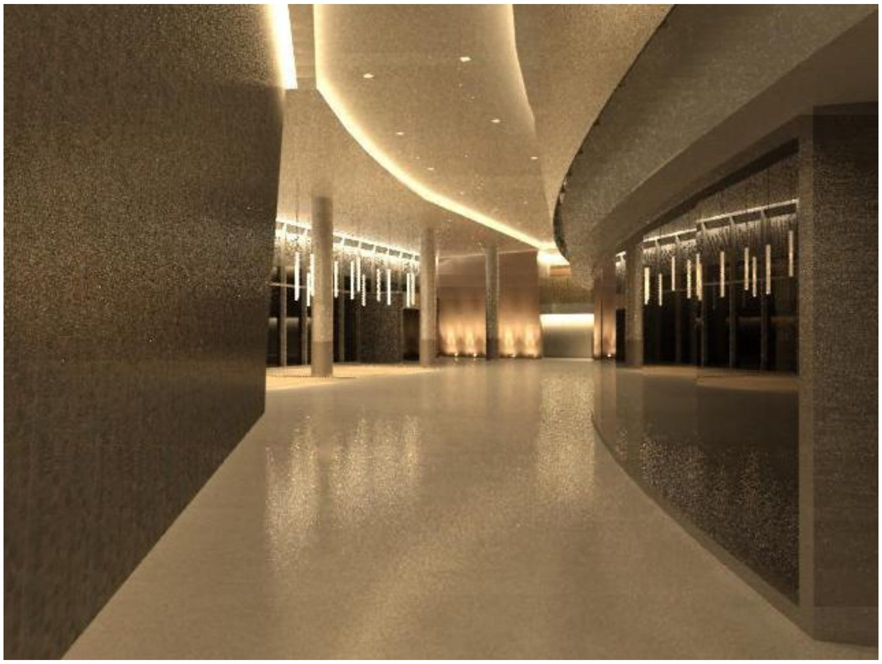


Figure 80: 3DS Max rendering of lobby lighting design

Figure 81: 3DS Max rendering of custom frit pattern for lobby glazing

Lighting Plan

See Appendix A for lighting plans, construction details, and control diagrams.

Luminaire Schedule

LUMINAIRE SCHEDULE								
TAG	IMAGE	MANUFACTURER/CATALOG #	DECRIPTION	LAMP	VOLT	BALLAST / POWER SUPPLY	WATT	LOCATION
LA		Kurt Versen / H8642-FM06-LL-UV-WT	6" square flush mount downlight. 42W CFL.	(1) Philips CDM 39W T-6 Elite. 3000K, 90 CRI	277	GE electronic ballast. GEC242-MVPS-3W. Input 47W, BF 1.0	47	21'-4" A.F.F. Located in cove above main lobby.
LB		Kurt Versen / H8632-FM06-LL-UV-WT	6" square flush mount downlight. 26W CFL.	(1) GE F26TBX. 3000K, 82 CRI	277	GE electronic ballast. GEC242-MVPS-3W. Input 32W, BF 1.0	32	9'-6" A.F.F. Located in cove above elevator lobby on ground and first floor.
LC		Visa / Sequence CP5201-Custom	4" diameter, 4' hieght stem mounted pendant. (1) 25W dimming T8 with 20W CMH MR16 downlight. Ballasts mounted in canopy.	(1) 25W F32T8 3000K, 85 CRI; (1) CMH20MR16 3000K, 85 CRI, 40D	277	Advance 277V IDA-132-SC, Input 27W, 0.99 BF; GEMH20-MC-120, Input 23W, BF 0.9	50	Mounted above seating area in main lobby, bottom luminaire 8' - 10' A.F.F.
LD		io / raye 0-08-3K-C33-1-18/72-277	Linear LED wall washer. High output (372 lms/ft), continous row mounting. 18" & 72" length as needed.	(1) LED Array 3000K, 86 CRI	277	Intergral LED driver. Input 7.4W per linear ft, BF 1.0	11.84/ 44.44	8" wall slot 1' from wall.
LE		io / line 0-03-I-3K-65-1-12/96-277	Linear LED wall washer. High output (68 lms/ft), continous row mounting. 18" & 72" length as needed.	(1) LED Array 3000K, 86 CRI	277	Remote io DR96MGD LED driver. Input 2.9W per linear ft, BF 1.0	4.35/ 17.4	Cove mounted above main lobby
LF		Allscape / SL-23-20MH-T4-MFLD-F-NA-DS	Recessed 7" diameter wall washer mounted flush with lobby floor. Medium flood optics, clear lens, directional shield.	(1) Philips CDM 20W T-6 Elite. 3000K, 84 CRI	277	Advance electronic ballast. IMH-G20-G. Input 35W, BF 1.0	24	Recessed in lobby floor, near stone wall at entrance
LG		Kurt Versen / H8606-FM06-LL-UV-WT	6" square flush mount downlight. LED module. 35W ceramic metal halide lamping.	(1) Philips CDM 39W T-6 Elite. 3000K, 90 CRI	277	Advance electronic ballast. IMH-P39-G. Input 35W, BF 1.0	45	8'-6" A.F.F. Located above reception desk.

Table 43: Main Lobby luminaire schedule

Control Scheme

Since the lobby will likely not host multiple functions and will be accessible 24 hours per day, a sophisticated control system is not necessary for the space. Most luminaires will be switched in groups. Luminaire types LA and LB, which provide general downlight in the lobby and elevator lobby, will be switched separately. The cove and slot lighting in the ground and second floor elevator lobby will be controlled together, but will have separate switching for each level. All luminaire type LE and LD located in the main lobby is to be switched separately. Decorative lighting will also be switched separately. Slot luminaires along glazing will be controlled by a photocell located above the seating area. For luminaire type LC, the fluorescent component will be controlled with a dimming switch independent of the switch for the metal halide downlight component. All switches are to be located behind the reception desk located adjacent to the entrance in the main lobby.

Performance

Performance was measured through calculations in AGI32 and 3D Studio Max. Material reflectance values were the same as those detailed in the Materials section. Performance was measured against IESNA and ASHRAE recommendations documented earlier. Light loss factors were also calculated for each luminaire in the space.

Luminaire Light Loss Factors for Courtyard

Luminaire Designation	Cleaning Interval	LDD Case	Initial Lumens	Design Lumens	LLD	LDD[a]	BF	Total LLF
LA	Clean, 12 mo.	W	3500	3150	0.90	0.91	0.95	0.77
LB	Clean, 12 mo.	W	1800	1620	0.90	0.91	0.95	0.77
LC1	Clean, 12 mo.	W	2500	2425	0.97	0.91	0.99	0.87
LC2	Clean, 12 mo.	W	1000	650	0.65	0.91	0.99	0.58
LD	Clean, 12mo.	W	372[d]	-	0.80[c]	0.91	1.00	0.73
LE	Clean, 12mo.	W	68[d]	-	0.80[c]	0.91	1.00	0.73
LF	Clean, 12mo.	W	1800	1620	0.90	0.91	0.95	0.77
LG	Clean, 12mo.	W	3500	3115	0.89[e]	0.91	0.95	0.86

Table 44: Light loss factor for lobby luminaires

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

[c] Assumed LED lamp lumen depreciation.

[d] Value per linear feet.

Lighting Power Density for Lobby			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
LA	26	47	1222
LB	12	32	384
LC	22	50	1100
LD	615 LF	7.4 W/LF	4551
LE	550 LF	2.9 W/LF	1595
LF	5	24	120
LG	4	45	180

Total Watts:	9152
Total Area (ft^2):	10628
LPD (W/ft^2):	0.86
Allowable (W/ft^2):	2.3

Table 45: Lighting power density calculation

Lighting systems were designed for additional areas outside the original scope due to the immediate adjacency to the spaces originally considered. This includes the ground and first floor elevator lobby as well as the first floor walkway that overlooks the main lobby. These areas and power consumptions were included in the table above and in the final calculated values. The lighting design meets ASHRAE and New York State power requirement of 1.3 W/SF with additional wattage available to be traded with other spaces. Luminaires LC, LD, LE, and LF were designed to highlight architectural elements within the space and can be considered decorative lighting, which would raise the total power requirement in the space to 2.3 W/SF. Compared to both values, the lighting design meets the power density requirements in the space.

IESNA Illumination Recommendations for Main Lobby		
Area	**Avg. Horizontal Illuminance**	
	Target	**Design**
Lobby	5 fc	-
General Waiting Area	10 fc	12.81 fc
Reading in Waiting Area	30 fc	33 fc
Corridors / Stairs	5 fc	10 fc
Reception	50 fc	49.56 fc

Table 46: Comparison of designed and recommended illumination values for main lobby

The illuminance values in the lobby all meet the designated criteria. It was assumed the lobby also functions as a waiting area, so the lighting levels were designed to meet the recommended values for such a space. The design of the lobby is very open, and as a result areas that would be considered a lobby also contain stairs and corridors, which is the reason for the higher illuminance values in this area. Pseudo color renderings below show the illuminance values in more detail.

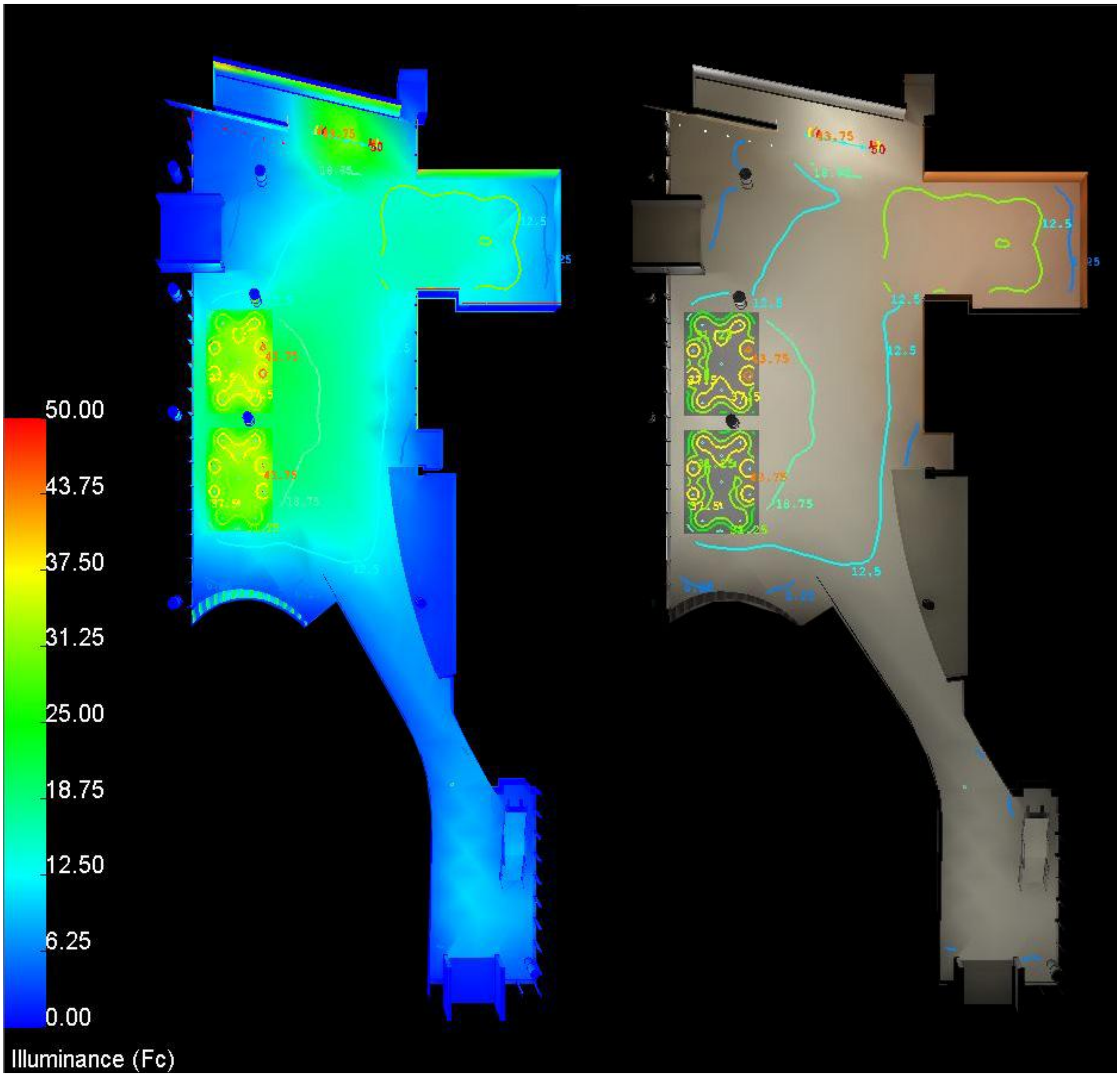


Figure 82: Pseudo color rendering and iso lines of illuminance levels in main lobby

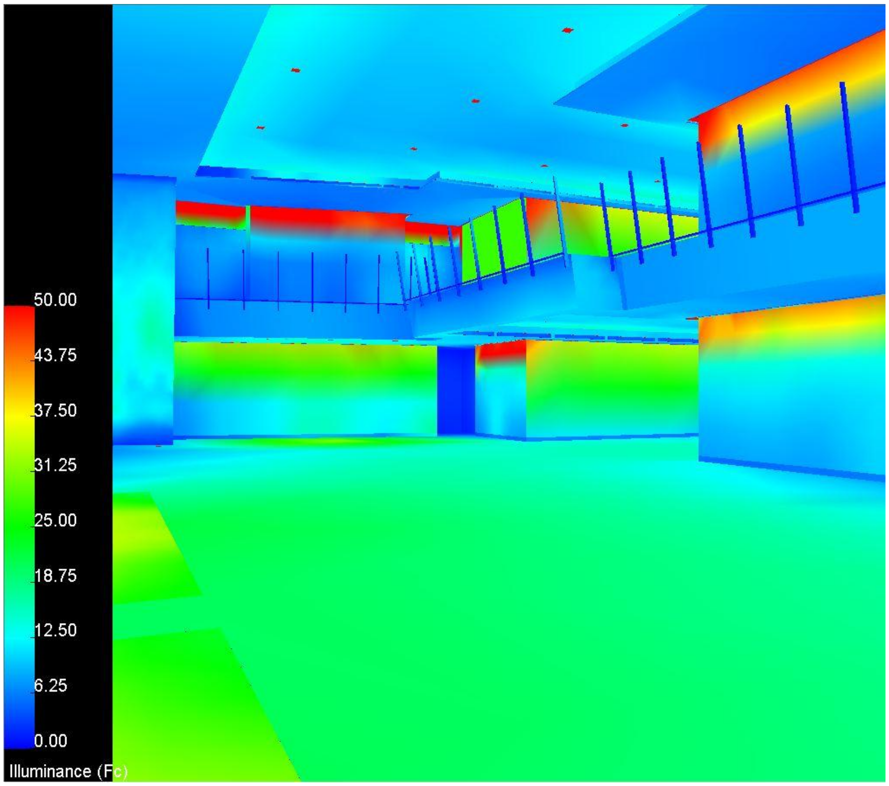


Figure 83: AGI32 pseudo color rendering of main lobby

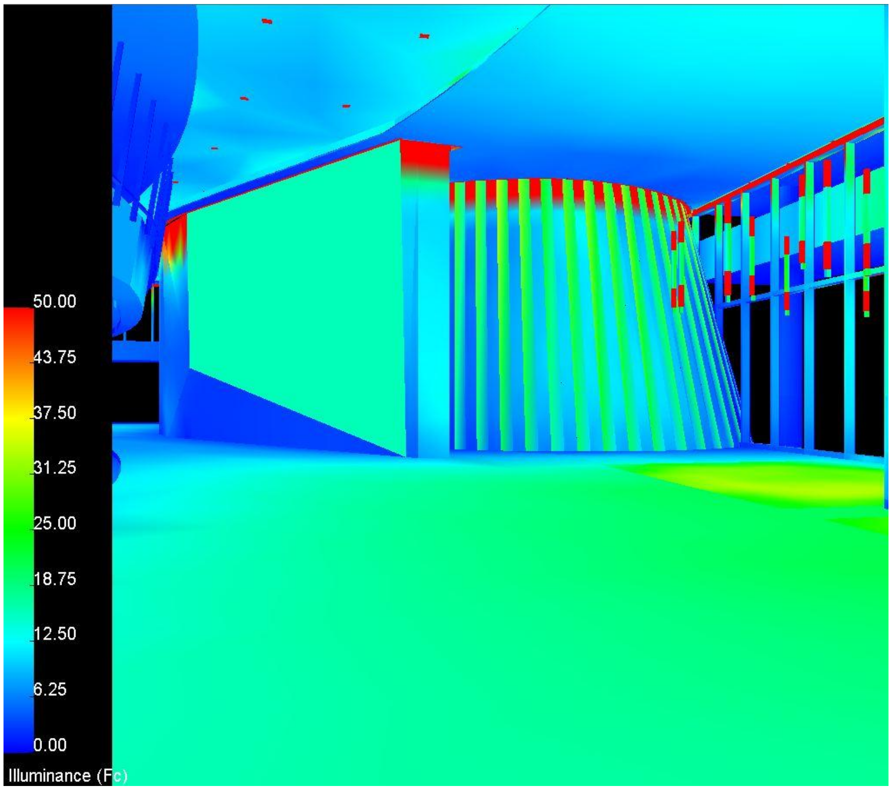


Figure 84: AGI32 pseudo color rendering of main lobby

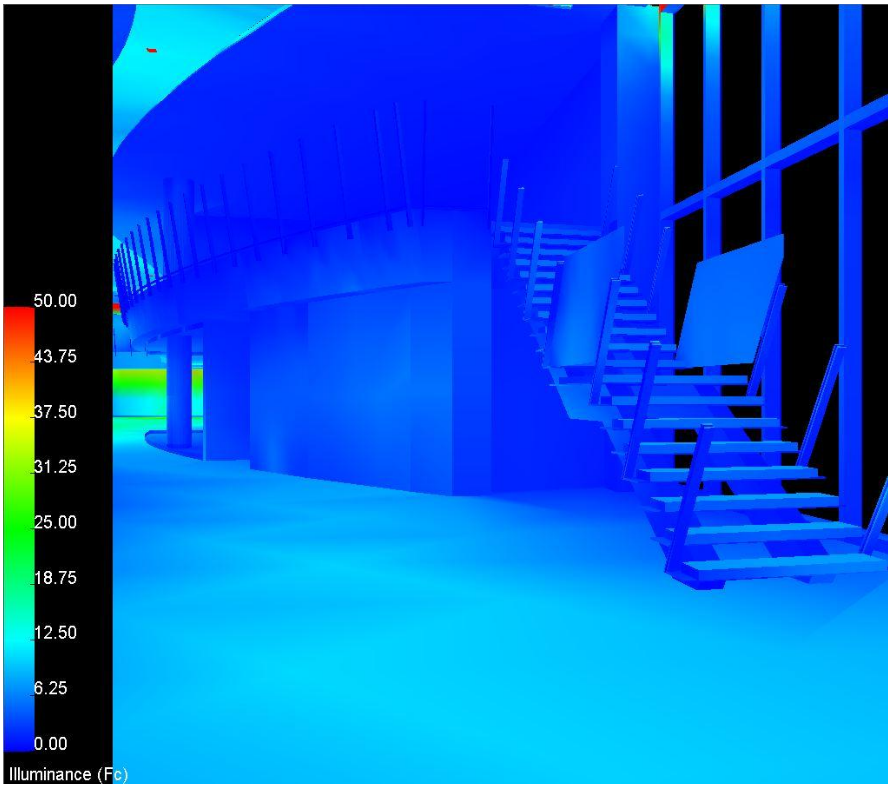


Figure 85: AGI32 pseudo color rendering of main lobby

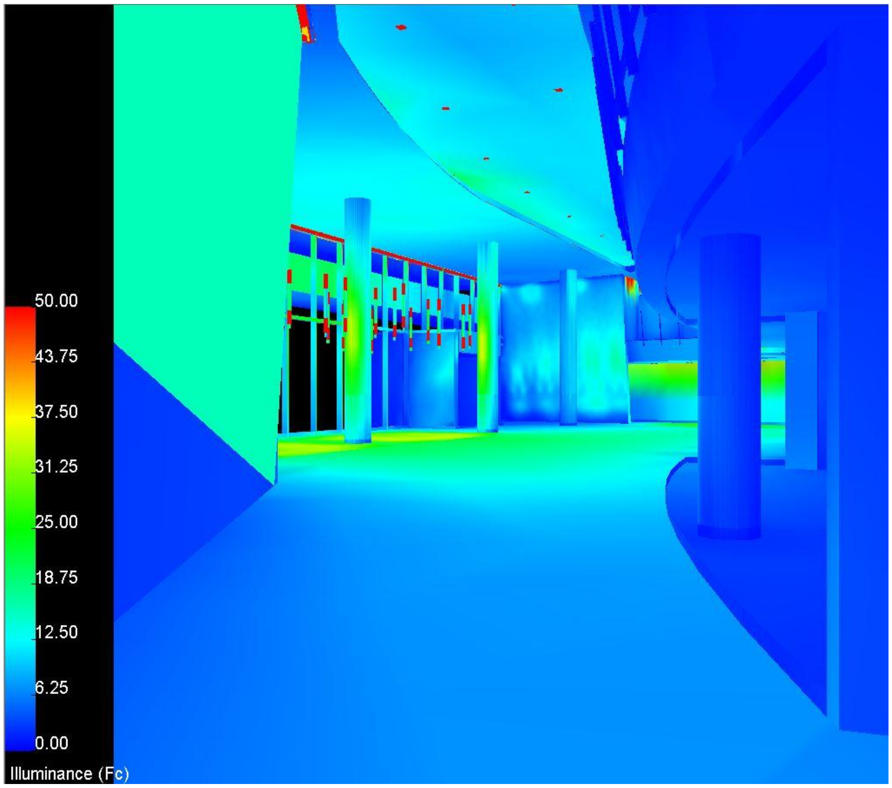


Figure 86: AGI32 pseudo color rendering of main lobby

The original design considerations for the space were also met using the following methods:

Summary of Considerations for Lobby		
Considerations	**Recommended**	**Design**
Appearance of Space and Luminaires	Enhance architecture, guide occupants. Uniform layout.	Cove / slot lighting illuminate walls and architecture. Cove guides circulation. Uniform and clean appearance
Psychological Impression	Welcoming, relaxing, spacious	Peripheral and ceiling lighting create spacious environment. Warm CCTs, smaller area creates relaxing seating area
Modeling of Faces	Avoid harsh shadows	Use of peripheral and indirect lighting reduces the need for high output downlighting and adds illuminance to surrounding area.
Daylighting	Make use of lobby glazing	Fluorescent fixtures use dimmable ballasts while independent switching allows luminaires to be controlled individually.
Glare	Avoid direct glare	Use of peripheral and indirect lighting reduces the need for high output downlighting and adds illuminance to surrounding area, shielding for cove.
Color Appearance	Good color rendering.	Use of ceramic metal halides with CRI in 90's, specify high CRI LEDs
Light Distribution	Avoid patterns	Uniform light levels on walls, main reception desk, and work plane of seating area.

Table 47: Summary of Design Considerations

Summary

The lighting in the lobby was designed to impress visitors and patients. The ceiling was redesigned to allow the architects original vision of an open ceiling to be expressed. Ceiling clutter was eliminated as much as possible. A selection of modern equipment and uniform layout of the lighting helps to create a modern image for the space. Lighting is used to accentuate the architecture by highlighting unique elements in the space such as the auditorium wall. Perimeter lighting helps to define the boundaries of the space while creating contrast between the walls and ceiling. The perimeter lighting also helps to make the space feel more spacious, as does the cove lighting throughout the lobby. The cove also helps to distinguish between pedestrian and waiting areas.

The lobby is also intended to feel welcoming. The use of low CCTs help to create a warm environment and complement the warm tones in the space. The seating area was also a major focus of the lighting design, and the use of pendants complement the height of the space while also reducing the scale in the immediate seating area.

While ASHRAE allows for 2.3 W/SF in this space, the lighting design was achieved with only 0.86 W/SF. The overall power density for the lobby may rise due to some areas not included in the scope; however it would not put the power density over the allowable limit. The substitution of the CFL cove lighting in the original design with newer lower wattage LEDs was a significant reason for the reduction in power density.

In addition to all power requirements, the lighting design meets or slightly exceeds all recommended illuminance values in the space.

Outdoor Space | Courtyard

Existing Conditions

Description

The courtyard serves as an extension of the conservatory and functions primarily as a circulation space that connects the conservatory to the older sections of the hospital. A small seating area sits just outside the entrance to the conservatory. Visual tasks in the space are primarily related to circulation, so the lighting design should facilitate safe and easy movement through the courtyard. The surrounding exterior walls of the hospital are brick with some brushed stainless steel panels. The shell of the conservatory is composed of clear laminated glass. The ground of the courtyard is concrete with surrounding planters covered with grass.

Area

Approximately 14,000 SF.

Materials:

Courtyard Materials and Reflectance Values					
Abbreviation	**Finish Type**	**Object**	**Manufacturer**	**Color**	**Reflectance**
B-3	Brick	Wall	-	Red Dark Iron	0.20[a]
C-1	Concrete	Ground	-	Grey	0.25[a]
GR	Grass	Ground	-	Green	0.10[b]
M-1	Metal	Wall	Trespa Virtuon	Red	0.60[a]
M-14	Metal	Wall	Texaa	Orce rouge 390	0.60[a]
P-12	Paint	Wall	Ben. Moore	Baked Clay	0.25[c]
Abbreviation	**Finish Type**	**Object**	**Manufacturer**	**Color**	**Transmittance**
G-1	Glazing	Wall	PPG Solarban 60	Clear	0.70[c]
G-4	Glazing	Conservatory	PPG Solarban 60	Clear	0.70[c]

Table 48: Materials and finishes for outdoor space

[a] Reflectance values not available. Assumed from Table 8.5, *Architectural Lighting Design*, Gary R. Steffy, 2008.

[b] From Figure 5-19, *IESNA Lighting Handbook*, 2000, IESNA

[c] Value obtained from manufacturer’s data.

Floor Plans, Elevations, and Images:

Figure 87: Photograph of existing courtyard from conservatory

Figure 88: Photograph of existing courtyard

Figure 89: Photograph of existing courtyard seating area

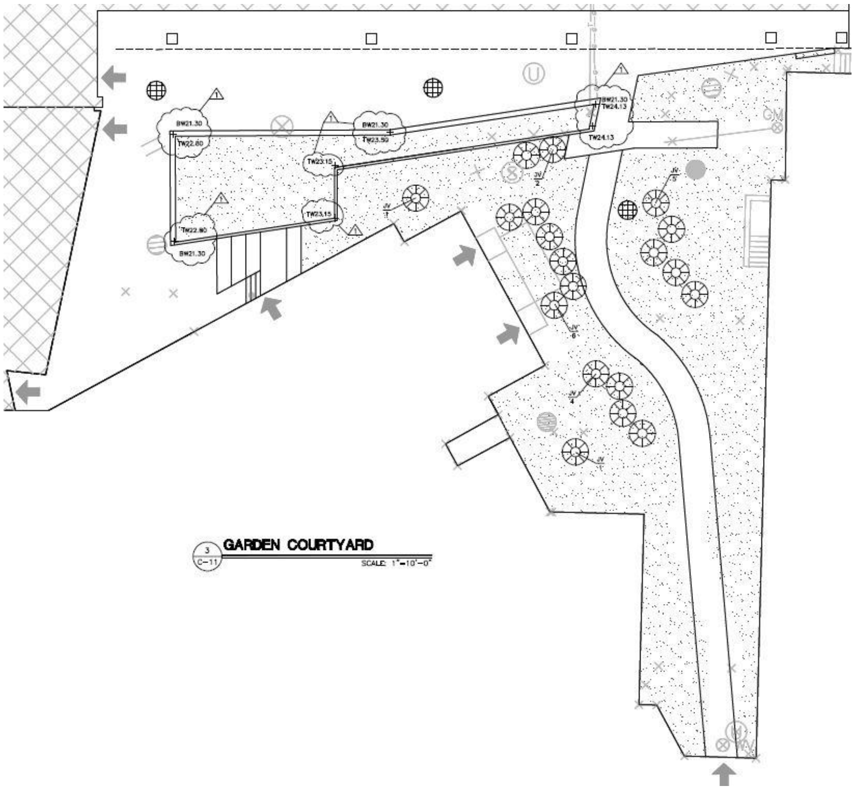


Figure 90: Courtyard existing landscaping plan

Figure 91: Existing lighting plan for courtyard

Existing Lighting Conditions

There is no lighting design for the seating area and main pathways in the courtyard. The only exterior lighting in the area comes from metal halide downlights (PX1) that are recessed in the overhang of the first floor.

Existing Lighting for Main Lobby							
Type	**Quantity**	**Input Watts**	**Location**	**Mounting**	**Manufacturer**	**Lamp Type**	**Notes**
PX1	19	94	First floor overhang	Ceiling Recessed DL	Gotham Lighting LGH-70M	(1) 70W MH	8” aperture Specular azlack reflector Fresnel lens

Table 49: Existing luminaires for Courtyard

Design Criteria and Considerations

Summary:

The following sections list important design criteria and considerations for the courtyard. Criteria listed include recommended illuminance values as well as power requirements. The final design will strive to meet all design criteria listed, and all existing conditions will be measured against these criteria. All issues listed under considerations come from the IESNA Lighting Handbook in addition to special design issues that relate to this space and project. While many design issues should be considered, the list provided below summarizes the most important issues for this application.

Design Criteria:

Table 50 shows recommended illuminance levels specifically for the courtyard. The space serves primarily as a circulation space, and other tasks would likely be performed in the adjacent conservatory. Table 51 and Table 52 summarize lighting power densities according to ASHRAE and the New York State Building Code.

IESNA Illumination Recommendations for Courtyard		
Area	**Illuminance**	
	Horizontal	**Vertical**
General Lighting	0.5 fc	0.2 fc
Paths	1 fc	0.3 fc
Steps	1 fc	0.3 fc
Emphasize trees	0.3 fc	0.3 fc
Small focal points	1 fc	0.3 fc

Table 50: IESNA illumination recommendations

ASHRAE 90.1-2007 Lighting Power Densities Allowance	
Space Type	**LPD**
Walkways < 10 ft. wide	1.0 W/ linear ft^2
Plaza areas	1.0 W/ft^2
Stairways	1.0 W/ft^2
Canopies	1.25 W/ft^2

Table 51: ASHRAE Lighting Power Densities Allowance

New York State Building Code Lighting Power Requirements	
Space Type	**LPD, W/ft^2**
Courtyard (Other)	1.0

Table 52: Building Code of New York State Lighting Power Requirements

Additional Power Requirements and Allowances:

- New York State Building Code requires automatic switching or photocell controls to be used for all exterior lighting not intended for 24-hour operation
- ASHRAE allows tradeoffs among spaces provided that the total installed interior lighting power does not exceed the interior lighting power allowance.
- For spaces where decorative lighting is installed in addition to the general lighting, an additional 1.0 W/ft^2 is allowed for the space.

Base on the values listed in Table 33, an average illuminance of 5 - 10 fc would be appropriate for this space. The amount of uplight from luminaires should be carefully considered since the patient rooms overlook the courtyard. When comparing allowable lighting power densities, the requirements for the state of New York and ASHRAE differ. For this space, ASHRAE recommendations should be followed since they are more stringent. In addition to the design criteria listed, there are many design considerations that must be taken into account. These considerations are summarized in the following section.

Design Considerations:

Direct and Reflecting Glare

The issue of direct glare is extremely important in the courtyard. Direct glare from luminaires can cause discomfort and can make it difficult for occupants to circulate through the space. Direct and reflected glare are especially important due to the close proximity of patient rooms, and as a result luminaires with no uplight and shields should be used.

Modeling of Faces and Objects

The modeling of faces at near the building entrance and pathways is very important. The ability of staff and security to read and interpret the facial expressions of occupants entering the building is critical to effective communication and safety.

Shadows

Shadows in an outdoor space can pose numerous safety concerns. Shadows on stairs and pathways can cause occupants to trip or fall which could be a liability for the hospital. Shadows can also set the mood for a space, and an outdoor area with numerous shadows can deter occupants from circulating through the area.

Light Distribution

Patterns of light on surfaces and the task plane can affect task visibility, comfort, and perception. As a result, the spacing and light distribution of luminaires should be carefully analyzed. Excessive brightness and shadows should be avoided. Illuminance levels should allow occupants to move through the space without creating a disruption to patients in nearby rooms.

Points of Interest

The lighting design should highlight features of the courtyard and should guide occupants through the space. The lighting design should also reinforce the architecture, landscaping, and materials of the surrounding area.

Daylighting Integration and Control

Luminaires used in the courtyard should be controlled by photocells that will switch luminaires on and off depending on the amount of sunlight available.

Flicker

Flicker and strobe can create an undesirable environment. Luminaires that utilize light sources prone to flickering should be avoided. High frequency electronic ballasts should also be used to eliminate flicker.

Evaluation and Critique

Summary

The only current lighting in the courtyard area is located under the overhang provide by the first floor. The metal halide source is appropriate for the outdoor space and the close proximity to the building. Illuminance levels are likely higher than recommended since the mounting height is approximately 9’-0” above the ground and the luminaires use a 70W lamp. High illuminance values in this area are of special concern since there office windows are located adjacent to the pathway under the overhang.

There was no attempt made to light the pathways from the existing hospital to the new addition, which deters occupants from using the space at night. Ambient lighting from inside the conservatory provides some light on the adjacent exteriors seating area. The decision to not illuminate the building features surrounding the courtyard was a good decision since patient rooms look into the courtyard on all sides. However, a method of lighting the walls or other architectural elements without producing direct and reflected glare should have been explored.

Since 70W lamps were used, the illuminance levels likely exceed the IESNA recommended values. The lighting power density, which is based on an overhang area of approximately 1136 SF, is 1.57 W/ft^2 and does not meet the required value of 1.25 W/ft^2.

Lighting Power Density for Courtyard			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
FT10	19	94	1786

Total Watts:	1786
Total Area (ft^2):	1136
LPD (W/ft^2):	1.57

Table 53: Lighting power density calculation

Schematic Design

Summary

The main goal for the new lighting design is to create an extension of the existing conservatory by creating an intimate and inviting courtyard. The initial goal based on the existing courtyard design was to give the courtyard a boundary by illuminating the surrounding walls and columns with uplighting. This is also intended to give the occupant a sense of security by eliminating shadows and dark areas in the space. Inground linear uplighting is used to accentuate the planters in the space. Additional uplighting was used to highlight the trees in the space.

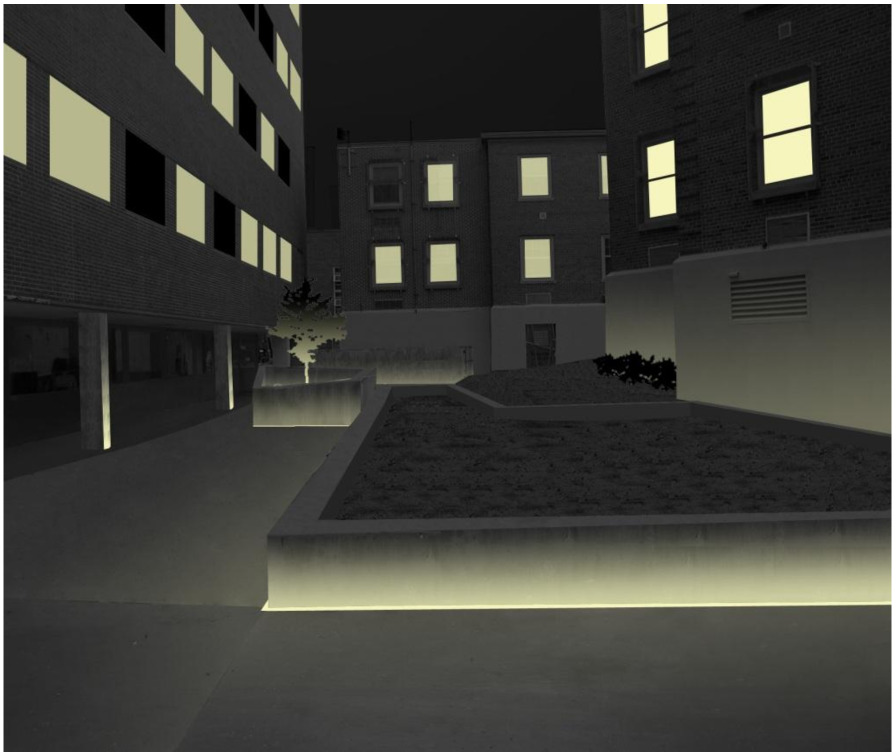


Figure 92: Schematic design for courtyard

Professional Comments from Lutron Presentation

Lee Brandt:

- Good to light edges in the courtyard

Luke Tigue

- In the courtyard, consider what is seen from the conservatory. Consider vertical brightness so that the courtyard can be seen through the glass at night.

Lighting Solution

Overview

Key concepts from the schematic design were carried over into the final design. Changes were made due to the redesign of the courtyard space for an architectural study and redesign of the space. Details of the architectural redesign can be found in the Architecture Breadth section of this report. Additionally, the space was considered as a backdrop for the conservatory as well as a space in itself. The main idea of creating boundaries was implemented through the use of direct indirect wall sconces on the north wall of the courtyard, while ingrade uplighting was used to graze the stone landscaping wall. LED downlights mounted in the brick hardscaping wall helps to define the shape of the space and accentuate the free flowing shape of the space. Ingrade uplighting was used to highlight the canopies of the main trees in the space. When illuminated, these trees serve as main focal points in the space. The tables, renderings, schedules, and lighting plans on the following pages convey the final design for this space.

Renderings

Figure 93: 3DS Max rendering of courtyard lighting design

Figure 94: 3DS Max rendering of courtyard lighting design

Figure 95: 3DS Max rendering of courtyard lighting design

Lighting Plan

See Appendix A for lighting plans, construction details, and control diagrams.

Luminaire Schedule

LUMINAIRE SCHEDULE

TAG	IMAGE	MANUFACTURER/CATALOG #	DECRIPTION	LAMP	VOLT	BALLAST / POWER SUPPLY	WATT	LOCATION
A		Lumiere / Boca 696-12WLEDN-120/12-BK	6-1/4" diameter adjustable inground LED fixture. LED module with 17° beam spread.	LED Module 3000K	12	Integral 12V transformer for connection to line voltage. Integral driver	12	Exterior, 9" offset from stone landscaping wall, column base
B		MP Lighting / L17-1W-W30S-12-1-W30S-1-S	Wallmount direct indirect LED fixture. LED module with standard CRI. 120° beam spread uplight, 12° beam spread downlight.	(2) 1 W LED 3000K	16	350mA integral driver for connection to 120V	2	Exterior between office windows on new addition. Mounted 5-1/2' A.F.F.
C		MP Lighting / L151-3-W30S-60-MA	Surface mount LED fixture. LED module with 60° beam spread with (3) LEDs with standard CRI. Remote 120V driver for connection to line voltage.	(3) 1 W LED 3000K	12	Advance 120V LED Driver LED-120A-0012V-50-F. Input 75W.	3	Exterior surface mount under landscaping wall lip Mounted 2'-4" A.F.F.
D		Allscape / SL33-20MH-T4-120-MFLD-F-GS	8.75" diameter inground metal halide. 20W warm white (3000K) T4 ceramic metal halide lamp.	(1) CDM-TC-20W/830-T4	120	Advance electronic ballast. RMH-G20-K. Input 24W, BF 0.9	24	Exterior, ingrade under trees

Table 54: Courtyard luminaire schedule

Control Scheme

Since the courtyard lighting is only necessary during night time hours, there is only one control scheme. Photosensors were considered for the space, however due to long shadows from the surrounding building and the trees throughout the space, it was determined that a digital timer switch was the most appropriate choice. The timer is designed to be programmed with a designated time to turn the luminaires on and off for each day of the year. These times should be set so that the luminaires turn on just before dusk and turn off shortly after dawn. More information on the controls is provided in the electrical design.

Performance

Performance was measured through calculations in AGI32 and 3D Studio Max. Material reflectance values were the same as those detailed in the Materials section. Performance was measured against IESNA and ASHRAE recommendations documented earlier. Light loss factors were also calculated for each luminaire in the space.

Luminaire Light Loss Factors for Courtyard								
Luminaire Designation	**Cleaning Interval**	**LDD Case**	**Initial Lumens**	**Design Lumens**	**LLD**	**LDD[a]**	**BF**	**Total LLF**
A	Dirty, 12 mo.	Y	5000	4600	0.80[c]	0.80	1.0	0.64
B	Mod., 12 mo.	X	NA	NA	0.80[c]	0.90	1.0	0.72
C	Dirty, 12 mo.	X	NA	NA	0.80[c]	0.80	1.0	0.64
D	Dirty, 12 mo.	Y	1650	1090	0.66	0.80	0.90	0.48

Table 55: Light loss factors for courtyard luminaires

[a] Luminaire dirt depreciation calculated using new method to be published in *IESNA Lighting Handbook* 10th ed.

[b] Room surface dirt depreciation calculated using Figure 9-19 in *IESNA Lighting Handbook* 9th ed., 2000, IESNA.

[c] Assumed LED lamp lumen depreciation.

Lighting Power Density for Courtyard			
Type	**Quantity**	**Watts / Luminaire**	**Total Watts**
A	40	12	480
B	12	2	24
C	11	75	825
D	5	24	120

Total Watts:	1449
Total Area (ft^2):	14000
LPD (W/ft^2):	0.1035
Allowable (W/ft^2):	1.0

Table 56: Lighting power density calculation

The lighting design meets ASHRAE and New York State power requirement of 1.0 W/SF with additional wattage available to be traded with other spaces. The main reason for the low lighting power density was the use of low wattage LED luminaires.

IESNA Illumination Recommendations for Courtyard		
Area	**Avg. Horizontal Illuminance**	
	Target	**Design**
General Lighting	0.5 fc	2 fc
Paths	1 fc	5 fc
Small focal points	1 fc	-
Emphasis	0.3 fc	-

Table 57: Comparison of designed and recommended illuminance values for courtyard

The courtyard serves primarily as a decorative space, and as a result some target illuminance values were difficult to meet or measure. The space was designed to be comfortable for the occupant, and although illuminance levels on the ground may not meet recommendations, the space will still feel safe due to peripheral lighting. An average illuminance value for the entire space was used to determine the general horizontal illuminance. The pseudo color renderings show some areas near the conservatory that are below the target illuminance. Under real conditions, the illuminance in this area would be higher due to reflected light from the uplit trees in the surrounding area. Additional illuminance would be added to the space from the lighting within the conservatory which would likely help the space meet the target illuminance. Illuminance levels are generally higher along the landscaping wall since this will likely serve as the main walking path and the space where most people will interact. It was not possible to attain illuminance values on trees, however with the accent lighting that was used it is reasonable to assume the trees and additional focal points are illuminated to a level which makes the object stand out in the space.

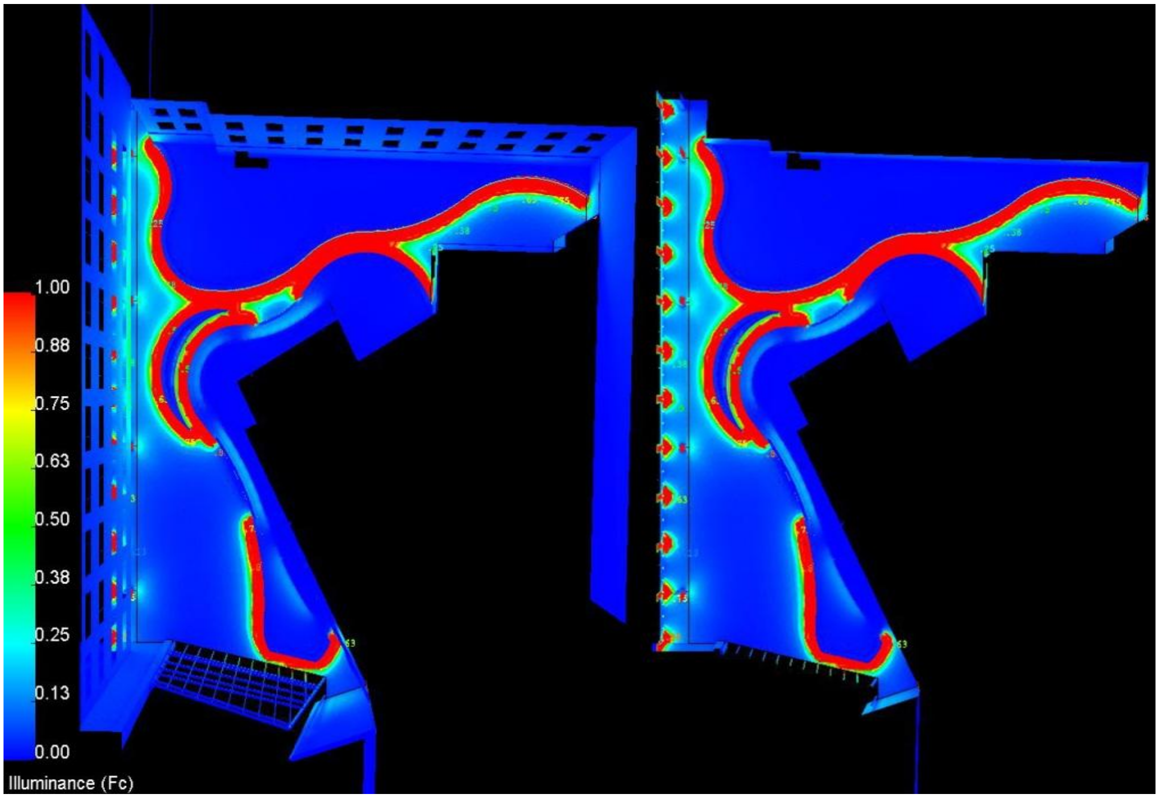


Figure 96: AGI32 pseudo color rendering of courtyard lighting design

The original design considerations for the space were also met using the following methods:

Summary of Considerations for Courtyard		
Considerations	**Recommended**	**Design**
Direct Glare	Minimize uplighting, use shields as necessary.	Mounting location was considered to eliminate any direct views of luminaires from patient rooms. Luminaires with shielding components were also specified.
Modeling of Faces	Avoid shadows, create a safe environment.	Peripheral lighting and reflected light from highlighted objects increases vertical illuminance in courtyard.
Shadows	Avoid shadows, dark areas.	Pathways are illuminated to target values. Shadowed areas are avoided to creating a welcoming space that encourages circulation.
Light Distribution	Carefully analyze distribution of luminaires.	Uniform spacing and proper mounting help the light distribution create patterns and rhythms of light.
Points of Interest	Lighting should enhance architecture and landscaping in space.	Lighting used to create pattern and enhance textures and materials in the space. Emphasis placed on landscaping wall and trees in the courtyard.
Daylighting Control	Automatic switching.	Time control used to automatically switch courtyard luminaires on and off at dusk and dawn.
Flicker	Avoid flicker and strobe effects.	Specified light sources with low potential for flicker and strobe effects.

Table 58: Summary of design considerations for courtyard

Summary

The lighting in the courtyard was designed to enhance the redesigned space and help the courtyard serve as an extension of the conservatory. The uniform placement of luminaires throughout the space helps to create rhythms and patterns that highlight architectural elements of the space as well as draw attention to landscaping in the area. Perimeter lighting helps to define the boundaries of the space while creating a safe and welcoming environment. This is also intended to give the occupant a sense of security by eliminating shadows and dark areas in the space. Inground linear uplighting is used to accentuate the planters in the space. Additional uplighting was used to highlight the trees in the space.

While ASHRAE allows for 2.3 W/SF in this space, the lighting design was achieved with only 0.10 W/SF. The substitution of the metal halide lighting in the original design with newer, lower wattage LEDs was a significant reason for the reduction in power density.

Since the courtyard serves primarily as a decorative space some target illuminance values were difficult to meet or measure. The space was designed to be comfortable for the occupant, and although illuminance levels on the ground may not meet recommendations, the space will still feel safe due to peripheral lighting. Under real conditions, the illuminance in this area would be higher due to reflected light from the uplit trees in the surrounding area. Additional illuminance would be added to the space from the lighting within the conservatory which would likely help the space meet the target illuminance.

M.A.E. Study | Biological Effects of Light

Overview

The area of study from graduate work in the M.A.E. program this is applied to this report is the biological effects of light on human health. Knowledge learned from AE 597C Color Science and AE 561 Light Sources was applied in the research of this topic and its implementation in the lighting design of the nurses’ station. Research on the biological effects of health was performed with the specific goal of researching methods in which light can be used to improve alertness and help adjust the circadian rhythms of night shift workers.

Nurses and doctors often work long hours without sleep or work on schedules that make a regular sleep cycle difficult. These working conditions can lead to a decrease in alertness and can lead to errors that could be potentially life threatening to patients and the workers themselves. A desired outcome of the research was to devise a lighting system that would increase worker productivity, increase worker alertness, and help adjust the circadian rhythms of night shift workers. Based on this research, it was determined that a ten to fifteen minute exposure of 20 – 50 fc of short wavelength radiation heavily saturated in the 480nm region would help improve alertness and adjust the circadian rhythms of night shift workers.

To achieve this lighting design, a custom fixture with royal blue and 4100K white LEDs was specified and is to be mounted just under the top shelf of the workstations, approximately 3.5’ above the floor and approximately 1’ above the work plane. The white LEDs have a lens which allows the light to illuminate the work plane while minimizing direct glare, while the blue LEDs have a 30° beam spread which allows for the recommended 20 – 50 fc of short wavelength to be delivered to a worker seated at a desk in the nurses’ station.

The research and studies on the biological effects of lighting completed as a part of this thesis relied heavily on knowledge and understanding gained through graduate coursework on the topic, and without this previous knowledge, this study would not have been possible. The following section includes a research paper on this topic and references can be found in the references section of this report.

Research Paper

Abstract

The lighting design of healthcare facilities presents a unique challenge. A lighting designer must create a lighting system for a wide variety of spaces ranging from lobbies and waiting areas to work stations and operating rooms. Each space has unique requirements, but the overall goal for each is to create a safe and comfortable environment.

The goal of this report is threefold: to investigate the impact of lighting design on circadian rhythms; to investigate current lighting methods, studies, and suggestions of ways in which circadian illumination can be incorporated into lighting designs; and how this information can be applied specifically to the lighting design of the nursing station for South Nassau Communities Hospital.

Introduction

The lighting design of nursing stations presents a unique challenge. In these areas, occupants must be able to perform a variety of critical tasks including reading, writing, monitoring, and other patient-related activities. The Illuminating Engineering Society of North America (IESNA) makes many recommendations with regard to the lighting of nursing stations, including illuminance levels, configuration and location of luminaires, and transition areas around the nursing station, all of which are commonly considered in effective lighting designs. A consideration that is becoming increasingly relevant and may be overlooked by designers is the biological effects of the lighting design on occupants. These effects should be carefully addressed and considered; however, this report focuses specifically on how artificial light affects night-shift nurses.

Night shift work is prone to error due to lapses in performance and alertness during shifts [1]. Not only is the medical worker at risk, but potential accidents could also put patients at risk. These risks are notably higher in the healthcare profession, where nurses and doctors often work on-call shifts [1]. The increased frequency of these shifts has been linked to higher risk of fatigue-related medical errors, preventable adverse events during the shift, and motor vehicle crashes during the commute home after a shift [1]. Night shift workers face personal health risks including loss of sleep, increased incidence of cardiovascular disease, gastrointestinal disturbance, cancer, reproductive dysfunction, decreased psychological well-being, and disrupted social and marital relationships [1,2,3]. It is not clear how much of a role artificial lighting plays in these risks as there are many factors that affect the night-shift work environment including stress, loss of sleep, diet, and genetic disposition [2,4]. However, artificial light has been shown to affect circadian rhythms, which have a major impact on our health and performance [1,2,3].

Circadian rhythms are daily rhythms that repeat approximately every 24 hours and are driven by an endogenous clock [5]. Nearly all behavioral and physiological parameters exhibit circadian rhythms and the efficient and appropriate functioning of our body is reliant upon circadian clock synchronization [5]. It is recognized that lighting is the primary stimulus for regulating these rhythms, which control the sleep-wake cycle, melatonin production, and single cell functions [4]. We have known that light incident on the retinas is converted to neural signals, which allow us to see. It was not until 2002 when David Berson discovered intrinsically photosensitive retinal ganglion cells (ipRGC) that we began to understand the important role ipRGCs play in synchronizing our circadian rhythms to the 24 hour solar day and natural light-dark cycle. Each day, the light-dark cycle resets the internal clock which then synchronizes the physiology and behavior controlled by the clock [3]. A phase shift can also occur in which our biological rhythms can be delayed or advanced relative the natural light-dark cycle. This is commonly experienced as jet-lag, and is common in night shift workers due to the disruption of the light-dark cycle and circadian rhythms.

The circadian system is designed to receive a daily light-dark cycle pattern from the retina. Time of day, or when light falls on the retina, is likely the most important dimension for the circadian system [4]. This cycle is typically synchronized with the 24 hour solar cycle, with daylight and the darkness of night providing the light-dark cycle. Electric light allows us to work outside of the solar cycle and may disrupt the 24 hour circadian pattern, but it may also provide opportunities to adjust circadian rhythms in a safe manner.

Dimensions of Light

To better understand how light affects circadian rhythms, it is important to look at ways of measuring light exposure such as quantity, spectrum, distribution, duration, and timing along with understanding the differences between the circadian and visual systems [4, 5].

Our visual system can process information over a wide range of luminances, allowing us to see in environments ranging from low illuminance levels such as dark outdoor nights to bright illuminance levels such as those experienced during the day. It is believed that the high threshold of the circadian system for both quantity and duration of light provides insurance against confusion between prolonged daylight and weak nighttime lighting from flashes of light [4]. Despite this high threshold, the circadian system is designed to receive a clear, unambiguous daily light-dark cycle from the retina, which is usually delivered via daylight [4]. The effect of the quantity of light required differs amongst studies, however an acceptable recommendation based on studies performed with a 4100K fluorescent source suggests 20 – 50 fc on the eye is enough to affect the circadian system [14]. The effect of the quantity of light is also largely dependent on the spectrum of the light source and other factors, such as sleep-wake cycles [2,5].

A major difference between our circadian and visual systems is their sensitivity to wavelength. For luminances typically higher than 0.3 cd/ft^2, our visual system is dominated by cone receptors. At these light levels our eyes are most sensitive to light emitted at 555 nm. At scotopic light levels (typically below 0.0001 cd/ft^2), our vision is dominated by rod receptors and our sensitivity peaks at 507 nm. The area between these two functions is considered mesopic vision where both rods and cone contribute. The peak sensitivity of circadian systems is believed to be shifted even more.

Studies have shown that the circadian pacemaker, melatonin production, and improving alertness are sensitive to short-wavelength (blue) visible light [3,5,7,12]. Additionally, exposure to monochromatic light at 460 nm induces a phase delay twice as long as exposure to monochromatic light at 555 nm for the same duration. This information shows not only that the circadian systems are more sensitive to shorter wavelengths, but also that it is not appropriate to use illuminance to characterize optical radiation for the circadian system [3,5,7]. Circadian photoreception sensitivity is believed to peak at about 480 nm, however additional studies have shown that this peak sensitivity may be higher [5].

Timing is also an issue when evaluating the two systems. It is known that visual sensitivity, and therefore the visual discrimination threshold, changes over a 24 hour day-night cycle. The sensitivity is low in the morning and increases gradually throughout the day. Similarly, at night thresholds are low at the beginning of night and high when night ends. Despite these changes, the visual system is sensitive to light at any time of day [5]. The circadian system is extremely sensitive to the timing of light exposure, and the time of day (or when light falls on the retina) is believed to be the most important dimension for the circadian system [4]. Exposure at one time of day can shift the circadian pacemaker timing earlier (meaning a person will go to bed earlier and wake earlier) while exposure at another time can shift the pacemaker timing later (meaning a person will go to bed later and rise later the following day) [4,5]. Optical radiation exposure has a maximum effect in shifting the pacemaker when it occurs during the biological night and is less effective during the day [5]. Exposure to light at night also has an alerting effect [4]. Based on these biological responses, it should be possible to use light in a work environment, such as a nursing station, to increase alertness, and to phase delay occupants' biological clocks to help them adjust to the schedules of night-shift work.

Both the visual system and circadian systems respond to the duration of exposure to optical radiation; however, the circadian system is more notably affected in that the phase shifting effects of optical radiation are particularly dependent upon the duration of this exposure [5]. Data suggests that intermittent exposure induces a greater phase shift than continuous exposure [5, 13]. Studies have also shown that the degree of phase shift increases exponentially with the duration of exposure to optical radiation and the first half of the exposure induces a disproportional higher effect than the latter half [5].

The spatial distribution of light is an important, if not the most important, dimension of light to our visual system. The processing of visual information depends heavily on the precise registration of spatial information [5]. Contrary to the visual system, the circadian system relies little on spatial distribution. However, it has been shown that optical radiation from the upper visual field which falls on the lower part of the retina suppresses melatonin more effectively than the same amount of radiation coming from below the horizon and stimulating the upper part of the retina [5]. Other studies have shown that exposing light to the nasal portion of the retina suppresses more melatonin than exposing light to the temporal portion of the retina [5,8,9].

These five dimensions of light should be considered when designing for both visual and circadian systems. In order to be of benefit to night-shift workers in nursing stations, these five dimensions need to be carefully considered. Studies have shown that the quantity of light is not as important as the spectrum and timing of light for affecting circadian rhythms. With the proper combination of both short-wavelength light and appropriate timing and duration of exposure, lighting can be used in an architectural setting to improve performance and enhance alertness of night-shift workers.

Measurement

A difficulty with designing architectural lighting for circadian systems is a lack of measurement. Direct measurement is commonly given as photon density or irradiance determined as function of wavelength. For a light source with a narrow spectral bandwidth, the total flux per unit area is an acceptable method to quantify the optical radiation stimulus, however when the optical radiation stimulus has an increased spectral bandwidth, as is the case with most electric light sources, this is not an adequate measure and necessitates a different method of measurement [5]. A characterization of wider bandwidth optical radiation can be achieved by weighing the spectral values in a way similar to the weighting functions used to produce the V(λ) and V'(λ) functions which define the visual responses of cones and rods respectively. This would result in the suggested C(λ) function [3].

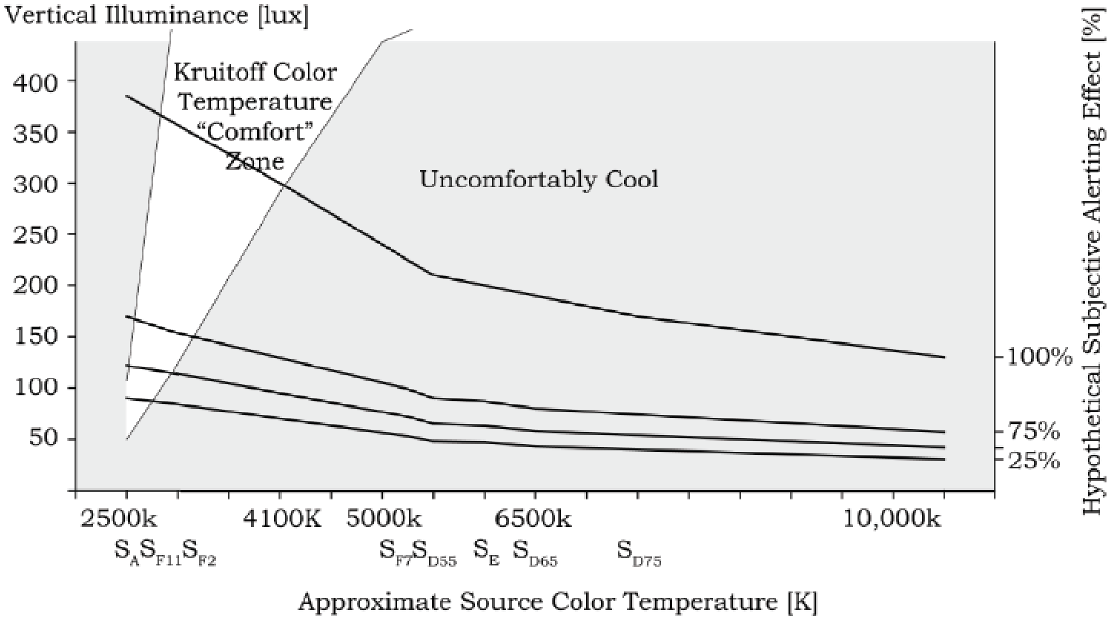


Figure 97: Comparison of Alertness Benefit from Illuminants by Color Temperature [3]

Perchacek et. al. have suggested using the C(λ) function to calculate circadian efficacy to better measure the impact of light sources on circadian rhythms [3]. To compare light sources, the circadian efficacies of light sources with known spectra are compared. Since spectral information is not readily available or easy to obtain, the standard CIE illuminants were used to make general conclusions that apply to commercially available lamps with similar characteristics [3]. This data was used to create the graph used in Figure 97, which gives a target illumination to achieve a hypothetical alerting effect. The figure shows that light sources with higher CCT (as a result of a larger emittance of shorter wavelengths) require less vertical illuminance to achieve an alerting effect. This is consistent with studies that have proven that short wavelength energy has a greater effect on the circadian system than long wavelength energy [3,4,5].

Applications

As mentioned previously, the limit to designing architectural lighting for circadian systems is a lack of measurement. Although experimental, the method proposed by Perchacek et. al. does have merit and could be used to provide a good indication of the source and vertical illuminance required to design for circadian systems. Perchacek et. al. determined that when designing to IESNA recommendations for a patient room in a healthcare facility, the vertical illuminance did not meet the circadian illumination goal determined by Figure 97 [3]. It was also determined that sources of artificial illumination were not suitable for circadian illumination because they do not correspond to social or environmental circadian organization in the way that natural light does. Given that most patient rooms will have exposure to natural lighting, which is better at stimulating circadian rhythms than artificial light, this conclusion is valid. However, in areas such as nursing stations, where natural light is not available, and where occupants work night shifts, architectural lighting could be used to stimulate circadian rhythms during working hours.

The goal of the lighting design is to increase alertness of night-shift nurses and to synchronize circadian rhythms of nurses with their night-shift schedules. It should be noted that with no definitive guidelines, the results of each study provided different outcomes. The timing, duration, spectrum, and quantity of light exposure varied, however the following guidelines are believed to be an acceptable basis for designing lighting systems for circadian systems.

Figure 97 will be used to provide a general guideline for the quantity of illuminance needed for a given light source. As mentioned earlier, circadian phase shifting and alerting effects are most sensitive to short wavelength radiation. A possible solution would be to use sources with narrow band-width blue light, such as blue LEDs, but this application may be difficult in an architectural application. Broad emitting sources with high concentrations of short wavelengths, such as linear fluorescents or LEDs with high output and high CCTs, may be more appropriate.

Based on research described earlier, the maximum effect on the circadian system will be achieved if optical radiation falls on the lower part of the retina. As a result, the designer should consider the location of luminaires. The design for the nursing stations may incorporate luminaires built into the workstation and desks, which would provide eye level illumination when nurses are seated at their stations.

The duration and timing of light exposure is also important. Studies have shown that the circadian clocks of night workers can be phase shifted for complete adaptation to night work. However, since night-shift nurses often work on rotating schedules with days off, a complete phase shift would leave workers out of phase on days off, an undesirable side effect. Yet it is possible to achieve compromised phase shift in which the sleepiest circadian time occurs outside of night shift schedule but falls within an acceptable time during days off [10,11]. Exposure should also be intermittent as opposed to continuous to achieve the maximum effect. A possible solution is to have the light sources located within the workstations described above to gradually increase output to a point that will achieve the desired illuminance from Figure 97. Once at this level, the luminaire will maintain output for a determined amount of time, hypothetically 10 to 15 minutes, before decreasing output. This would result in intermittent exposure for 10 to 15 minutes every hour.

In addition to meeting design goals for circadian systems, it is also important that the lighting design meets IESNA recommendations for illuminance levels and power density requirements. The luminaires used to stimulate the circadian system could be completely independent and able to be turned off when not in use. In the scenario described above, the luminaires located within the workstation could also be used as task lighting, helping to meet required illuminance values and keep power densities low.

Conclusion

The goal of this research was to explore the effects of artificial lighting on human circadian rhythms and behavior while exploring ways in which circadian illumination can be applied to architectural lighting to improving alertness in and to help adjust the circadian rhythms of night shift workers. It is clear from the research that lighting does have a significant effect on our circadian, neuroendocrine, and neurobehavioral systems. It is also clear that our circadian systems react differently than out visual systems to light exposure. The spectrum, timing, and duration of the radiation greatly affect the circadian system. While the quantity of illumination is believed to have some effect, it is dependent on adaptation and also the spectrum of the source. It has been demonstrated that using illuminance to characterize the optical radiation involved with melatonin suppression and circadian phase shifting is inappropriate. This necessitates the need for a different metric to incorporate all aspects of optical radiation stimuli including timing, duration, quantity, wavelength, pattern, and history. Preliminary models have been developed, but they do not incorporate all aspects of radiation. Although the recommendations in this paper are based on conclusions that are likely to change as more knowledge of the subject is gained, they are based on current studies and serve as an effective start for the application of circadian illumination in architectural lighting.

References

See references section of report.

Electrical Design | Overview

Overview

The four spaces included within the scope of the lighting redesign include the nursing station, auditorium, lobby, and courtyard. The existing design for the nurses' station includes indirect fluorescent lighting, which will be replaced with a combination of fluorescent wall washers and LED downlighting. The existing incandescent sources in the auditorium were replaced with LED downlighting and decorative LED lighting on the perimeter of the room. The redesign lobby replaces linear fluorescent sources with large amounts of LEDs in wall slot and cove applications with additional compact fluorescent lighting used to meet horizontal illuminance recommendations. There is currently no lighting design for the courtyard, but a mix of LED and ceramic metal halide sources will be used to achieve the desired lighting design for the space.

To accommodate the new lighting design, branch circuits have been added and or redesigned. Changes to the panelboard layout and feeder sizes are documented in the following section of this report. Control systems modifications are also documented. Table 59 below indicates the lighting panels that are affected by the new lighting design in each space.

PANELBOARDS						
PANEL TAG	VOLTAGE	SYSTEM	NURSES STATION	AUDITORIUM	LOBBY	COURTYARD
GLNH1	480Y/277V, 3P, 4W	N			X	X
GLNL2	208Y/120V, 3P, 4W	N				X
GLSH1	480Y/277V, 3P, 4W	N/E			X	
1LNH1	480Y/277V, 3P, 4W	N			X	
1LSH1	480Y/277V, 3P, 4W	N/E			X	
GLNL3	208Y/120V, 3P, 4W	N		X		
1LSL1	208Y/120V, 3P, 4W	N/E		X		
2LNH1	480Y/277V, 3P, 4W	N	X			
2LCH1	480Y/277V, 3P, 4W	N/E	X			
2LNL2	208Y/120V, 3P, 4W	N	X			

Table 59: Panels affected by lighting design

In addition to the panel redesign, a protective device coordination study addressing a single path through the distribution system was performed. The path extends from the utility entrance through the main switchboard to panel 4LNL1. A short circuit calculation is also included.

Two electrical depth studies were also performed. The first depth topic was to design a motor control panel for the motors added to the power plant as a part of the North Addition expansion. The second depth topic was to compare the first costs of increasing feeder sizes to the energy saved as a result of the lower resistance from the increase feeder size. Both depth topics are presented within this report.

Electrical Design | Four Lighting Spaces

Description

Nursing Station

Located throughout the hospital, the nursing stations are the center of activity for the surrounding area. The existing lighting was composed of indirect fluorescent pendants. The new lighting eliminated the pendants and replaced them with LED downlights. Fluorescent lighting was used in a wall slot application to peripheral illuminance. LED task lighting was also specified at the work stations. These luminaires function both as a task light and as a way to deliver optical radiation to the occupants working at the desk. This is achieved with a custom fixture composed of white and blue LEDs with custom optics. Lighting and electrical plans are located in Appendix A.

Auditorium

The auditorium functions as a special purpose space, and the original lighting design reflected this. Linear fluorescent lighting was used to provide illuminance in a conference setting, while incandescent lighting was used presumably for social and presentation settings. The high wattage incandescent sources were swapped with recessed LED downlighting in the new design. Additional downlights were provided, which allowed the linear fluorescent lighting to also be eliminated. To add visual interest to the space, linear LED strips were placed in a wall slot around the ceiling. Lighting and electrical plans are located in Appendix A.

Main Lobby

The lobby serves as a transition and circulation space between the elevator lobby, conservatory, and auditorium. The primary existing lighting in this space was T5HO linear fluorescents. Metal halide sources were used in some areas to accentuate the architecture. Compact fluorescent fixtures were also used throughout the space for cove lighting. The new lighting design eliminated the linear fluorescent downlights and replaced them with low voltage LED cove lighting and compact fluorescent downlights above the main circulation area. Metal halide downlights were used at the reception desk and to highlight the stone wall adjacent to the entrance. LED fixtures were also be used in slot lighting applications along the walls. Lighting and electrical plans are located in Appendix A.

Courtyard

The courtyard was redesigned to serve as an extension of the conservatory. The existing lighting in the space consisted only of metal halide downlights under the overhang adjacent to the offices facing the courtyard. The new lighting design incorporates landscaping lighting to accent the perimeter, provide adequate pathway illumination, and highlight trees throughout the space. The primary light sources used in the space were low wattage LEDs, with metal halide sources used for uplighting trees. Lighting and electrical plans are located in Appendix A.

Control Scheme

Nursing Station

The lighting in the nurses' station is controlled primarily through switching located in the adjacent break room. Luminaire type NB is controlled separately from luminaire type NA via two switches in the break room. Luminaire type NC is controlled with a Color Kinetics Light System Manager. The light system manager allows the circadian lighting system (the blue light component of luminaire NC) to be programmed to turn on and off and preset times. The system also allows for fine tuning of the circadian lighting system, allowing the blue LEDs to be dimmed to different levels based on the desired level of optical radiation at eye level. The Light System Manager also allows the task lighting component of Luminaire type NC to be controlled independently of the circadian lighting system. Each workstation can have up to four programmed scenes for task lighting, allowing for a total of eight task lighting scenes per desk. These scenes include one scene with the maximum output for the task lighting and three scenes that deliver lower illuminance levels on the work plane. These scenes are to be programmed into the light system manager and will be controlled through a keypad placed at each desk.

Auditorium

A main goal for the control system in the auditorium is to provide flexible lighting to accommodate the wide range of functions that can occur in the space. A Lutron Grafik Eye system with up to 16 programmable scenes was used to create flexibility in the space. There are three preset scenes for each of the three divided spaces, and three preset scenes for the space as a whole. The meeting scene allows for high light levels required in conference settings while the assembly scene allows for presentations with higher illuminance levels on the stage area and lower levels in the seating area. The third scene is intended for social settings, with low illuminance levels in the main event area and higher illuminance levels on the walls surrounding the space. Table 60 describes the control zones and scenes for the full space in more detail. The three divided spaces would be controlled with similar scene settings. Additional information on the control system and equipment can be found in the electrical portion and the appendices of the report.

Lobby

The lighting controls for the lobby involve simple switching. Digital control systems were considered, but were not pursued since scene lighting will not be needed in the lobby. The controls for both the ground and first floor of the lobby space are located behind the main reception desk on the ground floor. There are four sets of switches. The first set contains a switch for the slot mounted LED fixtures behind the desk (luminaire type LD, switch z) and a switch for luminaire the metal halide downlights above the desk (luminaire type LG, switch v). The second set of switches contains a switch for the slot mounted LEDs along the wall in the lobby and a switch for the slot fixtures in the elevator lobby on the ground floor (luminaire type LD, switches y and x respectively). The third switch controls the cove lighting and downlighting in the lobby (luminaire type LE and LB, switch w).

A third set of switches controls the slot mounted LEDs and compact fluorescent downlights in the first floor elevator lobby (luminaire type LD, switch d and luminaire type LB, switch g). The final set of switches controls the remaining luminaires in the lobby. The LED cove lighting (luminaire LE, switch m), compact fluorescent downlights (luminaire LA, switch h), LED slot lighting along the auditorium wall (luminaire LD, switch b), and the pendants above the reading area (luminaire LC, switch f) are each switched separately from behind the reception desk. Additionally, the ingrade metal halide sources and slot lighting located along the glazing are controlled by a ceiling mounted photosensor calibrated to turn these luminaires on during evening hours, or when the daylight level fall below a certain value.

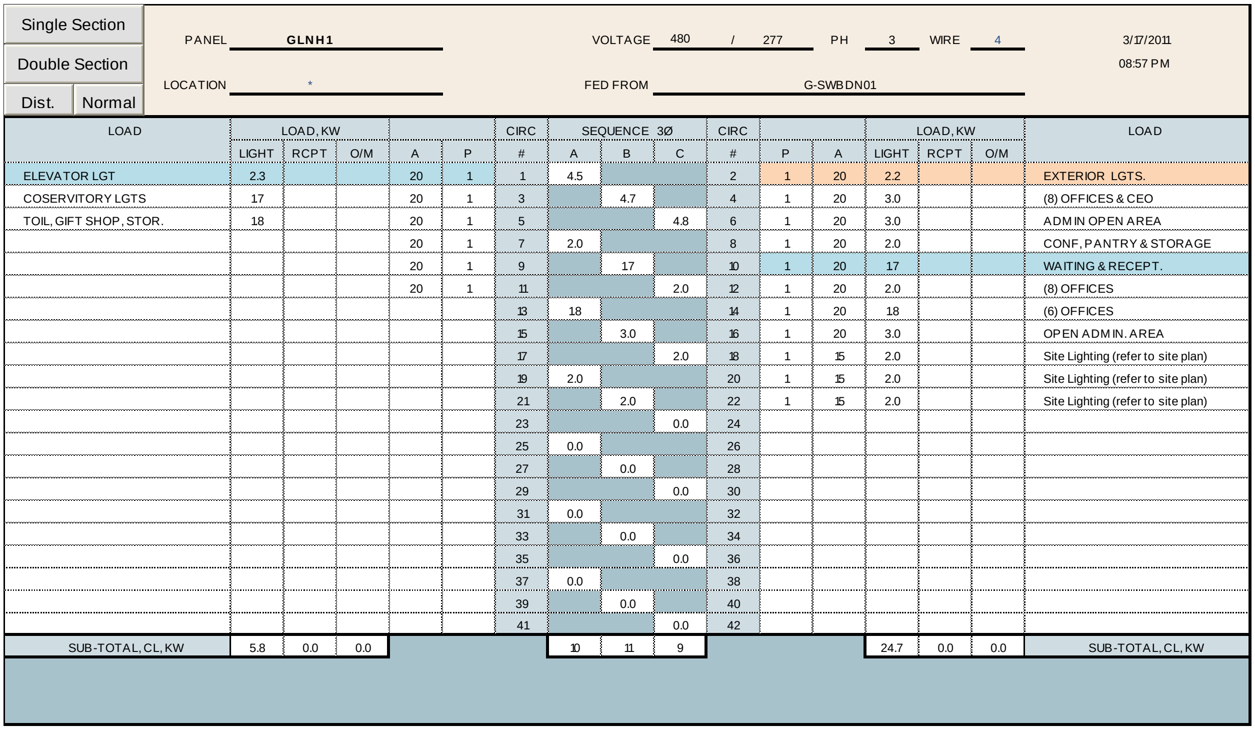
Auditorium Lighting Scene Settings			
	Scene 1	**Scene 2**	**Scene 3**
Label	Meeting	Assembly	Social
Description	General lighting levels for conferences	Lecture mode with emphasis on stage area	Low illuminance levels ideal for entertaining
Control Zone	**Dimming Level (% of Full Output)**		
a	100	100	15
b	100	100	15
c	100	30	15
d	75	25	25
g	100	30	15
h	75	25	25
r	100	30	15
s	100	30	15
t	0	0	0
u	75	25	25

Table 60: Auditorium lighting scene settings

Courtyard

Since the courtyard lighting is only necessary during night time hours, there is only one control scheme. Photosensors were considered for the space, however due to long shadows from the surrounding building and the trees throughout the space, it was determined that a digital timer switch was the most appropriate choice. The timer is designed to be programmed with a designated time to turn the luminaires on and off for each day of the year. These times should be set so that the luminaires turn on just before dusk and turn off shortly after dawn. The timer used is a Tork DG120 Digital Timer Switch. All of the lighting in the courtyard is on one circuit of panelboard GLNL2, and passes through the Tork time switch before enter the panelboard. The time switch is to be mounted on the wall below panelboard GLNL2 in electrical closet GB13, located on the ground floor.

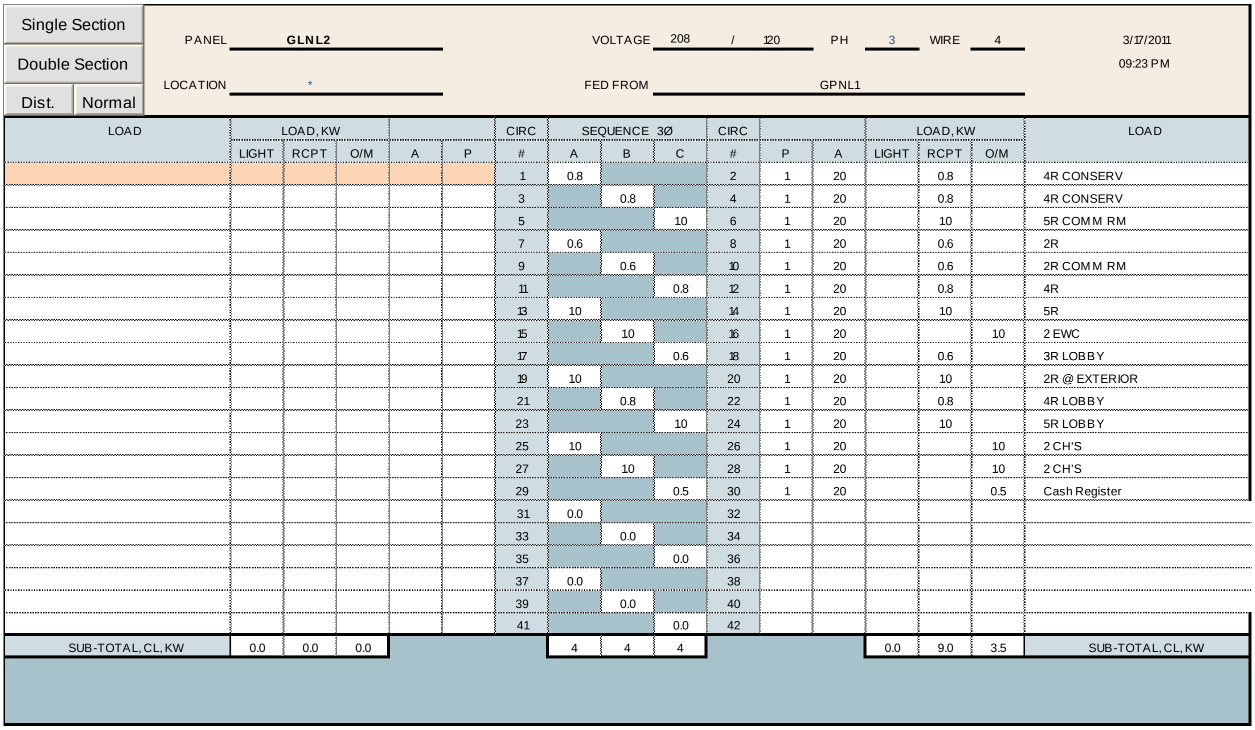
Existing Panelboards



PANEL GLNH1
VOLTAGE 480 / 277 PH 3 WIRE 4
3/17/2011
08:57 PM
LOCATION *
FED FROM G-SWBDN01

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
ELEVATOR LGT	2.3			20	1	1	4.5			2	1	20	2.2			EXTERIOR LGTS.
COSERVITORY LGTS	17			20	1	3		4.7		4	1	20	3.0			(8) OFFICES & CEO
TOIL, GIFT SHOP, STOR.	18			20	1	5			4.8	6	1	20	3.0			ADMIN OPEN AREA
				20	1	7	2.0			8	1	20	2.0			CONF, PANTRY & STORAGE
				20	1	9		17		10	1	20	17			WAITING & RECEPT.
				20	1	11			2.0	12	1	20	2.0			(8) OFFICES
						13	18			14	1	20	18			(6) OFFICES
						15		3.0		16	1	20	3.0			OPEN ADMIN. AREA
						17			2.0	18	1	15	2.0			Site Lighting (refer to site plan)
						19	2.0			20	1	15	2.0			Site Lighting (refer to site plan)
						21		2.0		22	1	15	2.0			Site Lighting (refer to site plan)
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	5.8	0.0	0.0				10	11	9				24.7	0.0	0.0	SUB-TOTAL, CL, KW

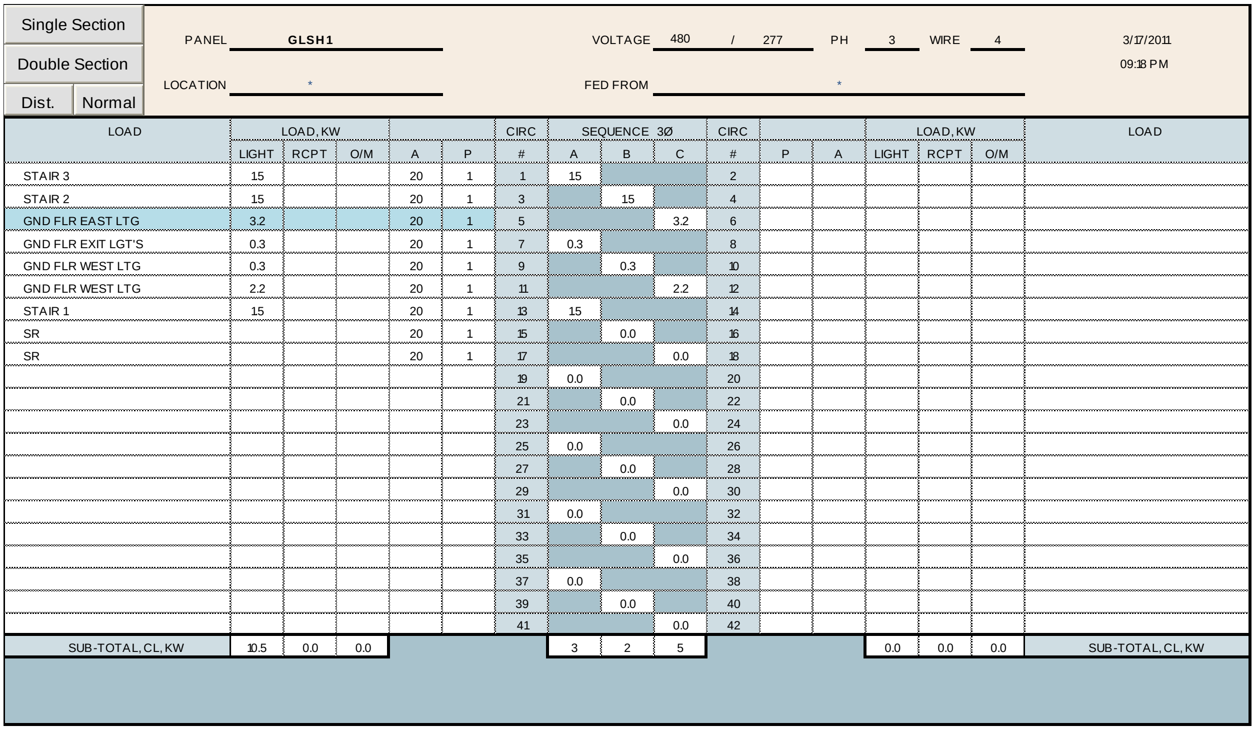
Figure 98: Existing panelboard GLNH1



PANEL GLNL2
VOLTAGE 208 / 120 PH 3 WIRE 4
3/17/2011
09:23 PM
LOCATION *
FED FROM GPNL1

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
						1	0.8			2	1	20		0.8		4R CONSERV
						3		0.8		4	1	20		0.8		4R CONSERV
						5			10	6	1	20		10		5R COMM RM
						7	0.6			8	1	20		0.6		2R
						9		0.6		10	1	20		0.6		2R COMM RM
						11			0.8	12	1	20		0.8		4R
						13	10			14	1	20		10		5R
						15		10		16	1	20			10	2 EWC
						17			0.6	18	1	20		0.6		3R LOBBY
						19	10			20	1	20		10		2R @ EXTERIOR
						21		0.8		22	1	20		0.8		4R LOBBY
						23			10	24	1	20		10		5R LOBBY
						25	10			26	1	20			10	2 CH'S
						27		10		28	1	20			10	2 CH'S
						29			0.5	30	1	20			0.5	Cash Register
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	0.0	0.0	0.0				4	4	4				0.0	9.0	3.5	SUB-TOTAL, CL, KW

Figure 99: Existing panelboard GLNL2

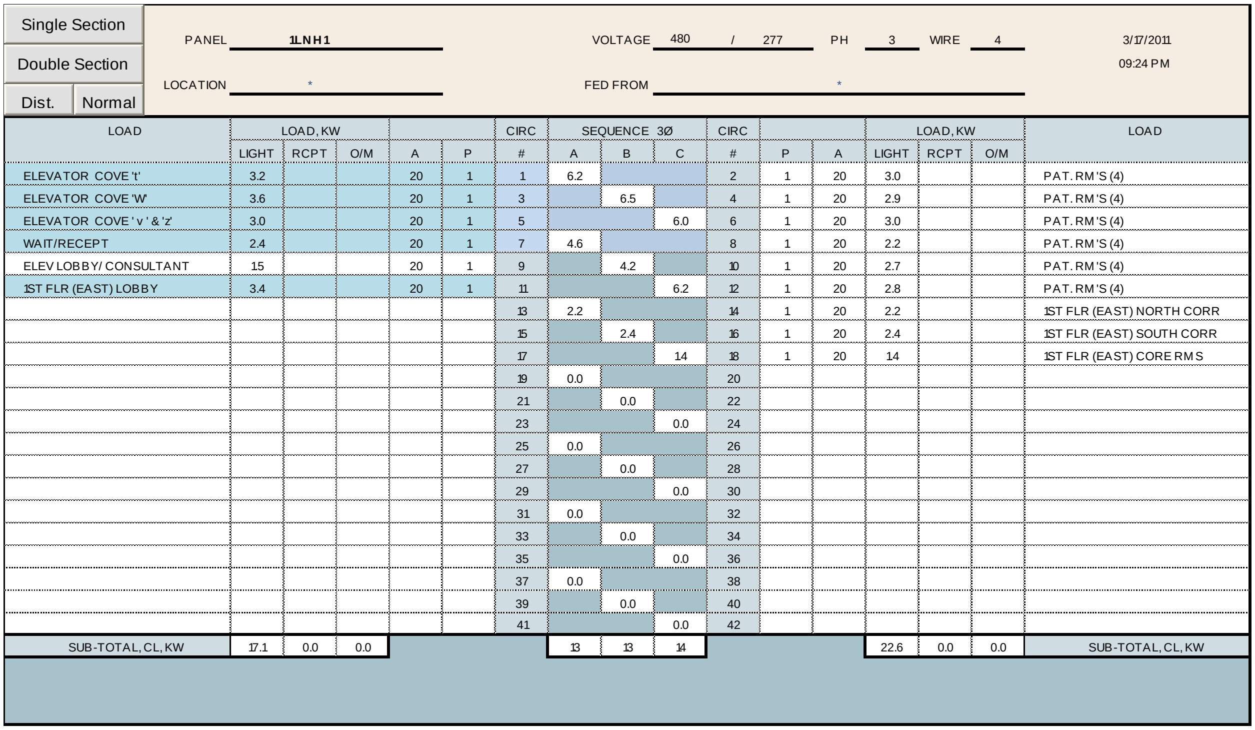


Single Section
Double Section
Dist. Normal

PANEL GLSH1 VOLTAGE 480 / 277 PH 3 WIRE 4 3/17/2011
09:18 PM
LOCATION * FED FROM *

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
STAIR 3	15			20	1	1	15			2						
STAIR 2	15			20	1	3		15		4						
GND FLR EAST LTG	3.2			20	1	5			3.2	6						
GND FLR EXIT LGT'S	0.3			20	1	7	0.3			8						
GND FLR WEST LTG	0.3			20	1	9		0.3		10						
GND FLR WEST LTG	2.2			20	1	11			2.2	12						
STAIR 1	15			20	1	13	15			14						
SR				20	1	15		0.0		16						
SR				20	1	17			0.0	18						
						19	0.0			20						
						21		0.0		22						
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	10.5	0.0	0.0				3	2	5				0.0	0.0	0.0	SUB-TOTAL, CL, KW

Figure 100: Existing panelboard GLSH1

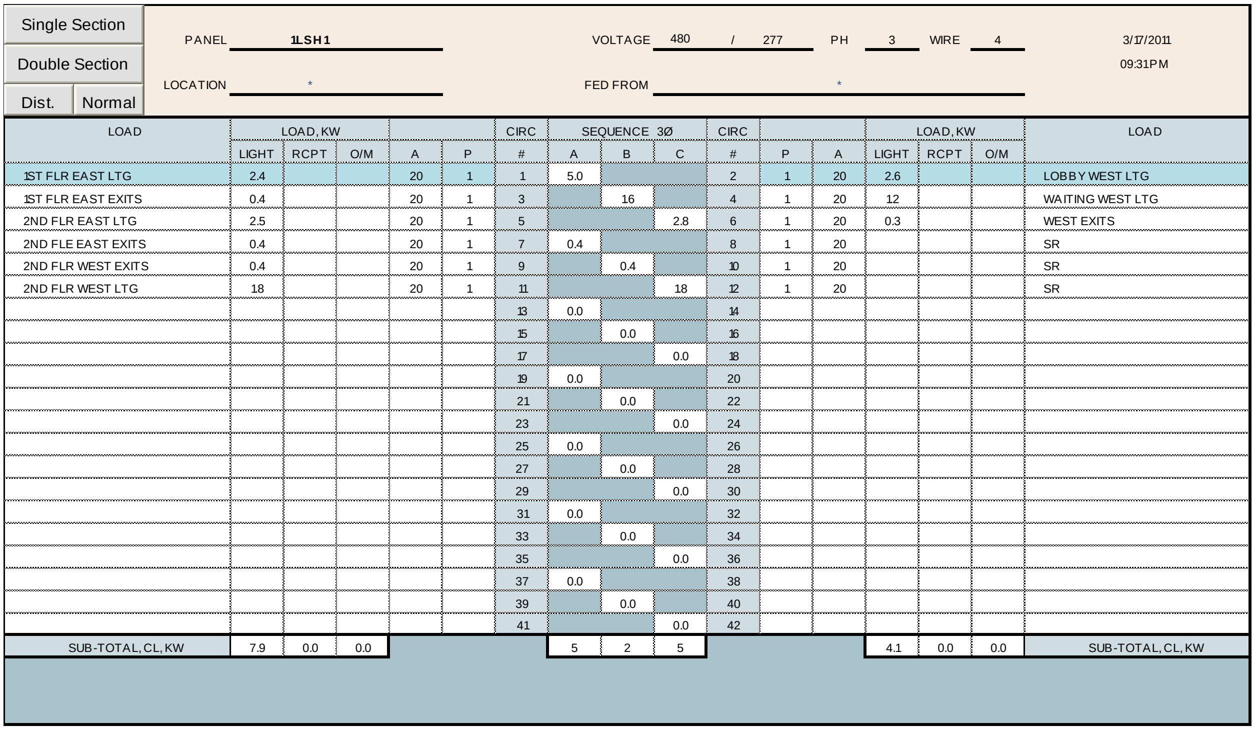


Single Section
Double Section
Dist. Normal

PANEL 1LNH1 VOLTAGE 480 / 277 PH 3 WIRE 4 3/17/2011
09:24 PM
LOCATION * FED FROM *

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
ELEVATOR COVE 't'	3.2			20	1	1	6.2			2	1	20	3.0			PAT. RM'S (4)
ELEVATOR COVE 'W'	3.6			20	1	3		6.5		4	1	20	2.9			PAT. RM'S (4)
ELEVATOR COVE ' v ' & 'z'	3.0			20	1	5			6.0	6	1	20	3.0			PAT. RM'S (4)
WAIT/RECEPT	2.4			20	1	7	4.6			8	1	20	2.2			PAT. RM'S (4)
ELEV LOBBY/ CONSULTANT	15			20	1	9		4.2		10	1	20	2.7			PAT. RM'S (4)
1ST FLR (EAST) LOBBY	3.4			20	1	11			6.2	12	1	20	2.8			PAT. RM'S (4)
						13	2.2			14	1	20	2.2			1ST FLR (EAST) NORTH CORR
						15		2.4		16	1	20	2.4			1ST FLR (EAST) SOUTH CORR
						17			14	18	1	20	14			1ST FLR (EAST) CORE RMS
						19	0.0			20						
						21		0.0		22						
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	17.1	0.0	0.0				13	13	14				22.6	0.0	0.0	SUB-TOTAL, CL, KW

Figure 101: Existing panelboard 1LNH1

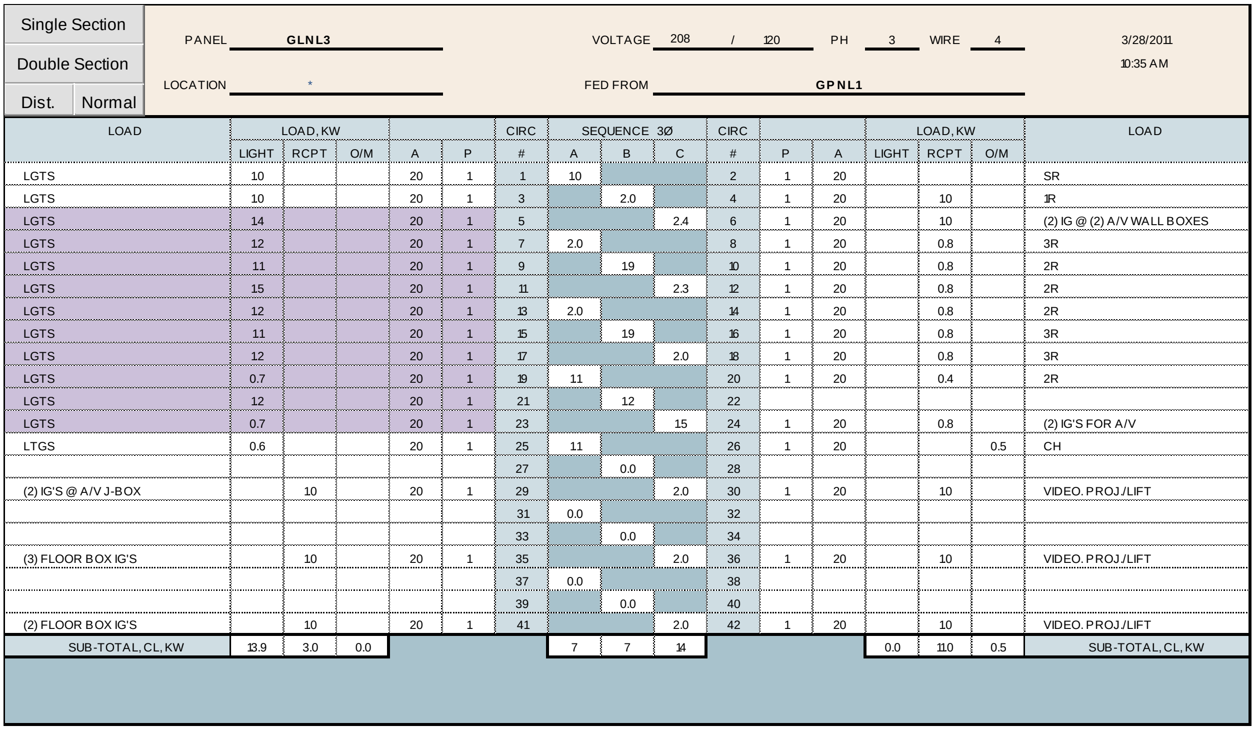


Single Section
Double Section
Dist. Normal

PANEL **1LSH1**
VOLTAGE 480 / 277 PH 3 WIRE 4
3/17/2011
09:31PM
LOCATION *
FED FROM *

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
1ST FLR EAST LTG	2.4			20	1	1	5.0			2	1	20	2.6			LOBBY WEST LTG
1ST FLR EAST EXITS	0.4			20	1	3		16		4	1	20	12			WAITING WEST LTG
2ND FLR EAST LTG	2.5			20	1	5			2.8	6	1	20	0.3			WEST EXITS
2ND FLE EAST EXITS	0.4			20	1	7	0.4			8	1	20				SR
2ND FLR WEST EXITS	0.4			20	1	9		0.4		10	1	20				SR
2ND FLR WEST LTG	18			20	1	11			18	12	1	20				SR
						13	0.0			14						
						15		0.0		16						
						17			0.0	18						
						19	0.0			20						
						21		0.0		22						
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	7.9	0.0	0.0				5	2	5				4.1	0.0	0.0	SUB-TOTAL, CL, KW

Figure 102: Existing panelboard 1LSH1

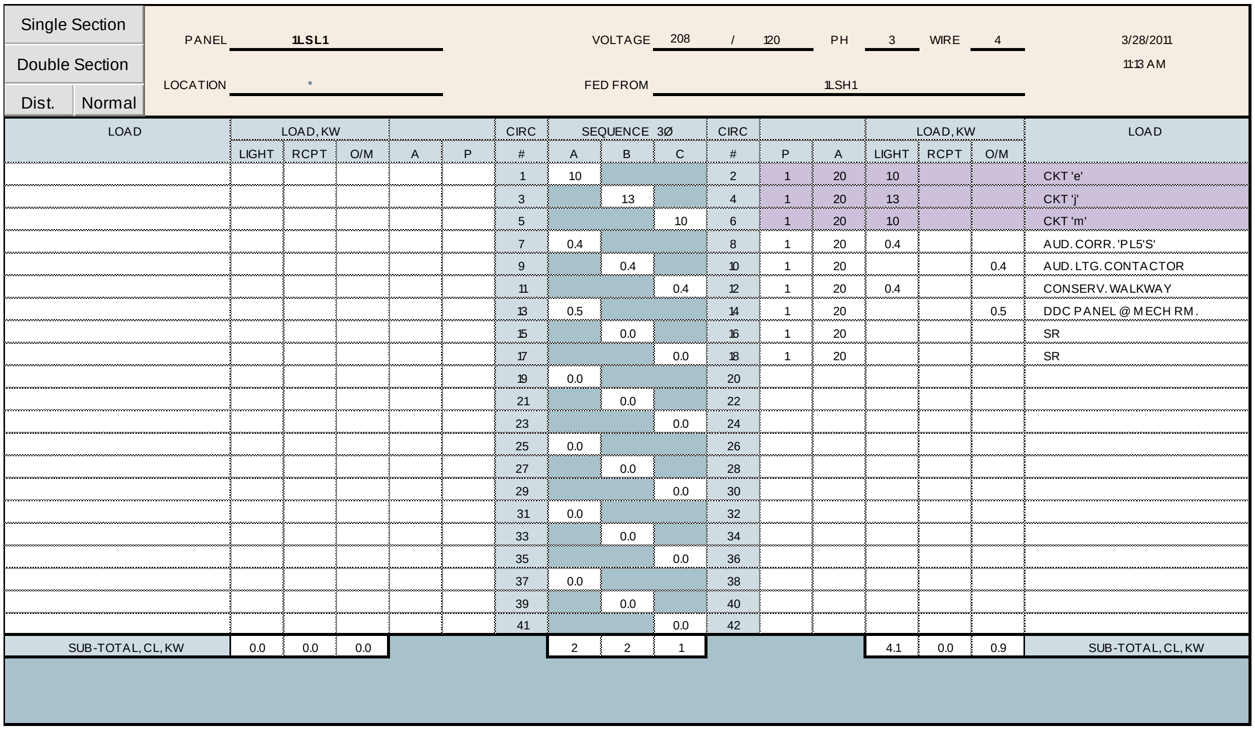


Single Section
Double Section
Dist. Normal

PANEL **GLNL3**
VOLTAGE 208 / 120 PH 3 WIRE 4
3/28/2011
10:35 AM
LOCATION *
FED FROM **GPNL1**

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
LGTS	10			20	1	1	10			2	1	20				SR
LGTS	10			20	1	3		2.0		4	1	20		10		1R
LGTS	14			20	1	5			2.4	6	1	20		10		(2) IG @ (2) A/V WALL BOXES
LGTS	12			20	1	7	2.0			8	1	20		0.8		3R
LGTS	11			20	1	9		19		10	1	20		0.8		2R
LGTS	15			20	1	11			2.3	12	1	20		0.8		2R
LGTS	12			20	1	13	2.0			14	1	20		0.8		2R
LGTS	11			20	1	15		19		16	1	20		0.8		3R
LGTS	12			20	1	17			2.0	18	1	20		0.8		3R
LGTS	0.7			20	1	19	11			20	1	20		0.4		2R
LGTS	12			20	1	21		12		22						
LGTS	0.7			20	1	23			15	24	1	20		0.8		(2) IG'S FOR A/V
LTGS	0.6			20	1	25	11			26	1	20			0.5	CH
						27		0.0		28						
(2) IG'S @ A/V J-BOX		10		20	1	29			2.0	30	1	20		10		VIDEO. PROJ./LIFT
						31	0.0			32						
						33		0.0		34						
(3) FLOOR BOX IG'S		10		20	1	35			2.0	36	1	20		10		VIDEO. PROJ./LIFT
						37	0.0			38						
						39		0.0		40						
(2) FLOOR BOX IG'S		10		20	1	41			2.0	42	1	20		10		VIDEO. PROJ./LIFT
SUB-TOTAL, CL, KW	13.9	3.0	0.0				7	7	14				0.0	11.0	0.5	SUB-TOTAL, CL, KW

Figure 103: Existing panelboard GLNL3

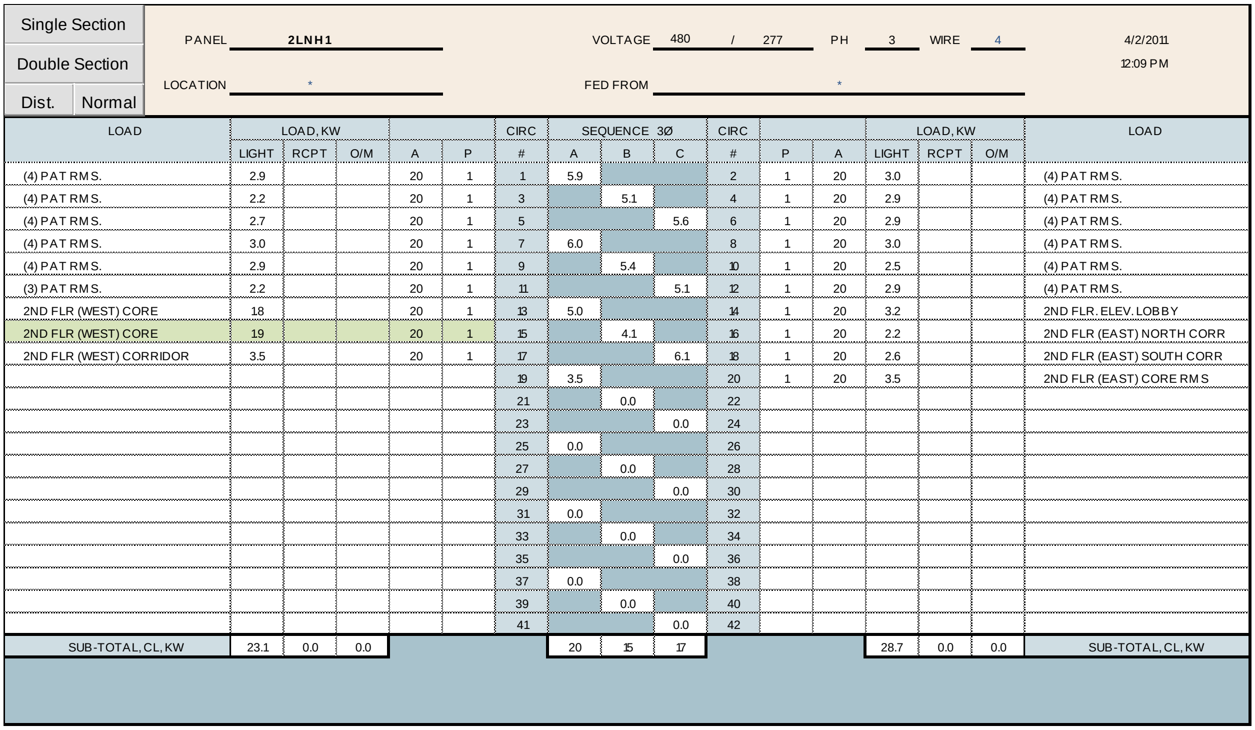


Single Section
Double Section
Dist. Normal

PANEL 1LSL1
VOLTAGE 208 / 120 PH 3 WIRE 4
3/28/2011
11:13 AM
LOCATION *
FED FROM 1LSH1

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
						1	10			2	1	20	10			CKT 'e'
						3		13		4	1	20	13			CKT 'j'
						5			10	6	1	20	10			CKT 'm'
						7	0.4			8	1	20	0.4			AUD. CORR. 'PL5'S'
						9		0.4		10	1	20			0.4	AUD. LTG. CONTACTOR
						11			0.4	12	1	20	0.4			CONSERV. WALKWAY
						13	0.5			14	1	20			0.5	DDC PANEL @ MECH RM.
						15		0.0		16	1	20				SR
						17			0.0	18	1	20				SR
						19	0.0			20						
						21		0.0		22						
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	0.0	0.0	0.0				2	2	1				4.1	0.0	0.9	SUB-TOTAL, CL, KW

Figure 104: Existing panelboard 1LSL1

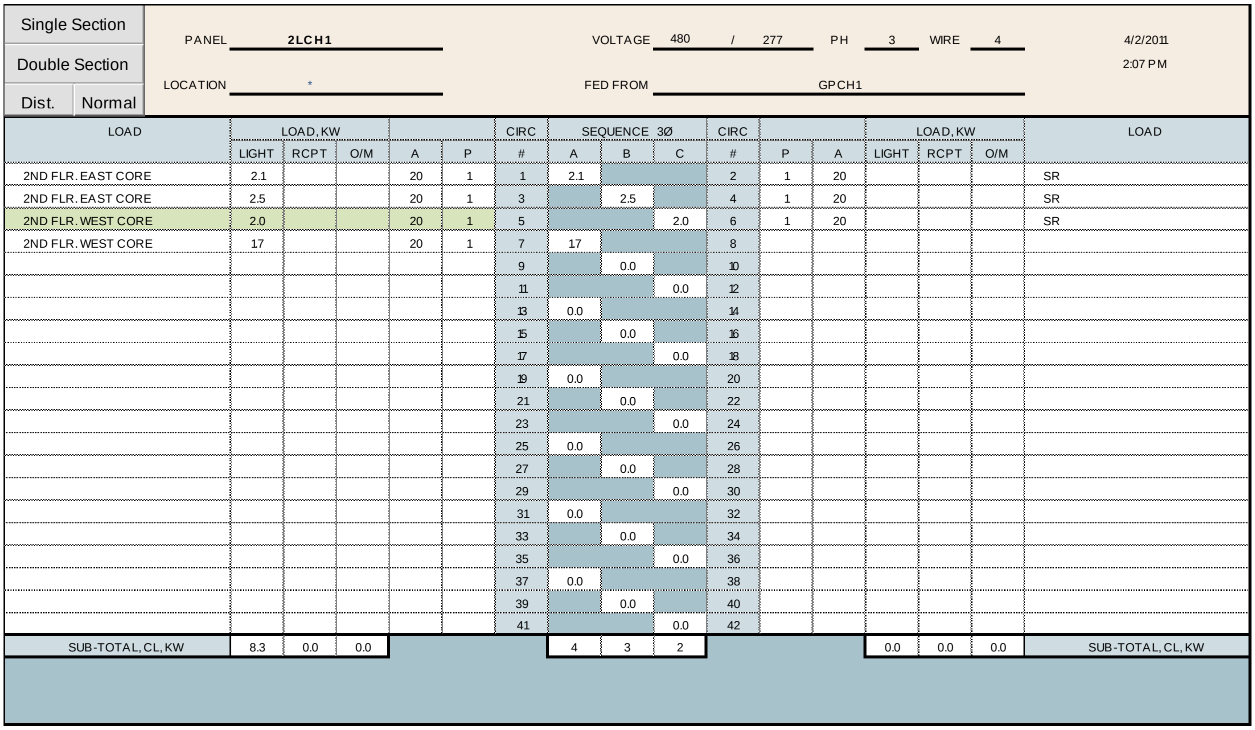


Single Section
Double Section
Dist. Normal

PANEL 2LNH1
VOLTAGE 480 / 277 PH 3 WIRE 4
4/2/2011
12:09 PM
LOCATION *
FED FROM *

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
(4) PAT RMS.	2.9			20	1	1	5.9			2	1	20	3.0			(4) PAT RMS.
(4) PAT RMS.	2.2			20	1	3		5.1		4	1	20	2.9			(4) PAT RMS.
(4) PAT RMS.	2.7			20	1	5			5.6	6	1	20	2.9			(4) PAT RMS.
(4) PAT RMS.	3.0			20	1	7	6.0			8	1	20	3.0			(4) PAT RMS.
(4) PAT RMS.	2.9			20	1	9		5.4		10	1	20	2.5			(4) PAT RMS.
(3) PAT RMS.	2.2			20	1	11			5.1	12	1	20	2.9			(4) PAT RMS.
2ND FLR (WEST) CORE	18			20	1	13	5.0			14	1	20	3.2			2ND FLR. ELEV. LOBBY
2ND FLR (WEST) CORE	19			20	1	15		4.1		16	1	20	2.2			2ND FLR (EAST) NORTH CORR
2ND FLR (WEST) CORRIDOR	3.5			20	1	17			6.1	18	1	20	2.6			2ND FLR (EAST) SOUTH CORR
						19	3.5			20	1	20	3.5			2ND FLR (EAST) CORE RMS
						21		0.0		22						
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	23.1	0.0	0.0				20	15	17				28.7	0.0	0.0	SUB-TOTAL, CL, KW

Figure 105: Existing panelboard 2LNH1

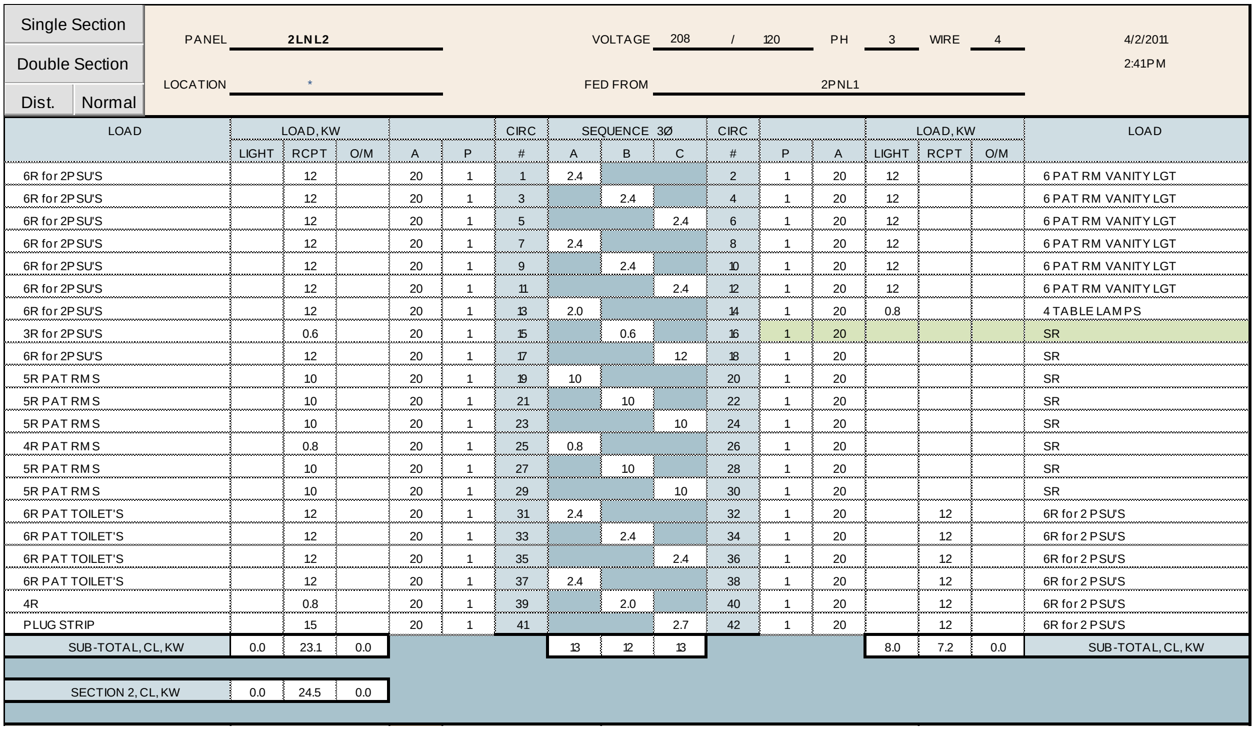


Single Section
Double Section
Dist. Normal

PANEL 2LCH1
VOLTAGE 480 / 277 PH 3 WIRE 4
4/2/2011
2:07 PM
LOCATION *
FED FROM GPCH1

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
2ND FLR. EAST CORE	2.1			20	1	1	2.1			2	1	20				SR
2ND FLR. EAST CORE	2.5			20	1	3		2.5		4	1	20				SR
2ND FLR. WEST CORE	2.0			20	1	5			2.0	6	1	20				SR
2ND FLR. WEST CORE	17			20	1	7	17			8						
						9		0.0		10						
						11			0.0	12						
						13	0.0			14						
						15		0.0		16						
						17			0.0	18						
						19	0.0			20						
						21		0.0		22						
						23			0.0	24						
						25	0.0			26						
						27		0.0		28						
						29			0.0	30						
						31	0.0			32						
						33		0.0		34						
						35			0.0	36						
						37	0.0			38						
						39		0.0		40						
						41			0.0	42						
SUB-TOTAL, CL, KW	8.3	0.0	0.0				4	3	2				0.0	0.0	0.0	SUB-TOTAL, CL, KW

Figure 106: Existing panelboard 2LCH1



Single Section
Double Section
Dist. Normal

PANEL 2LNL2
VOLTAGE 208 / 120 PH 3 WIRE 4
4/2/2011
2:41PM
LOCATION *
FED FROM 2PNL1

LOAD	LOAD, KW					CIRC	SEQUENCE 3Ø			CIRC			LOAD, KW			LOAD
	LIGHT	RCPT	O/M	A	P	#	A	B	C	#	P	A	LIGHT	RCPT	O/M	
6R for 2PSU'S		12		20	1	1	2.4			2	1	20	12			6 PAT RM VANITY LGT
6R for 2PSU'S		12		20	1	3		2.4		4	1	20	12			6 PAT RM VANITY LGT
6R for 2PSU'S		12		20	1	5			2.4	6	1	20	12			6 PAT RM VANITY LGT
6R for 2PSU'S		12		20	1	7	2.4			8	1	20	12			6 PAT RM VANITY LGT
6R for 2PSU'S		12		20	1	9		2.4		10	1	20	12			6 PAT RM VANITY LGT
6R for 2PSU'S		12		20	1	11			2.4	12	1	20	12			6 PAT RM VANITY LGT
6R for 2PSU'S		12		20	1	13	2.0			14	1	20	0.8			4 TABLE LAMPS
3R for 2PSU'S		0.6		20	1	15		0.6		16	1	20				SR
6R for 2PSU'S		12		20	1	17			12	18	1	20				SR
5R PAT RMS		10		20	1	19	10			20	1	20				SR
5R PAT RMS		10		20	1	21		10		22	1	20				SR
5R PAT RMS		10		20	1	23			10	24	1	20				SR
4R PAT RMS		0.8		20	1	25	0.8			26	1	20				SR
5R PAT RMS		10		20	1	27		10		28	1	20				SR
5R PAT RMS		10		20	1	29			10	30	1	20				SR
6R PAT TOILET'S		12		20	1	31	2.4			32	1	20		12		6R for 2 PSU'S
6R PAT TOILET'S		12		20	1	33		2.4		34	1	20		12		6R for 2 PSU'S
6R PAT TOILET'S		12		20	1	35			2.4	36	1	20		12		6R for 2 PSU'S
6R PAT TOILET'S		12		20	1	37	2.4			38	1	20		12		6R for 2 PSU'S
4R		0.8		20	1	39		2.0		40	1	20		12		6R for 2 PSU'S
PLUG STRIP		15		20	1	41			2.7	42	1	20		12		6R for 2 PSU'S
SUB-TOTAL, CL, KW	0.0	23.1	0.0				13	12	13				8.0	7.2	0.0	SUB-TOTAL, CL, KW
SECTION 2, CL, KW	0.0	24.5	0.0													

Figure 107: Existing panelboard 2LNL2

Revised Panelboards

PANELBOARD SIZING WORKSHEET											
Panel Tag------------------------->					GLNH1	Panel Location:			GA02		
Nominal Phase to Neutral Voltage------->					277	Phase:			3		
Nominal Phase to Phase Voltage-------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	New Lighting	2	Elev Lobby	1895	va	0.98	1857	1895		
2	A	Ext. Lights	2	Canopy	0.6	kw	0.90	600	667		
3	B	HID Lighting	2	Consv.	1.7	kw	0.90	1700	1889		
4	B	FL Lighting	2	Offices	3	kw	0.95	3000	3158		
5	C	FL Lighting	2	Gift Shop	1.8	kw	0.95	1800	1895		
6	C	FL Lighting	2	Open Off.	3	kw	0.95	3000	3158		
7	A	Spare			13	a	0.80	2881	3601		
8	A	FL Lighting	2	Conf. Storg.	2	kw	0.95	2000	2105		
9	B	Spare			13	a	0.80	2881	3601		
10	B	FL Lighting	2	Waiting	1.1	kw	0.95	1100	1158		
11	C	Spare			13	a	0.80	2881	3601		
12	C	FL Lighting	2	Offices	2	kw	0.95	2000	2105		
13	A	Spare			13	a	0.80	2881	3601		
14	A	FL Lighting	2	Open Adm.	3	kw	0.95	3000	3158		
15	B	Spare			13	a	0.80	2881	3601		
16	B	FL Lighting	2	Offices	1.8	kw	0.95	1800	1895		
17	C	Spare			13	a	0.80	2881	3601		
18	C	HID Lighting	1	Site	2	kw	0.90	2000	2222		
19	A	Spare			13	a	0.80	2881	3601		
20	A	HID Lighting	1	Site	2	kw	0.90	2000	2222		
21	B	Spare			13	a	0.80	2881	3601		
22	B	HID Lighting	1	Site	2	kw	0.90	2000	2222		
23	C	Spare			13	a	0.80	2881	3601		
24	C	Spare			13	a	0.80	2881	3601		
25	A	Spare			13	a	0.80	2881	3601		
26	A	Spare			13	a	0.80	2881	3601		
27	B	Spare			13	a	0.80	2881	3601		
28	B	Spare			13	a	0.80	2881	3601		
29	C	Spare			13	a	0.80	2881	3601		
30	C	Spare			13	a	0.80	2881	3601		
31	A	Spare			13	a	0.80	2881	3601		
32	A	Spare			13	a	0.80	2881	3601		
33	B	Spare			13	a	0.80	2881	3601		
34	B	Spare			13	a	0.80	2881	3601		
35	C	Spare			13	a	0.80	2881	3601		
36	C	Spare			13	a	0.80	2881	3601		
37	A	Spare			13	a	0.80	2881	3601		
38	A	Spare			13	a	0.80	2881	3601		
39	B	Spare			13	a	0.80	2881	3601		
40	B	Spare			13	a	0.80	2881	3601		
41	C	Spare			13	a	0.80	2881	3601		
42	C	Spare			13	a	0.80	2881	3601		
PANEL TOTAL								108.5	130.6	Amps=	157.1
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					35.4	42.5	33%	153.3
PHASE TOTAL			B					35.5	42.7	33%	154.3
PHASE TOTAL			C					37.6	43.9	34%	158.7
LOAD CATAGORIES				Connected			Demand				Ver. 104
				kW	kVA	DF	kW	kVA	PF		
1	HID Lighting			6.0	6.7	1.00	6.0	6.7	0.90		
2	Fluorescent Lighting			21.9	23.1	1.00	21.9	23.1	0.95		
3				0.0	0.0		0.0	0.0			
4				0.0	0.0		0.0	0.0			
5				0.0	0.0		0.0	0.0			
6				0.0	0.0		0.0	0.0			
7				0.0	0.0		0.0	0.0			
8				0.0	0.0		0.0	0.0			
9	unassigned			80.7	100.8		80.7	100.8	0.80		
Total Demand Loads							108.5	130.6			
Spare Capacity				20%			21.7	26.1			
Total Design Loads							130.2	156.7	0.83	Amps=	188.6

Table 61: Panel GLNH1 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	GLNH1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	GA02	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	200A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

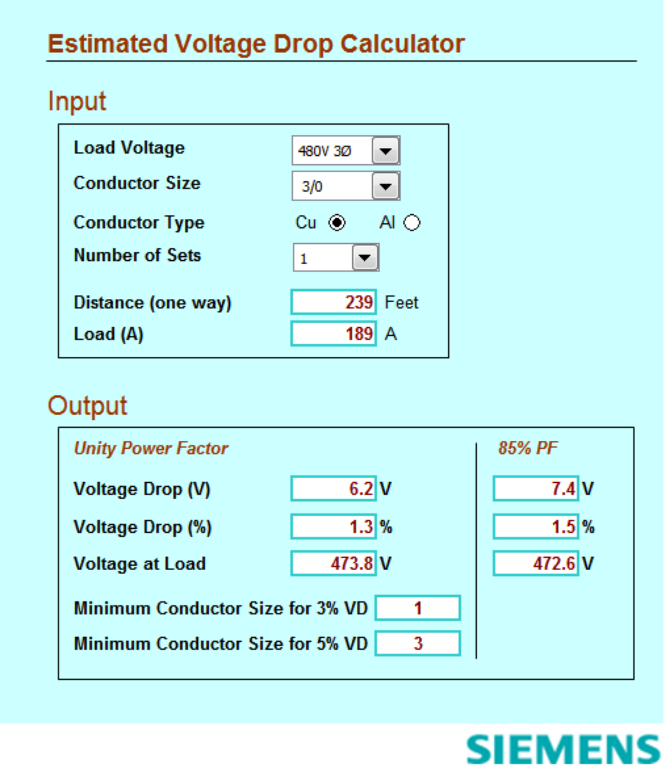
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
New Lighting	Elev Lobby	1857	20A/1P	1	*			2	20A/1P	600	Canopy	Ext. Lights
HID Lighting	Consv.	1700	20A/1P	3		*		4	20A/1P	3000	Offices	FL Lighting
FL Lighting	Gift Shop	1800	20A/1P	5			*	6	20A/1P	3000	Open Off.	FL Lighting
Spare		2881	20A/1P	7	*			8	20A/1P	2000	Conf. Storg.	FL Lighting
Spare		2881	20A/1P	9		*		10	20A/1P	1100	Waiting	FL Lighting
Spare		2881	20A/1P	11			*	12	20A/1P	2000	Offices	FL Lighting
Spare		2881	20A/1P	13	*			14	20A/1P	3000	Open Adm.	FL Lighting
Spare		2881	20A/1P	15		*		16	20A/1P	1800	Offices	FL Lighting
Spare		2881	20A/1P	17			*	18	20A/1P	2000	Site	HID Lighting
Spare		2881	20A/1P	19	*			20	20A/1P	2000	Site	HID Lighting
Spare		2881	20A/1P	21		*		22	20A/1P	2000	Site	HID Lighting
Spare		2881	20A/1P	23			*	24	20A/1P	2881		Spare
Spare		2881	20A/1P	25	*			26	20A/1P	2881		Spare
Spare		2881	20A/1P	27		*		28	20A/1P	2881		Spare
Spare		2881	20A/1P	29			*	30	20A/1P	2881		Spare
Spare		2881	20A/1P	31	*			32	20A/1P	2881		Spare
Spare		2881	20A/1P	33		*		34	20A/1P	2881		Spare
Spare		2881	20A/1P	35			*	36	20A/1P	2881		Spare
Spare		2881	20A/1P	37	*			38	20A/1P	2881		Spare
Spare		2881	20A/1P	39		*		40	20A/1P	2881		Spare
Spare		2881	20A/1P	41			*	42	20A/1P	2880.8		Spare

CONNECTED LOAD (KW) - A Ph.	35.38	TOTAL DESIGN LOAD (KW)	130.22
CONNECTED LOAD (KW) - B Ph.	35.53	POWER FACTOR	0.83
CONNECTED LOAD (KW) - C Ph.	37.61	TOTAL DESIGN LOAD (AMPS)	189

Table 62: Panel GLNH1

Feeder Sizing Worksheet		
Panelboard		
Tag		GLNH1
Voltage System		480Y/277V,3PH,4W
Calculated Design Load (kW)		130.22
Calculated Power Factor		0.83
Calculated Design Load (kVA)		156.69
Calculated Design Load (A)		189
Feeder		
Feeder Protection Size		200A/3P C/B
Number of Sets		1
Wire Size		
	Phase	(3) #3/0 AWG
	Neutral	(1) #3/0 AWG
	Ground	(1) #6 AWG
Wire Area (Table 5)		
	Each Phase	0.2679
	Total - All Phases	0.8037
	Neutral	0.2679
	Ground	0.0507
	Total - All Wires	1.1223
Minimum Conduit Area (above * 2.5)		2.80575
Conduit Size (Table 4)		2" EMT
Conduit Size (Table C.1)		2" EMT
Feeder Length		239'
Final Voltage Drop (V)		6.2
Final Voltage Drop (%)		1.3
Was Feeder Resized?		No

Table 63: Feeder Worksheet for Panel GLNH1



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 239 Feet
Load (A): 189 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	6.2 V	7.4 V
Voltage Drop (%)	1.3 %	1.5 %
Voltage at Load	473.8 V	472.6 V

Minimum Conductor Size for 3% VD: 1
Minimum Conductor Size for 5% VD: 3

Table 64: Voltage Drop Calculations for Panel GLNH1

PANELBOARD SIZING WORKSHEET											
Panel Tag-------------------------->					GLNL2	Panel Location:			GB13		
Nominal Phase to Neutral Voltage------->					120	Phase:			3		
Nominal Phase to Phase Voltage-------->					208	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Lighting	3	Courtyard	1450	w	0.90	1450	1611		
2	A	Receptacles (4R)	1	Consrv	0.8	kw	0.85	800	941		
3	B	Spare			13	a	0.80	1248	1560		
4	B	Receptacles (4R)	1	Consrv	0.8	kw	0.85	800	941		
5	C	Spare			13	a	0.80	1248	1560		
6	C	Receptacles (5R)	1	Comm. Rm	1	kw	0.85	1000	1176		
7	A	Spare			13	a	0.80	1248	1560		
8	A	Receptacles (2R)	1		0.6	kw	0.85	600	706		
9	B	Spare			13	a	0.80	1248	1560		
10	B	Receptacles (2R)	1	Comm. Rm	0.6	kw	0.85	600	706		
11	C	Spare			13	a	0.80	1248	1560		
12	C	Receptacles (4R)	1		0.8	kw	0.85	800	941		
13	A	Spare			13	a	0.80	1248	1560		
14	A	Receptacles (5R)	1		1	kw	0.85	1000	1176		
15	B	Spare			13	a	0.80	1248	1560		
16	B	EWC (2)	2		1	kw		1000	1250		
17	C	Spare			13	a	0.80	1248	1560		
18	C	Receptacles (3R)	1	Lobby	0.6	kw	0.85	600	706		
19	A	Spare			13	a	0.80	1248	1560		
20	A	Receptacles (2R)	1	Ext.	1	kw	0.85	1000	1176		
21	B	Spare			13	a	0.80	1248	1560		
22	B	Receptacles (4R)	1	Lobby	0.8	kw	0.85	800	941		
23	C	Spare			13	a	0.80	1248	1560		
24	C	Receptacles (5R)	1	Lobby	1	kw	0.85	1000	1176		
25	A	Spare			13	a	0.80	1248	1560		
26	A	Cash Register	2	Gift Shop	0.5	kw		500	625		
27	B	Spare			13	a	0.80	1248	1560		
28	B	CH (2)	2		1	kw		1000	1250		
29	C	Spare			13	a	0.80	1248	1560		
30	C	CH (2)	2		1	kw		1000	1250		
31	A	Spare			13	a	0.80	1248	1560		
32	A	Spare			13	a	0.80	1248	1560		
33	B	Spare			13	a	0.80	1248	1560		
34	B	Spare			13	a	0.80	1248	1560		
35	C	Spare			13	a	0.80	1248	1560		
36	C	Spare			13	a	0.80	1248	1560		
37	A	Spare			13	a	0.80	1248	1560		
38	A	Spare			13	a	0.80	1248	1560		
39	B	Spare			13	a	0.80	1248	1560		
40	B	Spare			13	a	0.80	1248	1560		
41	C	Spare			13	a	0.80	1248	1560		
42	C	Spare			13	a	0.80	1248	1560		
PANEL TOTAL								46.4	57.1	Amps=	158.7
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					15.3	18.7	33%	156.0
PHASE TOTAL			B					15.4	19.1	34%	159.4
PHASE TOTAL			C					15.6	18.7	33%	155.6
LOAD CATAGORIES				Connected			Demand				Ver. 104
				kW	kVA	DF	kW	kVA	PF		
1		Receptacles		9.0	10.6		9.0	10.6	0.85		
2		Other		3.5	4.4		3.5	4.4	0.80		
3		LED lighting		1.5	1.6		1.5	1.6	0.90		
4		HID lighting		0.0	0.0		0.0	0.0			
5				0.0	0.0		0.0	0.0			
6				0.0	0.0		0.0	0.0			
7				0.0	0.0		0.0	0.0			
8				0.0	0.0		0.0	0.0			
9		unassigned		32.4	40.6		32.4	40.6	0.80		
Total Demand Loads							46.4	57.1			
Spare Capacity				20%			9.3	11.4			
Total Design Loads							55.7	68.6	0.81	Amps=	190.4

Table 65: Panel GLNL2 Worksheet

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W	PANEL TAG: GLNL2	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 225A	PANEL LOCATION: GB13	OPTIONS: PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN: 200A/3P C/B	PANEL MOUNTING: SURFACE	FOR PANELBOARD 1L1B

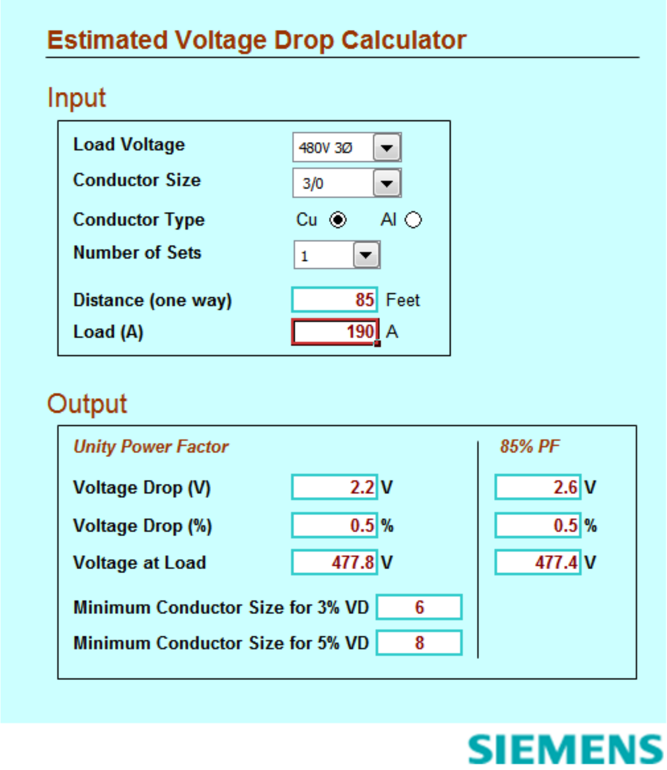
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	Courtyard	1450	20A/1P	1	*			2	20A/1P	800	Consrv	Receptacles (4R)
Spare		1248	20A/1P	3		*		4	20A/1P	800	Consrv	Receptacles (4R)
Spare		1248	20A/1P	5			*	6	20A/1P	1000	Comm. Rm	Receptacles (5R)
Spare		1248	20A/1P	7	*			8	20A/1P	600		Receptacles (2R)
Spare		1248	20A/1P	9		*		10	20A/1P	600	Comm. Rm	Receptacles (2R)
Spare		1248	20A/1P	11			*	12	20A/1P	800		Receptacles (4R)
Spare		1248	20A/1P	13	*			14	20A/1P	1000		Receptacles (5R)
Spare		1248	20A/1P	15		*		16	20A/1P	1000		EWC (2)
Spare		1248	20A/1P	17			*	18	20A/1P	600	Lobby	Receptacles (3R)
Spare		1248	20A/1P	19	*			20	20A/1P	1000	Ext.	Receptacles (2R)
Spare		1248	20A/1P	21		*		22	20A/1P	800	Lobby	Receptacles (4R)
Spare		1248	20A/1P	23			*	24	20A/1P	1000	Lobby	Receptacles (5R)
Spare		1248	20A/1P	25	*			26	20A/1P	500	Gift Shop	Cash Register
Spare		1248	20A/1P	27		*		28	20A/1P	1000		CH (2)
Spare		1248	20A/1P	29			*	30	20A/1P	1000		CH (2)
Spare		1248	20A/1P	31	*			32	20A/1P	1248		Spare
Spare		1248	20A/1P	33		*		34	20A/1P	1248		Spare
Spare		1248	20A/1P	35			*	36	20A/1P	1248		Spare
Spare		1248	20A/1P	37	*			38	20A/1P	1248		Spare
Spare		1248	20A/1P	39		*		40	20A/1P	1248		Spare
Spare		1248	20A/1P	41			*	42	20A/1P	1248		Spare

CONNECTED LOAD (KW) - A Ph.	15.33		TOTAL DESIGN LOAD (KW)	55.68
CONNECTED LOAD (KW) - B Ph.	15.43		POWER FACTOR	0.81
CONNECTED LOAD (KW) - C Ph.	15.63		TOTAL DESIGN LOAD (AMPS)	190

Table 66: Panel GLNH2

Feeder Sizing Worksheet	
Panelboard	
Tag	GLNL2
Voltage System	208Y/120V,3PH,4W
Calculated Design Load (kW)	55.68
Calculated Power Factor	0.81
Calculated Design Load (kVA)	68.56
Calculated Design Load (A)	190
Feeder	
Feeder Protection Size	200A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #3/0 AWG
Neutral	(1) #3/0 AWG
Ground	(1) #6 AWG
Wire Area (Table 5)	
Each Phase	0.2679
Total - All Phases	0.8037
Neutral	0.2679
Ground	0.0507
Total - All Wires	1.1223
Minimum Conduit Area (above * 2.5)	2.80575
Conduit Size (Table 4)	2" EMT
Conduit Size (Table C.1)	2" EMT
Feeder Length	85'
Final Voltage Drop (V)	2.2
Final Voltage Drop (%)	0.5
Was Feeder Resized?	Yes

Table 67: Feeder Worksheet for Panel GLNL2



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 85 Feet
Load (A): 190 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	2.2 V	2.6 V
Voltage Drop (%)	0.5 %	0.5 %
Voltage at Load	477.8 V	477.4 V

Minimum Conductor Size for 3% VD: 6
Minimum Conductor Size for 5% VD: 8

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Table 68: Voltage Drop Calculations for Panel GLNL2

PANELBOARD SIZING WORKSHEET											
Panel Tag------------------------->					GLSH1	Panel Location:			GA02		
Nominal Phase to Neutral Voltage------->					277	Phase:			3		
Nominal Phase to Phase Voltage-------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Lighting	1	Stair 3	1.5	kw	0.95	1500	1579		
2	A	Spare			13	a	0.80	2881	3601		
3	B	Lighting	1	Stair 2	1.5	kw	0.95	1500	1579		
4	B	Spare			13	a	0.80	2881	3601		
5	C	Lighting	1	G FLR E	2.7	kw	0.95	2700	2842		
6	C	Spare			13	a	0.80	2881	3601		
7	A	Exit Lighting	1	G FLR E	0.3	kw	0.95	300	316		
8	A	Spare			13	a	0.80	2881	3601		
9	B	Exit Lighting	1	G FLR W	0.3	kw	0.95	300	316		
10	B	Spare			13	a	0.80	2881	3601		
11	C	Lighting	1	G FLR W	2.2	kw	0.95	2200	2316		
12	C	Spare			13	a	0.80	2881	3601		
13	A	Lighting	1	Stair 1	1.5	kw	0.95	1500	1579		
14	A	Spare			13	a	0.80	2881	3601		
15	B	Spare			13	a	0.80	2881	3601		
16	B	Spare			13	a	0.80	2881	3601		
17	C	Spare			13	a	0.80	2881	3601		
18	C	Spare			13	a	0.80	2881	3601		
19	A	Spare			13	a	0.80	2881	3601		
20	A	Spare			13	a	0.80	2881	3601		
21	B	Spare			13	a	0.80	2881	3601		
22	B	Spare			13	a	0.80	2881	3601		
23	C	Spare			13	a	0.80	2881	3601		
24	C	Spare			13	a	0.80	2881	3601		
25	A	Spare			13	a	0.80	2881	3601		
26	A	Spare			13	a	0.80	2881	3601		
27	B	Spare			13	a	0.80	2881	3601		
28	B	Spare			13	a	0.80	2881	3601		
29	C	Spare			13	a	0.80	2881	3601		
30	C	Spare			13	a	0.80	2881	3601		
31	A	Spare			13	a	0.80	2881	3601		
32	A	Spare			13	a	0.80	2881	3601		
33	B	Spare			13	a	0.80	2881	3601		
34	B	Spare			13	a	0.80	2881	3601		
35	C	Spare			13	a	0.80	2881	3601		
36	C	Spare			13	a	0.80	2881	3601		
37	A	Spare			13	a	0.80	2881	3601		
38	A	Spare			13	a	0.80	2881	3601		
39	B	Spare			13	a	0.80	2881	3601		
40	B	Spare			13	a	0.80	2881	3601		
41	C	Spare			13	a	0.80	2881	3601		
42	C	Spare			13	a	0.80	2881	3601		
PANEL TOTAL								110.8	136.6	Amps=	164.3
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					35.0	43.1	32%	155.5
PHASE TOTAL			B					36.4	45.1	33%	162.8
PHASE TOTAL			C					39.5	46.9	35%	169.4
LOAD CATAGORIES				Connected			Demand				Ver. 104
				kW	kVA	DF	kW	kVA	PF		
1	Fluorescent lighting			10.0	10.5	1.00	10.0	10.5	0.95		
2	Exit Lighting			0.0	0.0	1.00	0.0	0.0			
3				0.0	0.0		0.0	0.0			
4				0.0	0.0		0.0	0.0			
5				0.0	0.0		0.0	0.0			
6				0.0	0.0		0.0	0.0			
7				0.0	0.0		0.0	0.0			
8				0.0	0.0		0.0	0.0			
9	unassigned			100.8	126.0		100.8	126.0	0.80		
Total Demand Loads							110.8	136.6			
Spare Capacity				20%			22.2	27.3			
Total Design Loads							133.0	163.9	0.81	Amps=	197.2

Table 69: Panel GLSH1 Worksheet

PANELBOARD SCHEDULE

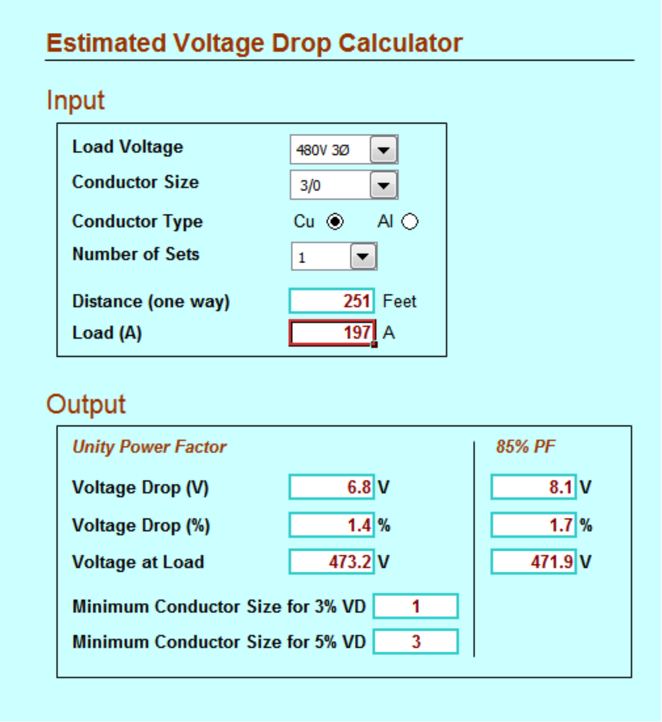
VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	GLSH1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	GA02	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	200A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	Stair 3	1500	20A/1P	1	*			2	20A/1P	2881		Spare
Lighting	Stair 2	1500	20A/1P	3		*		4	20A/1P	2881		Spare
Lighting	G FLR E	2700	20A/1P	5			*	6	20A/1P	2881		Spare
Exit Lighting	G FLR E	300	20A/1P	7	*			8	20A/1P	2881		Spare
Exit Lighting	G FLR W	300	20A/1P	9		*		10	20A/1P	2881		Spare
Lighting	G FLR W	2200	20A/1P	11			*	12	20A/1P	2881		Spare
Lighting	Stair 1	1500	20A/1P	13	*			14	20A/1P	2881		Spare
Spare		2881	20A/1P	15		*		16	20A/1P	2881		Spare
Spare		2881	20A/1P	17			*	18	20A/1P	2881		Spare
Spare		2881	20A/1P	19	*			20	20A/1P	2881		Spare
Spare		2881	20A/1P	21		*		22	20A/1P	2881		Spare
Spare		2881	20A/1P	23			*	24	20A/1P	2881		Spare
Spare		2881	20A/1P	25	*			26	20A/1P	2881		Spare
Spare		2881	20A/1P	27		*		28	20A/1P	2881		Spare
Spare		2881	20A/1P	29			*	30	20A/1P	2881		Spare
Spare		2881	20A/1P	31	*			32	20A/1P	2881		Spare
Spare		2881	20A/1P	33		*		34	20A/1P	2881		Spare
Spare		2881	20A/1P	35			*	36	20A/1P	2881		Spare
Spare		2881	20A/1P	37	*			38	20A/1P	2881		Spare
Spare		2881	20A/1P	39		*		40	20A/1P	2881		Spare
Spare		2881	20A/1P	41			*	42	20A/1P	2880.8		Spare
CONNECTED LOAD (KW) - A Ph.		34.99								TOTAL DESIGN LOAD (KW)		132.99
CONNECTED LOAD (KW) - B Ph.		36.37								POWER FACTOR		0.81
CONNECTED LOAD (KW) - C Ph.		39.47								TOTAL DESIGN LOAD (AMPS)		197

Table 70: Panel GLSH1

Feeder Sizing Worksheet	
Panelboard	
Tag	GLSH1
Voltage System	480Y/277V,3PH,4W
Calculated Design Load (kW)	132.99
Calculated Power Factor	0.81
Calculated Design Load (kVA)	163.87
Calculated Design Load (A)	197
Feeder	
Feeder Protection Size	200A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #3/0 AWG
Neutral	(1) #3/0 AWG
Ground	(1) #6 AWG
Wire Area (Table 5)	
Each Phase	0.2679
Total - All Phases	0.8037
Neutral	0.2679
Ground	0.0507
Total - All Wires	1.1223
Minimum Conduit Area (above * 2.5)	2.80575
Conduit Size (Table 4)	2" EMT
Conduit Size (Table C.1)	2" EMT
Feeder Length	251'
Final Voltage Drop (V)	6.8
Final Voltage Drop (%)	1.4
Was Feeder Resized?	Yes

Table 71: Feeder Worksheet for Panel GLSH1



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 251 Feet
Load (A): 197 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	6.8 V	8.1 V
Voltage Drop (%)	1.4 %	1.7 %
Voltage at Load	473.2 V	471.9 V
Minimum Conductor Size for 3% VD	1	
Minimum Conductor Size for 5% VD	3	

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Table 72: Voltage Drop Calculations for Panel GLSH1

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	480	Panel Location:	1LNH1	
Nominal Phase to Neutral Voltage------->	277	Phase:	3	
Nominal Phase to Phase Voltage-------->	480	Wires:	4	

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	Slot Lighting	3	Lobby	3397	va	0.98	3329	3397	
2	A	Lighting	1	Pat. Rooms	3	kw	0.95	3000	3158	
3	B	Cove Lighting	3	Lobby	3093	va	0.98	3031	3093	
4	B	Lighting	1	Pat. Rooms	2.9	kw	0.95	2900	3053	
5	C	Lighting	1	Elev Lobby	1.5	kw	0.95	1500	1579	
6	C	Lighting	1	Pat. Rooms	3	kw	0.95	3000	3158	
7	A	Spare			13	a	0.80	2881	3601	
8	A	Lighting	1	Pat. Rooms	2.2	kw	0.95	2200	2316	
9	B	Spare			13	a	0.80	2881	3601	
10	B	Lighting	1	Pat. Rooms	2.7	kw	0.95	2700	2842	
11	C	Spare			13	a	0.80	2881	3601	
12	C	Lighting	1	Pat. Rooms	2.8	kw	0.95	2800	2947	
13	A	Spare			13	a	0.80	2881	3601	
14	A	Lighting	1	1st FLR NE	2.2	kw	0.95	2200	2316	
15	B	Spare			13	a	0.80	2881	3601	
16	B	Lighting	1	1st FLR SE	1.4	kw	0.95	1400	1474	
17	C	Spare			13	a	0.80	2881	3601	
18	C	Lighting	1	1st FLR RM	2.4	kw	0.95	2400	2526	
19	A	Spare			13	a	0.80	2881	3601	
20	A	Spare			13	a	0.80	2881	3601	
21	B	Spare			13	a	0.80	2881	3601	
22	B	Spare			13	a	0.80	2881	3601	
23	C	Spare			13	a	0.80	2881	3601	
24	C	Spare			13	a	0.80	2881	3601	
25	A	Spare			13	a	0.80	2881	3601	
26	A	Spare			13	a	0.80	2881	3601	
27	B	Spare			13	a	0.80	2881	3601	
28	B	Spare			13	a	0.80	2881	3601	
29	C	Spare			13	a	0.80	2881	3601	
30	C	Spare			13	a	0.80	2881	3601	
31	A	Spare			13	a	0.80	2881	3601	
32	A	Spare			13	a	0.80	2881	3601	
33	B	Spare			13	a	0.80	2881	3601	
34	B	Spare			13	a	0.80	2881	3601	
35	C	Spare			13	a	0.80	2881	3601	
36	C	Spare			13	a	0.80	2881	3601	
37	A	Spare			13	a	0.80	2881	3601	
38	A	Spare			13	a	0.80	2881	3601	
39	B	Spare			13	a	0.80	2881	3601	
40	B	Spare			13	a	0.80	2881	3601	
41	C	Spare			13	a	0.80	2881	3601	
42	C	Spare			13	a	0.80	2881	3601	

PANEL TOTAL						116.9	139.9	Amps=	168.3
PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					39.5	47.2	34%	170.4
PHASE TOTAL	B					38.8	46.5	34%	167.8
PHASE TOTAL	C					38.5	44.8	32%	161.7

LOAD CATAGORIES			Connected			Demand				Ver. 104
			kW	kVA	DF	kW	kVA	PF		
1	fluorescent lighting		24.1	25.4	1.00	24.1	25.4	0.95		
2	HID lighting		0.0	0.0	1.00	0.0	0.0			
3	LED Lighting		6.4	6.5	1.00	6.4	6.5	0.98		
4	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
5			0.0	0.0		0.0	0.0			
6			0.0	0.0		0.0	0.0			
7			0.0	0.0		0.0	0.0			
8			0.0	0.0		0.0	0.0			
9	unassigned		86.4	108.0		86.4	108.0	0.80		
Total Demand Loads						116.9	139.9			
Spare Capacity			20%			23.4	28.0			
Total Design Loads						140.3	167.9	0.84	Amps=	202.0

Table 73: Panel 1LNH1 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	480	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	1LNH1	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

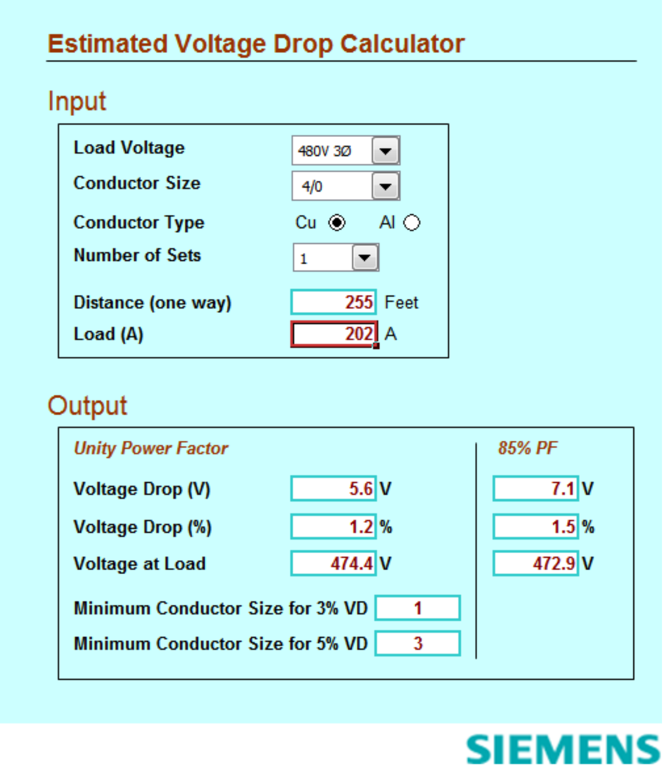
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Slot Lighting	Lobby	3329	20A/1P	1	*			2	20A/1P	3000	Pat. Rooms	Lighting
Cove Lighting	Lobby	3031	20A/1P	3		*		4	20A/1P	2900	Pat. Rooms	Lighting
Lighting	Elev Lobby	1500	20A/1P	5			*	6	20A/1P	3000	Pat. Rooms	Lighting
Spare		2881	20A/1P	7	*			8	20A/1P	2200	Pat. Rooms	Lighting
Spare		2881	20A/1P	9		*		10	20A/1P	2700	Pat. Rooms	Lighting
Spare		2881	20A/1P	11			*	12	20A/1P	2800	Pat. Rooms	Lighting
Spare		2881	20A/1P	13	*			14	20A/1P	2200	1st FLR NE	Lighting
Spare		2881	20A/1P	15		*		16	20A/1P	1400	1st FLR SE	Lighting
Spare		2881	20A/1P	17			*	18	20A/1P	2400	1st FLR RM	Lighting
Spare		2881	20A/1P	19	*			20	20A/1P	2881		Spare
Spare		2881	20A/1P	21		*		22	20A/1P	2881		Spare
Spare		2881	20A/1P	23			*	24	20A/1P	2881		Spare
Spare		2881	20A/1P	25	*			26	20A/1P	2881		Spare
Spare		2881	20A/1P	27		*		28	20A/1P	2881		Spare
Spare		2881	20A/1P	29			*	30	20A/1P	2881		Spare
Spare		2881	20A/1P	31	*			32	20A/1P	2881		Spare
Spare		2881	20A/1P	33		*		34	20A/1P	2881		Spare
Spare		2881	20A/1P	35			*	36	20A/1P	2881		Spare
Spare		2881	20A/1P	37	*			38	20A/1P	2881		Spare
Spare		2881	20A/1P	39		*		40	20A/1P	2881		Spare
Spare		2881	20A/1P	41			*	42	20A/1P	2880.8		Spare

CONNECTED LOAD (KW) - A Ph.	39.54		TOTAL DESIGN LOAD (KW)	140.26
CONNECTED LOAD (KW) - B Ph.	38.84		POWER FACTOR	0.84
CONNECTED LOAD (KW) - C Ph.	38.51		TOTAL DESIGN LOAD (AMPS)	202

Table 74: Panel 1LNH1

Feeder Sizing Worksheet	
Panelboard	
Tag	480
Voltage System	480Y/277V,3PH,4W
Calculated Design Load (kW)	140.26
Calculated Power Factor	0.84
Calculated Design Load (kVA)	167.87
Calculated Design Load (A)	202
Feeder	
Feeder Protection Size	225A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #4/0 AWG
Neutral	(1) #4/0 AWG
Ground	(1) #4 AWG
Wire Area (Table 5)	
Each Phase	0.3237
Total - All Phases	0.9711
Neutral	0.3237
Ground	0.0824
Total - All Wires	1.3772
Minimum Conduit Area (above * 2.5)	3.443
Conduit Size (Table 4)	2.5" EMT
Conduit Size (Table C.1)	2.5" EMT
Feeder Length	255'
Final Voltage Drop (V)	7.1
Final Voltage Drop (%)	1.5
Was Feeder Resized?	Yes

Table 75: Feeder Worksheet for Panel 1LNH1



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 4/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 255 Feet
Load (A): 202 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	5.6 V	7.1 V
Voltage Drop (%)	1.2 %	1.5 %
Voltage at Load	474.4 V	472.9 V

Minimum Conductor Size for 3% VD: 1
Minimum Conductor Size for 5% VD: 3

Table 76: Voltage Drop Calculations for Panel 1LNH1

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					1LSH1	Panel Location:			1A02		
Nominal Phase to Neutral Voltage------->					277	Phase:			3		
Nominal Phase to Phase Voltage-------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Lighting	1	1ST FLR E	1.8	kw	0.95	1800	1895		
2	A	New Emrg Ltg	1	LOBBY	744	va	0.95	707	744		
3	B	Exit Lighting	2	1ST FLR E	0.4	kw	0.95	400	421		
4	B	Lighting	1	WAITING	1.2	kw	0.95	1200	1263		
5	C	Lighting	1	2ND FLR E	2.5	kw	0.95	2500	2632		
6	C	Exit Lighting	2	WEST EX.	0.3	kw	0.95	300	316		
7	A	Exit Lighting	2	2ND FLR E	0.4	kw	0.95	400	421		
8	A	Spare			13	a	0.95	3421	3601		
9	B	Exit Lighting	2	2ND FLR W	0.4	kw	0.95	400	421		
10	B	Spare			13	a	0.95	3421	3601		
11	C	Lighting	1	2ND FLR W	1.8	kw	0.95	1800	1895		
12	C	Spare			13	a	0.95	3421	3601		
13	A	Spare			13	a	0.95	3421	3601		
14	A	Spare			13	a	0.95	3421	3601		
15	B	Spare			13	a	0.95	3421	3601		
16	B	Spare			13	a	0.95	3421	3601		
17	C	Spare			13	a	0.95	3421	3601		
18	C	Spare			13	a	0.95	3421	3601		
19	A	Spare			13	a	0.95	3421	3601		
20	A	Spare			13	a	0.95	3421	3601		
21	B	Spare			13	a	0.95	3421	3601		
22	B	Spare			13	a	0.95	3421	3601		
23	C	Spare			13	a	0.95	3421	3601		
24	C	Spare			13	a	0.95	3421	3601		
25	A	Spare			13	a	0.95	3421	3601		
26	A	Spare			13	a	0.95	3421	3601		
27	B	Spare			13	a	0.95	3421	3601		
28	B	Spare			13	a	0.95	3421	3601		
29	C	Spare			13	a	0.95	3421	3601		
30	C	Spare			13	a	0.95	3421	3601		
31	A	Spare			13	a	0.95	3421	3601		
32	A	Spare			13	a	0.95	3421	3601		
33	B	Spare			13	a	0.95	3421	3601		
34	B	Spare			13	a	0.95	3421	3601		
35	C	Spare			13	a	0.95	3421	3601		
36	C	Spare			13	a	0.95	3421	3601		
37	A	Spare			13	a	0.95	3421	3601		
38	A	Spare			13	a	0.95	3421	3601		
39	B	Spare			13	a	0.95	3421	3601		
40	B	Spare			13	a	0.95	3421	3601		
41	C	Spare			13	a	0.95	3421	3601		
42	C	Spare			13	a	0.95	3421	3601		
PANEL TOTAL								122.4	128.8	Amps=	155.0
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					40.5	42.7	33%	154.0
PHASE TOTAL			B					39.6	41.7	32%	150.6
PHASE TOTAL			C					42.2	44.1	34%	159.2
LOAD CATAGORIES				Connected			Demand				Ver. 104
				kW	kVA	DF	kW	kVA	PF		
1	Fluorescent lighting			8.0	8.4		8.0	8.4	0.95		
2	Exit Lighting			1.5	1.6		1.5	1.6	0.95		
3				0.0	0.0		0.0	0.0			
4				0.0	0.0		0.0	0.0			
5				0.0	0.0		0.0	0.0			
6				0.0	0.0		0.0	0.0			
7				0.0	0.0		0.0	0.0			
8				0.0	0.0		0.0	0.0			
9	unassigned			112.9	118.8		112.9	118.8	0.95		
Total Demand Loads							122.4	128.8			
Spare Capacity				20%			24.5	25.8			
Total Design Loads							146.9	154.6	0.95	Amps=	186.1

Table 77: Panel 1LSH1 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	1LSH1	MIN. C/B AIC:	14K
SIZE/TYPE BUS:	200A	PANEL LOCATION:	1A02	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

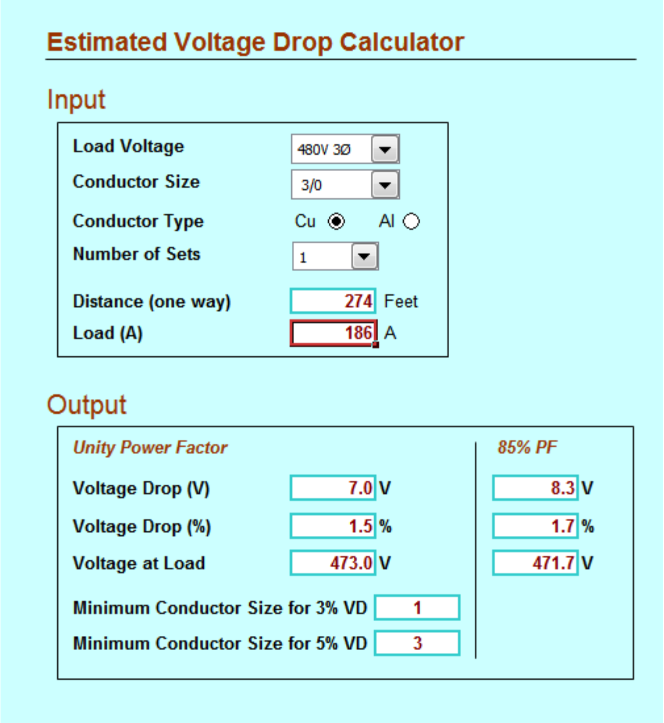
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	1ST FLR E	1800	20A/1P	1	*			2	20A/1P	707	LOBBY	New Emrg Ltg
Exit Lighting	1ST FLR E	400	20A/1P	3		*		4	20A/1P	1200	WAITING	Lighting
Lighting	2ND FLR E	2500	20A/1P	5			*	6	20A/1P	300	WEST EX	Exit Lighting
Exit Lighting	2ND FLR E	400	20A/1P	7	*			8	20A/1P	3421		Spare
Exit Lighting	2ND FLR W	400	20A/1P	9		*		10	20A/1P	3421		Spare
Lighting	2ND FLR W	1800	20A/1P	11			*	12	20A/1P	3421		Spare
Spare		3421	20A/1P	13	*			14	20A/1P	3421		Spare
Spare		3421	20A/1P	15		*		16	20A/1P	3421		Spare
Spare		3421	20A/1P	17			*	18	20A/1P	3421		Spare
Spare		3421	20A/1P	19	*			20	20A/1P	3421		Spare
Spare		3421	20A/1P	21		*		22	20A/1P	3421		Spare
Spare		3421	20A/1P	23			*	24	20A/1P	3421		Spare
Spare		3421	20A/1P	25	*			26	20A/1P	3421		Spare
Spare		3421	20A/1P	27		*		28	20A/1P	3421		Spare
Spare		3421	20A/1P	29			*	30	20A/1P	3421		Spare
Spare		3421	20A/1P	31	*			32	20A/1P	3421		Spare
Spare		3421	20A/1P	33		*		34	20A/1P	3421		Spare
Spare		3421	20A/1P	35			*	36	20A/1P	3421		Spare
Spare		3421	20A/1P	37	*			38	20A/1P	3421		Spare
Spare		3421	20A/1P	39		*		40	20A/1P	3421		Spare
Spare		3421	20A/1P	41			*	42	20A/1P	3420.95		Spare

CONNECTED LOAD (KW) - A Ph.	40.54	TOTAL DESIGN LOAD (KW)	146.88
CONNECTED LOAD (KW) - B Ph.	39.63	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C Ph.	42.23	TOTAL DESIGN LOAD (AMPS)	186

Table 78: Panel 1LSH1

Feeder Sizing Worksheet	
Panelboard	
Tag	1LSH1
Voltage System	480Y/277V,3PH,4W
Calculated Design Load (kW)	146.88
Calculated Power Factor	0.95
Calculated Design Load (kVA)	154.61
Calculated Design Load (A)	186
Feeder	
Feeder Protection Size	225A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #3/0 AWG
Neutral	(1) #3/0 AWG
Ground	(1) #6 AWG
Wire Area (Table 5)	
Each Phase	0.2679
Total - All Phases	0.8037
Neutral	0.2679
Ground	0.0507
Total - All Wires	1.1223
Minimum Conduit Area (above * 2.5)	2.80575
Conduit Size (Table 4)	2" EMT
Conduit Size (Table C.1)	2" EMT
Feeder Length	274'
Final Voltage Drop (V)	7
Final Voltage Drop (%)	1.5
Was Feeder Resized?	Yes

Table 79: Feeder Worksheet for Panel 1LSH1



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 274 Feet
Load (A): 186 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	7.0 V	8.3 V
Voltage Drop (%)	1.5 %	1.7 %
Voltage at Load	473.0 V	471.7 V

Minimum Conductor Size for 3% VD: 1
Minimum Conductor Size for 5% VD: 3

SIEMENS

Table 80: Voltage Drop Calculations for Panel 1LSH1

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	GLNL3	Panel Location:	GB03C
Nominal Phase to Neutral Voltage------->	120	Phase:	3
Nominal Phase to Phase Voltage-------->	208	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	LTGS	4	Hallway	1	kw	1.00	1000	1000		
2	A	SPARE			13	a	0.80	1248	1560		
3	B	LTGS	4	Hallway	1	kw	1.00	1000	1000		
4	B	Recptacles (1R)	1		1	kw	0.80	1000	1250		
5	C	Lighting	3	Auditorium	1515	va	0.98	1485	1515		
6	C	A/V Wallbox	5		1	kw	0.80	1000	1250		
7	A	Lighting	3	Auditorium	1215	va	0.98	1191	1215		
8	A	Recptacles (3R)	1		0.8	kw	0.80	800	1000		
9	B	Lighting	3	Auditorium	1274	va	0.98	1249	1274		
10	B	Recptacles (2R)	1		0.8	kw	0.80	800	1000		
11	C	Lutron AC Motor	5	Auditorium	13	a	0.80	1248	1560		
12	C	Recptacles (2R)	1		0.8	kw	0.80	800	1000		
13	A	SPARE			13	a	0.80	1248	1560		
14	A	Recptacles (2R)	1		0.8	kw	0.80	800	1000		
15	B	SPARE			13	a	0.80	1248	1560		
16	B	Recptacles (3R)	1		0.8	kw	0.80	800	1000		
17	C	SPARE			13	a	0.80	1248	1560		
18	C	Recptacles (3R)	1		0.8	kw	0.80	800	1000		
19	A	SPARE			13	a	0.80	1248	1560		
20	A	Recptacles (2R)	1		0.4	kw	0.80	400	500		
21	B	SPARE			13	a	0.80	1248	1560		
22	B	SPARE			13	a	0.80	1248	1560		
23	C	SPARE			13	a	0.80	1248	1560		
24	C	A/V Wallbox	5		0.8	kw	0.80	800	1000		
25	A	LTGS	4		0.6	kw	1.00	600	600		
26	A	CH	7		0.5	kw	0.80	500	625		
27	B	SPARE			13	a	0.80	1248	1560		
28	B	SPARE			13	a	0.80	1248	1560		
29	C	SPARE			13	a	0.80	1248	1560		
30	C	SPARE			13	a	0.80	1248	1560		
31	A	SPARE			13	a	0.80	1248	1560		
32	A	SPARE			13	a	0.80	1248	1560		
33	B	SPARE			13	a	0.80	1248	1560		
34	B	SPARE			13	a	0.80	1248	1560		
35	C	(3) Floor Box IG's	5		1	kw	0.80	1000	1250		
36	C	Video Proj. Lift	6		1	kw		1000	1250		
37	A	A/V Wallbox	5		1	kw	0.80	1000	1250		
38	A	Video Proj. Lift	6		1	kw		1000	1250		
39	B	(2) Floor Box IG's	5		1	kw	0.80	1000	1250		
40	B	Video Proj. Lift	6		1	kw		1000	1250		
41	C	SPARE			13	a	0.80	1248	1560		
42	C	SPARE			13	a	0.80	1248	1560		
PANEL TOTAL								44.7	54.4	Amps=	151.0

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	13.5	16.2	30%	135.3
PHASE TOTAL	B	15.6	18.9	35%	157.9
PHASE TOTAL	C	15.6	18.6	35%	154.7

LOAD CATAGORIES		Connected			Demand				Ver. 104
		kW	kVA	DF	kW	kVA	PF		
1	Receptacles	6.2	7.8	0.80	5.0	6.2	0.80		
2	Fluorescent Lighting	0.0	0.0	1.00	0.0	0.0			
3	LED Lighting	3.9	4.0	1.00	3.9	4.0	0.98		
4	Incandescent Lighting	2.6	2.6	1.00	2.6	2.6	1.00		
5	A/V	6.0	7.6	0.90	5.4	6.8	0.80		
6	Video Proj. Lift	3.0	3.8	0.90	2.7	3.4	0.80		
7	Other	0.5	0.6		0.5	0.6	0.80		
8		0.0	0.0		0.0	0.0			
9	unassigned	22.5	28.1		22.5	28.1	0.80		
Total Demand Loads					42.6	51.7			
Spare Capacity		20%			8.5	10.3			
Total Design Loads					51.1	62.0	0.82	Amps=	172.3

Table 81: Panel GLNL3 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	GLNL3	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	200A	PANEL LOCATION:	GB03C	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

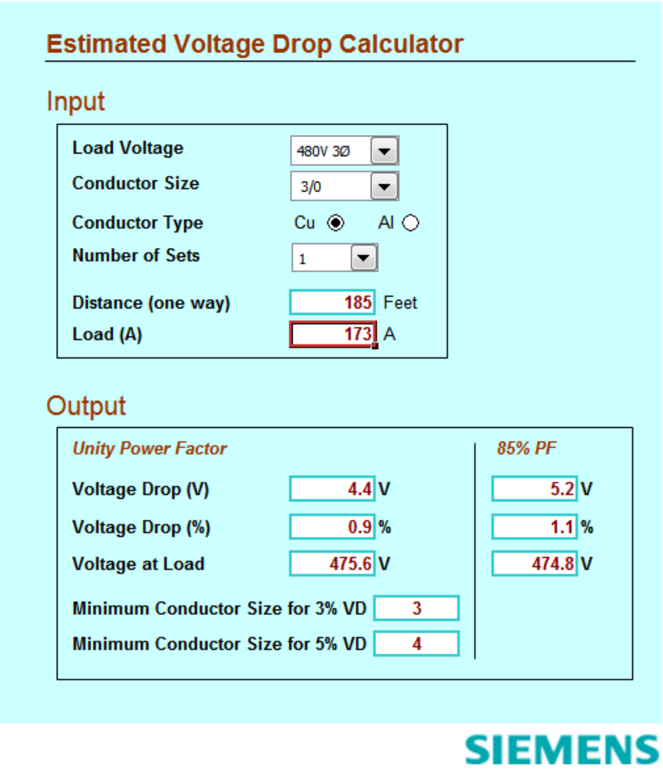
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LTGS	Hallway	1000	20A/1P	1	*			2	20A/1P	1248		SPARE
LTGS	Hallway	1000	20A/1P	3		*		4	20A/1P	1000		Recptacles (1R)
Lighting	Auditorium	1485	20A/1P	5			*	6	20A/1P	1000		A/V Wallbox
Lighting	Auditorium	1191	20A/1P	7	*			8	20A/1P	800		Recptacles (3R)
Lighting	Auditorium	1249	20A/1P	9		*		10	20A/1P	800		Recptacles (2R)
Lutron AC Motor	Auditorium	1248	20A/1P	11			*	12	20A/1P	800		Recptacles (2R)
SPARE		1248	20A/1P	13	*			14	20A/1P	800		Recptacles (2R)
SPARE		1248	20A/1P	15		*		16	20A/1P	800		Recptacles (3R)
SPARE		1248	20A/1P	17			*	18	20A/1P	800		Recptacles (3R)
SPARE		1248	20A/1P	19	*			20	20A/1P	400		Recptacles (2R)
SPARE		1248	20A/1P	21		*		22	20A/1P	1248		SPARE
SPARE		1248	20A/1P	23			*	24	20A/1P	800		A/V Wallbox
LTGS		600	20A/1P	25	*			26	20A/1P	500		CH
SPARE		1248	20A/1P	27		*		28	20A/1P	1248		SPARE
SPARE		1248	20A/1P	29			*	30	20A/1P	1248		SPARE
SPARE		1248	20A/1P	31	*			32	20A/1P	1248		SPARE
SPARE		1248	20A/1P	33		*		34	20A/1P	1248		SPARE
(3) Floor Box IG's		1000	20A/1P	35			*	36	20A/1P	1000		Video Proj. Lift
A/V Wallbox		1000	20A/1P	37	*			38	20A/1P	1000		Video Proj. Lift
(2) Floor Box IG's		1000	20A/1P	39		*		40	20A/1P	1000		Video Proj. Lift
SPARE		1248	20A/1P	41			*	42	20A/1P	1248		SPARE

CONNECTED LOAD (KW) - A Ph.	13.53	TOTAL DESIGN LOAD (KW)	51.11
CONNECTED LOAD (KW) - B Ph.	15.58	POWER FACTOR	0.82
CONNECTED LOAD (KW) - C Ph.	15.62	TOTAL DESIGN LOAD (AMPS)	172

Table 82: Panel GLNL3

Feeder Sizing Worksheet		
Panelboard		
Tag		GLNL3
Voltage System		208Y/120V,3PH,4W
Calculated Design Load (kW)		51.26
Calculated Power Factor		0.82
Calculated Design Load (kVA)		62.21
Calculated Design Load (A)		173
Feeder		
Feeder Protection Size		225A/3P C/B
Number of Sets		1
Wire Size		
	Phase	(3) #3/0 AWG
	Neutral	(1) #3/0 AWG
	Ground	(1) #6 AWG
Wire Area (Table 5)		
	Each Phase	0.2679
	Total - All Phases	0.8037
	Neutral	0.2679
	Ground	0.0507
	Total - All Wires	1.1223
Minimum Conduit Area (above * 2.5)		2.80575
Conduit Size (Table 4)		2" EMT
Conduit Size (Table C.1)		2" EMT
Feeder Length		185'
Final Voltage Drop (V)		4.4
Final Voltage Drop (%)		0.9
Was Feeder Resized?		Yes

Table 83: Feeder Worksheet for Panel GLNL3


Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 185 Feet
Load (A): 173 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	4.4 V	5.2 V
Voltage Drop (%)	0.9 %	1.1 %
Voltage at Load	475.6 V	474.8 V

Minimum Conductor Size for 3% VD: 3
Minimum Conductor Size for 5% VD: 4

SIEMENS

Table 84: Voltage Drop Calculations for Panel GLNL3

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	1LSL1	Panel Location:	1A02	
Nominal Phase to Neutral Voltage------->	120	Phase:	3	
Nominal Phase to Phase Voltage-------->	208	Wires:	4	

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	Spare			13	a	0.80	1248	1560	
2	A	Em. Lighting	2	Auditorium	372	va	0.98	365	372	
3	B	Spare			13	a	0.80	1248	1560	
4	B	Spare			13	a	0.80	1248	1560	
5	C	Spare			13	a	0.80	1248	1560	
6	C	Spare			13	a	0.80	1248	1560	
7	A	Spare			13	a	0.80	1248	1560	
8	A	LTG	1	Aud. Corr.	0.4	kw		400	500	
9	B	Spare			13	a	0.80	1248	1560	
10	B	Other	3		0.4	kw		400	500	
11	C	Spare			13	a	0.80	1248	1560	
12	C	LTG	1	Consrv.	0.4	kw		400	500	
13	A	Spare			13	a	0.80	1248	1560	
14	A	DOC Panel	3	Mech. Room	0.5	kw		500	625	
15	B	Spare			13	a	0.80	1248	1560	
16	B	Spare			13	a	0.80	1248	1560	
17	C	Spare			13	a	0.80	1248	1560	
18	C	Spare			13	a	0.80	1248	1560	
19	A	Spare			13	a	0.80	1248	1560	
20	A	Spare			13	a	0.80	1248	1560	
21	B	Spare			13	a	0.80	1248	1560	
22	B	Spare			13	a	0.80	1248	1560	
23	C	Spare			13	a	0.80	1248	1560	
24	C	Spare			13	a	0.80	1248	1560	
25	A	Spare			13	a	0.80	1248	1560	
26	A	Spare			13	a	0.80	1248	1560	
27	B	Spare			13	a	0.80	1248	1560	
28	B	Spare			13	a	0.80	1248	1560	
29	C	Spare			13	a	0.80	1248	1560	
30	C	Spare			13	a	0.80	1248	1560	
31	A	Spare			13	a	0.80	1248	1560	
32	A	Spare			13	a	0.80	1248	1560	
33	B	Spare			13	a	0.80	1248	1560	
34	B	Spare			13	a	0.80	1248	1560	
35	C	Spare			13	a	0.80	1248	1560	
36	C	Spare			13	a	0.80	1248	1560	
37	A	Spare			13	a	0.80	1248	1560	
38	A	Spare			13	a	0.80	1248	1560	
39	B	Spare			13	a	0.80	1248	1560	
40	B	Spare			13	a	0.80	1248	1560	
41	C	Spare			13	a	0.80	1248	1560	
42	C	Spare			13	a	0.80	1248	1560	
PANEL TOTAL								48.2	60.2	Amps= 167.3

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	15.0	18.7	31%	155.5
PHASE TOTAL	B	16.6	20.8	35%	173.2
PHASE TOTAL	C	16.6	20.2	34%	168.0

LOAD CATAGORIES		Connected			Demand			Ver. 104
		kW	kVA	DF	kW	kVA	PF	
1	Lighting	0.8	1.0		0.8	1.0	0.80	
2	LED Lighting	0.4	0.4		0.4	0.4	0.98	
3	Motor/Other	0.9	1.1		0.9	1.1	0.80	
4		0.0	0.0		0.0	0.0		
5		0.0	0.0		0.0	0.0		
6		0.0	0.0		0.0	0.0		
7		0.0	0.0		0.0	0.0		
8		0.0	0.0		0.0	0.0		
9	unassigned	46.2	57.7		46.2	57.7	0.80	
Total Demand Loads					48.2	60.2		
Spare Capacity		20%			9.6	12.0		
Total Design Loads					57.9	72.3	0.80	Amps= 200.7

Table 85: Panel 1LSL1 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	1LSL1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	1A02	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

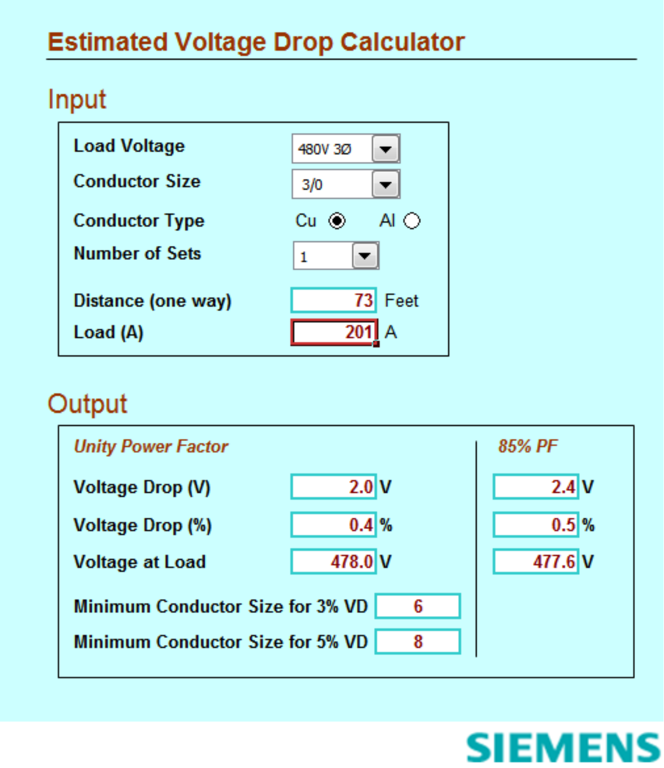
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Spare		1248	20A/1P	1	*			2	20A/1P	365	Auditorium	Em. Lighting
Spare		1248	20A/1P	3		*		4	20A/1P	1248		Spare
Spare		1248	20A/1P	5			*	6	20A/1P	1248		Spare
Spare		1248	20A/1P	7	*			8	20A/1P	400	Aud. Corr.	LTG
Spare		1248	20A/1P	9		*		10	20A/1P	400		Other
Spare		1248	20A/1P	11			*	12	20A/1P	400	Consrv.	LTG
Spare		1248	20A/1P	13	*			14	20A/1P	500	Mech. Room	DOC Panel
Spare		1248	20A/1P	15		*		16	20A/1P	1248		Spare
Spare		1248	20A/1P	17			*	18	20A/1P	1248		Spare
Spare		1248	20A/1P	19	*			20	20A/1P	1248		Spare
Spare		1248	20A/1P	21		*		22	20A/1P	1248		Spare
Spare		1248	20A/1P	23			*	24	20A/1P	1248		Spare
Spare		1248	20A/1P	25	*			26	20A/1P	1248		Spare
Spare		1248	20A/1P	27		*		28	20A/1P	1248		Spare
Spare		1248	20A/1P	29			*	30	20A/1P	1248		Spare
Spare		1248	20A/1P	31	*			32	20A/1P	1248		Spare
Spare		1248	20A/1P	33		*		34	20A/1P	1248		Spare
Spare		1248	20A/1P	35			*	36	20A/1P	1248		Spare
Spare		1248	20A/1P	37	*			38	20A/1P	1248		Spare
Spare		1248	20A/1P	39		*		40	20A/1P	1248		Spare
Spare		1248	20A/1P	41			*	42	20A/1P	1248		Spare

CONNECTED LOAD (KW) - A Ph.	14.99	TOTAL DESIGN LOAD (KW)	57.89
CONNECTED LOAD (KW) - B Ph.	16.62	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	16.62	TOTAL DESIGN LOAD (AMPS)	201

Table 86: Panel 1LSL1

Feeder Sizing Worksheet	
Panelboard	
Tag	1LSL1
Voltage System	208Y/120V,3PH,4W
Calculated Design Load (kW)	57.89
Calculated Power Factor	0.80
Calculated Design Load (kVA)	72.26
Calculated Design Load (A)	201
Feeder	
Feeder Protection Size	225A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #4/0 AWG
Neutral	(1) #4/0 AWG
Ground	(1) #4 AWG
Wire Area (Table 5)	
Each Phase	0.3237
Total - All Phases	0.9711
Neutral	0.3237
Ground	0.0824
Total - All Wires	1.3772
Minimum Conduit Area (above * 2.5)	3.443
Conduit Size (Table 4)	2.5" EMT
Conduit Size (Table C.1)	2.5" EMT
Feeder Length	43'
Final Voltage Drop (V)	2
Final Voltage Drop (%)	0.4
Was Feeder Resized?	Yes

Table 87: Feeder Worksheet for Panel 1LSL1



Estimated Voltage Drop Calculator

Input

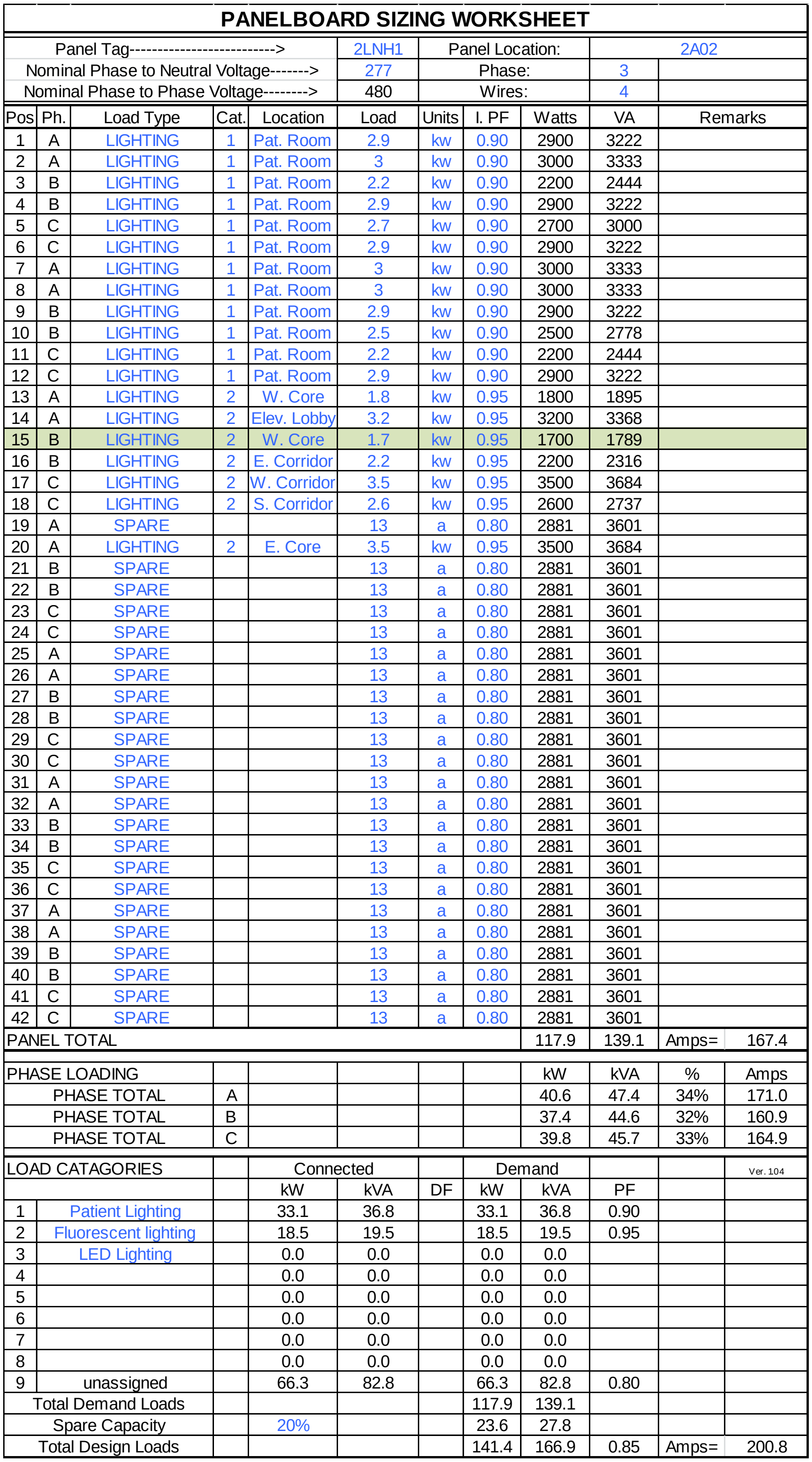
Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 73 Feet
Load (A): 201 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	2.0 V	2.4 V
Voltage Drop (%)	0.4 %	0.5 %
Voltage at Load	478.0 V	477.6 V

Minimum Conductor Size for 3% VD: 6
Minimum Conductor Size for 5% VD: 8

Table 88: Voltage Drop Calculations for Panel 1LSL1



PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	2LNH1	Panel Location:	2A02
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	LIGHTING	1	Pat. Room	2.9	kw	0.90	2900	3222	
2	A	LIGHTING	1	Pat. Room	3	kw	0.90	3000	3333	
3	B	LIGHTING	1	Pat. Room	2.2	kw	0.90	2200	2444	
4	B	LIGHTING	1	Pat. Room	2.9	kw	0.90	2900	3222	
5	C	LIGHTING	1	Pat. Room	2.7	kw	0.90	2700	3000	
6	C	LIGHTING	1	Pat. Room	2.9	kw	0.90	2900	3222	
7	A	LIGHTING	1	Pat. Room	3	kw	0.90	3000	3333	
8	A	LIGHTING	1	Pat. Room	3	kw	0.90	3000	3333	
9	B	LIGHTING	1	Pat. Room	2.9	kw	0.90	2900	3222	
10	B	LIGHTING	1	Pat. Room	2.5	kw	0.90	2500	2778	
11	C	LIGHTING	1	Pat. Room	2.2	kw	0.90	2200	2444	
12	C	LIGHTING	1	Pat. Room	2.9	kw	0.90	2900	3222	
13	A	LIGHTING	2	W. Core	1.8	kw	0.95	1800	1895	
14	A	LIGHTING	2	Elev. Lobby	3.2	kw	0.95	3200	3368	
15	B	LIGHTING	2	W. Core	1.7	kw	0.95	1700	1789	
16	B	LIGHTING	2	E. Corridor	2.2	kw	0.95	2200	2316	
17	C	LIGHTING	2	W. Corridor	3.5	kw	0.95	3500	3684	
18	C	LIGHTING	2	S. Corridor	2.6	kw	0.95	2600	2737	
19	A	SPARE			13	a	0.80	2881	3601	
20	A	LIGHTING	2	E. Core	3.5	kw	0.95	3500	3684	
21	B	SPARE			13	a	0.80	2881	3601	
22	B	SPARE			13	a	0.80	2881	3601	
23	C	SPARE			13	a	0.80	2881	3601	
24	C	SPARE			13	a	0.80	2881	3601	
25	A	SPARE			13	a	0.80	2881	3601	
26	A	SPARE			13	a	0.80	2881	3601	
27	B	SPARE			13	a	0.80	2881	3601	
28	B	SPARE			13	a	0.80	2881	3601	
29	C	SPARE			13	a	0.80	2881	3601	
30	C	SPARE			13	a	0.80	2881	3601	
31	A	SPARE			13	a	0.80	2881	3601	
32	A	SPARE			13	a	0.80	2881	3601	
33	B	SPARE			13	a	0.80	2881	3601	
34	B	SPARE			13	a	0.80	2881	3601	
35	C	SPARE			13	a	0.80	2881	3601	
36	C	SPARE			13	a	0.80	2881	3601	
37	A	SPARE			13	a	0.80	2881	3601	
38	A	SPARE			13	a	0.80	2881	3601	
39	B	SPARE			13	a	0.80	2881	3601	
40	B	SPARE			13	a	0.80	2881	3601	
41	C	SPARE			13	a	0.80	2881	3601	
42	C	SPARE			13	a	0.80	2881	3601	
PANEL TOTAL								117.9	139.1	Amps= 167.4

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					40.6	47.4	34%	171.0
PHASE TOTAL	B					37.4	44.6	32%	160.9
PHASE TOTAL	C					39.8	45.7	33%	164.9

LOAD CATAGORIES			Connected			Demand				Ver. 104
			kW	kVA	DF	kW	kVA	PF		
1	Patient Lighting		33.1	36.8		33.1	36.8	0.90		
2	Fluorescent lighting		18.5	19.5		18.5	19.5	0.95		
3	LED Lighting		0.0	0.0		0.0	0.0			
4			0.0	0.0		0.0	0.0			
5			0.0	0.0		0.0	0.0			
6			0.0	0.0		0.0	0.0			
7			0.0	0.0		0.0	0.0			
8			0.0	0.0		0.0	0.0			
9	unassigned		66.3	82.8		66.3	82.8	0.80		
Total Demand Loads						117.9	139.1			
Spare Capacity			20%			23.6	27.8			
Total Design Loads						141.4	166.9	0.85	Amps=	200.8

Table 89: Panel 2LNH1 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	2LNH1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	2A02	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

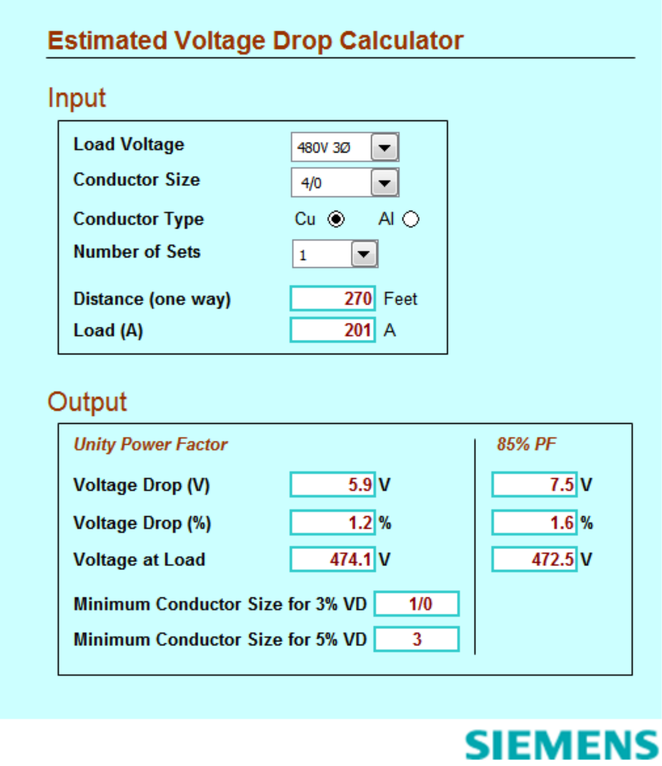
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	Pat. Room	2900	20A/1P	1	*			2	20A/1P	3000	Pat. Room	LIGHTING
LIGHTING	Pat. Room	2200	20A/1P	3		*		4	20A/1P	2900	Pat. Room	LIGHTING
LIGHTING	Pat. Room	2700	20A/1P	5			*	6	20A/1P	2900	Pat. Room	LIGHTING
LIGHTING	Pat. Room	3000	20A/1P	7	*			8	20A/1P	3000	Pat. Room	LIGHTING
LIGHTING	Pat. Room	2900	20A/1P	9		*		10	20A/1P	2500	Pat. Room	LIGHTING
LIGHTING	Pat. Room	2200	20A/1P	11			*	12	20A/1P	2900	Pat. Room	LIGHTING
LIGHTING	W. Core	1800	20A/1P	13	*			14	20A/1P	3200	Elev. Lobby	LIGHTING
LIGHTING	W. Core	1700	20A/1P	15		*		16	20A/1P	2200	E. Corridor	LIGHTING
LIGHTING	W. Corridor	3500	20A/1P	17			*	18	20A/1P	2600	S. Corridor	LIGHTING
SPARE		2881	20A/1P	19	*			20	20A/1P	3500	E. Core	LIGHTING
SPARE		2881	20A/1P	21		*		22	20A/1P	2881		SPARE
SPARE		2881	20A/1P	23			*	24	20A/1P	2881		SPARE
SPARE		2881	20A/1P	25	*			26	20A/1P	2881		SPARE
SPARE		2881	20A/1P	27		*		28	20A/1P	2881		SPARE
SPARE		2881	20A/1P	29			*	30	20A/1P	2881		SPARE
SPARE		2881	20A/1P	31	*			32	20A/1P	2881		SPARE
SPARE		2881	20A/1P	33		*		34	20A/1P	2881		SPARE
SPARE		2881	20A/1P	35			*	36	20A/1P	2881		SPARE
SPARE		2881	20A/1P	37	*			38	20A/1P	2881		SPARE
SPARE		2881	20A/1P	39		*		40	20A/1P	2881		SPARE
SPARE		2881	20A/1P	41			*	42	20A/1P	2880.8		SPARE

CONNECTED LOAD (KW) - A Ph.	40.57	TOTAL DESIGN LOAD (KW)	141.43
CONNECTED LOAD (KW) - B Ph.	37.45	POWER FACTOR	0.85
CONNECTED LOAD (KW) - C Ph.	39.85	TOTAL DESIGN LOAD (AMPS)	201

Table 90: Panel 2LNH1

Feeder Sizing Worksheet	
Panelboard	
Tag	2LNH1
Voltage System	480Y/277V,3PH,4W
Calculated Design Load (kW)	141.43
Calculated Power Factor	0.85
Calculated Design Load (kVA)	166.89
Calculated Design Load (A)	201
Feeder	
Feeder Protection Size	225A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #4/0 AWG
Neutral	(1) #4/0 AWG
Ground	(1) #4 AWG
Wire Area (Table 5)	
Each Phase	0.3237
Total - All Phases	0.9711
Neutral	0.3237
Ground	0.0824
Total - All Wires	1.3772
Minimum Conduit Area (above * 2.5)	3.443
Conduit Size (Table 4)	2.5" EMT
Conduit Size (Table C.1)	2.5" EMT
Feeder Length	270'
Final Voltage Drop (V)	5.9
Final Voltage Drop (%)	1.2
Was Feeder Resized?	Yes

Table 91: Feeder Worksheet for Panel 2LNH1



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 4/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 270 Feet
Load (A): 201 A

Output

	Unity Power Factor	*85% PF*
Voltage Drop (V)	5.9 V	7.5 V
Voltage Drop (%)	1.2 %	1.6 %
Voltage at Load	474.1 V	472.5 V

Minimum Conductor Size for 3% VD: 1/0
Minimum Conductor Size for 5% VD: 3

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Table 92: Voltage Drop Calculations for Panel 2LNH1

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	2LCH1	Panel Location:	2A02
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	LIGHTING	1	East Core	2.1	kw	0.90	2100	2333		
2	A	Spare			13	a	0.80	2881	3601		
3	B	LIGHTING	1	East Core	2.5	kw	0.90	2500	2778		
4	B	Spare			13	a	0.80	2881	3601		
5	C	LIGHTING	1	West Core	2.2	kw	0.90	2200	2444		
6	C	Spare			13	a	0.80	2881	3601		
7	A	LIGHTING	1	West Core	1.7	kw	0.90	1700	1889		
8	A	Spare			13	a	0.80	2881	3601		
9	B	Spare			13	a	0.80	2881	3601		
10	B	Spare			13	a	0.80	2881	3601		
11	C	Spare			13	a	0.80	2881	3601		
12	C	Spare			13	a	0.80	2881	3601		
13	A	Spare			13	a	0.80	2881	3601		
14	A	Spare			13	a	0.80	2881	3601		
15	B	Spare			13	a	0.80	2881	3601		
16	B	Spare			13	a	0.80	2881	3601		
17	C	Spare			13	a	0.80	2881	3601		
18	C	Spare			13	a	0.80	2881	3601		
19	A	Spare			13	a	0.80	2881	3601		
20	A	Spare			13	a	0.80	2881	3601		
21	B	Spare			13	a	0.80	2881	3601		
22	B	Spare			13	a	0.80	2881	3601		
23	C	Spare			13	a	0.80	2881	3601		
24	C	Spare			13	a	0.80	2881	3601		
25	A	Spare			13	a	0.80	2881	3601		
26	A	Spare			13	a	0.80	2881	3601		
27	B	Spare			13	a	0.80	2881	3601		
28	B	Spare			13	a	0.80	2881	3601		
29	C	Spare			13	a	0.80	2881	3601		
30	C	Spare			13	a	0.80	2881	3601		
31	A	Spare			13	a	0.80	2881	3601		
32	A	Spare			13	a	0.80	2881	3601		
33	B	Spare			13	a	0.80	2881	3601		
34	B	Spare			13	a	0.80	2881	3601		
35	C	Spare			13	a	0.80	2881	3601		
36	C	Spare			13	a	0.80	2881	3601		
37	A	Spare			13	a	0.80	2881	3601		
38	A	Spare			13	a	0.80	2881	3601		
39	B	Spare			13	a	0.80	2881	3601		
40	B	Spare			13	a	0.80	2881	3601		
41	C	Spare			13	a	0.80	2881	3601		
42	C	Spare			13	a	0.80	2881	3601		
PANEL TOTAL								118.0	146.3	Amps=	176.0

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	38.4	47.4	33%	171.2
PHASE TOTAL	B	40.0	49.6	34%	179.0
PHASE TOTAL	C	39.7	47.8	33%	172.6

LOAD CATAGORIES			Connected			Demand				Ver. 104
			kW	kVA	DF	kW	kVA	PF		
1	Fluorescent lighting		8.5	9.4	1.00	8.5	9.4	0.90		
2	Fluor. / LED lighting		0.0	0.0	1.00	0.0	0.0			
3			0.0	0.0		0.0	0.0			
4			0.0	0.0		0.0	0.0			
5			0.0	0.0		0.0	0.0			
6			0.0	0.0		0.0	0.0			
7			0.0	0.0		0.0	0.0			
8			0.0	0.0		0.0	0.0			
9	unassigned		109.5	136.8		109.5	136.8	0.80		
Total Demand Loads						118.0	146.3			
Spare Capacity			20%			23.6	29.3			
Total Design Loads						141.6	175.5	0.81	Amps=	211.2

Table 93: Panel 2LCH1 Worksheet

P A N E L B O A R D S C H E D U L E

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	2LCH1	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	2A02	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

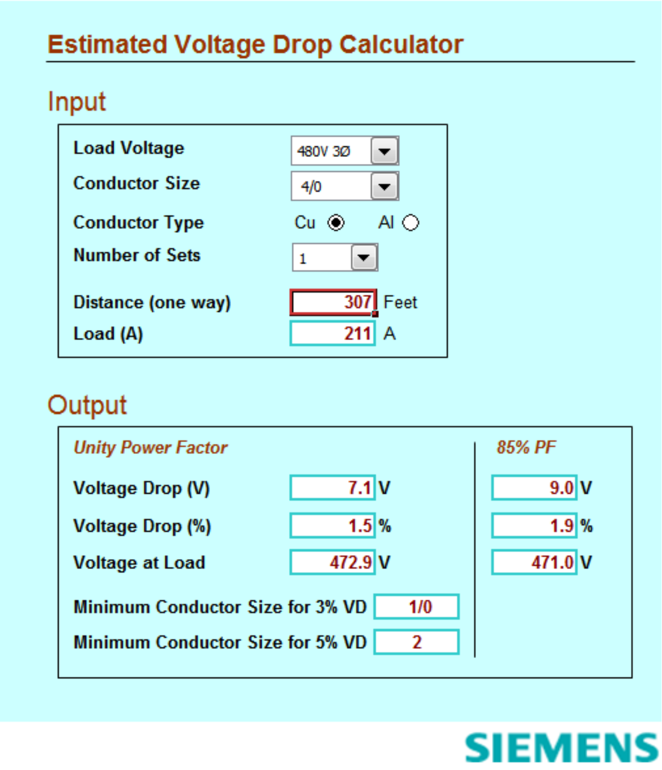
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	East Core	2100	20A/1P	1	*			2	20A/1P	2881		Spare
LIGHTING	East Core	2500	20A/1P	3		*		4	20A/1P	2881		Spare
LIGHTING	West Core	2200	20A/1P	5			*	6	20A/1P	2881		Spare
LIGHTING	West Core	1700	20A/1P	7	*			8	20A/1P	2881		Spare
Spare		2881	20A/1P	9		*		10	20A/1P	2881		Spare
Spare		2881	20A/1P	11			*	12	20A/1P	2881		Spare
Spare		2881	20A/1P	13	*			14	20A/1P	2881		Spare
Spare		2881	20A/1P	15		*		16	20A/1P	2881		Spare
Spare		2881	20A/1P	17			*	18	20A/1P	2881		Spare
Spare		2881	20A/1P	19	*			20	20A/1P	2881		Spare
Spare		2881	20A/1P	21		*		22	20A/1P	2881		Spare
Spare		2881	20A/1P	23			*	24	20A/1P	2881		Spare
Spare		2881	20A/1P	25	*			26	20A/1P	2881		Spare
Spare		2881	20A/1P	27		*		28	20A/1P	2881		Spare
Spare		2881	20A/1P	29			*	30	20A/1P	2881		Spare
Spare		2881	20A/1P	31	*			32	20A/1P	2881		Spare
Spare		2881	20A/1P	33		*		34	20A/1P	2881		Spare
Spare		2881	20A/1P	35			*	36	20A/1P	2881		Spare
Spare		2881	20A/1P	37	*			38	20A/1P	2881		Spare
Spare		2881	20A/1P	39		*		40	20A/1P	2881		Spare
Spare		2881	20A/1P	41			*	42	20A/1P	2880.8		Spare

CONNECTED LOAD (KW) - A Ph.	38.37	TOTAL DESIGN LOAD (KW)	141.56
CONNECTED LOAD (KW) - B Ph.	39.95	POWER FACTOR	0.81
CONNECTED LOAD (KW) - C Ph.	39.65	TOTAL DESIGN LOAD (AMPS)	211

Table 94: Panel 2LCH1

Feeder Sizing Worksheet	
Panelboard	
Tag	2LCH1
Voltage System	480Y/277V,3PH,4W
Calculated Design Load (kW)	141.56
Calculated Power Factor	0.81
Calculated Design Load (kVA)	175.54
Calculated Design Load (A)	211
Feeder	
Feeder Protection Size	225A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #4/0 AWG
Neutral	(1) #4/0 AWG
Ground	(1) #4 AWG
Wire Area (Table 5)	
Each Phase	0.3237
Total - All Phases	0.9711
Neutral	0.3237
Ground	0.0824
Total - All Wires	1.3772
Minimum Conduit Area (above * 2.5)	3.443
Conduit Size (Table 4)	2.5" EMT
Conduit Size (Table C.1)	2.5" EMT
Feeder Length	307'
Final Voltage Drop (V)	7.1
Final Voltage Drop (%)	1.5
Was Feeder Resized?	No

Table 95: Feeder Worksheet for Panel 2LCH1



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 4/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 307 Feet
Load (A): 211 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	7.1 V	9.0 V
Voltage Drop (%)	1.5 %	1.9 %
Voltage at Load	472.9 V	471.0 V

Minimum Conductor Size for 3% VD: 1/0
Minimum Conductor Size for 5% VD: 2

Table 96: Voltage Drop Calculations for Panel 2LCH1

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	2LNL2	Panel Location:	2B48
Nominal Phase to Neutral Voltage------->	120	Phase:	3
Nominal Phase to Phase Voltage-------->	208	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
2	A	Vanity Lighting	2	Pat. Room	1.2	kw	0.90	1200	1333		
3	B	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
4	B	Vanity Lighting	2	Pat. Room	1.2	kw	0.90	1200	1333		
5	C	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
6	C	Vanity Lighting	2	Pat. Room	1.2	kw	0.90	1200	1333		
7	A	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
8	A	Vanity Lighting	2	Pat. Room	1.2	kw	0.90	1200	1333		
9	B	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
10	B	Vanity Lighting	2	Pat. Room	1.2	kw	0.90	1200	1333		
11	C	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
12	C	Vanity Lighting	2	Pat. Room	1.2	kw	0.90	1200	1333		
13	A	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
14	A	Table Lamps	2		0.8	kw	0.90	800	889		
15	B	Receptacles (3R)	1	PSU	0.6	kw	0.80	600	750		
16	B	LED Task Lighting	3	NS	875	w	0.90	875	972		
17	C	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
18	C	Spare			13	a	0.80	1248	1560		
19	A	Receptacles (5R)	1	Pat. Room	1	kw	0.80	1000	1250		
20	A	Spare			13	a	0.80	1248	1560		
21	B	Receptacles (5R)	1	Pat. Room	1	kw	0.80	1000	1250		
22	B	Spare			13	a	0.80	1248	1560		
23	C	Receptacles (5R)	1	Pat. Room	1	kw	0.80	1000	1250		
24	C	Spare			13	a	0.80	1248	1560		
25	A	Receptacles (4R)	1	Pat. Room	0.8	kw	0.80	800	1000		
26	A	Spare			13	a	0.80	1248	1560		
27	B	Receptacles (5R)	1	Pat. Room	1	kw	0.80	1000	1250		
28	B	Spare			13	a	0.80	1248	1560		
29	C	Receptacles (5R)	1	Pat. Room	1	kw	0.80	1000	1250		
30	C	Spare			13	a	0.80	1248	1560		
31	A	Receptacles (6R)	1	Pat. Toilet	1.2	kw	0.80	1200	1500		
32	A	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
33	B	Receptacles (6R)	1	Pat. Toilet	1.2	kw	0.80	1200	1500		
34	B	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
35	C	Receptacles (6R)	1	Pat. Toilet	1.2	kw	0.80	1200	1500		
36	C	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
37	A	Receptacles (6R)	1	Pat. Toilet	1.2	kw	0.80	1200	1500		
38	A	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
39	B	Receptacles (4R)	1		0.8	kw	0.80	800	1000		
40	B	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
41	C	Plug Strip	1		1.5	kw	0.80	1500	1875		
42	C	Receptacles (6R)	1	PSU	1.2	kw	0.80	1200	1500		
PANEL TOTAL								47.9	58.7	Amps=	162.9

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	15.9	19.4	34%	161.9
PHASE TOTAL	B	15.2	18.5	32%	154.2
PHASE TOTAL	C	16.8	20.0	35%	167.1

LOAD CATAGORIES		Connected			Demand				Ver. 104
		kW	kVA	DF	kW	kVA	PF		
1	Receptacles	30.3	37.9		30.3	37.9	0.80		
2	Lighting	8.0	8.9		8.0	8.9	0.90		
3	LED Lighting	0.9	1.0		0.9	1.0	0.90		
4		0.0	0.0		0.0	0.0			
5		0.0	0.0		0.0	0.0			
6		0.0	0.0		0.0	0.0			
7		0.0	0.0		0.0	0.0			
8		0.0	0.0		0.0	0.0			
9	unassigned	8.7	10.9		8.7	10.9	0.80		
Total Demand Loads					47.9	58.7			
Spare Capacity		20%			9.6	11.7			
Total Design Loads					57.5	70.4	0.82	Amps=	195.5

Table 97: Panel 2LNL2 Worksheet

PANELBOARD SCHEDULE

VOLTAGE:	208Y/120V,3PH,4W	PANEL TAG:	2LNL2	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	200A	PANEL LOCATION:	2B48	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

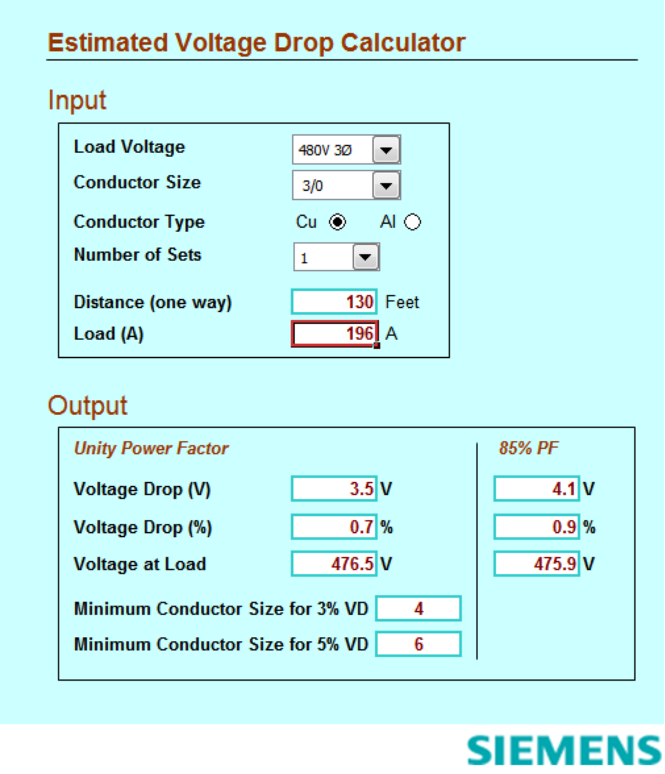
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Receptacles (6R)	PSU	1200	20A/1P	1	*			2	20A/1P	1200	Pat. Room	Vanity Lighting
Receptacles (6R)	PSU	1200	20A/1P	3		*		4	20A/1P	1200	Pat. Room	Vanity Lighting
Receptacles (6R)	PSU	1200	20A/1P	5			*	6	20A/1P	1200	Pat. Room	Vanity Lighting
Receptacles (6R)	PSU	1200	20A/1P	7	*			8	20A/1P	1200	Pat. Room	Vanity Lighting
Receptacles (6R)	PSU	1200	20A/1P	9		*		10	20A/1P	1200	Pat. Room	Vanity Lighting
Receptacles (6R)	PSU	1200	20A/1P	11			*	12	20A/1P	1200	Pat. Room	Vanity Lighting
Receptacles (6R)	PSU	1200	20A/1P	13	*			14	20A/1P	800	0	Table Lamps
Receptacles (3R)	PSU	600	20A/1P	15		*		16	20A/1P	875	NS	LED Task Lighting
Receptacles (6R)	PSU	1200	20A/1P	17			*	18	20A/1P	1248		Spare
Receptacles (5R)	Pat. Room	1000	20A/1P	19	*			20	20A/1P	1248		Spare
Receptacles (5R)	Pat. Room	1000	20A/1P	21		*		22	20A/1P	1248		Spare
Receptacles (5R)	Pat. Room	1000	20A/1P	23			*	24	20A/1P	1248		Spare
Receptacles (4R)	Pat. Room	800	20A/1P	25	*			26	20A/1P	1248		Spare
Receptacles (5R)	Pat. Room	1000	20A/1P	27		*		28	20A/1P	1248		Spare
Receptacles (5R)	Pat. Room	1000	20A/1P	29			*	30	20A/1P	1248		Spare
Receptacles (6R)	Pat. Toilet	1200	20A/1P	31	*			32	20A/1P	1200	PSU	Receptacles (6R)
Receptacles (6R)	Pat. Toilet	1200	20A/1P	33		*		34	20A/1P	1200	PSU	Receptacles (6R)
Receptacles (6R)	Pat. Toilet	1200	20A/1P	35			*	36	20A/1P	1200	PSU	Receptacles (6R)
Receptacles (6R)	Pat. Toilet	1200	20A/1P	37	*			38	20A/1P	1200	PSU	Receptacles (6R)
Receptacles (4R)	0	800	20A/1P	39		*		40	20A/1P	1200	PSU	Receptacles (6R)
Plug Strip		1500	20A/1P	41			*	42	20A/1P	1200	PSU	Receptacles (6R)

CONNECTED LOAD (KW) - A Ph.	15.90		TOTAL DESIGN LOAD (KW)	57.49
CONNECTED LOAD (KW) - B Ph.	15.17		POWER FACTOR	0.82
CONNECTED LOAD (KW) - C Ph.	16.84		TOTAL DESIGN LOAD (AMPS)	196

Table 98: Panel 2LNL2

Feeder Sizing Worksheet	
Panelboard	
Tag	2LNL2
Voltage System	208Y/120V,3PH,4W
Calculated Design Load (kW)	57.49
Calculated Power Factor	0.82
Calculated Design Load (kVA)	70.39
Calculated Design Load (A)	196
Feeder	
Feeder Protection Size	225A/3P C/B
Number of Sets	1
Wire Size	
Phase	(3) #3/0 AWG
Neutral	(1) #3/0 AWG
Ground	(1) #6 AWG
Wire Area (Table 5)	
Each Phase	0.2679
Total - All Phases	0.8037
Neutral	0.2679
Ground	0.0507
Total - All Wires	1.1223
Minimum Conduit Area (above * 2.5)	2.80575
Conduit Size (Table 4)	2" EMT
Conduit Size (Table C.1)	2" EMT
Feeder Length	130'
Final Voltage Drop (V)	3.5
Final Voltage Drop (%)	0.7
Was Feeder Resized?	Yes

Table 99: Feeder Worksheet for Panel 2LNL2



Estimated Voltage Drop Calculator

Input

Load Voltage: 480V 3Ø
Conductor Size: 3/0
Conductor Type: Cu ● Al ○
Number of Sets: 1
Distance (one way): 130 Feet
Load (A): 196 A

Output

	Unity Power Factor	85% PF
Voltage Drop (V)	3.5 V	4.1 V
Voltage Drop (%)	0.7 %	0.9 %
Voltage at Load	476.5 V	475.9 V

Minimum Conductor Size for 3% VD: 4
Minimum Conductor Size for 5% VD: 6

Table 100: Voltage Drop Calculations for Panel 2LNL2

Electrical Design | Over-Current Device Coordination Study

Overview

Description

A protective device coordination study ensures efficient performance and safe operation of the distribution system. The study can help to isolate faults at a specific protection device to avoid equipment damage and injury to personnel. The coordination study guarantees a properly designed system in which downstream breakers trip before those higher in the system, preventing disruptions and damage to the equipment.

For this study, a single path through the North Addition of the South Nassau Communities Hospital was tested. The path extends from the utility entrance to the main switchboard to panel 4LNL1. This path includes the distribution panel 3PNL1 and step-down transformer 3-T01. The coordination of protective devices will be shown along this path. The feeders along this run are numbers 12 and 35. The location of the path can be seen in Figure ##. Figure ## shows the simplified coordination path. Circuit breakers were specified from the Eaton website and were overlaid to examine coordination between the devices.

The path extends from the utility entrance to the main switchboard to panel 4LNL1. This path includes the distribution panel 3PNL1 and step-down transformer 3-T01. The coordination of protective devices will be shown along this path. The feeders along this run are numbers 12 and 35.

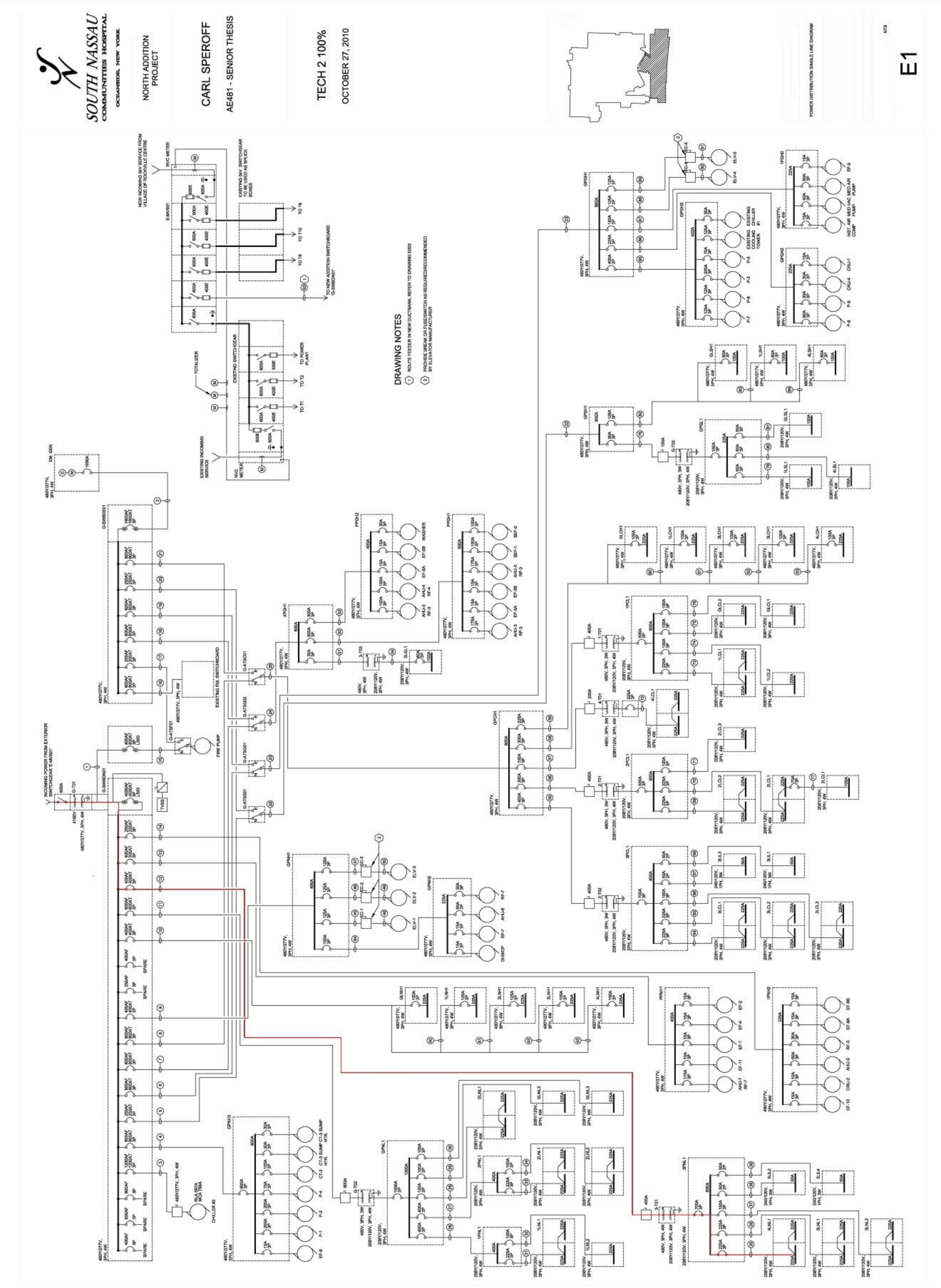


Figure 108: Location of Protective Device Coordination Study

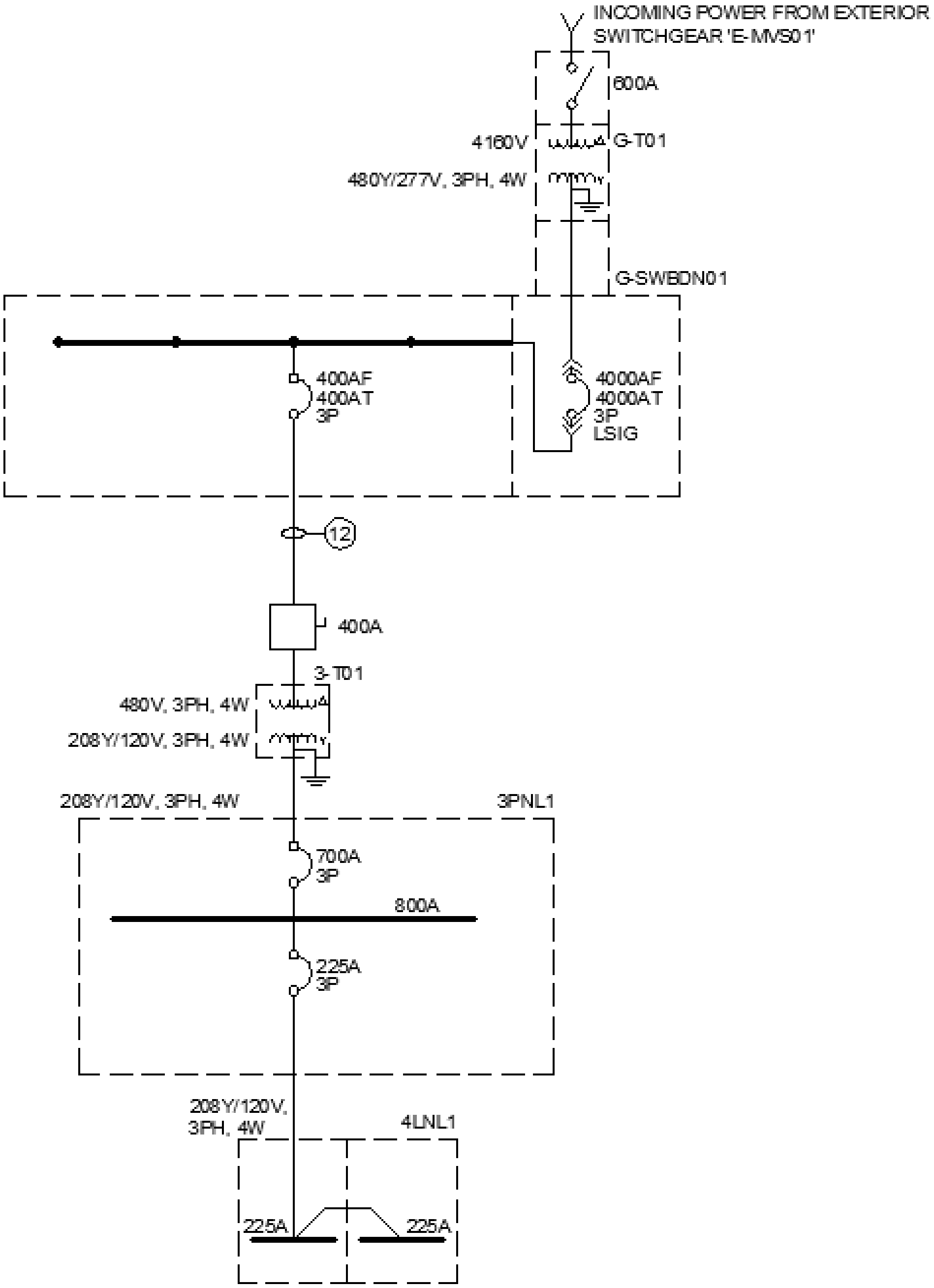


Figure 109: Simplified Protective Device Coordination Path

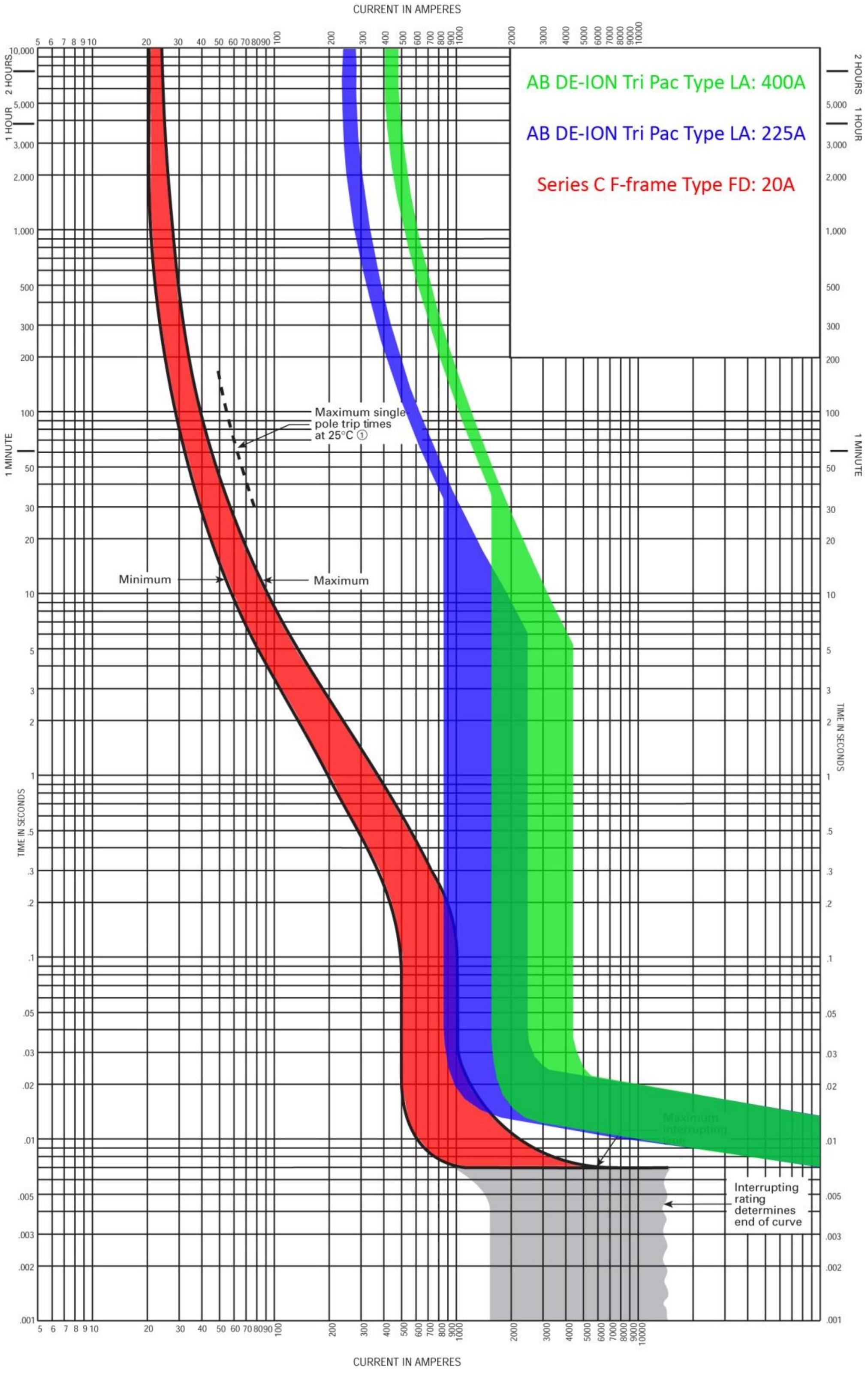


Figure 110: Trip Curves

Electrical Design | Short Circuit Analysis

Overview

Description

The following short circuit analysis predicts the maximum available fault current at various points within the electrical system of the North Addition. Through this analysis, it is ensured that the proper interruption ratings are provided for each component. The short circuit at the utility, transformer, switchboard, distribution panel, and power panel are given below. The utility short circuit was not provided and is assumed to be 500,000 kVA. Additional assumptions were made based on average or common values if specific values were not provided. The direct (ohmic) method was used in this calculation.

Direct (Ohmic) Method

Primary Utility

Assumptions:

Available Fault = 500,000 kVA
X/R = 12
%Z = 5.5%
kVA_{XFRMR} = 2500 kVA

Calculations:

$Z_{UTIL} = (kV^2 \times 10^6) / kVA_{UTIL} = ((0.480V)^2 \times 10^6) / (500000\ kVA) = 0.461\ m\Omega$
$R_{UTIL} = Z_{UTIL} \cos(\tan^{-1}(X/R)) = 0.461\cos(\tan^{-1}(12)) = 0.038\ m\Omega$
$X_{UTIL} = Z_{UTIL} \sin(\tan^{-1}(X/R)) = 0.461\sin(\tan^{-1}(12)) = 0.191\ m\Omega$

Switchboard & Transformer

Assumptions:

X/R = 12
%Z = 5.5%
kVA_{XFRMR} = 2500 kVA

Calculations:

$R_{XFRMR} = kV^2 \times \%Z \times 10^4 \times \cos(\tan^{-1}(X/R)) / kVA_{XFRMR}$
$= (.480V)^2 \times 5.5 \times 10^4 \times \cos(\tan^{-1}(12)) / 2500$
$= 0.421\ m\Omega$
$X_{XFRMR} = kV^2 \times \%Z \times 10^4 \times \sin(\tan^{-1}(X/R)) / kVA_{XFRMR}$
$= (.480V)^2 \times 5.5 \times 10^4 \times \sin(\tan^{-1}(12)) / 2500$
$= 5.051\ m\Omega$
$Z_{TOTAL} = Z_{UTIL} + Z_{XFRMR}$
$= (0.038 + j0.459) + (0.421 + j5.051) = 4.59 + j5.51\ m\Omega$

ISC = VL-N x 1000 / |ZTOTAL|
= 277 X 1000 / sqrt($4.59^2 + 5.51^2$)
= **38,625 A**

Distribution Panel (3PNL1) Through Transformer 3-T01

Feeder from Switchboard to Panel:

244' of 2 Sets of (4) #3/0 AWG
From ANSI/IEEE Std. 242:
R = 6.68 mΩ / 100'
X = 3.37 mΩ / 100'

Calculations:

$R_{CONDUCTOR}$ = L/100 x R x 1/# Sets
= 244/100 x 6.68 x ½ =
= 8.150 mΩ
$X_{CONDUCTOR}$ = L/100 x X x 1/# Sets
= 244/100 x 3.37 x ½ =
= 4.111 mΩ
Z_{TOTAL} = Z_{TRANSF} + Z_{XFRMR}
= (4.59 + j5.51) + (8.150 + j4.111) = 12.76 + j9.621 mΩ

Assumptions:

X/R = 5.5
%Z = 4.5%
kVA_{XFRMR} = 225 kVA

Calculations:

$\alpha = V_{PRIMARY} / V_{SECONDARY}$ = 480V/208V = 2.308
$1/\alpha^2 = 1/(2.308)^2 = 0.188$
$Z_{SECONDARY} = (1/\alpha^2) \times Z_{PRIMARY}$
= 0.188 x (12.76 + j9.621) = (2.398 + j1.808)
$R_{XFRMR} = kV^2 \times \%Z \times 10^4 \times \cos(\tan^{-1}(X/R)) / kVA_{XFRMR}$
= $(.208V)^2 \times 4.5 \times 10^4 \times \cos(\tan^{-1}(5.5)) / 225$
= 1.547 mΩ
$X_{XFRMR} = kV^2 \times \%Z \times 10^4 \times \sin(\tan^{-1}(X/R)) / kVA_{XFRMR}$
= $(.208V)^2 \times 4.5 \times 10^4 \times \sin(\tan^{-1}(5.5)) / 225$
= 8.513 mΩ
Z_{TOTAL} = Z_{UTIL} + Z_{XFRMR}
= (2.398 + j1.808) + (1.547 + j8.513) = 3.946 + j10.321 mΩ

ISC = VL-N x 1000 / |ZTOTAL|

= 120 X 1000 / sqrt(3.946^2 + 10.321^2)

= **10,860 A**

Panel (4LNL1)

Feeder from Panel 3PNL1 to Panel 4LNL1:

88' of 1 Set of (4) #4/0 AWG

From ANSI/IEEE Std. 242:

R = 5.34 mΩ / 100'

X = 3.31 mΩ / 100'

Calculations:

$R_{CONDUCTOR}$ = L/100 x R x 1/# Sets

= 88/100 x 5.34 x 1 =

= 4.699 mΩ

$X_{CONDUCTOR}$ = L/100 x X x 1/# Sets

= 88/100 x 3.31 x 1 =

= 2.913 mΩ

Z_{TOTAL} = $Z_{DIST\ PANEL}$ + $Z_{CONDUCTOR}$

= (3.946 + j10.321) + (4.699 + j2.913) = 8.645 + j13.234mΩ

ISC = VL-N x 1000 / |ZTOTAL|

= 120 X 1000 / sqrt(8.645^{2} + 13.234^2)

= **7591 A**

Electrical Depth #1 | Motor Control Center

Overview

Description

The purpose of this study is to gain experience and learn the steps and process involved in designing a motor control center. This study was chosen because of applicability to the existing power plant on the hospitals campus. The power plant is located to the east of the new North Addition. It primarily houses boilers and chillers for the existing hospital, and also additional equipment required for the North Addition. Most of the equipment in the space is motors for the new chiller and cooling tower, as well as two heaters for the cooling tower. The loads from this equipment were studied and used in conjunction with the 2008 NEC as well as equipment catalogs from Eaton, General Electric, and Siemens to design the motor control center and its associated feeder. The following section includes a schedule of the equipment that was added to the motor control center, and motor control center schedule, and an isometric view showing the dimensions of the motor control center and the location of the various starters.

Calculations

Table 101 below shows the equipment included in the motor control center and the calculations resources used to design the motor control center.

Motor Control Center Design

Using the previous table and manufacturer's data, the motor control center was designed as described in the table below. MCA was used to determine the minimum ampacity of approximately 808 A. The circuit breakers available for the Eaton Freedom 2100 series were either 800A or 1200A, so the 1200A circuit breaker was chosen. Based on the remaining loads, it was calculated that six additional sections were needed. The dimensions of the motor control center are 14' 4-3/8" X 7'-6" X 1'-9". Table 101 below shows the location of each component of the motor control center as well as a description of the circuit. An elevation and isometric view of the motor control center is also provided. Manufacturer's information can be found in Appendix D.

MOTOR CONTROL CENTER: MCC1 **LOCATION:** POWER PLANT
AMPS: 1200 **VOLTS:** 480 3 PHASE 3 **WIRE** **NEMA:** 1A **kAIC:** 100

UNIT #	TAG	EQUIPMENT	HP	VOLT	PHASE	PF	MOTOR AMPS[a]	MCA[b]	kVA	PROTECTION (MCCB)[c]	STARTER TYPE	STARTER (NEMA SIZE)[d]	# SPACES (STD/MAX)[e]	FLA	STARTER		CIRCUIT PROTECTION		FEEDER
															TYPE	SIZE	TYPE	TRIP	
1A	-	INCOMING FEEDER	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MCCB	1200	(3) 600 MCM & #1 G in 3" C ea.
2A	P-1	PUMP #1 PACKAGED CHILLER WATER UNIT	100	480	3	0.95	124	155.00	128.71	400	VFD	4	12X	124	VFD	4	MCCB	400	(1) 600 MCM & #3 G in 3" C
3A	P-2	PUMP #2 PACKAGED CHILLER WATER UNIT	100	480	3	0.95	124	124.00	102.97	400	VFD	4	12X	124	VFD	4	MCCB	400	(1) 600 MCM & #3 G in 3" C
4A	P-3	PUMP #3 PACKAGED CHILLER WATER UNIT	100	480	3	0.95	124	124.00	102.97	400	VFD	4	12X	124	VFD	4	MCCB	400	(1) 600 MCM & #3 G in 3" C
5A	P-4	PUMP #4 PACKAGED CHILLER WATER UNIT	25	480	3	0.95	34	34.00	28.23	70	FVNR	2	2X / 3X	65	VFD	3	MCCB	150	(1) 1/0 & #6 G in 3/4" C
5B	P-5	PUMP #5 PACKAGED CHILLER WATER UNIT	25	480	3	0.95	34	34.00	28.23	70	FVNR	2	2X / 3X	96	FVNR	4	MCCB	150	(1) 1/0 & #6 G in 3/4" C
6A	P-6	PUMP #6 PACKAGED CHILLER WATER UNIT	75	480	3	0.95	96	96.00	79.72	150	FVNR	4	3X / 4X	96	FVNR	4	MCCB	150	(1) 1/0 & #6 G in 3/4" C
6B	P-7	PUMP #7 PACKAGED CHILLER WATER UNIT	75	480	3	0.95	96	96.00	79.72	150	FVNR	4	3X / 4X	34	FVNR	2	MCCB	70	(1) #4 & #8G in 3/4" C
6C	CT-3	COOLING TOWER 3	50	480	3	0.95	65	65.00	53.98	150	VFD	3	9X	34	FVNR	2	MCCB	70	(1) #4 & #8G in 3/4" C
6D	DWBP-1	DOMESTIC WATER BOOSTER PUMP	10	480	3	0.95	14	14.00	11.63	35	FVNR	1	2X / 3X	14	FVNR	1	MCCB	35	(1) #8 & #10G in 3/4" C
6E	DWBP-2	DOMESTIC WATER BOOSTER PUMP	10	480	3	0.95	14	14.00	11.63	35	FVNR	1	2X / 3X	14	FVNR	1	MCCB	35	(1) #8 & #10G in 3/4" C
6F	-	SPACE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7A	DWBP-3	DOMESTIC WATER BOOSTER PUMP	5	480	3	0.95	7.6	7.60	6.31	15	FVNR	1	2X / 3X	7.6	FVNR	1	MCCB	15	(1) #12 & #12G in 3/4" C
7B	EF-6	EXHAUST FAN 6	3	480	3	0.85	4.8	4.80	3.99	15	FVNR	1	2X / 3X	4.8	FVNR	1	MCCB	15	(1) #12 & #12G in 3/4" C
7C	CT-3 HTR-1	COOLING TOWER 3 HEATER 1	20 A	480	3	0.95	20	20.00	16.61	50[f]	-	-	2X	20	-	-	MCCB	50	(1) #6 & #10G in 3/4" C
7C	CT-3 HTR-2	COOLING TOWER 3 HEATER 2	20 A	480	3	0.95	20	20.00	16.61	50[f]	-	-	2X	20	-	-	MCCB	50	(1) #6 & #10G in 3/4" C
7D	-	SPACE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS								**808.40**	**671.30**				**65**						

Notes:

1. Eaton Freedom 2100 Series Motor Control Center
2. 1200A Frame size based on 808.40 MCA. Requires 12X for main incoming line

[a] NEC Table 430.250

[b] 125% of largest load, 100% of remaining loads

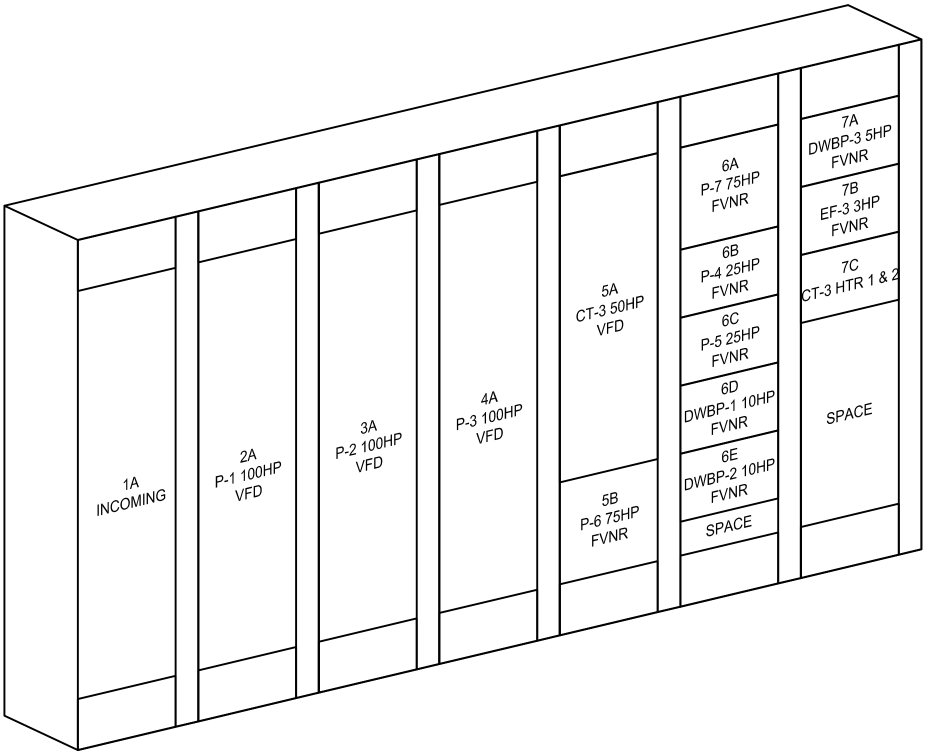
[c] Eaton Consulting Application Guide Table 30.1-2, Table 30.1-88, Table 30.1-61

[d] Siemens Basics of Motor Control Centers

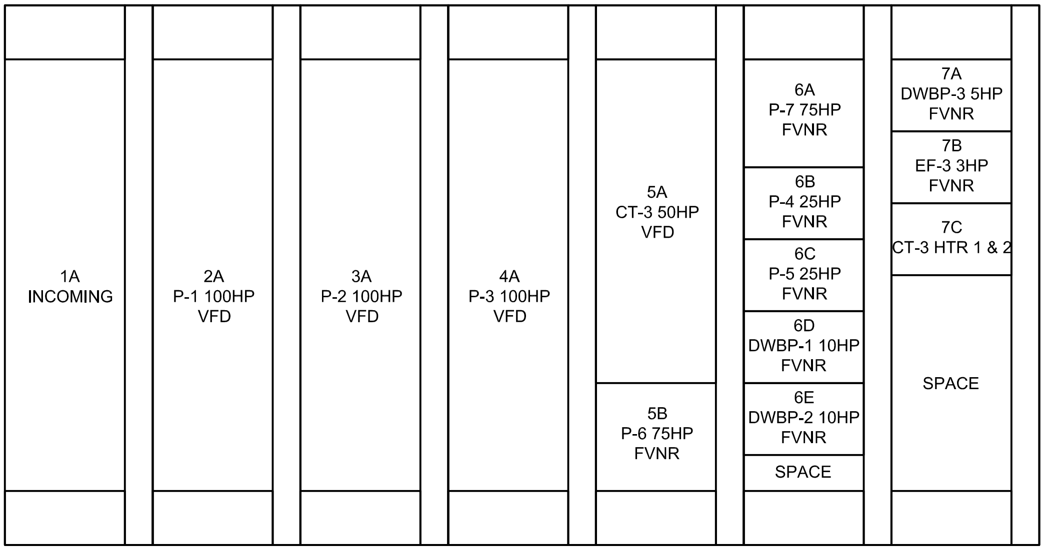
[e] Eaton Consulting Application Guide Table 30.1-2, Table 30.1-29

[f] Eaton Consulting Application Guide Table 30.1-61 Dual MCCB

Table 101: Motor Control Center calculations and schedule



MCC-1 ISOMETRIC



MCC-1 ELEVATION

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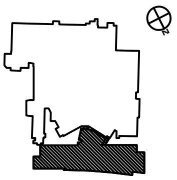
NORTH ADDITION
PROJECT



Motor Control Center Elevation and Isometric

Elevation Scale: 3/8" = 1'

AE Senior Thesis Final Report

Carl Speroff

Electrical Depth #2 | Cost Benefit Analysis of Increasing Feeder Size

Overview

Description

The purpose of this study is to compare the cost of energy lost in feeders to the cost of increasing feeder sizes. While the increasing feeder sizes will result in a higher initial cost, the larger wire sizes will have lower impedance and less energy will be lost during transmission. The initial costs of various wire sizes and the total cost of lost energy were calculated for each feeder and were compared to determine which is choice is more economical and cost effective.

Methods

The total length and load of each feeder for the North Addition was calculated. The loads were calculated by using the design loads (in amps) listed on the panelboard schedules provided. Since the utility statements provided show the amount of power consumed by the entire South Nassau Hospital and do not indicate the amount of power consumed by the North Addition, the peak and service entrance demand loads are unknown. As a result, average loads were calculated at 30%, 50%, 70%, and 90% of the design load. To determine the amount of energy lost during transmission, the voltage drop for each feeder was calculated. These calculations were performed using voltage drop tables and equations listed in Section 1.3-23 in Eaton's 2006 Consulting Application Guide. Assuming a load power factor of 90%, the voltage drop (measured in volts per ampere per 100 feet, was obtained from Table 1.3-23. The following equation was used:

Voltage Drop (V) = Voltage Drop Factor x (Current (A) x Length of Feeder (ft)) / 100

To determine the total energy lost from each feeder, the resulting voltage drop was then multiplied by the average load. The annual cost of energy lost was calculated by multiplying the utility rates below by 24 hours and 365 days. The utility rates from the utility company, Village of Rockville Centre, are split into four categories. Step 1 of the energy charge is applied to the first 30,000 kwh each month, which averages out to about 21% of the total consumption each month. To account for this, the adjusted energy was used to determine the cost for energy. In addition to energy costs, the average fuel adjustment over a year was calculated. An increased cost is applied to high voltage demand, which is not broken down to a cost per kilowatt-hour on the statement. To account for the high voltage demand in the analysis, an average cost per kilowatt-hour was calculated by dividing the total charge for high voltage over a year by the total kilowatt-hours used. The utility charges are shown below along with the final cost per kilowatt-hour used in the calculations.

Energy

Step 1: $ 0.0881 per kwh
Step 2: $ 0.0792 per kwh
Adjusted Energy = $(0.2 x Average Load x Step 1) + (0.79 x Average Load x Step 2)

Fuel Adjustment

$ 0.0166 per kwh

High Voltage Demand

$ 0.0062 per kwh

Total Cost for Calculations

$(0.21 x Average Load x 0.1109) + (0.79 x Average Load x 0.102)

The initial cost of the original and increased feeders was calculated using the 2011 RS Means Construction Data for Electrical Systems. The data was used to calculate the total cost of labor, materials, overhead, and profit. These calculations were performed for each feeder.

The feeder sizes were increased by 1, 2, and 3 sizes and an initial cost and total cost of energy lost was calculated for each. The follows tables and graphs show the results of the comparison. The different scenarios were compared by comparing the difference in wire size and the percentage of design load used to calculate the average load. A calculation of the payback period for each scenario was also performed and is presented below.

Feeders 16 through 21 were not included in this study since they are not located on the normal / emergency system. Additionally, the largest feeder size used was 500 kcmil. When these feeders were increased, more sets of smaller wires were used. This process was used for Feeders 2, 3, 4, 11, 13, 52, 53, 56, 58, and 92. Detailed calculations are provided in Appendix E.

Cost Analysis at 30% Demand Load - Existing vs. Increased Size				
	Existing Wire Size	**1 Wire Size Larger**	**2 Wire Size Larger**	**3 Wire Size Larger**
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$4,443.52	$3,939.05	$3,526.08	$3,141.49
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$504.47	$917.44	$1,302.03
TOTAL INITIAL COST ($)	$974,846.50	$1,123,657.45	$1,275,636.98	$1,453,580.38
TOTAL INITIAL COST INCREASE ($)	$0.00	$148,810.95	$300,790.48	$478,733.88
SIMPLE PAYBACK PERIOD (YEARS)	-	294.99	327.86	367.68

Table 102: Cost Analysis at 30% Demand Load

Cost Analysis at 50% Demand Load - Existing vs. Increased Size				
	Existing Wire Size	1 Wire Size Larger	2 Wire Size Larger	3 Wire Size Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$12,343.11	$10,941.81	$9,794.66	$8,726.36
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$1,401.29	$2,548.44	$3,616.74
TOTAL INITIAL COST ($)	$974,846.50	$1,123,657.45	$1,275,636.98	$1,453,580.38
TOTAL INITIAL COST INCREASE ($)	$0.00	$148,810.95	$300,790.48	$478,733.88
SIMPLE PAYBACK PERIOD (YEARS)	-	106.20	118.03	132.37

Table 103: Cost Analysis at 50% Demand Load

Cost Analysis at 70% Demand Load - Existing vs. Increased Size				
	Existing Wire Size	1 Wire Size Larger	2 Wire Size Larger	3 Wire Size Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$24,192.49	$21,445.96	$19,197.54	$17,103.67
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$2,746.53	$4,994.95	$7,088.82
TOTAL INITIAL COST ($)	$974,846.50	$1,123,657.45	$1,275,636.98	$1,453,580.38
TOTAL INITIAL COST INCREASE ($)	$0.00	$148,810.95	$300,790.48	$478,733.88
SIMPLE PAYBACK PERIOD (YEARS)	-	54.18	60.22	67.53

Table 104: Cost Analysis at 70% Demand Load

Cost Analysis at 90% Demand Load - Existing vs. Increased Size				
	Existing Wire Size	1 Wire Size Larger	2 Wire Size Larger	3 Wire Size Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$39,991.67	$35,451.48	$31,734.71	$28,273.42
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$4,540.19	$8,256.96	$11,718.25
TOTAL INITIAL COST ($)	$974,846.50	$1,123,657.45	$1,275,636.98	$1,453,580.38
TOTAL INITIAL COST INCREASE ($)	$0.00	$148,810.95	$300,790.48	$478,733.88
SIMPLE PAYBACK PERIOD (YEARS)	-	32.78	36.43	40.85

Table 105: Cost Analysis at 90% Demand Load

Cost Analysis at 90% Demand Load - Existing vs. Increased Size for Large Feeders				
	Existing Wire Size	**1 Wire Size Larger**	**2 Wire Size Larger**	**3 Wire Size Larger**
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$19,985.83	$17,724.18	$16,111.38	$13,993.72
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$2,261.65	$3,874.44	$5,992.10
TOTAL INITIAL COST ($)	$335,346.21	$382,370.92	$425,263.57	$509,525.87
TOTAL INITIAL COST INCREASE ($)	$0.00	$47,024.71	$89,917.36	$174,179.66
SIMPLE PAYBACK PERIOD (YEARS)	-	20.79	23.21	29.07

Table 106: Cost Analysis at 90% Demand Load

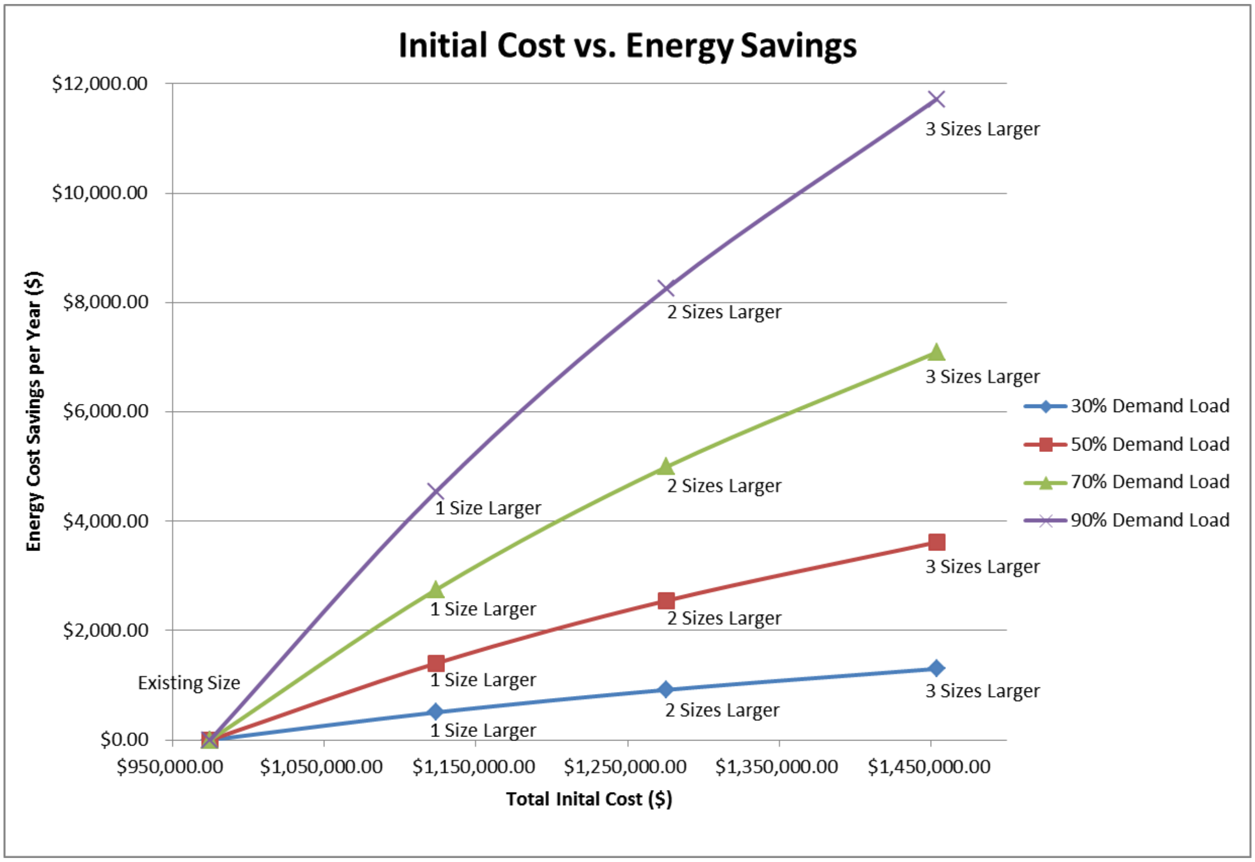


Figure 111: Initial Cost vs. Energy Savings

Discussion

The total cost shown in these results is the sum of the conductors and conduit. The total cost savings per year was calculated by subtracting the total cost of energy loss per year for each wire size from the total cost of energy loss per year for the next larger wire size. The total initial cost increase was calculated in a similar manner. Many useful conclusions can be made from the results of this study. As expected, as the wire sizes increased, the energy cost savings increased due to reduction in lost energy. Another expected result wise the increase of the initial cost as feeder sizes were increased. The graphs and tables above show that as the wire sizes get larger, the amount of energy saved increases.

Tables 101 through 104 show the payback period for each scenario. The total initial cost increase per linear foot for each wire size increase was divided by the total energy cost savings per year to determine how many years it would take for the increased feeders to be economically beneficial. The results show that the payback period increases as the wire size increases. It would be most economical to select the wire size that provides the shortest payback period, which occurs when the feeders are increased by two sizes.

An interesting trend that emerged was the way in which energy savings increased as the demand load increased. The cost savings increase as the loads get larger. This is expected, since the energy saved is dependent on the amount of energy consumed. This is important, especially when considering the loads on the feeders. Many panels in the building contain very small loads, which results in a small load across the feeder. This increases the initial cost of the system, which increases the payback period. This also shows the importance of consolidating circuits. Additionally, as shown by Table 106, the feeders with the greatest length and greatest load will benefit the most from increased feeder sizes. The simple payback period is significantly less for these feeders compared to the system as a whole. As a result, an alternate solution may be increasing only the feeder size for feeders supplying a large load over a long distance.

Based on the results, the benefit of increasing the wire size depends on the percentage of demand load used. As shown from the results, the most savings occur with 90% of the demand load and present the best situation to increase the feeder size. In a hospital, many loads will be running full time, which makes it reasonable to assume a higher demand load. Feeders serving areas such as nursing stations or patient rooms which require a large amount of energy for sustained periods of time will benefit the most from increased feeder sizes. Areas such as the offices and auditorium, which will have various demand loads, will benefit less. This again shows that a better approach may be to increase select feeders. Considering the high demand loads of a hospital paired with the long life of the facility, increasing feeder sizes may be economically feasible, however the payback period is very long. A better economical solution may be to only increase the size of feeders with longs runs and a large load.

Architecture / Landscape Architecture Breadth | Courtyard Design

Overview

Description

The courtyard is located on the ground floor of the building accessible from the North Addition from through the conservatory. The courtyard encompasses approximately 14,000 SF of space and is surrounded by the new North Addition on the North and West and by the existing South Nassau Hospital on the South and East. It was designed with seating areas just outside of the conservatory and minimal landscaping and hardscaping throughout the space. The result is a somewhat bland design which feels enclosed and serves as a poor extension to the conservatory. Figures show the photographs of the existing design, while Figure 114 shows the existing plan for the space.

Design Goal

The owner's vision for the hospital is a facility which is modern, dignified, and comfortable. This vision was the basis for the redesign of the courtyard. The courtyard should serve as a welcoming extension of the conservatory. It should stand as an impressive backdrop for events held in the conservatory and should invite occupants to move outdoors and explore the space.

Concepts and Design

A major concept of the design was to reduce the harsh edges and linearity prominent in the existing design. This was achieved by designing a free form planter with built in benches which flows from the conservatory and around the wing of the existing hospital. The planter is made of brick with a granite top and contains small scale shrubs as well as large trees to anchor both ends. A second defining element is the ashlar landscaping wall located behind the planter. The wall serves as both an architectural element and a privacy screen used to shield the existing wall of the old hospital. Thuja Emerald Green evergreens located behind the wall provides additional screening of the lower portion of the existing hospital. These trees are also located along the east perimeter of the space to shield views of the eastern wing of the existing hospital. To add visual interest and a larger scale to the space, American elm trees will be planted just outside of the conservatory and in the back corner of the space. Renderings of the space are shown in Figure 100 through Figure 103. Architectural plans and details as well as a landscaping plan are provided at the end of this section.

Figure 112: Photograph of existing courtyard area

Figure 113: Photograph of existing courtyard seating

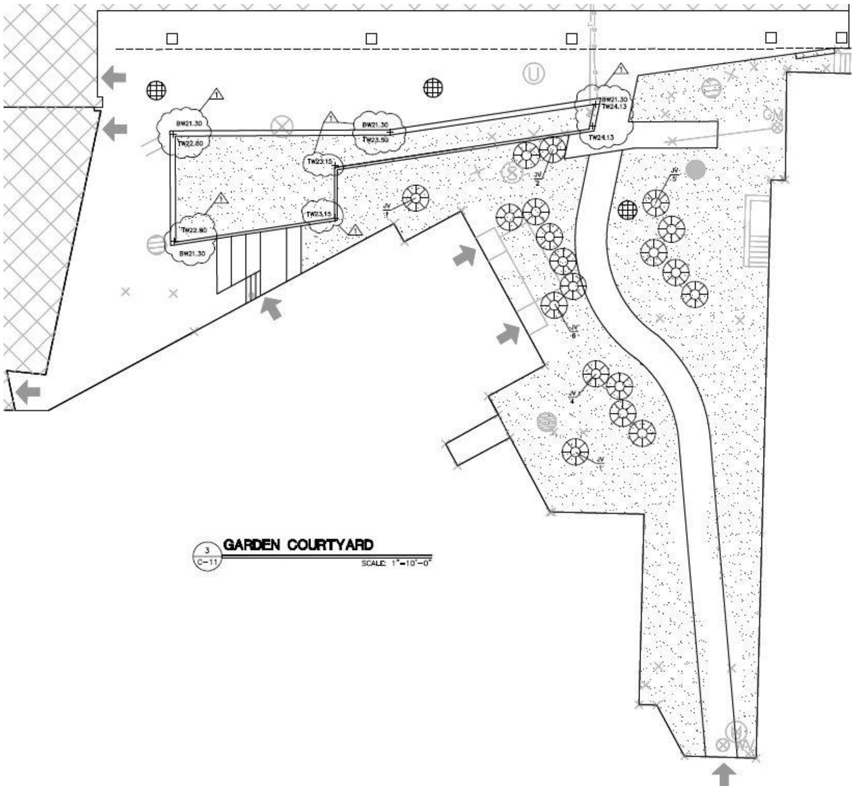


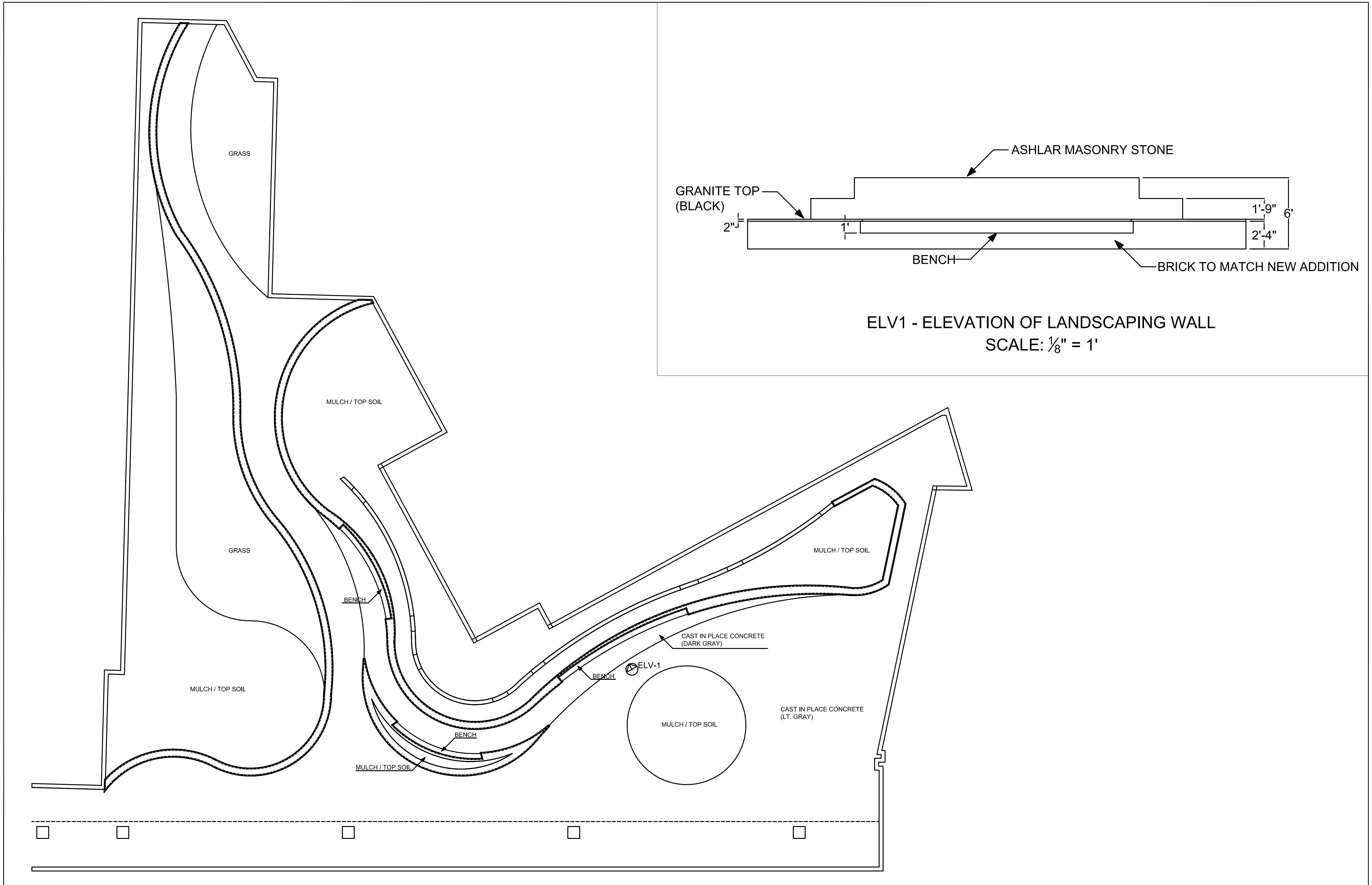
Figure 114: Courtyard existing landscaping plan

Figure 115: 3DS Max daytime rendering of courtyard

Figure 116: 3DS Max nighttime rendering of courtyard

Figure 117: 3DS Max daytime rendering of courtyard

Figure 118: 3DS Max nighttime rendering of courtyard



ELV1 - ELEVATION OF LANDSCAPING WALL
SCALE: 1/8" = 1'

COURTYARD ARCHITECTURAL PLAN
SCALE: 1/16" = 1'

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Final Report

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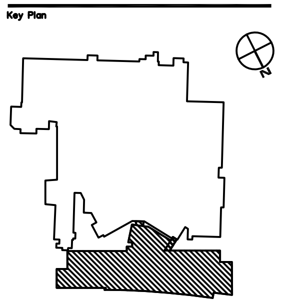
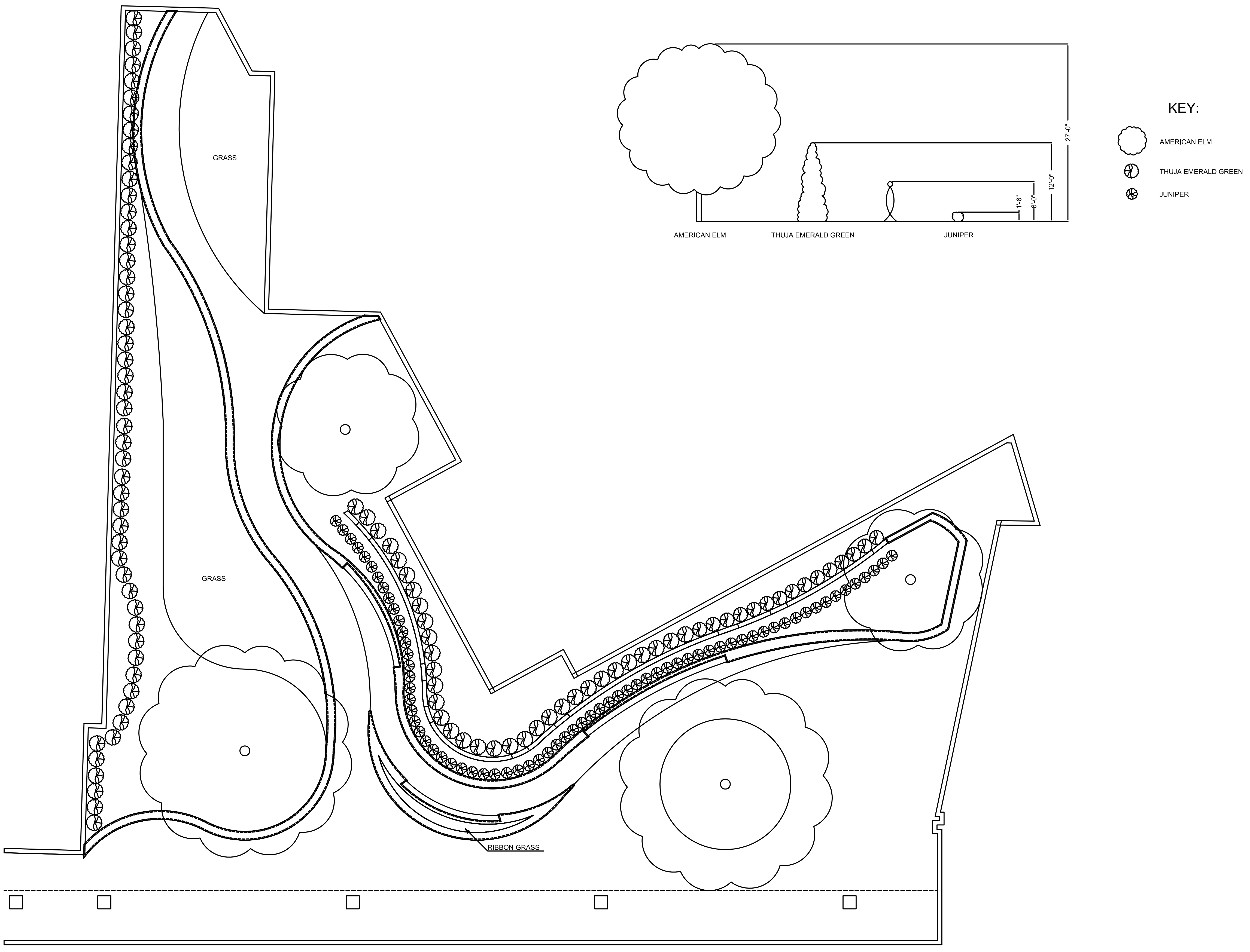


Scale:
1/16" = 1'

Courtyard
Architectural
Plan 1

A101



COURTYARD LANDSCAPING PLAN
SCALE: $\frac{1}{16}$" = 1'

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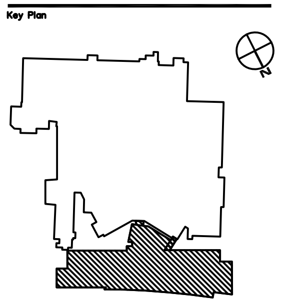


Scale:
1/16" = 1'

Courtyard
Landscaping
Plan 1

A102

Mechanical Breadth | Lobby HVAC Ductwork and Diffuser Design

Overview

Description

The lobby is the first space a visitor will see when entering South Nassau Communities Hospital. The owner's vision for the hospital is a facility which is modern, dignified, and comfortable and this should be evident when entering the hospital for the first time. It is therefore critical the first impression created by the architecture and design of the lobby clearly conveys this vision. The architect's original concept for the lobby created a clean and modern image with open ceiling and ceilings which reflected the light throughout the space. This vision was lost in the final design, in which harsh linear lines created by the diffuser and lighting layout divide the ceiling and eliminate the spaciousness shown in the initial design. In addition to minor architectural changes required in the space, the linear diffusers in the lobby needed to be relocated to allow the architects original vision to be achieved and to create a more modern and grand lobby.

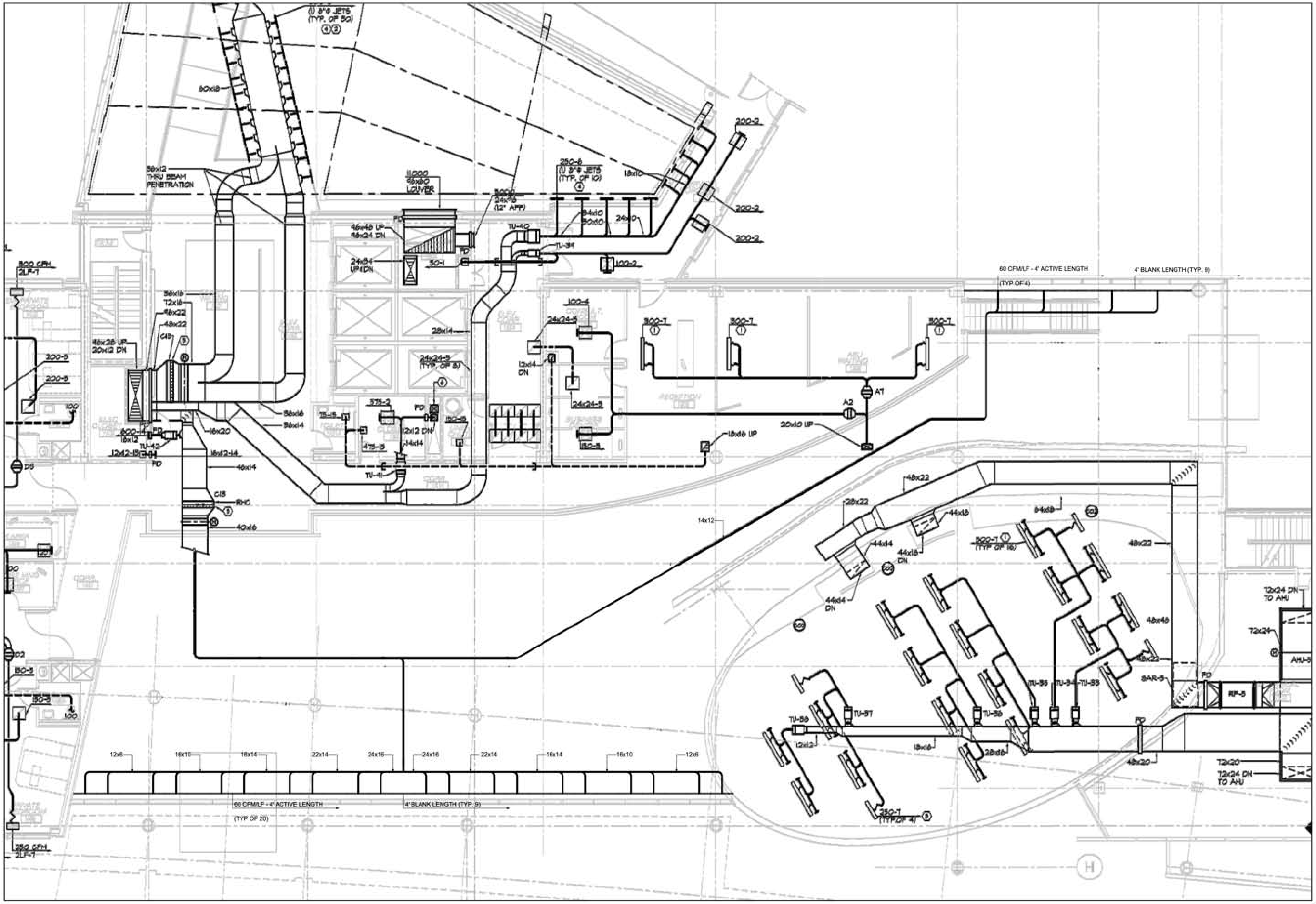
Design Goal

The goal of the design was to eliminate ceiling clutter and relocate the diffusers to a location where they fit seamlessly into the architectural and lighting design of the space.

Design Solution

It was determined that the most discrete type of diffuser would be a thin slot diffuser located on the perimeter of the ceiling and an Anemostat linear diffuser was selected. In order to select the size of the diffuser, the amount of air delivered to the space and the required throw needed to be analyzed. The current design delivers 5800 cfm of air to the space, which was determined to be adequate and was not changed. Since the diffuser is located along the glazing and pushes the air vertically, the throw of the new diffuser must be at least the height of the ceiling, which is 20'. The smallest diffuser available with a throw close to 20' is a linear diffuser four feet in length with a 1" slot. The diffuser delivers 60 cfm per linear foot and has a noise criterion of 20, which is under the recommendation for a lobby. The number of diffusers required was calculated based on the amount of air being delivered into the space and the capacity of the four foot length of diffuser. Twenty four foot sections were located along the glazing with nine spare diffusers included to create a continuous slot in the ceiling. The return fans located on the other side of lobby ensure the air will travel down from the diffusers and across the lobby.

In addition to the layout of the diffusers, new duct sizes were also calculated. These calculations were based on the volume of air as well as the velocity of air moving through the duct. The recommended maximum velocity used for the main duct was 1300 fpm, while the maximum for branch duct was 900 fpm. A ductwork plan showing the new layout and duct sizes is provided in this section of the report. Specifications for the diffuser are provided in Appendix F.



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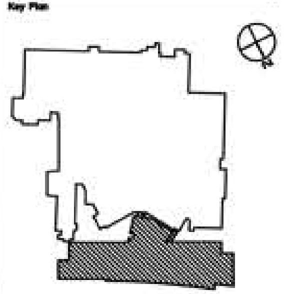
Key Plan



Scale:
1/16" = 1'

LOBBY HVAC
DUCTWORK

M101

Summary and Conclusions

The result of this year-long thesis conducted on South Nassau Communities Hospital North Addition is a new set of design solutions that enhances the aesthetics and performance of the building and its spaces. The lighting solutions for each space creates a design that not only enhances the hospitals modern image, but also creates a welcoming environment for both new and returning visitors. The lighting solution in the nurses' station eliminates the visual clutter and haze created by the original design and uses peripheral lighting and soft downlighting to create a relaxing, spacious, and functional work environment. Research on the biological effects of light on humans showed that artificial lighting, or more appropriately short wavelength optical radiation can be used to improve alertness, productivity, and can adjust the circadian rhythms of night shift workers to make adjustments to night work easier on the body and circadian systems. In the auditorium, the new lighting design expands on the flexibility of the first design while significantly reduces power consumption. The addition of perimeter lighting in the space helps draw attention to the unique wall and emphasizes the unique shape of the space.

The mechanical and minor architectural changes to the lobby help to achieve the architect's original vision for the space. The relocation of the diffusers in the space eliminated the ceiling clutter and harsh lines created by the original design and created a new canvas for the lighting design. The use of perimeter and cove lighting helped to create a feeling of spaciousness and grandeur in the lobby. The cove lighting helps to guide circulation in the space while the slender pendants add visual interest to the space and help to make the seating area more intimate.

The redesign of the courtyard as a part of the architectural breadth creates a welcoming space the serves as an extension of the lobby. The combination of fluid hardscaping and landscaping help to shield the existing hospital and creates calming area. The lighting design for the space accents these new features in the space. Uplighting along the decorative wall is used to bring out texture. The uniform placement of luminaires in the space helps to create pleasant rhythms and patterns. Under the darkness of night, the large trees in the space become focal point of the space through the use of uplighting.

Changes made to the electrical system were designed to accommodate the lighting changes made in each space. The existing panelboards and feeders were resized the accommodate the new lighting design. A short circuit and coordination study proves that the system will function properly. The design of a motor control center for the power plant provided a valuable opportunity to learn the steps and process involved in designing a motor control center. An analysis of the cost benefit of increasing wire sizes show that a whole building approach is not feasible due to the length of payback, however increasing feeders by one size may be beneficial in energy and cost saving for large demand loads over long runs.

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The following software was used for calculations, renderings, and analyses:

AGI32

Autodesk 3D Studio Max 2011

Autodesk AutoCAD 2011

Adobe Photoshop CS3