Final Report

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National Intrepid Center of Excellence | Bethesda, MD

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National Intrepid Center of Excellence (NICoE)

Bethesda, MD

Senior Thesis Building Abstract

Building Statistics

Location: National Naval Medical Center, Bethesda, MD
Function: Facility for research, diagnosis, and treatment of military personnel and veterans suffering from traumatic brain injury and psychological health issues.
Size: 72,000 sq. ft.
Number of Stories: 2
Budget: $65 million
Construction Dates: June 2008 – October 2009
Delivery Method: GMP Contract

Design Team

Owner: Plaza Construction
Construction Manager: Turner Construction Company
Soils Engineer: Schnabel Engineering, Inc.
Civil Engineer: A. Morton Thomas & Associates, Inc.
Landscape Architect: JJR
Architect: SmithGroup
Structural Engineer: Cagley & Associates, Inc.
MEP Engineer: SmithGroup
Lighting Designer: SmithGroup

Architecture

- Two distinct zonal areas of building:
  - "L" shaped "bar" zone contains spaces dedicated to the clinical functions of the facility.
  - Amorphous form houses the healing and public areas of the building.
- Indoor/outdoor spaces for patient relaxation and interaction.
- Exterior walls consist of curtainwall system around open areas, and pre-cast panels with punched window openings.
- Roof is composed of a concrete slab with TPO membrane system

Lighting

- Majority of lighting is general fluorescent with decorative fixtures in lobbies, waiting rooms, and other similar areas
- Exterior lighting at entrances, exits, pathways, recreation, and service spaces
- Switches, timers, occupancy sensors, and photosensors utilized for control
- Fluorescent and H.I.D. sources on 277/480V and incandescent on 120/208V

Electrical

- Serviced from existing 15 kV primary loop feeders
- Primary transformer rated 2500kVA with 3000A main switchboard
- Essential system divided into equipment and life safety branches
- Emergency power provided by a 400kW/500KVA diesel standby generator
- UPS rated at 225 kVA connected to two PDUs to distribute output

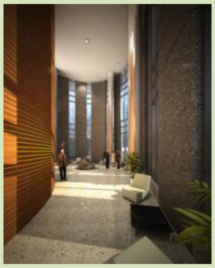
Mechanical

- Combination of VAV and constant volume control boxes are utilized
- Primary heating from high pressure campus steam
- Constant volume unitary air conditioning units
- Air handling unit is field-erected
- Equipment located in first and second floor mechanical rooms

Structural

- Foundation consists of slab on grade concrete system
- Remaining levels supported by two-way concrete slabs
- Reinforced concrete columns aligned on a primarily rectilinear grid
- Concrete columns support exterior curtainwall and architectural concrete panels





Christine Clowes | Lighting / Electrical | www.engr.psu.edu/ae/thesis/portfolios/2009/cmc5004

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Executive Summary

The National Intrepid Center of Excellence (NICoE), located at the National Naval Medical Center in Bethesda, MD, is a state of the art facility for veterans and military personnel with traumatic brain injuries and psychological issues. The building will provide advanced services through research, diagnosis, and treatment. Two distinct zonal areas make up the building's composition. The "L" shape is located on the east and south sides and contains spaces dedicated to the clinical function of the facility. The remaining amorphous form is positioned on the north and west areas of the site, housing the healing and public areas of the building, including the open lobby, waiting rooms, lounge, auditorium, and rehabilitation rooms. There are also indoor/outdoor spaces for patients and families to relax and interact.

One of the main focuses of this report was to research and redesign the lighting and electrical systems in four distinct spaces within the building: the exterior façade, main lobby, auditorium, and physical and occupational therapy spaces. The main concept portrayed in the design is the qualities of a soldier. The goal was for the occupants to feel comfortable and appreciated in each space. The characteristics of unity, leadership, focus, and strength are presented through unique lighting designs that are functional and meet the special needs of each patient. The presence of daylight and the necessity for daylight controls was also closely examined.

The existing electrical design was altered to accommodate for these new lighting features. Modifications were completed within the power distribution system, including the addition of advanced controls. A study was completed to determine the effects of voltage drop on the existing feeder sizes. The voltage drop and energy reduction produced through increasing the wire sizes was analyzed. A detailed electrical system study using the SKM software helped to determine the coordination among various system components.

In order to fully integrate all of the building systems in the auditorium space, a redesign of distinct architectural features was completed. It is important that all components within the space work together to achieve optimum performance.

Lastly, a comparison of the cooling loads from different wall systems in the physical and occupational therapy space is included. The removal of the clerestory as a daylighting element resulted in a significant change in the mechanical loads within the space.

The following report provides the details, process, and conclusions of a wide range of research and system studies. The proposed elements will enable NICoE to exhibit high functional and aesthetic performance.

Building Background

The National Intrepid Center of Excellence (NICoE) will serve as a facility for veterans and military personnel with traumatic brain injuries and other psychological issues. The Navy planned construction of NICoE to provide the best in research, assessment, diagnosis, treatment planning, and long term follow-up for psychological health. It is to be constructed at the National Naval Medical Center in Bethesda, MD at a site previously occupied by the Chief Petty Officer barracks, which is used was administrative space. This location is adjacent to existing medical facilities and to the existing warrior transition barracks. The funding for construction and fit-out of the new facility is provided by the Intrepid Fallen Heroes Fund, an independent not-for-profit organization founded and supported by the Fisher family. It is dedicated to supporting the men and women of the Armed Forces and their families.

NICoE will consist of large amorphous interior/exterior spaces for intensive evaluation, treatment, and meditation. There are group and family treatment rooms clustered with offices, as well as landscaped exterior space and playgrounds to be used for evaluation and treatment of the wounded and their families. Non-clinical space for clinical and leader education, research, and administration is also included.

Building Statistics

Building Name: National Intrepid Center of Excellence (NICoE)

Location and Site: National Naval Medical Center, Bethesda, MD

Building Occupant Name: Intrepid Fallen Heroes Fund, then transferred to the Department of Defense upon completion

Occupancy or Function Types: The building will provide advanced services through research, diagnosis, and treatment for military personnel and veterans suffering from traumatic brain injury and psychological health issues.

Size: 72,000 sq. ft.

Number of Stories: 2 stories

Project Team Directory:

- **Owner:** Plaza Construction - www.plazaconstruction.com
- **Construction Manager/General Contractor:** Turner Construction Company - www.tccc.com
- **Soils Engineer:** Schnabel Engineering, Inc. - www.schnabel-eng.com
- **Civil Engineer:** A. Morton Thomas & Associates, Inc. - www.amtengineering.com
- **Landscape Architect:** JJR - www.smithgroup.com
- **Architect:** SmithGroup - www.smithgroup.com
- **Structural Engineer:** Cagley & Associates, Inc. - www.cagley.com
- **MEP Engineer**: SmithGroup - www.smithgroup.com
- **Medical Equipment Consultant:** Gene Burton & Associates - www.gbainc.com
- **Acoustical/Vibration Consultant:** Miller, Beam, & Paganelli - www.millerbp.com
- **Communication Consultant:** Vantage Technology Consulting Group - www.vantagetcg.com
- **Lighting Designer:** SmithGroup - www.smithgroup.com
- **Blast:** Weidlinger Associates, Inc. - www.wai.com
- **Arts:** Aesthetics, Inc. - www.aesthetics.net

Dates of Construction: Start - June 2008
Finish - October 2009

Construction Budget: $65 million

Project Delivery Method: Design-Bid-Build

Design and Functional Components:
The building will provide services to support the men and women of the United States Armed Forces and their families through state of the art research, diagnosis and treatment. The structure is designed with two distinct zonal areas. The "L" shape is located on the east and south sides of the building. This area contains spaces dedicated to the clinical functions of the facility, such as exam rooms, research labs, offices, and simulation rooms. The amorphous form positioned on the north and west areas of the site houses the healing and public areas of the

building, including the open lobby, waiting rooms, lounge, auditorium, and rehabilitation rooms. There are also indoor/outdoor spaces for patients and families to relax and interact.

Codes:

Building Construction: International Building Code – 2006 Edition (IBC)
Egress and Life Safety: NFPA 101 Life Safety Code (LSC) – 2006 Edition
Interior Finish: NFPA 101 Life Safety Code (LSC) – 2006 Edition
Mechanical (General): International Mechanical Code – 2006 Edition
Mechanical (Duct Penetrations): NFPA 90A and 90B
Electrical: National Electrical Code – 2005 Edition
Plumbing: International Plumbing Code – 2006 Edition (IPC)
Energy: International Energy Conservation Code – 2006 Edition (IECC)
Fire: International Fire Code – 2006 Edition (IFC)
Other: Accessibility Code ADAAG (Universal Accessibility Standards); ANSI/ASME A17.1 Safety Code for Elevators and Escalators, as adopted by the Local State Department of Labor and Industry, Division of Elevators; Boiler Code ASME Boiler & Pressure Vessel Code (Local State Boiler Law and Regulations); Unified Facilities Criteria (UFC); Leadership in Energy and Environment Design (LEED) NC 2.2

Zoning: The site is classified as federal property so there are no zoning ordinances.

Historical Requirements: In an historic zone controlled by NPCP (National Capital Planning Commission).

Building Envelope:
In an attempt to achieve a LEED silver rating, many sustainable design factors are implemented. The exterior wall system consists of architectural precast concrete backed with recycled insulation. Exterior wall panels are punched with two story windows at openings. Two curtainwall systems are located on the north and west building facades and provide four sided structural glazing. Clerestories are positioned on the east and south elevations where the high roof and low roof join. All of the glass is low-e insulated and laminated with a visible light transmission of 63% and a U-value of 0.28. Patterns in the spandrel glass are dot fritted with gradation.

The roofing system is comprised of both a high roof (amorphous section) and a low roof ("L" section). Both sections consist of a single-ply thermoplastic polyolefin (TPO) membrane system that is mechanically or adhesively attached. The TPO sheet has an initial solar reflectance of 0.76, an emissivity of at least 0.9, and is U.S. EPA Energy Star certified. The insulation is composed of 4 inch, Type II polyisocyanurate board backed by modified bituminous vapor retarder. This system is at a 1/4"/ft. slope with a concrete slab. The high roof also contains a circular skylight positioned above the Central Park space.

Construction:
The construction of the National Intrepid Center of Excellence began in June 2008 and is scheduled for completion in October 2009. The General Contractor/Construction Manager is Turner Construction using a design-bid-build delivery method. The initial budget is $65 million under a GMP contract.

It is located in Bethesda, Maryland at the National Naval Medical Center. It is adjacent to the new Walter Reed National Military Medical Center, with close access to the Uniformed Services University, the National Institute of Health, and the Veterans Health Administration.

The use of building information modeling (BIM) in the design provides for smooth and cost efficient construction process.

Electrical:

NICoE's overall electrical system is a radial system with one point of service entrance at the southwest corner. It is tied to a campus system and receives this power through a 2500kVA utility transformer that steps down the voltage from 13.8kV to a 480Y/277V, 3P, 4W voltage system. A 3000A switchboard provides power to all equipment loads. Transformers feed a 208Y/120V, 3P, 4W main system to receptacles and some lighting devices. All other loads are connected to the 480Y/277V voltage system.

An exterior diesel standby emergency generator rated at 400kW, 480Y/277V, 3P, 4W provides backup power to both life safety and equipment branches. A 225kVA UPS battery backup system is also connected to two PDUs that are utilized for Server Room emergency power.

Lighting:

In order to accommodate for the needs of patients with traumatic brain injuries, a lighting design with high brightness and contrast is minimized. Fixtures are concealed through glare accessories and are focused on articulating surfaces for a calm and healing environment.

A majority of the lighting in the L-shaped "bar" area is generally functional with fluorescent downlights. Other fixtures are used in spaces with specialized medical operations. Corridors contain a mix of linear fluorescents, downlights, and LEDs to create visual interest in the long hallways. Decorative and custom fixtures that provide indirect, wallwash, accent, and track lighting are placed in lobbies, waiting rooms, and other similar areas. Exterior fixtures located at entrances, exits, pathways, recreation areas and service spaces provide lighting for nighttime use. A large curtainwall system and clerestories provide a large amount of daylight in the space throughout the day.

Switches, timers, occupancy sensors, and photosensors are utilized and connected through control panels throughout the building. Fluorescent and H.I.D. sources operate on 480Y/277 volts and incandescents run from 208Y/120 volt panels.

Illuminance levels are based on those from the IESNA recommendations and criteria from the Department of Defense.

Mechanical:

The mechanical system is comprised of a combination of VAV and constant volume control boxes to maintain required space temperatures and minimum airflow rates. The primary heating is from high pressure campus steam. It will be distributed through the mechanical rooms and serve as a source for domestic hot water. Gravity or a duplex electrical condensate pump will return condensate to a central location. Constant volume unitary air conditioning units are utilized to cool the building. All equipment is located on the first and second floor mechanical room, upon which the second floor contains a field-erected air handling unit. Primary hot water and chilled water distribution pumps will be variable speed and located in the second floor Mechanical Equipment Room.

Structural:

The NICoE's structural system consists of a cast-in-place concrete system with a 5" slab on grade for the ground floor. The remaining levels contain 9" thick two way concrete slabs with flat slab drop panels at the columns.

Reinforced concrete columns create a mostly rectilinear grid throughout the building and are directly aligned between floors. A majority of these elements are 24"x24", with others ranging from 12"x24" to 16"x30". At the high roof, low roof, and around the curved north and west facade, 24"diameter circular concrete columns support the exterior wall system.

HSS steel provides support for the west curved wall between the second level and upper roof level. This material also sustains the large circular skylight located above Central Park. Structural steel is utilized to support the elevator slab.

Fire Protection:

The fire suppression system consists of a wet sprinkler system to provide protection to the entire building. The elevator machine room is provided with an automatic wet system with dedicated zone control assembly. The fire department connection is located on the north side of the building.

The fire alarm system is voice activation type and consists of ADA compliant strobes and audible speakers. It includes duct mounted smoke detectors, manual pull stations, photoelectric smoke detectors, sprinklers, annunciation panels, wall mounted panels, and radio frequency transmitter and associated equipment. The main fire alarm control panel, along with other critical panels, is located in the Emergency Equipment Room 112A. All other devices are spread throughout the building according to fire protection codes.

Transportation:

The building is serviced by two hydraulic elevators located in the center of the building. They are positioned on the north to south division line between the amorphous and "bar" sections of the structure. One is front opening only, connecting the first floor Interior Lobby to the second floor Waiting area. The second is front and reverse opening, also servicing a corridor in the "bar" area. They are machine room-less with a 5,000lb carrying capacity.

Two sets of stairs link the first and second levels. One is centrally located next to the elevators in the Interior Lobby space, which is open to the second floor above. It provides transportation to the Waiting Area on the second floor. The second stairwell is positioned on the west side of the building across from the exit door. It connects the first floor Recreational Therapy space to the upper Interior Lobby.

Telecommunications:

The telephone and data systems are connected to the interior Server Room with 4" conduit. Almost every room contains voice/data and computer outlets for occupant usage. Media and wireless outlets are also widespread. Nurse call technologies are located in most of the spaces. These enable maximum patient care at anytime and from anywhere. The main telecommunications room is located on the ground floor adjacent to the main electrical room. Each floor will also be provided with a local telecommunications closet.

Audiovisual System:

Various spaces throughout the building contain speakers and flat panel displays for general patient viewing. Audiovisual input and output panels are positioned for multimedia connections throughout different areas. The Auditorium, Media Dive Room, Classroom, and Research/Tech Room contain projectors and projection screens for seminars and presentations. Cameras are located on the second floor Physical Therapy and Occupational Therapy spaces. They are also present to monitor patient progress in the ADL Suite and Recreational Therapy area.

Security System:

The security system consists of card readers in various locations of the building. They are placed outside of select spaces for limited access. A dedicated conduit system is provided.

Lighting Depth

Overall Design Concept

As a facility for military veterans, the main goal within the building is to make the occupants feel comfortable and calm within the healing environment. By utilizing the concept of the qualities of a soldier, the space will exhibit the appreciation of these patients. Each of the selected spaces should portray one of the following qualities: unity, leadership, focus, and strength. The unique building shape should also be emphasized by the lighting design. Surfaces and architectural features within the building should be articulated, especially the curved walls. Due to the sensitivity of TBI patients, high brightness, glare, and contrast should be avoided.

Outdoor Space - Exterior Façade

Spatial Summary

- **Description**
  The north-facing facade is situated along Palmer Road South. The eastern portion of the elevation is flat and about 83 feet in length, while the central and western portion of the facade is a large curved wall with a total perimeter of 345 feet. Sidewalks line the road and wrap around the east facade to lead visitors around the campus. A U-shaped driveway directs cars to the building entrance. Here, a 22'x10' canopy extends toward the street protecting the entry doors.

- **Drawings**

Figure 1: Exterior Location (NTS)

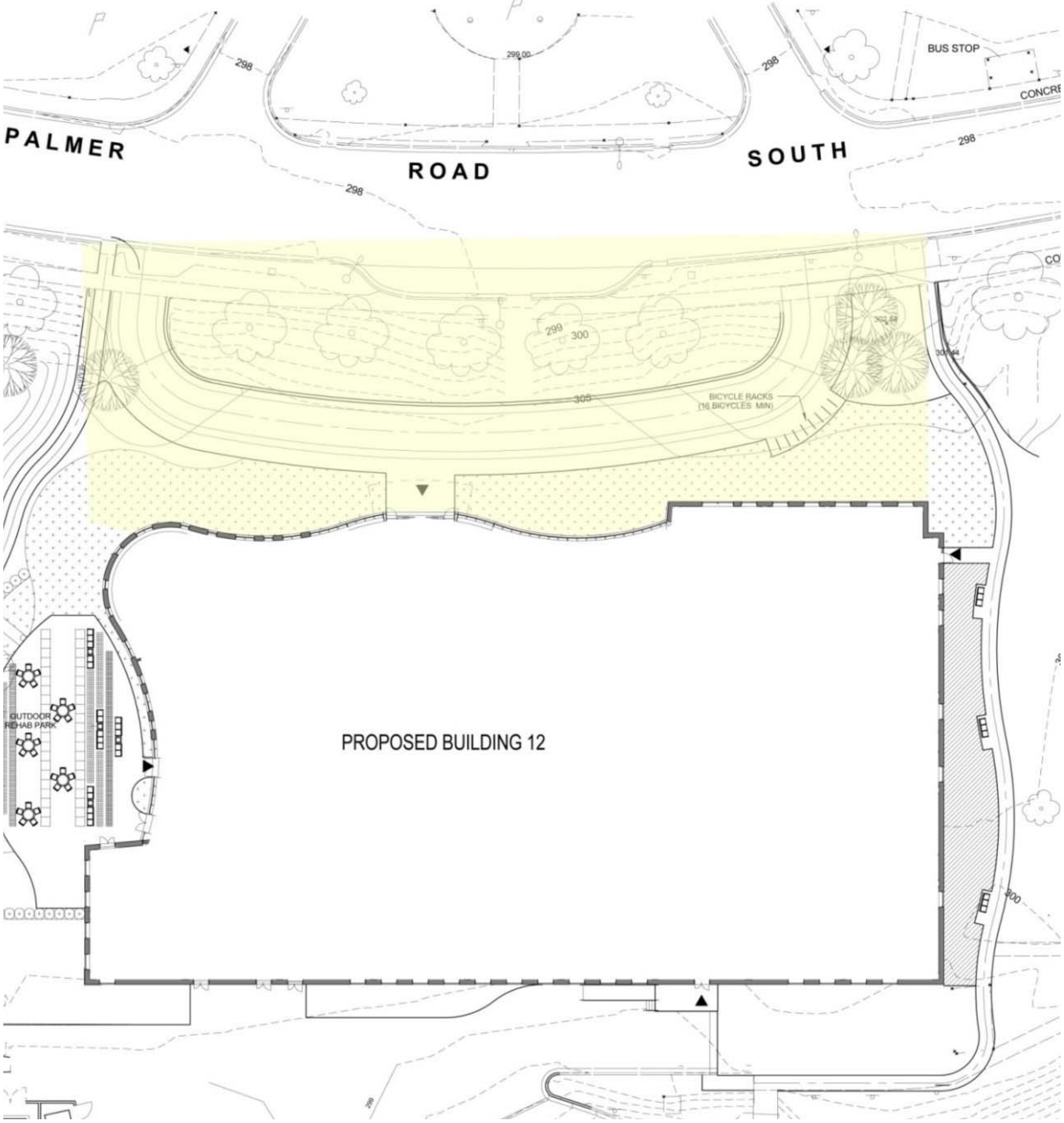


Figure 2: North Façade Dimensions (West Side) (NTS)

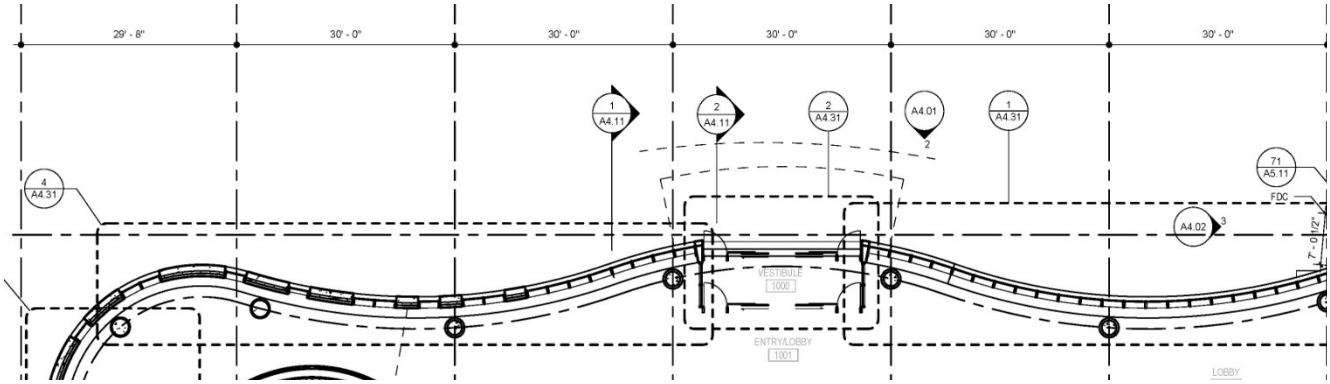


Figure 3: North Façade Dimensions (East Side) (NTS)

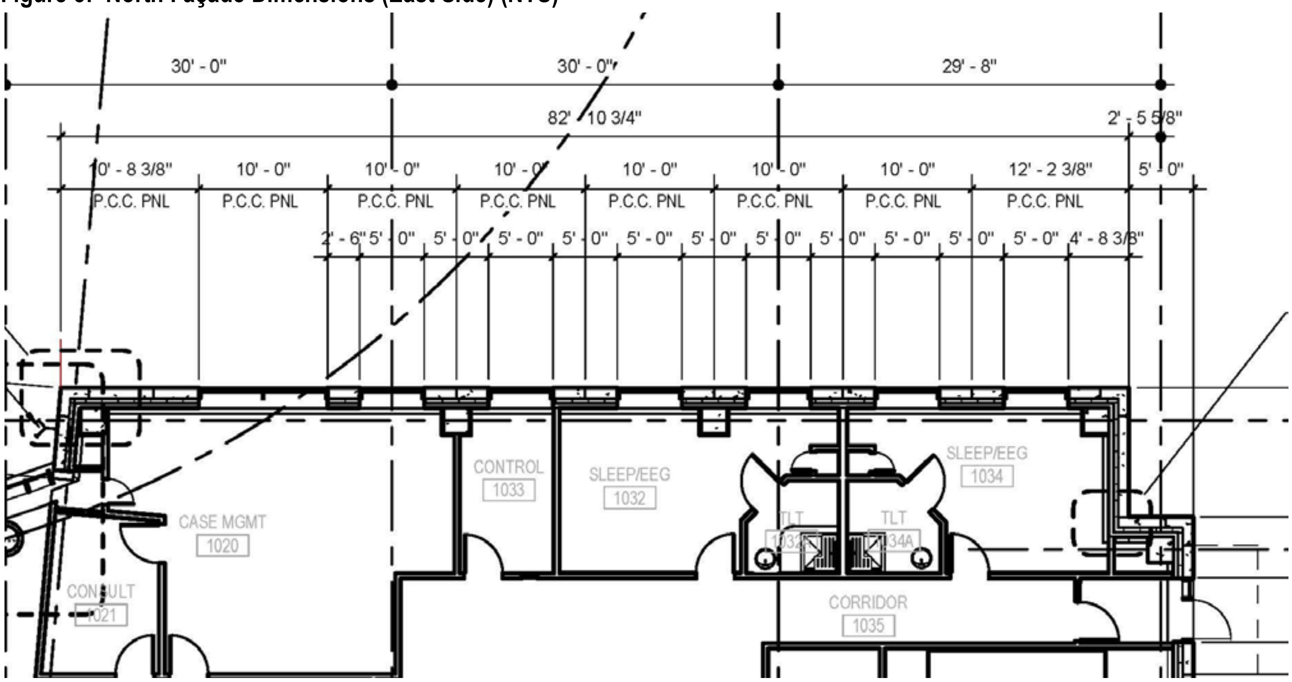


Figure 4: North Façade Elevation (NTS)

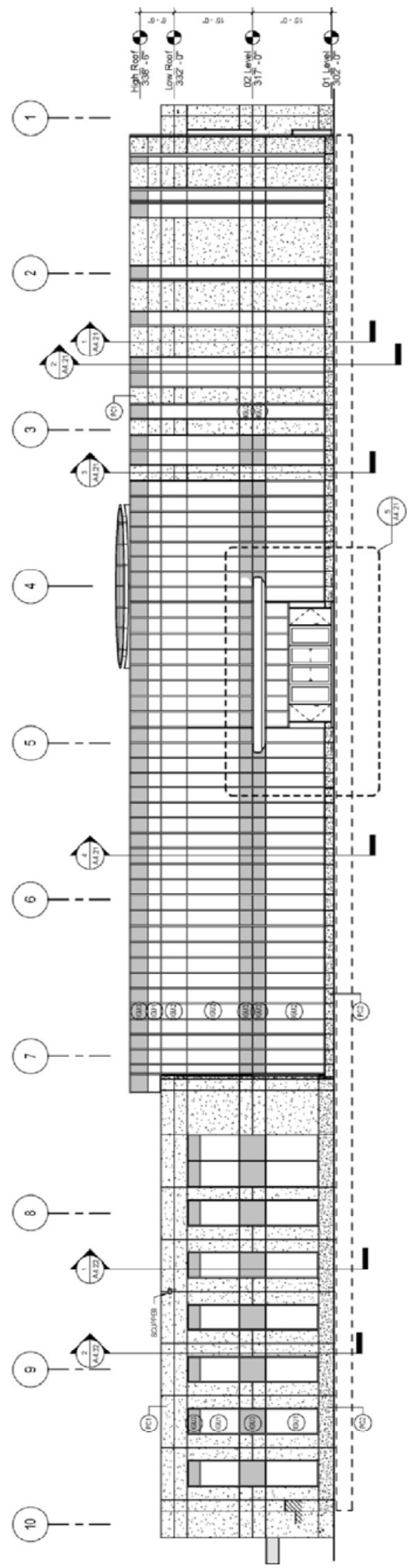
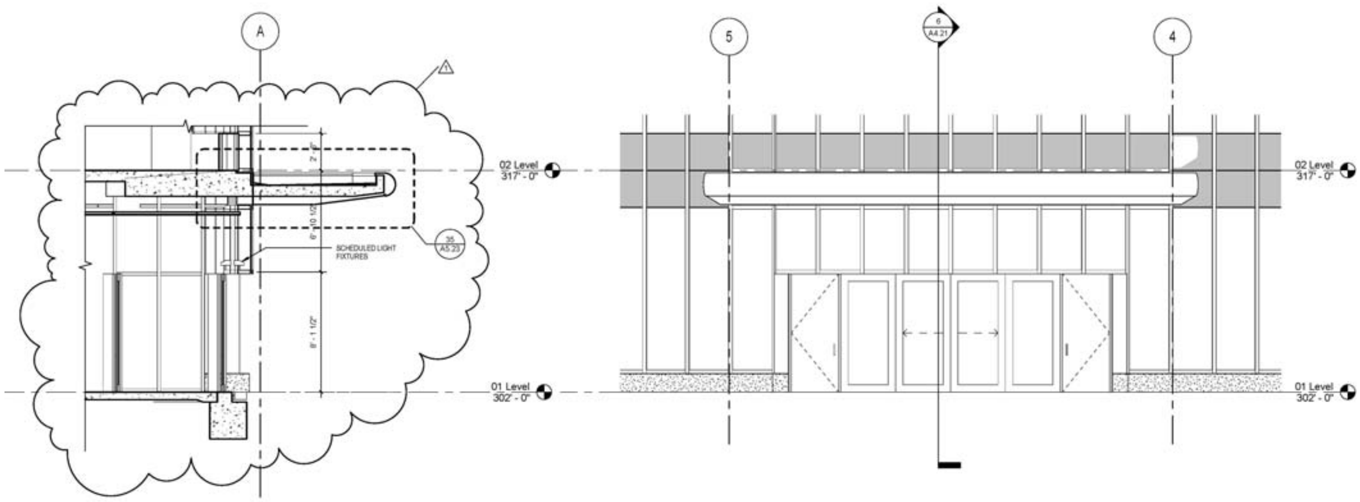


Figure 5: Canopy Section and Enlarged Elevation (NTS)



- **Surface Materials**

  Facade - The east and west ends of the northern exterior wall system consist of architectural precast concrete punched with two story windows at the openings. On the east end of the facade, the windows consist of spandrel and clear vision glass. On the west end of the facade, these windows consist of spandrel glass at the top section of windows then (from top to bottom) a section of clear vision glass, and five sections of vision glass with ceramic frit. The curtainwall system located in the center of the northern facade provides four sided structural glazing with an aluminum framing system. The windows consist of spandrel glass at the top section of windows then (from top to bottom) a section of clear vision glass, two sections of vision glass with ceramic frit, two sections of spandrel glass, and a section of vision glass with ceramic frit.

  Doorway - Two single glass doors with medium stile glass and double automatic sliding glass doors lead into the vestibule and lobby spaces.

  Canopy - The canopy consists of a concrete structure covered with an aluminum plate cladding.

Figure 6: Material Properties

Material	Color/Style	Reflectance
PRECAST CONCRETE	CONCRETE / GRAY	0.45
ALUMINUM FRAME	ALUMINUM	0.7
ALUMINUM PLATE CLADDING	ALUMINUM	0.7
GROUND	CONCRETE & GRASS	0.15

Figure 7: Glass Properties

Material	Description	Transmittance	SHGCC	Shading Coefficient	Winter U-value	Outdoor Reflectance
IGU-1	CLEAR VISION GLASS WITH LGU-1	63%	0.27	0.31	0.28	12%
IGU-2*	VISION GLASS WITH CERAMIC FRIT (40% COVERAGE) WITH LGU-1 (LAMINATED GLASS) ON INTERIOR	63% FOR GLASS 16% FOR DOTS	0.27 (FOR GLASS)	0.31 (FOR GLASS)	0.28 (FOR GLASS)	12% (FOR GLASS)
IGU-3	SPANDREL GLASS WITH LGU-2 (LAMINATED GLASS) ON INTERIOR	0% (FLOOR STRUCTURE)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
	MEDIUM STILE GLASS (DOORS AND INTERIOR GLASS)	90% (ASSUME SINGLE PANE CLEAR)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE

*NOT ALL INFORMATION PROVIDED, SO ASSUMPTIONS MADE FROM COMPARISON TO OTHER PRODUCTS

- **Furnishings**
  N/A

- **Activities/Tasks**
  As an outdoor space, the front of the building is an entrance that should be inviting to visitors. People use the drive-through road in front of the entryway as a drop-off or pick-up area. The canopy over the front entrance is used to shield one from harsh weather conditions and sunlight. The sidewalks also provide a leisurely activity for patients.

Design Concept

As an outdoor space, the front of the building is an entrance that should be inviting to visitors. Visual clarity is very important in this area. The walkway should be adequately lit as a path to the doorway. The lighting should also properly light the people moving throughout the area. The concept of unity and teamwork should be implemented through the lighting of the building façade. Creating a similar lighting scheme on both ends of the structure will bring all parts of the building together as one. The idea of stars and stripes should also be resembled on the façade design. The entrance should stand out in order to draw and guide occupants inside. These exterior lights should be controlled by an astronomical time clock.

Design Criteria

(IESNA Handbook: Building Exteriors, Entrances, Active)

- **Appearance of Space and Luminaires** (Very Important)
  As a state of the art facility at the National Naval Medical Center, the lighting should reflect its importance. The lighting design should make the building standout and flow with the unique architectural features. Higher quality fixtures should be utilized to ensure superior performance. Light should be integrated into the site as a subtle feature through hidden fixtures. The glass should appear lit from within and emphasize surfaces that seem to glow (see Design Criteria for interior spaces). Traumatic brain injury patients are sensitive to high brightness and contrast, so these features should be mitigated as much as possible. The exterior of the building and the building entrance should be softly lit to provide a smooth transition to the interior.

- **Psychological Impressions**
  Strive for an impression of visual clarity throughout the area. Implement a bright, uniform lighting mode with some peripheral emphasis, such as lighting on the building façade.

  A feeling of relaxation should be the mood outside of the building. The lighting should be based on the concept of smooth verticality of the structure.

- **Color Appearance (and Color Contrast)** (Very Important)
  A mid to high range of CCT from about 3500K to 4000K should be specified in order to portray daylight. This will keep a consistent look of the building from day to night. The concrete, glass, and metal materials will better match the cooler tones of light. As mainly a transition and transportation space, a high CRI is not necessary. An average CRI of about 80 will be adequate around the building exterior. However, the color rendering will be appropriate for distinguishing between various textures at the site.

- **Direct Glare** (Very Important)
  Direct glare from the lamp sources should be eliminated by integrating the fixtures within the architecture to conceal the luminaires and through the use of glare accessories.

- **Light Distribution on Surfaces** (Important)
  Provide uniform, ambient light along walkways, the roadway, and at the building entrance to provide for easy maneuvering and circulation around the site. Graze the concrete paneling on the façade to create light and dark shadows for a visually interesting feature. This will also accentuate the building's unique shape. Appropriate luminaire spacing will create non-uniform levels on the vertical surface. Graze the bottom surface of the metal canopy from the building to uniformly illuminate the surface without creating reflected glare.

- **Light Pollution/Trespass** (Very Important)
  There are no light trespass requirements for the National Naval Medical Center Campus or surrounding areas.

- **Modeling of Faces or Objects** (Very Important)
  As main transition areas for people moving around the building, the entrance and pathways should adequately light the faces of users. This should be done through direct lighting from above and from the sides to emphasize features and expressions.

- **Peripheral Detection** (Very Important)
  People will continually be walking in and out of the building, and cars will be driving through. There should be adequate light to the left and right of a user walking along the sidewalk and under the canopy. This is a necessary safety feature at night so that one is aware of his/her surroundings at all times. Lighting on the site will also assist drivers in viewing people walking around the building.

- **Point(s) of Interest** (Very Important)
  The walkways and U-shaped roadway in front of the building should contain uniform ambient light for movement along the pathways. This will also serve as a transitional element to guide people around the site to the building entrance. Navigating around a large building, especially at night can be difficult in the absence of adequate light levels.

The entryway and canopy should also be illuminated to guide visitors into the building. This will make the entrance stand out not only as a tool for guidance, but also as an aesthetically pleasing architectural element to those passing by.

The unique architecture and curved façade should be emphasized by lighting up the concrete panels from the base of the building.

- **Reflected Glare and Source/Task/Eye Geometry** (Very Important)
  Avoid reflected glare from curtainwall façade. The abundance of windows makes it imperative for one to ensure that luminaires are not placed close to or directly aimed at the glass. This will disturb those working inside the building, people walking to and from the facility, and those driving in front of the entrance. Be sure that light around the metal canopy is also not aimed at a 90-degree angle to the surface.

- **Shadows** (Very Important)
  Areas with little light should be present around the building to create a visually interesting structure. The building façade should have dark and light areas to accentuate its unique architectural features. However, the pathways and building entrance should contain no shadows and provide a well-lit walkway.

- **Sparkle/Desirable Reflected Highlights** (Important)
  Large amounts of sparkle will try to be avoided. The brain injury patients are sensitive to high light levels and contrast.

- **Surface Characteristics** (Very Important)
  The light colored concrete walkways and entryway will diffuse the light throughout the surface. The metal canopy is highly reflective, so a little light will go a long way. The blacktop on the road surface will require higher light levels. The precast concrete façade will provide an easily luminated surface.

- **Maintenance**
  The fixtures should require little maintenance and have a long lamp life to reduce time between relamping. They should be rated to endure the variable weather conditions of Bethesda, MD. The fixtures should be fully enclosed (water-proof) to protect the lamp from weather and dirt. Fixtures should have simple relamping availability.

- **Controls**
  As an exterior space, there should be no local controls for the lighting system. All of the lighting should either be connected to a light sensor that switches the lights on when the sun begins to set, or on a timer that is connected to an astronomical controller. There should be an override switch located at the control panel. No dimming is necessary, and an all on/off setting is sufficient.

- **Horizontal Illuminance** (Very Important)
  The required horizontal illuminance is as follows (<u>IESNA Handbook</u>):
    - Building Exteriors, Entrances, Active = 5 fc
    - Sidewalks (roadside) and Type A bikeways = 0.6 fc (Figure 22-10)
    - Local, Intermediate Roadway = 0.7 fc (Figure 22-8 (b))

    Deviations: none

- **Vertical Illuminance** (Very Important)
  The required vertical illuminance is as follows (IESNA Handbook):
  - Building Exteriors, Entrances, Active = 3 fc
  - Sidewalks (roadside) and Type A bikeways = 1.1 fc (Figure 22-10)

  Deviations: none

- **Power Allowance**
  The allowable power densities are as follows (ASHRAE 90.1 - 2007):
  - Walkways = 1 W/linear foot
  - Overhang = 1.25 W/sq.ft.
  - Building Facade = 0.2 W/sq.ft. for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length

Lighting Plans

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

Luminaires

Figure 8: Exterior Luminaire Schedule

Type		Manufacturer	Product Name	Catalog Number	Description	Lamp	Voltage	Ballast/Power Supply	Watts	Location
E		KIM Lighting	Solitaire	FM-SRS4F5-100PMH277-PS-P	-Die-cast aluminum top -White acrylic lens -Vertical lamp orientation -Symmetric diffused downlight distribution -Sealed housing and split beam reflector technology -Post-top mounting	MPD/100/U/MED/840 Osram Sylvania: 64426 Metalarc Pro-Tech Pulse Start	277	71A5337BP ADVANCE Metal Halide Lamp Ballast	118	EXTERIOR - Along sidewalk
F		KIM Lighting	Round Steel (Non-Tapered) Pole	KRS10-4120-FM-PS	-Luminaire is flush mounted directly to top of pole -Platinum silver finish -Cast aluminum anchor bolt covers and pole cap included -Standard thermoset polyester powder coat paint	N/A	N/A	N/A	N/A	EXTERIOR - Support structure for fixture type E
G		PHILIPS Color Kinetics	eW Graze Powercore	523-000030-09 4000K, 10°x60°, 1' fixture	-Linear lighting fixture optimized for surface grazing and wall-washing applications requiring high-quality white light. -Processes power directly from the line voltage, eliminating the need for low-voltage, external power supplies. -Aluminum housing and flexible mounting options.	14.3W White LEDs Included with luminaire	277	Included with luminaire	14.3	EXTERIOR - Building Façade
H		PHILIPS Color Kinetics	eW Graze Powercore	523-000030-11 4000K, 10°x60°, 4' fixture	-Linear lighting fixture optimized for surface grazing and wall-washing applications requiring high-quality white light. -Processes power directly from the line voltage, eliminating the need for low-voltage, external power supplies. -Aluminum housing and flexible mounting options.	57.2W White LEDs Included with luminaire	277	Included with luminaire	57.2	EXTERIOR - Building Façade, Overhang
I		Iagotronics	Dot 21/42 Waterproof IP67	DecaLED Dot 21/42 95129249	-Multiple LED cluster, mounted onto the surface of a building -Can be controlled directly by DMX and capable of operating in indoor and outdoor environments -High manufacturing standards and a solid weatherproof housing ensure a long and maintenance-free lifespan	4W White LEDs Included with luminaire	24	Included with luminaire	300 per controller	EXTERIOR - Building Façade

See Appendix B for full luminaire schedule and cut sheets.

Figure 9: Exterior Spatial Assumptions

Type	Maintenance Category	Distribution Type	Degree of Dirtiness	Cleaning Cycle	Room Cavity Ratio
E	N/A	Direct	Dirty	2 Years	N/A
G	N/A	Direct	Dirty	2 Years	N/A
H	N/A	Direct	Dirty	2 Years	N/A
I	N/A	Direct	Dirty	2 Years	N/A

Figure 10: Exterior Light Loss Factors

Type	BF	LLD	LDD	RSDD	Total LLF
E	1	0.88	0.82	N/A	0.72
G	N/A	0.85	0.82	N/A	0.70
H	N/A	0.85	0.82	N/A	0.70
I	N/A	0.85	0.82	N/A	0.70

Controls

As an exterior space, the lighting will only need to be turned on at night. An astronomical time clock will be used to automatically turn the lighting on and off each day.

Figure 11: Exterior Equipment Schedule

Type	Manufacturer	Product Name	Catalog Number	Description	Location
EQ 5	Watt Stopper	MSC-100 Astronomic Time Clock	MSC-100	-Five-channel clock used with Watt Stopper's wireless RF lighting control systems -Provides ON/OFF control signals based on time of day, day of week, holiday, and calculated sunrise/sunset (astronomic) time	Main Electrical Room 1124
EQ 6	Lagotronics	USB-i 505	95380247	-Allows unlimited access to DMX-i Strips by using any of the available control devices within the DMX-i system -Built-in power supply unit provides power and data for up to eight strip per output	Main Electrical Room 1124

See Appendix C for full equipment schedule and cut sheets.

Performance Data

The following are calculation grids and numerical summaries of the exterior lighting.

Figure 12: Exterior Rendering

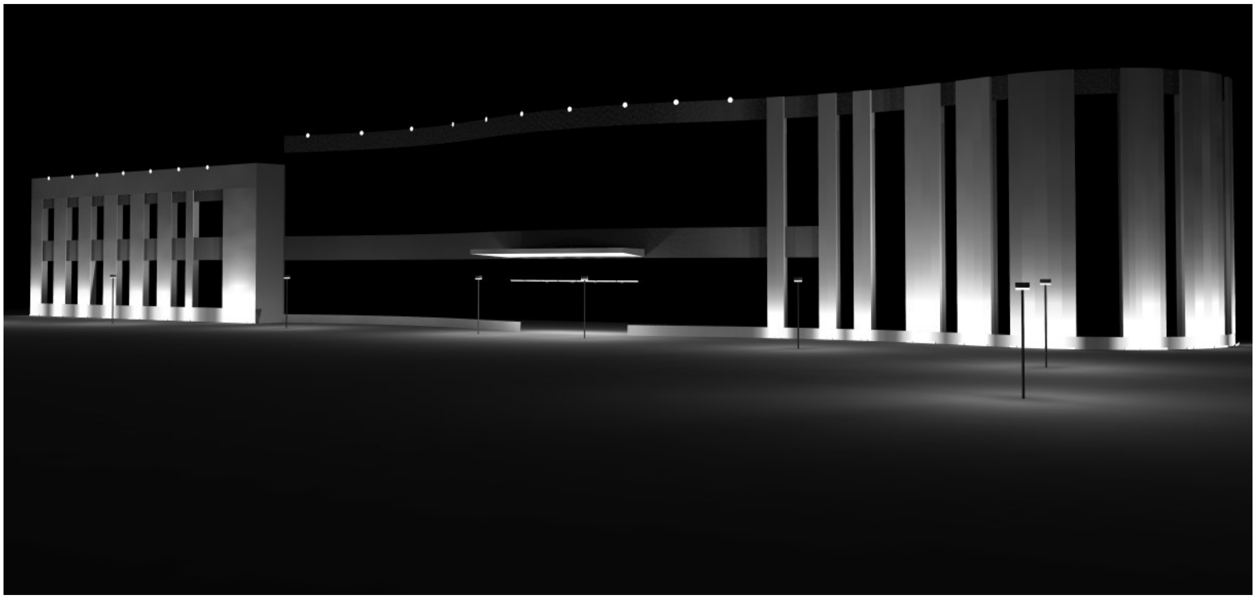


Figure 13: Exterior Luminance Pseudo Color Rendering (cd/sq.m.)

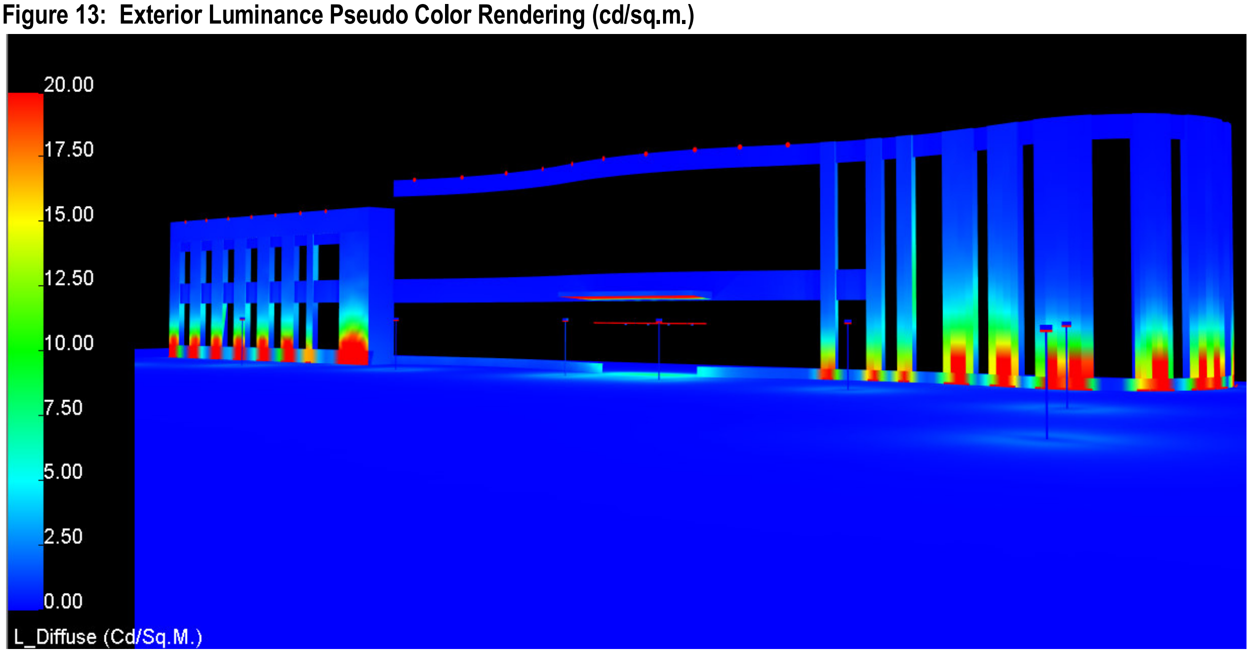


Figure 14: Road, Sidewalk, and Entrance Horizontal Illuminance (fc)

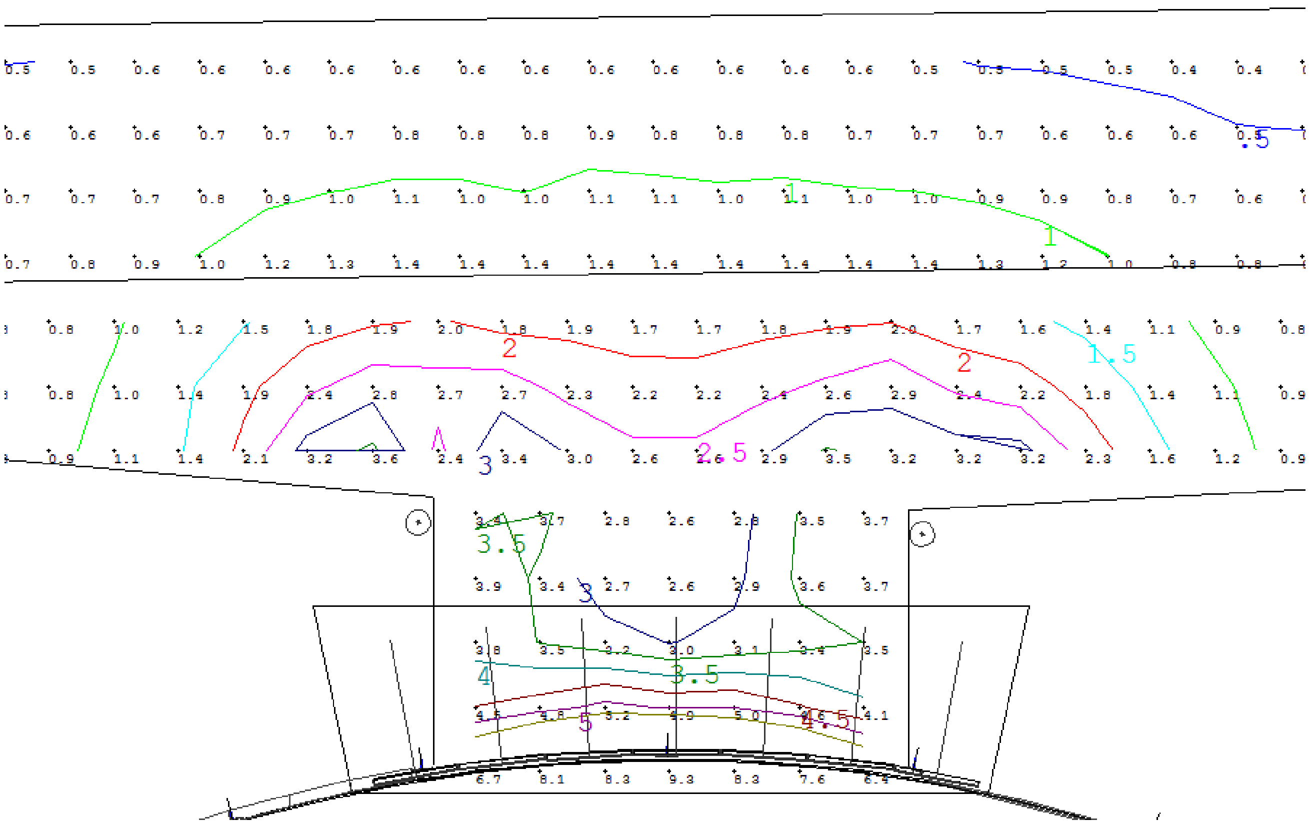


Figure 15: Entrance Vertical Illuminance (fc)

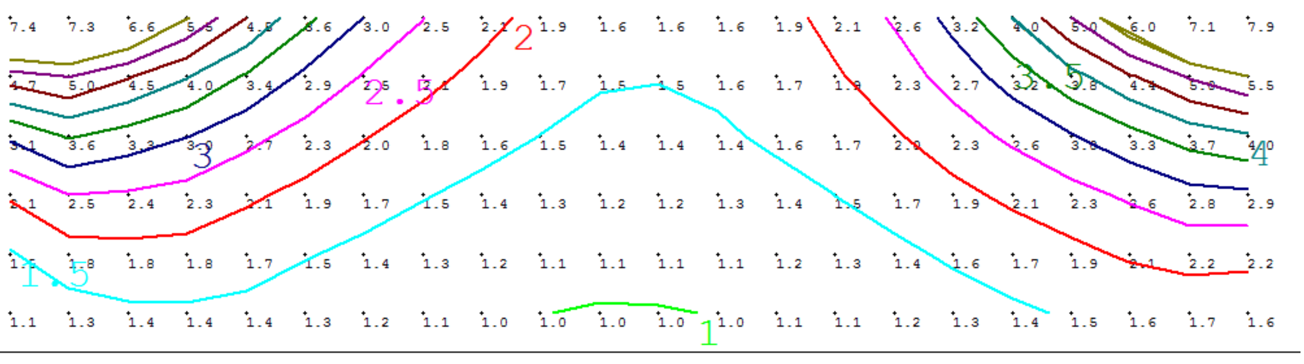


Figure 16: Sidewalk Vertical Illuminance (fc)

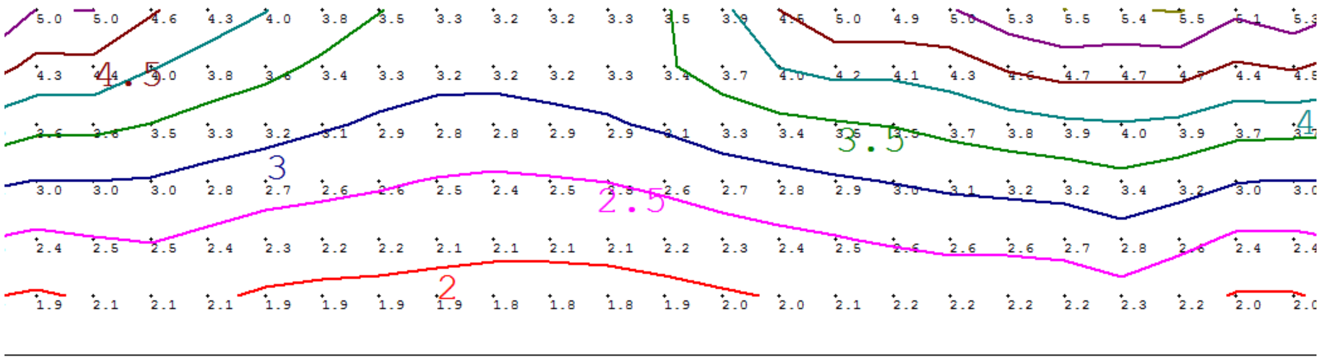


Figure 17: Exterior Illuminance Values (fc)

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Road (horizontal ground)	0.88	2.1	0.4	5.25
Sidewalk (horizontal ground)	1.8	3.6	0.6	6
Sidewalk (vertical)	2.1	9.5	0.4	23.75
Entrance (horizontal ground)	4.47	9.3	2.6	3.58
Entrance (vertical)	2.38	7.9	1	7.9

Energy Code Compliance

Figure 18: Total Energy Calculation

ASHRAE Standard 90.1

Space	Spatial Size	Allowable Lighting Power Density	Total Allowable Watts	Total Watts Used
Façade Lighting (Nontradable)	7926 sq.ft.	0.2 W/sq.ft.	**1585.2**	**1508**
Building Entrance (Tradable)	22 lin.ft.	30 W/lin.ft.	660	400.4
Walkway (Tradable)	370 lin.ft.	1.0 W/lin.ft.	370	1062
Roadway (Drive) (Tradable)	3300	0.15 W/sq.ft.	495	
		Total (Tradable Surfaces)	**1525**	**1462.4**

Performance Summary

The new lighting design for the building's exterior is both functional and visually pleasing. It provides a high-tech feel that is symbolic of the state of the art facility. The lighting of the building façade follows the concept of unity through the uniform lighting that spans the length of the façade. The symbolism of stars and stripes is present in the grazing of the concrete panels (stripes) and the LED marker lights that line the roof edge. Uniform lighting along the roadway, sidewalk, and at the building entrance, in addition to some peripheral emphasis on the building façade, provide visual clarity throughout the space.

Most of the fixtures are integrated into the surroundings to prevent direct glare. A high CCT and CRI mimics daylight and renders color well. The taller pole-mounted fixture provides adequate vertical illuminance along the sidewalk for facial modeling. Grazing the concrete façade from the base of the building creates vertical non-uniformity. The narrow distribution of these fixtures aids in avoiding light from spilling onto the curtainwall glazing. The LED fixtures have a long lamp life, and all luminaires are able to withstand outdoor conditions.

The illuminance levels meet those specified in the IESNA Handbook. There is enough light for people to drive into the pull-through and drop people off at the entrance. When walking on the sidewalk, one is able to properly see where they are walking as well as view the faces of people passing by. The horizontal and vertical illuminance levels at the entrance also meet those required. These levels are slightly higher than those on the roadway and sidewalk, which cause the main doorway to stand out against the rest of the façade. This provides way-finding light for visitors.

Electrical Redesign

For a complete spatial description of the Exterior Facade, see page 13.

The lighting design for the exterior space is focused on providing adequate light levels on each of the task planes (road, sidewalk, and building entrance). The horizontal surfaces are important for providing a pathway, while the vertical planes aid in modeling faces and visitors moving throughout the space. The unique architecture of the building is also highlighted by grazing the canopy and building façade with light. This emphasizes the smooth curvature of the structure. The concept of unity is portrayed by creating a consistent design across the length of the building. In addition, the vertical grazing of light, paired with the marker lights along the roof edge symbolizes stars and stripes.

For the electrical redesign of the space, all of the new lighting replaces the existing lighting circuits on each respective panelboard. All fixtures are powered by 277V except for the Type I marker lights, which run on 24VDC power from a 120V controller. All fixtures will be controlled with an astronomical time clock, which will automatically turn the lights on in the evenings. The circuits will run through this controller before reaching each panelboard.

- **Layout of Circuiting**
  See Appendix A for complete lighting plans with all electrical circuiting.

- **Existing Panelboards/Modified Circuits**
  The following are the panelboards that contain the existing light fixtures for the space. The specific circuits to be modified are highlighted.

Figure 19: Existing Panelboard L1

(13) 20A, 1P, SPARES
(6) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "L1" (SURFACE MTD IN MAIN ELEC RM 1124) - 480Y/277V, 3PH, 4W, BUS RATING 225A, MLO, AIC 42000, TYPE1 ENCL. (42 POLE)

Circuit Number	Load Name	Rating	Apparent Load: Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting BREAK OUT AREA 1134	20 A	39 VA	39 VA	0 VA	0 VA	1	0 A
2	Lighting	20 A	143 VA	143 VA	0 VA	0 VA	1	1 A
3	Lighting EM ELEC 1123	20 A	64 VA	0 VA	64 VA	0 VA	1	0 A
4	Lighting	20 A	350 VA	0 VA	350 VA	0 VA	1	1 A
5	Lighting	20 A	2547 VA	0 VA	0 VA	2547 VA	1	9 A
7	Lighting	20 A	510 VA	510 VA	0 VA	0 VA	1	2 A
8	Lighting MECH 1122	20 A	768 VA	768 VA	0 VA	0 VA	1	3 A
9		20 A	1058 VA	0 VA	1058 VA	0 VA	1	4 A
10,12,14	EF-3, MAIN ELEC 1124	20 A	1100 VA	367 VA	367 VA	367 VA	3	1 A
11,13,15	SF-3, EM ELEC 1123	20 A	1300 VA	433 VA	433 VA	433 VA	3	2 A
16,18,20	CP-1(DUPLEX), MECH 1122	15 A	5600 VA	1867 VA	1867 VA	1867 VA	3	7 A
17,19,21	P-1(P-2-STANDBY), MECH 1122	70 A	28300 VA	9433 VA	9433 VA	9433 VA	3	34 A
22,24,26	T30 (R1)	50 A	30000 VA	10000 VA	10000 VA	10000 VA	3	36 A
Grand total: 13			71779 VA	23560 VA	23572 VA	24647 VA		100 A

- ## New Panelboard Worksheets and Schedules

Figure 20: New Panelboard L1 Worksheet

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					L1	Panel Location:		MAIN ELEC 1124		
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	3	BREAK OUT AREA 1134	39	va	0.95	37	39	
2	A	Lighting	3	EXTERIOR	143	va	0.95	136	143	
3	B	Lighting	3	EM ELEC 1123	64	va	0.95	61	64	
4	B	Lighting	3	FLOOR 1	350	va	0.95	333	350	
5	C	Lighting	3	VR LAB 1127	2547	va	0.95	2420	2547	
6	C				0	w		0	0	
7	A	Lighting	4	EXTERIOR	1062	w	0.90	1062	1180	
8	A	Lighting	3	MECH 1122	768	va	0.95	730	768	
9	B	Lighting	9	EXTERIOR	915.2	w	1.00	915	915	
10	B	EF-3	6	MAIN ELEC 1124	367	va	0.90	330	367	
11	C	SF-3	6	EM ELEC 1123	433	va	0.90	390	433	
12	C	EF-3	6	MAIN ELEC 1124	367	va	0.90	330	367	
13	A	SF-3	6	EM ELEC 1123	433	va	0.90	390	433	
14	A	EF-3	6	MAIN ELEC 1124	367	va	0.90	330	367	
15	B	SF-3	6	EM ELEC 1123	433	va	0.90	390	433	
16	B	CP-1(DUPLEX)	9	MECH 1122	1867	va	0.90	1680	1867	
17	C	P-1(P-2-STANDBY)	9	MECH 1122	9433	va	0.90	8490	9433	
18	C	CP-1(DUPLEX)	9	MECH 1122	1867	va	0.90	1680	1867	
19	A	P-1(P-2-STANDBY)	9	MECH 1122	9433	va	0.90	8490	9433	
20	A	CP-1(DUPLEX)	9	MECH 1122	1867	va	0.90	1680	1867	
21	B	P-1(P-2-STANDBY)	9	MECH 1122	9433	va	0.90	8490	9433	
22	B	T30 (R1)	9	ELEC 1101	10000	va	0.90	9000	10000	
23	C				0	w		0	0	
24	C	T30 (R1)	9	ELEC 1101	10000	va	0.90	9000	10000	
25	A				0	w		0	0	
26	A	T30 (R1)	9	ELEC 1101	10000	va	0.90	9000	10000	
27	B	Lighting	9	EXTERIOR	929.5	w	1.00	930	930	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								66.3	73.2	Amps= 88.1

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					21.9	24.2	33%	87.5
PHASE TOTAL	B					22.1	24.4	33%	87.9
PHASE TOTAL	C					22.3	24.6	34%	89.0

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		3.7	3.9	1.00	3.7	3.9	0.95		
4	HID lighting		1.1	1.2	1.00	1.1	1.2	0.90		
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		2.2	2.4	0.80	1.7	1.9	0.90		
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9	unassigned		59.4	65.7		59.4	65.7	0.90		
Total Demand Loads						65.9	72.8			
Spare Capacity			20%			13.2	14.6			
Total Design Loads						79.0	87.3	0.91	Amps=	105.1

Figure 21: New Panelboard Schedule L1

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: L1	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 225A	PANEL LOCATION: MAIN ELEC 1124	OPTIONS:
SIZE/TYPE MAIN: 150A/3P C/B	PANEL MOUNTING: SURFACE	(4) #1, (1) #6 G, 1 1/2" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	BREAK OUT AREA 1134	37	20A/1P	1	*			2	20A/1P	136	EXTERIOR	Lighting
Lighting	EM ELEC 1123	61	20A/1P	3		*		4	20A/1P	333	FLOOR 1	Lighting
Lighting	VR LAB 1127	2420	20A/1P	5			*	6	20A/1P	0		
Lighting	EXTERIOR	1062	20A/1P	7	*			8	20A/1P	730	MECH 1122	Lighting
Lighting	EXTERIOR	915	20A/1P	9		*		10		330	MAIN ELEC 1124	EF-3
SF-3	EM ELEC 1123	390		11			*	12	20A/3P	330	MAIN ELEC 1124	EF-3
SF-3	EM ELEC 1123	390	20A/3P	13	*			14		330	MAIN ELEC 1124	EF-3
SF-3	EM ELEC 1123	390		15		*		16		1680	MECH 1122	CP-1(DUPLEX)
P-1(P-2-STANDBY)	MECH 1122	8490		17			*	18	15A/3P	1680	MECH 1122	CP-1(DUPLEX)
P-1(P-2-STANDBY)	MECH 1122	8490	70A/3P	19	*			20		1680	MECH 1122	CP-1(DUPLEX)
P-1(P-2-STANDBY)	MECH 1122	8490		21		*		22		9000	ELEC 1101	T30 (R1)
		0		23			*	24	50A/3P	9000	ELEC 1101	T30 (R1)
		0		25	*			26		9000	ELEC 1101	T30 (R1)
Lighting	EXTERIOR	930	20A/1P	27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	21.85	TOTAL DESIGN LOAD (KW)	79.03
CONNECTED LOAD (KW) - B	22.13	POWER FACTOR	0.91
CONNECTED LOAD (KW) - C	22.31	TOTAL DESIGN LOAD (AMPS)	105

Feeder Size Calculation:

105.1 A * 125% = 131.25A → 225A Bus, 150A Main, (4) #1 AWG Cu THWN, (1) #6 AWG Cu Ground, 1 1/2" Conduit

Figure 22: New Panelboard Worksheet R1

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->				R1	Panel Location:			MAIN ELEC 1124		
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	5	FATS/ GOLF 1129	18	va	1.00	18	18	
2	A	Motorized Damper	6	EM ELEC 1123	400	va	0.90	360	400	
3	B	UH-1	7	MECH 1122	200	va	1.00	200	200	
4	B	Receptacles	1	ENTRY LBY 1001	1260	va	0.85	1071	1260	
5	C	FCU-1	6	EQUIP 1122A	300	va	0.90	270	300	
6	C	EF-4	6	MECH 1122	700	va	0.90	630	700	
7	A	Printer	2	WRK AREA 1126	780	va	0.85	663	780	
8	A	AV Rack	9	BRK OUT AREA 1134	1000	va	1.00	1000	1000	
9	B	Receptacles	1	RM 1126, 1129	1260	va	0.85	1071	1260	
10	B	Coffee Machine	8	REC THPY 1125	1670	va	1.00	1670	1670	
11	C	Microwave	8	REC THPY 1125	1600	va	0.90	1440	1600	
12	C	REF/FRZR	8	REC THPY 1125	1800	va	0.85	1530	1800	
13	A	Receptacles	1	VR LAB 1127	1080	va	0.85	918	1080	
14	A	Receptacles	1	RM 1134	1080	va	0.85	918	1080	
15	B	BMS Panel	9	MECH 1122	500	va	1.00	500	500	
16	B	Receptacles	1	VR LAB 1127	1080	va	0.85	918	1080	
17	C	Printer	2	VR LAB 1127	500	va	0.85	425	500	
18	C	WS & DSP		INFO 1002	1080	va	1.00	1080	1080	
19	A	BMS Panel	9	EM ELEC 1123	500	va	1.00	500	500	
20	A	Receptacles	1	RM 1128, 1120A, 1121A, 1122	1080	va	0.85	918	1080	
21	B	Receptacles	1	OUTDOOR	1080	va	0.85	918	1080	
22	B	Receptacles	1	RM 1125, 1012	1440	va	0.85	1224	1440	
23	C	Receptacles	1	RM 1122, 1123, 1127, 1124	1080	va	0.85	918	1080	
24	C	WS Receptacles	1	RM 1126, 1128	1440	va	0.85	1224	1440	
25	A	Receptacles	1	RM 1012, 1009, 1012A	1080	va	0.85	918	1080	
26	A	Receptacles	1	INT. LBY 1012	1440	va	0.85	1224	1440	
27	B	Lighting	9	EXTERIOR	300	w	1.00	300	300	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								22.8	25.7	Amps= 71.5

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					7.4	8.5	33%	70.5
PHASE TOTAL	B					7.9	8.8	34%	73.3
PHASE TOTAL	C					7.5	8.5	33%	70.8

LOAD CATAGORIES		Connected			Demand				Ver. 1.02
		kW	kVA	DF	kW	kVA	PF		
1 receptacles		12.2	14.4	0.70	8.6	10.1	0.85		
2 computers		1.1	1.3	0.90	1.0	1.2	0.85		
3 fluorescent lighting		0.0	0.0	1.00	0.0	0.0			
4 HID lighting		0.0	0.0	1.00	0.0	0.0			
5 incandescent lighting		0.0	0.0	1.00	0.0	0.0	1.00		
6 HVAC fans		1.3	1.4	0.80	1.0	1.1	0.90		
7 heating		0.2	0.2	1.25	0.3	0.3	1.00		
8 kitchen equipment		4.6	5.1	0.80	3.7	4.1	0.92		
9 unassigned		3.4	3.4		3.4	3.4	1.00		
Total Demand Loads					17.9	20.1			
Spare Capacity		20%			3.6	4.0			
Total Design Loads					21.5	24.1	0.89	Amps=	66.9

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 23: New Panelboard Schedule R1

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

VOLTAGE: 208Y/120V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 90A/3P C/B

PANEL TAG: R1
PANEL LOCATION: MAIN ELEC 1124
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:
(4) #6, (1) #8 G, 1" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	FATS/ GOLF 1129	18	20A/1P	1	*			2	20A/1P	360	EM ELEC 1123	Motorized Damper
UH-1	MECH 1122	200	20A/1P	3		*		4	20A/1P	1071	ENTRY LBY 1001	Receptacles
FCU-1	ENG EQUIP 1122A	270	20A/1P	5			*	6	20A/1P	630	MECH 1122	
Printer	WRK AREA 1126	663	20A/1P	7	*			8	20A/1P	1000	BRK OUT AREA 1134	AV Rack
Receptacles	RM 1126, 1129	1071	20A/1P	9		*		10	20A/1P	1670	REC THPY 1125	Coffee Machine
Microwave	REC THPY 1125	1440	20A/1P	11			*	12	20A/1P	1530	REC THPY 1125	REF/FRZR
Receptacles	VR LAB 1127	918	20A/1P	13	*			14	20A/1P	918	RM 1134	Receptacles
BMS Panel	MECH 1122	500	20A/1P	15		*		16	20A/1P	918	VR LAB 1127	Receptacles
Printer	VR LAB 1127	425	20A/1P	17			*	18	20A/1P	1080	INFO 1002	WS & DSP
BMS Panel	EM ELEC 1123	500	20A/1P	19	*			20	20A/1P	918	RM 1128, 1120A, 1121A, 1122	Receptacles
Receptacles	OUTDOOR	918	20A/1P	21		*		22	20A/1P	1224	RM 1125, 1012	Receptacles
Receptacles	RM 1122, 1123, 1127, 1124	918	20A/1P	23			*	24	20A/1P	1224	RM 1126, 1128	WS Receptacles
Receptacles	RM 1012, 1009, 1012A	918	20A/1P	25	*			26	20A/1P	1224	INT. LBY 1012	Receptacles
Lighting	EXTERIOR	300	20A/1P	27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	7.44	TOTAL DESIGN LOAD (KW)	21.50
CONNECTED LOAD (KW) - B	7.87	POWER FACTOR	0.89
CONNECTED LOAD (KW) - C	7.52	TOTAL DESIGN LOAD (AMPS)	67

Feeder Size Calculation:

67.9 A * 125% = 83.75A → 100A Bus*, 90A Main, (4) #6 AWG Cu THWN, (1) #8 AWG Cu Ground, 1" Conduit

*Minimum bus size = 100A

Circulation Space - Lobby

Spatial Summary

- **Description**

  As the main circulation space of the building, the lobby is occupied by all who enter. It is located on the first floor of the amorphous section of the building along the north facade facing Palmer Road South. All of the walls, except for that to the east, are curved in shape.

  Upon entering this irregularly shaped space, one first passes through the vestibule, as the main transition space between the exterior and interior. Two single doors on either side of the vestibule allow access to the main entryway. The break out area is located to the west of this space, and entrances to the auditorium and media "dive" room are south. An information desk, coffee shop (includes kitchen area and countertop), and reception desk are also located within the area. Other spaces, including corridors and the interior lobby branch off of the space to the east and south.

- **Drawings**

Figure 24: Lobby Location (NTS)

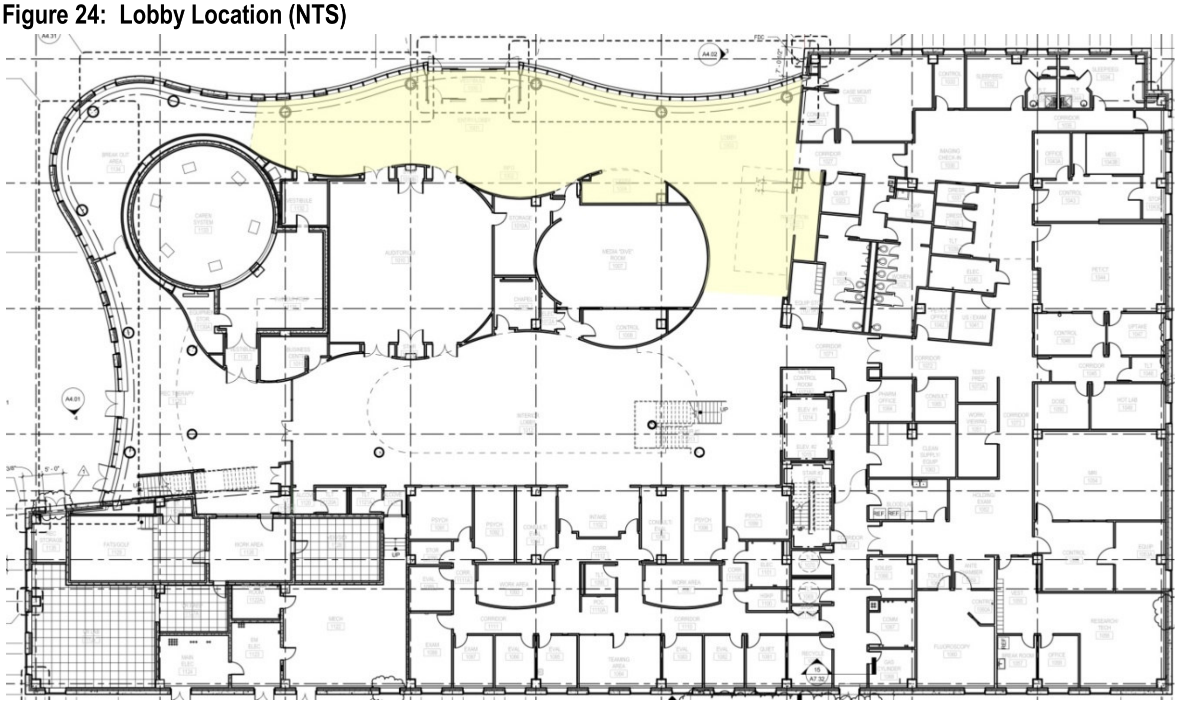


Figure 25: Lobby Floor Plan (NTS)

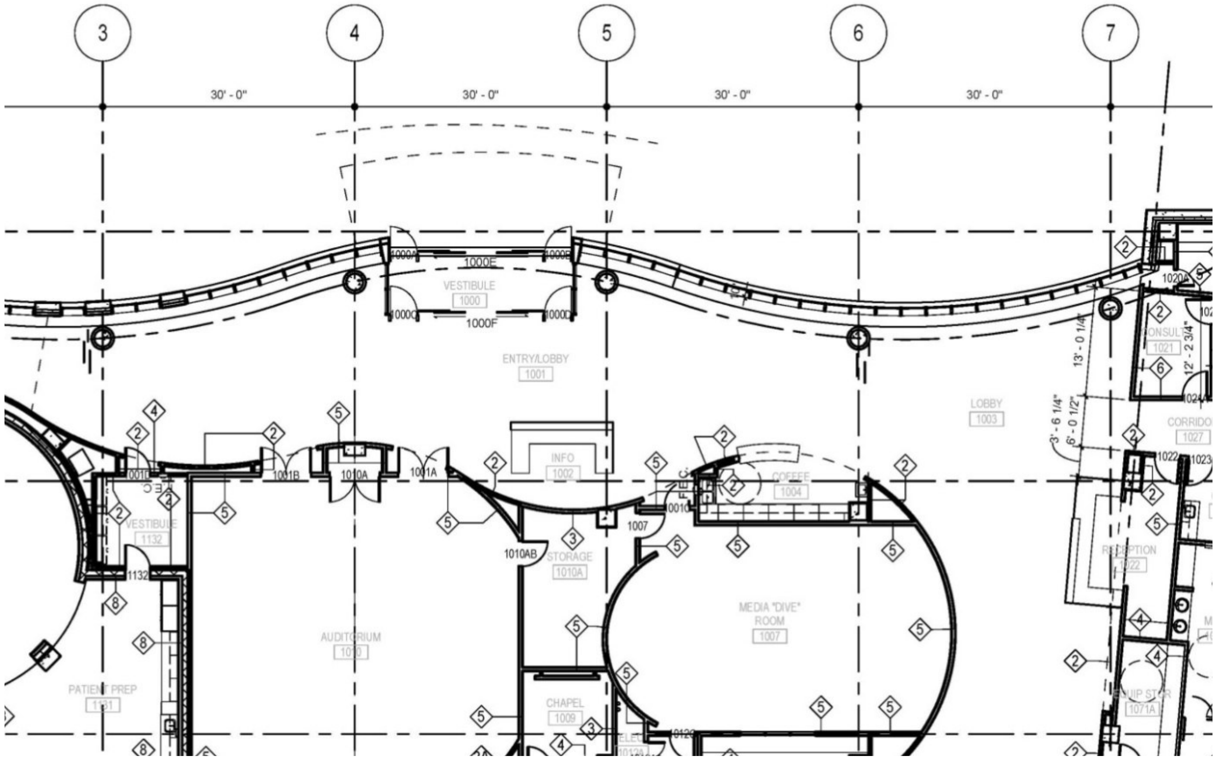


Figure 26: Lobby Reflected Ceiling Plan (NTS)

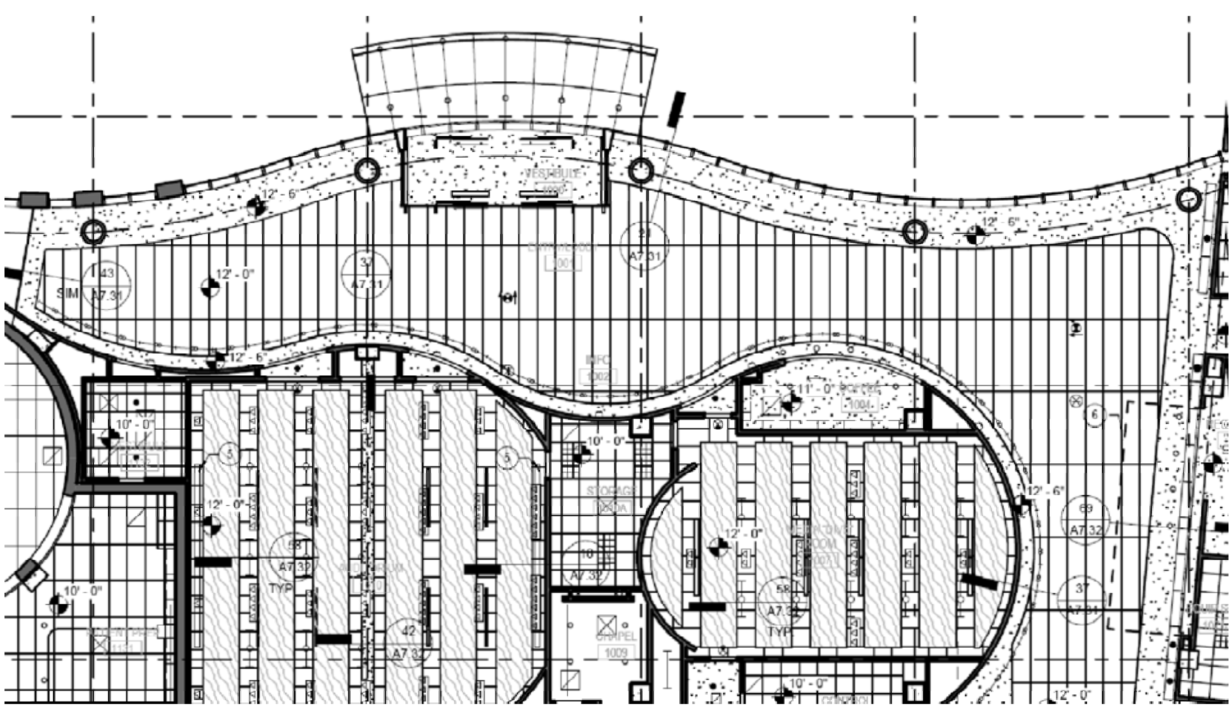


Figure 27: Lobby Interior South Elevation (NTS)

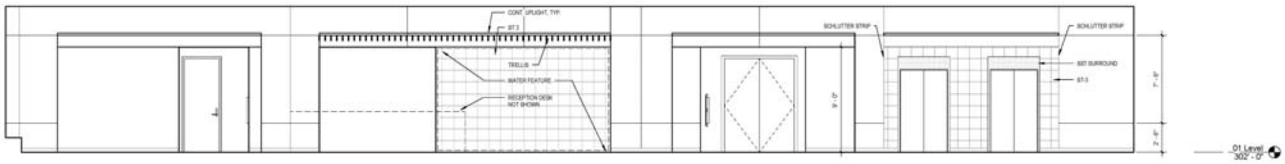


Figure 28: Lobby Interior East Elevation (NTS)

- **Surface Materials**

<u>Entry/Lobby</u>

Floor - The floor consists of carpet tile (CPT-1) throughout the space.

Base - A solid wood base satined to match the adjacent surfaces (WDB-1) is utilized.

Walls - Most of the interior wall surfaces consist of a wood veneer wall covering (WC-1) with painted (P-1) aluminum at the raised ceiling along the perimeter wall. The exterior wall is comprised of a curtainwall system with an aluminum framing system. The glass is vision glass with ceramic frit with a small section of spandrel glass lining the top portion. At a height of 10 feet from the floor, a trellis spans the length of the wall behind the reception desk.

Ceiling - The center of the space consists of 24"x96" acoustic ceiling tile (ACT-1) while the raised ceiling along the perimeter wall is painted gypsum wall board.

<u>Vestibule</u>

Floor - The floor consists of a stainless steel entrance mat (EM-1).

Base - A metal base (MB-1) lines the perimeter of the lower wall.

Walls - Two glass doors with medium stile glass on each side of the north and south walls. Double automatic sliding glass doors are also present on the north and south walls.

Ceiling - The ceiling is gypsum wall board (GWB-1).

<u>Coffee Shop</u>

Floor - The floor is composed of slat defend static dissipative tile (ST-1).

Base - A static wood base stained to match the adjacent surface (WDB-1) is continued around the perimeter.

Walls - The walls match that of the rest of the lobby space with a wood veneer wall covering (WC-1) and painted (P-1) aluminum at the raised ceiling along the perimeter wall. Kitchen cabinets cover most of the wall space in this area. Plastic laminate (PL-1) is located above the cabinets.

Ceiling - The ceiling is covered with painted gypsum wall board (GWB-1).

Reception

Floor - The floor is covered with carpet tile (CPT-3), as a continuation from the other lobby area.

Base - The base is wood that is mdf painted to match the adjacent wall surfaces (WDB-2).

Walls - The walls are painted a color yet to be determined (P-1).

Ceiling - The ceiling is covered with painted gypsum wall board (GWB-1).

Figure 29: Material Properties

Material	Color/Style	Reflectance
CPT-1	PRAIRIE 59525 / DRFTWOOD 23750	0.3
CPT-3	BEIGE	0.4
EM-1	STAINLESS STEEL ENTRANCE MAT	0.7
ST-1	BROUGHTON MOOR HONED	0.3
ST-2	BROUGHTON MOOR HONED	0.3
MB-1	METAL BASE	0.6
WDB-1	WOOD BASE	0.3
WDB-2	WOOD BASE	0.3
WC-1	WOOD COVERING	0.3
P-1	CREAM	0.7
PL-1	RED LAMINATE	0.5
ACT-1	ULTIMA WHITE	0.8
GWB-1	PAINTED P-11 - EXTRA WHITE	0.8
ALUMINUM FRAME	ALUMINUM	0.86
WOOD DOORS	STAINED WOOD	0.2
DOOR FRAME	PAINTED P-1	0.65

Figure 30: Glass Properties

Material	Description	Transmittance	SHGCC	Shading Coefficient	Winter U-value	Outdoor Reflectance
IGU-1	CLEAR VISION GLASS WITH LGU-1	63%	0.27	0.31	0.28	12%
IGU-2*	VISION GLASS WITH CERAMIC FRIT (40% COVERAGE) WITH LGU-1 (LAMINATED GLASS) ON INTERIOR	63% FOR GLASS 16% FOR DOTS	0.27 (FOR GLASS)	0.31 (FOR GLASS)	0.28 (FOR GLASS)	12% (FOR GLASS)
IGU-3	SPANDREL GLASS WITH LGU-2 (LAMINATED GLASS) ON INTERIOR	0% (FLOOR STRUCTURE)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
	MEDIUM STILE GLASS (DOORS AND INTERIOR GLASS)	90% (ASSUME SINGLE PAIN CLEAR)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE

*NOT ALL INFORMATION PROVIDED, SO ASSUMPTIONS MADE FROM COMPARISON TO OTHER PRODUCTS

- **Furnishings**
  Benches line the exterior curtainwall on each side of the vestibule. In the northeast corner of the space, small tables and chairs provide additional lobby seating as well as a workspace. The Info and Reception desks are both furnished with chairs and computers. The Coffee area includes basic kitchen necessities.

- **Activities/Tasks**
  As the main circulation space in the building, the lobby should help to guide people to their destination. Building users will pass through the space to reach their destination, or sit at the benches or tables to rest. At the Info and Reception desks newcomers will speak with the building employees to gain information. Normal desk activities such as reading, writing, and computer work will be prevalent. The Coffee station will require beverage preparation and service. One may also pass through the space to view and enjoy its unique features.

Design Concept

The lobby should create a smooth transition from the exterior. As the main circulation space in the building, the lobby should help to guide people to their destination. A sense of relaxation and pleasantness is necessary to calm anxious patients. The concept of leadership should be implemented through light that guides visitors through the space. Points of interest which include the information desk, coffee shop, and reception desk should stand out and lead occupants from one location to another. The curved interior wood wall should be highlighted to accentuate the unique shape and material. A wash of light onto the ceiling from a soffit along the curtainwall will portray daylight entering into the space. The lighting should be suitable for a variety of tasks to be performed in the area. Lights washing the ceiling along the curtainwall should be dimmable and controlled with photosensors that are dependent on the amount of daylight that enters the space throughout the day. All other lighting should be on timers. At night, only lights in the vestibule and highlighting the curved interior wall should be on.

Design Criteria

(IESNA Handbook: Health Care Facilities, Lobby)

- **Appearance of Space and Luminaires** (Important)
  When entering the building, the lobby is the first space that the occupants encounter. Many of the visitors will be patients as well as high ranking government and military officials who will expect high quality from this state of the art facility. The building should reflect this characteristic through high end and/or concealed fixtures. The lighting design should also be functional and provide adequate illuminance levels for numerous tasks. This

transitional space should not be extremely bright or have high contrast in order to accommodate for the sensitivities of traumatic brain injury patients.

- **Psychological Impressions**
  The impression of pleasantness should be present throughout the space. A uniform lighting mode with some peripheral wall emphasis should be implemented.

  Many of the visitors in the space will be patients coming for treatment or analysis. The mood should be very calm and relaxing to ease nerves or tension. A concept of flow and movement is applicable.

- **Color Appearance (and Color Contrast)** (Very Important)
  A low CCT would naturally complement the wood walls throughout; however, there is also a lot of natural daylight (cooler CCT) that enters the space. In order to accommodate for both of these features, an average CCT of about 3500K is desirable. This will accent skin tones, as well. A high CRI is important in order to impress occupants and accurately see materials and objects throughout the space.

- **Daylighting Integration and Control** (Very Important)
  The curtainwall system lining the northern wall of this space provides a large amount of light during the day. Since the glass faces north and a majority of it consists of ceramic frit, direct sun angles are easily avoided. The abundance of daylight allows for little electric light to be needed in the space during the daytime. Photosensors are necessary to control ambient electric lighting through dimming the fixtures. The time of day and amount of light present in the space determines the necessary dimming levels.

- **Direct Glare** (Important)
  For adequate and comfortable usage of the space, there should be no direct glare viewable by the users. This is especially important for patients with traumatic brain injuries because they are extremely sensitive to brightness. Direct glare from the lamp sources should be eliminated by integrating the fixtures within the architecture to conceal the luminaires.

- **Flicker (and Strobe)** (Very Important)
  As a facility for patients with traumatic brain injury, the users are very sensitive to brightness and contrast, so flicker and strobe from lights should be avoided at all costs. However, the space will just be used as a transition area, so rapid movement will not be present. Therefore, flicker will not be as noticeable, but the use of magnetic ballasts should be avoided whenever possible.

- **Light Distribution on Surfaces** (Very Important)
  Light distribution on the wood walls should be horizontally uniform, but vertically transition from bright to dark. Non-uniformity across other vertical surfaces and the ceiling will create visual interest.

- **Light Distribution on Task Plane (Uniformity)**
  There are several task planes throughout the space, which include the information desk (reading and writing), coffee counter, reception desk (reading and writing, and floor (walking). The locations should include uniform light distribution that provides the recommended light levels.

- **Luminances of Room Surfaces / Surface Characteristics** (Very Important)
  Highlight the wood walls throughout the space through wall grazing. The elevated ceiling along the wall provides a built-in cove that will easily house fixtures to illuminate and emphasize the beautiful texture of the wood material. The unique curved geometry will draw attention as well. The white ceiling should be lit to mimic daylight entering the space.

- **Modeling of Faces or Objects** (Very Important)
  At the many specialty areas throughout the space, there will be constant interaction between people. Facial expressions and hand motions are necessary for successful communication. Appropriate light levels will also enable TBI patients to easily interact with others. Some direct downlighting as well as sidelight from the windows or sconces is appropriate.

- **Point(s) of Interest**
  One of the main points of interest in the space is the vestibule, which should have appropriate lighting in order to distinguish it from the rest of the facade. Since it is located in the center of the continuous glass curtainwall, lighting should be used to make the area stand out at night. As an all glass structure, light should be integrated to make the space glow or stand out in a subtle way.

  The information desk is one of the first items seen when entering the space. Building newcomers should first approach this area to gain assistance in navigating the building. Overhead lighting or fixtures integrated in the furniture should catch visitors' attention so they immediately know the area's purpose.

  The coffee area should have general lighting to serve customers. Countertop or under cabinet lighting will assist in adequate vision while making and distributing beverages. The serving counter should be well illuminated to exchange money, read, or write.

  As one of the interest points in the space, the reception desk should provide users with a good impression of the facility. Since it serves a similar purpose as the info desk, it should also have comparable lighting. A trellis is located above the reception desk and creates an opportunity for a subtle glow of light from within the structure.

- **Reflected Glare and Source/Task/Eye Geometry** (Important)
  Avoid reflected glare from windows and tabletops. The abundance of windows throughout the space makes it imperative for one to ensure that luminaires are not placed close to or aimed at the glass. Tabletops may have a glossy finish, so place lights at a reasonable height and choose fixtures that avoid direct glare.

- **Shadows**
  Shadows should be avoided on the task planes, such as the information desk, coffee counter, reception desk, and floor. However, the raised ceiling near the curtainwall provides a very unique and mysterious feature to the space, as one wonders what is above.

- **Sparkle/Desirable Reflected Highlights** (Important)
  Large amounts of sparkle will try to be avoided. The brain injury patients are sensitive to high light levels and contrast. However, sconces without really bright sources can be utilized along the walls around doorways to adjacent spaces. This creates an additional functional quality as a circulation symbol.

- **System Control and Flexibility** (Very Important)
  With the abundance of daylight in the space, some fixtures should be dimmed through the use of photosensors to save energy during the day. There should also be some fixtures that remain on all the time, even at night to create a please visual effect from the exterior. This will also act as a security measure. The vestibule should be lit at all times. All other fixtures in the space should be on an automatic time clock and programmed to shut off at the end of each work day.

- **Maintenance**
  The large ceiling heights make required maintenance and relamping difficult. Choose fixtures with a long lamp life to decrease the time between relamping as well as replacement costs. The lamps should have color consistency over time.

- **Special Considerations** (Very Important)
  Since the lobby is the main circulation space of the building, users should have no question as to how to navigate throughout the space. The points of interest should be well lit, and a path of light should guide occupants from one area to another.

- **Horizontal Illuminance** (Important)
  The required horizontal illuminance is as follows (IESNA Handbook):
  - Lobby/Waiting Area (consider visually impaired) = 10 fc
  - Reception and Info Desk = 30 fc (Reading, Printed tasks, 8- and 10-point type)
  - Kitchen Counter, General = 30 fc
  - Kitchen Counter, Critical Seeing = 50 fc
  - Vestibule = 5 fc (Building Entrance, Active)

  Deviations: none

- **Vertical Illuminance** (Important)
  The required vertical illuminance is as follows (IESNA Handbook):
  - Lobby/Waiting Area = 3 fc
  - Kitchen Counter, General = 3 fc
  - Vestibule = 3 fc (Building Entrance, Active)

  Deviations: none

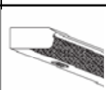
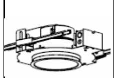
- **Power Allowance**
  The allowable power densities are as follows (ASHRAE 90.1 - 2007):
  - Lobby = 1.3 W/sq.ft.
  - Decorative = +1.0 W/sq.ft.

Lighting Plans

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

Luminaires

Figure 31: Lobby Luminaire Schedule

Type		Manufacturer	Product Name	Catalog Number	Description	Lamp	Voltage	Ballast/Power Supply	Watts	Location
B		WINONA LIGHTING	4614 Triad	4614-F-277V-OA-PC-STD	-UL listed and CUL approved -Custom sizes and finishes available upon request -Polished chrome clips (other options available) -Etched opal acrylic lens	CF13DD/830/ECO Osram Sylvania: 20705 Dulux D Preheat 2-pin Ecologic CFL	277	VH-2B13-TP-BLS ADVANCE CFL Magnetic Ballast	27	AUDITORIUM, LOBBY, OT, THERAPY WAIT - Walls - 6.5' on center
C		Lighting Services Inc.	CP100 SERIES	C100-2G-CC-WL-B	-Sturdy aluminum housing -Rugged steel self-locking yoke allows for horizontal and vertical focusing -On/off safety switch -Integral dimmer available -Various finishes and accessory clips available	35PAR20/HAL/NSP10 Osram Sylvania: 14467 Capsylite PAR 20	120	N/A	35	AUDITORIUM - Ceiling Panels
J		Elliptipar	Style 306	F-306-A132-S-00-V-000	-Compact and flexible - effective slot and valance lighting using T5 for precise optical or widely utilized T8 -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Integral electronic ballast thru wiring for easy installation -Durable - all parts are aluminum or stainless steel	FO32/835/XPS/ECO Osram Sylvania: 21697 Octron 800 XPS Lamp	277	ICN-3P32-SC@277V ADVANCE 2 Lamp Electronic Ballast	2 lamps: 65	LOBBY - Interior curved wall PT - Interior curved wall
O3a		Elliptipar	Style 305	F-305-T121-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP21/835/ECO Osram Sylvania: 20921 Pentron, High Performance T5 Lamp	277	ECO-T521-C-277-2 Lutron Hi-Lume, Compact SE, Eco-10 3-Wire Dimming Ballast	2 lamps: 52.63	LOBBY - Ceiling cove
O3b		Elliptipar	Style 305	F-305-T121-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP21/835/ECO Osram Sylvania: 20921 Pentron, High Performance T5 Lamp	277	ICN-2S28-N@277 ADVANCE Electronic Programmed Start Ballast	25	RECEPTION - Ceiling cove
O4a		Elliptipar	Style 305	F-305-T128-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP28/835/ECO Osram Sylvania: 20901 Pentron, High Performance T5 Lamp	277	ECO-T528-277-2 Lutron Hi-Lume, Compact SE, Eco-10 3-Wire Dimming Ballast	2 lamps: 69.25	LOBBY - Ceiling cove
O4b		Elliptipar	Style 305	F-305-T128-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP28/835/ECO Osram Sylvania: 20901 Pentron, High Performance T5 Lamp	277	ICN-2S28@277V ADVANCE 1 Lamp Electronic Programmed Start Ballast	31	LOBBY - Ceiling cove
O4c		Elliptipar	Style 305	F-305-T128-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP28/835/ECO Osram Sylvania: 20901 Pentron, High Performance T5 Lamp	277	ICN-2S28@277V ADVANCE 2 Lamp Electronic Programmed Start Ballast	2 lamps: 60	LOBBY - Ceiling cove
P		LIGHTOLIER	FP01 Vetro Architectural Decorative	FP1-PM32SA-PG01-32CFL-277V-SK01	-Satin machined aluminum and hand-blown opal glass -Handsome proportion of materials engineered to provide a functional design element and an efficient luminaire -Brushed and clear lacquer finish	CF32DT/E/835/ECO Osram Sylvania: 20885 Dulux T/E/IN Amalgam 4-Pin Ecologic Compact Fluorescent Lamp	277	ICF2S26H1LDQS @277 ADVANCE Electronic Programmed Start Ballast	36	LOBBY - Info desk, reception desk, coffee shop
Q		Birchwood Lighting	WP System	WP-T5-US-AC-277-STD-121-HRW	-20 gauged steel construction -Uses standard or high output T5 fluorescent lamps, other lamp types available -Formed snap-on acrylic cover -Standard finish is high reflectivity white powder coat done post production -Treated with a multi-stage phosphate process which ensures proper finish bonding and inhibits rust	FP21/835/ECO Osram Sylvania: 20921 Pentron, High Performance T5 Lamp	277	ICN-2S28-N@277 ADVANCE Electronic Programmed Start Ballast	25	COFFEE SHOP
R		Gotham Lighting	6" AF Lensed Reflector Compact Fluorescent Downlights	AF-1/26TRT-6AR-T73-277	-Fluted vertical upper section works in conjunction with Bounding Ray Optical Principle design to provide lamp before lamp image and smooth transition from top of reflector to bottom -Minimum flange matches reflector finish -Semi-specular clear upper reflector -Hinged lamp door seals upper trim for optimal fixture efficiency and the reduction of stray light in the plenum	CF26DT/E/835/ECO Osram Sylvania: 20881 Dulux T/E/IN Amalgam 4-Pin Ecologic Compact Fluorescent Lamp	277	ICF2S26H1LDQS @277 ADVANCE Programmed Start Ballast	29	VESTIBULE, COFFEE SHOP, LOBBY

Type		Manufacturer	Product Name	Catalog Number	Description	Lamp	Voltage	Ballast/Power Supply	Watts	Location
S1		RSA Lighting	LEDeon	LEDEON-W-12'	-A totally flexible, sealed 24V DC LED strip for indoor applications -Super bright LEDs with close 1/2" o/c spacing for uniform illumination -Two inch mounting clips (P9) for freeform flexed installation or six food mouting channels (P9CH) for rigid linear installation are available with through holes for screw mounting -May be cut to size in the field.	Included with luminaire	24VDC to 277V through driver	LEDINTA-0024-41FO 277V Xitanium ADVANCE LED Driver	117	LOBBY - Info desk
S2		RSA Lighting	LEDeon	LEDEON-W-15'	-A totally flexible, sealed 24V DC LED strip for indoor applications -Super bright LEDs with close 1/2" o/c spacing for uniform illumination -Two inch mounting clips (P9) for freeform flexed installation or six food mouting channels (P9CH) for rigid linear installation are available with through holes for screw mounting -May be cut to size in the field.	Included with luminaire	24VDC to 277V through driver	LEDINTA-0024-41FO 277V Xitanium ADVANCE LED Driver	117	LOBBY - Info desk

See Appendix B for full luminaire schedule and cut sheets.

Figure 32: Lobby Spatial Assumptions

Type	Maintenance Category	Distribution Type	Degree of Dirtiness	Cleaning Cycle	Room Cavity Ratio
B	II	Direct-Indirect	Clean	12 Months	3.19
C	IV	Direct	Clean	12 Months	3.19
J	III	Direct-Indirect	Clean	12 Months	3.19
O3a	IV	Indirect	Clean	12 Months	3.19
O3b	IV	Indirect	Clean	12 Months	3.19
O4a	IV	Indirect	Clean	12 Months	3.19
O4b	IV	Indirect	Clean	12 Months	3.19
O4c	IV	Indirect	Clean	12 Months	3.19
P	II	Semi-direct	Clean	12 Months	3.19
Q	V	Direct	Clean	12 Months	3.19
R	V	Direct	Clean	12 Months	3.19
S1	V	Direct-Indirect	Clean	12 Months	3.19
S2	V	Direct-Indirect	Clean	12 Months	3.19

Figure 33: Light Loss Factors

Type	BF	LLD	LDD	RSDD	Total LLF
B	0.91	0.86	0.95	0.94	0.70
C	1	0.95	0.95	0.98	0.88
J	1.01	0.95	0.9	0.94	0.81
O3a	0.91	0.93	0.88	0.88	0.66
O3b	1.06	0.93	0.88	0.88	0.76
O4a	0.91	0.93	0.88	0.88	0.66
O4b	1.05	0.93	0.88	0.88	0.76
O4c	1	0.93	0.88	0.88	0.72
P	0.98	0.86	0.97	0.95	0.78
Q	1.06	0.93	0.87	0.98	0.84
R	1.1	0.86	0.87	0.98	0.81
S1	N/A	0.85	0.87	0.94	0.70
S2	N/A	0.85	0.87	0.94	0.70

Controls

During the day, the linear cove lights along the outer perimeter of the ceiling (fixture types O3a, O4a, and O4b) will be on photosensors. They will be dimmed depending on the amount of daylight that enters the space. These fixtures will also be connected to a time clock for automatic-off during after hours. The interior wall grazing lights and vestibule fixtures (fixture types J and R) will be on both during the day and at night for security and safety measures. All other fixtures will be on a general time clock. They will only be on throughout normal operating hours during the day. It was decided not to place the remaining lights on photosensors because the amount of daylight that enters the space varies depending on the location within the room. Also, these are mostly task lights that should not be fluctuating in light level.

Figure 34: Lobby Equipment Schedule

Type	Manufacturer	Product Name	Catalog Number	Description	Location
EQ 5	Watt Stopper	MSC-100 Astronomic Time Clock	MSC-100	-Five-channel clock used with Watt Stopper's wireless RF lighting control systems -Provides ON/OFF control signals based on time of day, day of week, holiday, and calculated sunrise/sunset (astronomic) time	Main Electrical Room 1124
EQ 7	Watt Stopper	LightSaver LS-290C Photosensor	LS-290C	-Provides the daylight data necessary for operation of LCD-203 daylighting control system -Utilizes a photodiode element to continuously measure ambient light levels -Positioned to "see" incoming daylight from either a window or skylight without seeing electrical light -Users select the applicable footcandle range by a jumper beneath the front cover	PT 2104 and Lobby 1001
EQ 8	Watt Stopper	LightSaver LCD-203 Dimming Controller	LCD-203	-Provides automatic dimming control for fluorescent and HID fixtures -Open loop controller providing up to three zones of control from a single photocell -Simplified setup and calibration -Seven individually adjuatable parameters for each chanel -Automatic internal calculation for dimming requirements of individual channels for simplified setup	Electrical Room 1040
EQ 9	Watt Stopper	LightSaver BT-203 Power Pack	BT-203	-Powers the LightSaver LCD-203 control module -Connects via a quick connect cable -Has three normally open relays used to switch line voltage in response to signals from the connected controller -Automatically resetting fuse	Electrical Room 1040

See Appendix C for full equipment schedule and cut sheets.

Performance Data

The following are renderings, calculation grids, and numerical summaries of the lobby lighting setting:

Figure 35: Lobby Rendering at Entrance

Figure 36: Lobby Rendering at Coffee Shop

Figure 37: Lobby Rendering at Reception Desk

Figure 38: Lobby Horizontal Illuminance (fc)

Figure 39: Lobby Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Lobby Workplane (floor)	14.22	26.8	6.2	4.32
Lobby Vertical	15.52	18.4	11.5	1.6

Figure 40: Vestibule Horizontal Illuminance (fc)

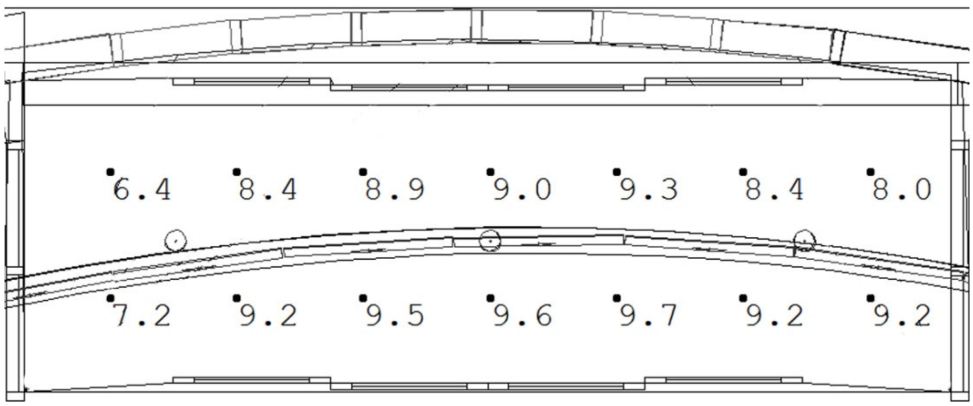


Figure 41: Vestibule Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Vestibule Workplane (floor)	8.77	9.7	6.2	1.49
Vestibule Vertical	2.7	3.6	0.8	4.5

Figure 42: Info Desk Horizontal Illuminance (fc)

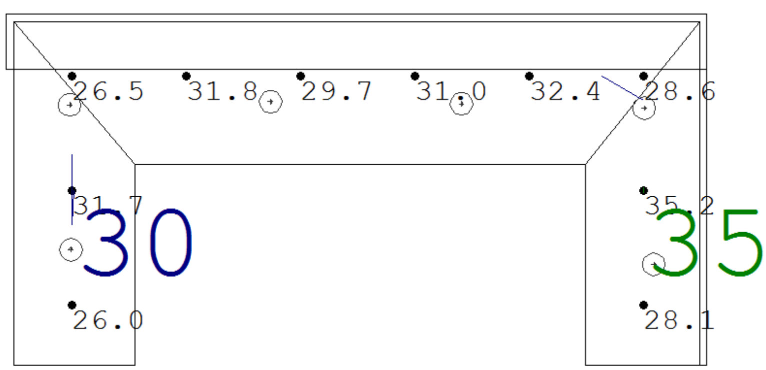


Figure 43: Info Desk Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Info Desk Workplane (horizontal 2.5' AFF)	30.1	35.2	26	1.35

Figure 44: Coffee Shop Horizontal Illuminance (fc)

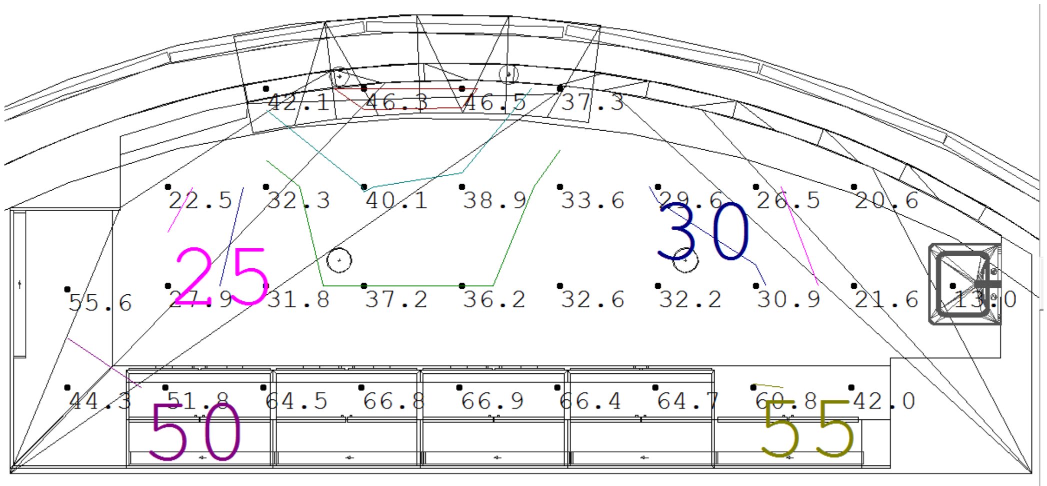


Figure 45: Coffee Shop Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Coffee Shop Workplane (horizontal 3.5' AFF)	32.37	46.5	13	3.58
Countertop Workplane (horizontal 3' AFF)	58.38	66.9	42	1.59
Coffee Shop Vertical	21.91	50.4	2.2	22.91

Figure 46: Reception Desk Horizontal Illuminance (fc)

Figure 47: Reception Desk Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Reception Desk Workplane (horizontal 2.5' AFF)	28.03	41.1	14.6	2.82

Energy Code Compliance

Figure 48: Energy Code Calculations

ASHRAE Standard 90.1

Space	Total Area (sq.ft)	Allowable Lighting Power Density (W/sq.ft.)	Total Allowable Watts	Total Watts Used
Lobby	3822	1.3	**4968.6**	**3922**
Lobby (decorative)	3822	1	**3822**	**108**

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Performance Summary

The redesign of the lighting for the lobby space adequately meets the stated design criteria. It closely follows the concept of leadership through the way-finding lights that guide occupants from one location to another. Immediately as one enters the building, he or she is drawn to the uniquely lit information desk. LED fixtures integrated into the front of the desk provide a signal of navigation in the space. The coffee shop provides a welcoming glow for visitors to stop for a drink. Finally, the reception desk invites occupants to check-in under adequate and aesthetically pleasing lighting. In each of these locations, the lighting enables each area to stand out and guide the visitors. Throughout the entire length of the space, light is integrated into the architecture and highlights the solid interior wood wall. On the opposite side of each space along the curtainwall, the lighting is integrated into a soffit that extends from the ceiling. Fixtures wash the ceiling, mimicking daylight that enters the space. This constant array of light from one end of the space to the other provides further guidance. The peripheral wall emphasis and indirect lighting also creates a relaxing and pleasant feel. Sconces accentuate the peripheral walls and provide way-finding light to the space's entrances and exits. Allowing the interior wall lighting to remain on at night reinforces the building's strong interior. The columns were left unlit in order to make them standout as a structural element. Other fixtures provide visual clarity and interest necessary in this important entrance space.

The luminaires throughout the space portray a sleek and high-tech design. Most of the fixtures are integrated into the surroundings to avoid direct glare. A mid CCT and high CRI enhance skin tones and materials while also rendering colors well. Uniform lighting on the workplanes enables task completion at the info desk, coffee shop, and reception desk; however, non-uniform peripheral emphasis creates visual interest. The unique materials throughout the space are also accentuated. Luminaires are placed far enough away from the glass to avoid reflected glare. All signage (behind the info desk) is adequately lit.

As shown in the calculation grids and summaries, the lighting successfully meets the IESNA light level requirements. The overall light levels in the lobby are a little higher than necessary; however, some of the building's visitors are visually impaired, so slightly higher numbers are acceptable. All other workplanes, such as the information desk, reception desk, and countertops follow the specified criteria. The vertical illuminance levels are met as well. This is particularly important for face-to-face conversations and interaction.

Throughout the day, there is also a significant daylight contribution in all spaces. The large curtainwall along the north side of the space provides a large amount of daylight. The use of an open loop dimming photosensor will control the fixtures lighting the ceiling. This will provide an energy-saving way to take advantage of the natural daylight.

The controls used in the space enable an efficient use of daylight to save energy. They also follow the automatic lighting shutoff requirements of ASHRAE 90.1.

Electrical Redesign

For a complete spatial description of the lobby, see page 31.

The lobby is comprised of several areas that are used for various tasks. When one first enters through the front entrance, they are first led to the information desk. Moving further through the space there is a coffee shop, seating area, and main reception desk. Lighting these particular areas helps to guide and lead people through the space. Therefore, the lighting is based on the concept of leadership and movement. Adequate light levels are provided on the task planes of each area, which includes the floor and desk/table height. A large amount of indirect lighting is applied to avoid direct glare. Light grazes the interior wood wall to accent the material and curved architecture. A ceiling cove is used to house a fixture that lights the ceiling along the exterior curtainwall. This mimics daylight entering the space. Wall sconces along the peripheral walls are used to create some visual interest. The large amount of daylight is welcomed into the space throughout the curved curtainwall.

For the electrical redesign of the space, all of the new lighting replaces the existing lighting circuits on each respective panelboard. The fixtures in the space use a combination of dimming photosensors and a time clock. The wall grazing and vestibule fixtures are on at all times of the day for security purposes. These fixtures are also located on the normal/emergency system. The ceiling cove lights throughout the lobby are on a photosensor dimming system during the day, and a time clock for automatic off after hours. All remaining fixtures are located on a time clock. They will operate throughout the day, and will switch off when the building closes at night. Almost all fixtures are run on 277V panelboards that are located in Electrical Room 1040. The fixture type C spots are run on 120V power and are connected to a 120Y/208V panelboard in a nearby storage room. These spaces also house the time clocks and photosensor controls.

- **Layout of Circuiting**
  See Appendix A for complete lighting plans with all electrical circuiting.

- **Existing Panelboards/Modified Circuits**
  The following are the panelboards that contain the existing light fixtures for the space. The specific circuits to be modified are highlighted.

Figure 49: Existing Panelboard L1B

(6) 20A, 1P, SPARES
(3) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "L1B" (SURFACE MTD IN ELEC RM 1040) - 480Y/277V, 3PH, 4W, BUS RATING 225A, MCB 150A, AIC 42000, TYPE1 ENCL. (42 POLE)								
			Apparent Load					
Circuit Number	Load Name	Rating	Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting	20 A	60 VA	60 VA	0 VA	0 VA	1	0 A
2	Lighting COFFEE 1004	20 A	213 VA	213 VA	0 VA	0 VA	1	1 A
3	Lighting CORRIDOR 1035	20 A	128 VA	0 VA	128 VA	0 VA	1	0 A
4	Lighting BREAK OUT AREA 1134	20 A	384 VA	0 VA	384 VA	0 VA	1	1 A
5	Lighting CORRIDOR 1074	20 A	135 VA	0 VA	0 VA	135 VA	1	0 A
6	Lighting BREAK OUT AREA 1134	20 A	450 VA	0 VA	0 VA	450 VA	1	2 A
7	Lighting LOBBY 1003	20 A	678 VA	678 VA	0 VA	0 VA	1	2 A
8	Lighting SLEEP/EEG 1034	20 A	1733 VA	1733 VA	0 VA	0 VA	1	6 A
9	Lighting BREAK OUT AREA 1134	20 A	859 VA	0 VA	859 VA	0 VA	1	3 A
10	Lighting BREAK OUT AREA 1134	20 A	906 VA	0 VA	906 VA	0 VA	1	3 A
11	Lighting RECEPTION 1022	20 A	498 VA	0 VA	0 VA	498 VA	1	2 A
12	Lighting CORRIDOR 1074	20 A	1843 VA	0 VA	0 VA	1843 VA	1	7 A
13	Lighting DOSE 1050	20 A	3274 VA	3274 VA	0 VA	0 VA	1	12 A
14,16,18	FCU-2, ELEV. CONTROL ROOM 1071B	15 A	900 VA	300 VA	300 VA	300 VA	3	1 A
15	Lighting GAS CYLINDER 1068	20 A	3693 VA	0 VA	3693 VA	0 VA	1	13 A
17	Lighting BLOOD LAB 1062	20 A	3060 VA	0 VA	0 VA	3060 VA	1	11 A
19,21,23	H-1, HOLDING/ EXAM 1052	25 A	16600 VA	5533 VA	5533 VA	5533 VA	3	20 A
20,22,24	H-3, CORRIDOR 1035	40 A	26600 VA	8867 VA	8867 VA	8867 VA	3	32 A
25,27,29	T75	125 A	75000 VA	25000 VA	25000 VA	25000 VA	3	90 A
Grand total: 19			137014 VA	45658 VA	45670 VA	45686 VA		208 A

Figure 50: Existing Panelboard LSL1B

(10) 20A, 1P, SPARES
(24) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "LSL1B" (SURFACE MTD IN ELEC RM 1040) - 480Y/277V, 3PH, 4W, BUS RATING 100A, MLO, AIC 22000, TYPE1 ENCL. (42 POLE)								
			Apparent Load					
Circuit Number	Load Name	Rating	Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting	20 A	384 VA	384 VA	0 VA	0 VA	1	1 A
2,4,6	T15 (LSR1B)	25 A	15000 VA	5000 VA	5000 VA	5000 VA	3	18 A
3	Lighting CORRIDOR 1074	20 A	770 VA	0 VA	770 VA	0 VA	1	3 A
5,7,9	LSL2B	50 A	1251 VA	691 VA	0 VA	560 VA	3	2 A
Grand total: 4			17405 VA	6075 VA	5770 VA	5560 VA		24 A

Figure 51: Exisiting Panelboard LSL2A

(12) 20A, 1P, SPARES
(26) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "LSL2A" (SURFACE MTD IN ELEC RM 2081) - 480Y/277V, 3PH, 4W, BUS RATING 100A, MCB 50A, AIC 22000, TYPE1 ENCL. (42 POLE)								
			Apparent Load					
Circuit Number	Load Name	Rating	Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting CENTRAL PARK 2103	20 A	148 VA	148 VA	0 VA	0 VA	1	1 A
2	Lighting STOR 2070	20 A	927 VA	927 VA	0 VA	0 VA	1	3 A
3	Lighting CORRIDOR 277	20 A	1095 VA	0 VA	1095 VA	0 VA	1	4 A
5	Lighting MEDIA "DIVE" ROOM 1007	20 A	1378 VA	0 VA	0 VA	1378 VA	1	5 A
Grand total: 4			3548 VA	1075 VA	1095 VA	1378 VA		13 A

- ## New Panelboard Worksheets and Schedules

Figure 52: New Panelboard Worksheet L1B

PANELBOARD SIZING WORKSHEET											
Panel Tag------------------------->					L1B	Panel Location:			ELEC ROOM 1040		
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	3	LOBBY 1003	1092	w	1.05	1092	1040		
2	A	Lighting	3	LOBBY 1003	412	w	1.00	412	412		
3	B	Lighting	3	CORRIDOR 1035	128	va	0.95	122	128		
4	B	Lighting	3	COFFEE 1004	280	w	0.99	280	283		
5	C	Lighting	3	CORRIDOR 1074	135	va	0.95	128	135		
6	C	Lighting	3	BREAK OUT AREA 1134	130	va	0.95	124	130		
7	A	Lighting	3	LOBBY 1003	230	va	0.95	219	230		
8	A	Lighting	3	SLEEP/EEG 1034	1733	va	0.95	1646	1733		
9	B	Lighting	3	LOBBY 1003	449	va	0.99	445	449		
10	B	Lighting	3	BREAK OUT AREA 1134	362	va	0.95	344	362		
11	C	Lighting	3	RECEPT 1022	508	va	0.99	503	508		
12	C	Lighting	3	CORRIDOR 1074	1843	va	0.95	1751	1843		
13	A	Lighting	3	DOSE 1050	3274	va	0.95	3110	3274		
14	A	FCU-2	6	ELEV. CONTROL ROOM 1071B	300	va	0.90	270	300		
15	B	Lighting	3	GAS CYLINDER 1068	3693	va	0.95	3508	3693		
16	B	FCU-2	6	ELEV. CONTROL ROOM 1071B	300	va	0.90	270	300		
17	C	Lighting	3	BLOOD LAB 1062	3060	va	0.95	2907	3060		
18	C	FCU-2	6	ELEV. CONTROL ROOM 1071B	300	va	0.90	270	300		
19	A	H-1	7	HOLDING/ EXAM 1052	5533	va	1.00	5533	5533		
20	A	H-3	7	CORRIDOR 1035	8867	va	1.00	8867	8867		
21	B	H-1	7	HOLDING/ EXAM 1052	5533	va	1.00	5533	5533		
22	B	H-3	7	CORRIDOR 1035	8867	va	1.00	8867	8867		
23	C	H-1	7	HOLDING/ EXAM 1052	5533	va	1.00	5533	5533		
24	C	H-3	7	CORRIDOR 1035	8867	va	1.00	8867	8867		
25	A	T75	9	ELEC ROOM 1040	25000	va	0.95	23750	25000		
26	A				0	w		0	0		
27	B	T75	9	ELEC ROOM 1040	25000	va	0.95	23750	25000		
28	B				0	w		0	0		
29	C	T75	9	ELEC ROOM 1040	25000	va	0.95	23750	25000		

30	C				0	w		0	0		
31	A				0	w		0	0		
32	A				0	w		0	0		
33	B				0	w		0	0		
34	B				0	w		0	0		
35	C				0	w		0	0		
36	C				0	w		0	0		
37	A				0	w		0	0		
38	A				0	w		0	0		
39	B				0	w		0	0		
40	B				0	w		0	0		
41	C				0	w		0	0		
42	C				0	w		0	0		
PANEL TOTAL								131.9	136.4	Amps=	164.1
PHASE LOADING								kW	kVA	%	Amps
		PHASE TOTAL	A					44.9	46.4	34%	167.5
		PHASE TOTAL	B					43.1	44.6	33%	161.1
		PHASE TOTAL	C					43.8	45.4	33%	163.8
LOAD CATAGORIES				Connected			Demand				Ver. 1.02
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			16.6	17.3	1.00	16.6	17.3	0.96		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.8	0.9	0.80	0.6	0.7	0.90		
7	heating			43.2	43.2	1.25	54.0	54.0	1.00		
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
9	unassigned			71.3	75.0		71.3	75.0	0.95		
	Total Demand Loads						142.5	147.0			
	Spare Capacity			20%			28.5	29.4			
	Total Design Loads						171.0	176.4	0.97	Amps=	212.3

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 53: New Panelboard Schedule L1B

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 400A SIZE/TYPE MAIN: 300A/3P C/B	PANEL TAG: L1B PANEL LOCATION: ELEC ROOM 1040 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: (4) #250, (1) #4 G, 2 1/2" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	LOBBY 1003	1092	20A/1P	1	*			2	25A/3P	412	LOBBY 1003	Lighting
Lighting	CORRIDOR 1035	122	20A/1P	3		*		4		280	COFFEE 1004	Lighting
Lighting	CORRIDOR 1074	128	50A/3P	5			*	6		124	BREAK OUT AREA 1134	Lighting
Lighting	LOBBY 1003	219		7	*			8	20A/1P	1646	SLEEP/EEG 1034	Lighting
Lighting	LOBBY 1003	445		9		*		10	20A/1P	344	BREAK OUT AREA 1134	Lighting
Lighting	RECEPT 1022	503	20A/1P	11			*	12	20A/1P	1751	CORRIDOR 1074	Lighting
Lighting	DOSE 1050	3110	20A/1P	13	*			14	15A/3P	270	ELEV. CONTROL ROOM 1071B	FCU-2
Lighting	GAS CYLINDER 1068	3508	20A/1P	15		*		16		270	ELEV. CONTROL ROOM 1071B	FCU-2
Lighting	BLOOD LAB 1062	2907	20A/1P	17			*	18		270	ELEV. CONTROL ROOM 1071B	FCU-2
H-1	HOLDING/ EXAM 1052	5533	25A/3P	19	*			20	40A/3P	8867	CORRIDOR 1035	H-3
H-1	HOLDING/ EXAM 1052	5533		21		*		22		8867	CORRIDOR 1035	H-3
H-1	HOLDING/ EXAM 1052	5533		23			*	24		8867	CORRIDOR 1035	H-3
T75	ELEC ROOM 1040	23750	125A/3P	25	*			26		0		
T75	ELEC ROOM 1040	23750		27		*		28		0		
T75	ELEC ROOM 1040	23750		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	44.90	TOTAL DESIGN LOAD (KW)	170.99
CONNECTED LOAD (KW) - B	43.12	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	43.83	TOTAL DESIGN LOAD (AMPS)	212.3

Feeder Size Calculation:

212.3 A * 125% = 265 A → 400A Bus, 300A Main, (4) #250 kcmil Cu THWN, (1) #4 AWG Cu Ground, 2 1/2" Conduit

Figure 54: New Panelboard Worksheet LSL1B

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					LSL1B	Panel Location:		ELEC ROOM 1040		
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	3	LOBBY 1003	1192	w	0.98	1192	1216	
2	A	T15 (LSR1B)	9	ELEC 1040	5000	va	0.95	4750	5000	
3	B	Lighting	3	CORRIDOR 1074	770	va	0.95	732	770	
4	B	T15 (LSR1B)	9	ELEC 1040	5000	va	0.95	4750	5000	
5	C	LSL2B		ELEC 2018	691	va	1.00	691	691	
6	C	T15 (LSR1B)	9	ELEC 1040	5000	va	0.95	4750	5000	
7	A	LSL2B	9	ELEC 2018	0	va	1.00	0	0	
8	A				0	w		0	0	
9	B	LSL2B	9	ELEC 2018	560	va	1.00	560	560	
10	B				0	w		0	0	
11	C				0	w		0	0	
12	C				0	w		0	0	
13	A				0	w		0	0	
14	A				0	w		0	0	
15	B				0	w		0	0	
16	B				0	w		0	0	
17	C				0	w		0	0	
18	C				0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								17.4	18.2	Amps= 21.9

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					5.9	6.2	34%	22.4
PHASE TOTAL	B					6.0	6.3	35%	22.9
PHASE TOTAL	C					5.4	5.7	31%	20.5
LOAD CATAGORIES		Connected			Demand				Ver. 1.02
		kW	kVA	DF	kW	kVA	PF		
1 receptacles		0.0	0.0	0.70	0.0	0.0			
2 computers		0.0	0.0	0.90	0.0	0.0			
3 fluorescent lighting		1.9	2.0	1.00	1.9	2.0	0.97		
4 HID lighting		0.0	0.0	1.00	0.0	0.0			
5 incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6 HVAC fans		0.0	0.0	0.80	0.0	0.0			
7 heating		0.0	0.0	1.25	0.0	0.0			
8 kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9 unassigned		15.5	16.3		15.5	16.3	0.95		
Total Demand Loads					17.4	18.2			
Spare Capacity		20%			3.5	3.6			
Total Design Loads					20.9	21.9	0.96	Amps=	26.3

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 55: New Panelboard Schedule LSL1B

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

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: LSL1B PANEL LOCATION: ELEC ROOM 1040 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: (4) #12, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	LOBBY 1003	1192	20A/1P	1	*			2	25A/3P	4750	ELEC 1040	T15 (LSR1B)
Lighting	CORRIDOR 1074	732	20A/1P	3		*		4		4750	ELEC 1040	T15 (LSR1B)
LSL2B	ELEC 2018	691	50A/3P	5			*	6		4750	ELEC 1040	T15 (LSR1B)
LSL2B	ELEC 2018	0		7	*			8		0	0	0
LSL2B	ELEC 2018	560		9		*		10		0		
		0		11			*	12		0		
		0		13	*			14		0		
		0		15		*		16		0		
		0		17			*	18		0		
		0		19	*			20		0		
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	5.94	TOTAL DESIGN LOAD (KW)	20.91
CONNECTED LOAD (KW) - B	6.04	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	5.44	TOTAL DESIGN LOAD (AMPS)	26.3

Feeder Size Calculation:

26.3 A * 125% = 32.8A → 100A Bus*, 50A Main*, (4) #12 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4" Conduit

*Minimum Bus size = 100A
*Minimum Main Circuit Breaker size = 50A

Figure 56: New Panelboard Worksheet LSL2A

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					LSL2A	Panel Location:			ELEC ROOM 2081	
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	3	CENTRAL PARK 2103	148	va	0.98	145	148	
2	A	Lighting	3	STOR 2070	927	va	0.95	881	927	
3	B	Lighting	3	CORRIDOR 277	1095	va	0.95	1040	1095	
4	B				0	w		0	0	
5	C				0	w		0	0	
6	C				0	w		0	0	
7	A				0	w		0	0	
8	A				0	w		0	0	
9	B				0	w		0	0	
10	B				0	w		0	0	
11	C				0	w		0	0	
12	C				0	w		0	0	
13	A				0	w		0	0	
14	A				0	w		0	0	
15	B				0	w		0	0	
16	B				0	w		0	0	
17	C				0	w		0	0	
18	C				0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								2.1	2.2	Amps= 2.6

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					1.0	1.1	50%	3.9
PHASE TOTAL	B					1.0	1.1	50%	4.0
PHASE TOTAL	C					0.0	0.0		0.0

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		2.1	2.2	1.00	2.1	2.2	0.95		
4	HID lighting		0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9	unassigned		0.0	0.0		0.0	0.0			
Total Demand Loads						2.1	2.2			
Spare Capacity			20%			0.4	0.4			
Total Design Loads						2.5	2.6	0.95	Amps=	3.1

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 57: New Panelboard Schedule LSL2A

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

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: LSL2A PANEL LOCATION: ELEC ROOM 2081 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: (4) #14, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	CENTRAL PARK 2103	145	20A/1P	1	*			2	20A/1P	881	STOR 2070	Lighting
Lighting	CORRIDOR 277	1040	20A/1P	3		*		4		0		
		0		5			*	6		0		
		0		7	*			8		0		
		0		9		*		10		0		
		0		11			*	12		0		
		0		13	*			14		0		
		0		15		*		16		0		
		0		17			*	18		0		
		0		19	*			20		0		
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	1.03	TOTAL DESIGN LOAD (KW)	2.48
CONNECTED LOAD (KW) - B	1.04	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	0.00	TOTAL DESIGN LOAD (AMPS)	3.1

Feeder Size Calculation:

3.1 A * 125% = 3.9 A → 100A Bus*, 50A Main*, (4) #14 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4" Conduit

*Minimum Bus size = 100A

*Minimum Main Circuit Breaker size = 50A

Figure 58: New Panelboard Worksheet RPA

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->				RPA	Panel Location:			STORAGE 1010A		
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	5	CNTRL 1008	52	va	0.95	49	52	
2	A	VP		AUD 1010	180	va	1.00	180	180	
3	B	VP		AUD 1010	180	va	1.00	180	180	
4	B	RECEPTACLES	1	AUD1010	1440	va	0.85	1224	1440	
5	C	PROJ SCREEN		AUD 1010	1000	va	1.00	1000	1000	
6	C	RECEPTACLES	1	STOR 1010A	1000	va	0.85	850	1000	
7	A	IP RECEPTACLES	1	AUD 1010	360	va	0.85	306	360	
8	A	PROJ SCREEN		AUD 1010	1000	va	1.00	1000	1000	
9	B	IP RECEPTACLES	1	AUD 1010	360	va	0.85	306	360	
10	B				0	w		0	0	
11	C	IP RECEPTACLES	1	AUD 1010, STOR 1010A	360	va	0.85	306	360	
12	C				0	w		0	0	
13	A	IP RECEPTACLES	1	AUD 1010	360	va	0.85	306	360	
14	A	Lighting	5	AUD 1010	35	w	1.00	35	35	
15	B	Lighting	5	AUD 1010	35	w	1.00	35	35	
16	B	Lighting	5	AUD 1010	35	w	1.00	35	35	
17	C	Lighting	5	AUD 1010	35	w	1.00	35	35	
18	C	Lighting	5	AUD 1010	35	w	1.00	35	35	
19	A	Lighting	5	AUD 1010	35	w	1.00	35	35	
20	A	Lighting	5	LOBBY 1003	70	w	1.00	70	70	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								6.0	6.6	Amps= 18.3

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	2.0	2.1	32%	17.4
PHASE TOTAL	B	1.8	2.1	31%	17.1
PHASE TOTAL	C	2.2	2.4	37%	20.3

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		3.3	3.9	0.70	2.3	2.7	0.85		
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		0.0	0.0	1.00	0.0	0.0			
4	HID lighting		0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting		0.3	0.3	1.00	0.3	0.3	0.99		
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9	unassigned		2.4	2.4		2.4	2.4	1.00		
	Total Demand Loads					5.0	5.4			
	Spare Capacity		20%			1.0	1.1			
	Total Design Loads					6.0	6.5	0.92	Amps=	18.0

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 59: New Panelboard Schedule RPA

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

VOLTAGE: 208Y/120V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: RPA PANEL LOCATION: STORAGE 1010A PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: (4) #14, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	CNTRL 1008	49	20A/1P	1	*			2	20A/1P	180	AUD 1010	VP
VP	AUD 1010	180	20A/1P	3		*		4	20A/1P	1224	AUD1010	RECEPTACLES
PROJ SCREEN	AUD 1010	1000	20A/1P	5			*	6	20A/1P	850	STOR 1010A	RECEPTACLES
IP RECEPTACLES	AUD 1010	306	20A/1P	7	*			8	20A/1P	1000	AUD 1010	PROJ SCREEN
IP RECEPTACLES	AUD 1010	306	20A/1P	9		*		10	20A/1P	0	0	0
IP RECEPTACLES	) 1010, STOR 1(	306	20A/1P	11			*	12	20A/1P	0		0
IP RECEPTACLES	AUD 1010	306	20A/1P	13	*			14	20A/1P	35	AUD 1010	Lighting
Lighting	AUD 1010	35	20A/1P	15		*		16	20A/1P	35	AUD 1010	Lighting
Lighting	AUD 1010	35	20A/1P	17			*	18	20A/1P	35	AUD 1010	Lighting
Lighting	AUD 1010	35	20A/1P	19	*			20	20A/1P	70	LOBBY 1003	Lighting
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	1.98	TOTAL DESIGN LOAD (KW)	6.00
CONNECTED LOAD (KW) - B	1.78	POWER FACTOR	0.92
CONNECTED LOAD (KW) - C	2.23	TOTAL DESIGN LOAD (AMPS)	18.0

Feeder Size Calculation:

18 A * 125% = 22.5A → 100A Bus*, 50A Main*, (4) #14 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4” Conduit

*Minimum Bus size = 100A

*Minimum Main Circuit Breaker size = 50A

Special Purpose Space - Auditorium

Spatial Summary

- **Description**

  The auditorium is centrally located on the first floor of the amorphous section of the building. It is a total of 1460 square feet and can be divided into two smaller rooms (about 730 square feet each) using moveable partitions that run north to south.

  The space can be entered from one of four sets of double doors. Two of these entrances are located on the north end of the room, connecting the auditorium to the entry/lobby. The other two sets of doors are positioned on the south end of the space, and open onto the interior lobby. This allows for entering and exiting through both ends of the room from either side of the partition. Two partition pocket doors are located at the north and south ends of the space between each of the sets of entrance/exit doors for partition storage.

  A storage room is located in the northeast corner for furniture placement.

- **Drawings**

Figure 60: Auditorium Location (NTS)

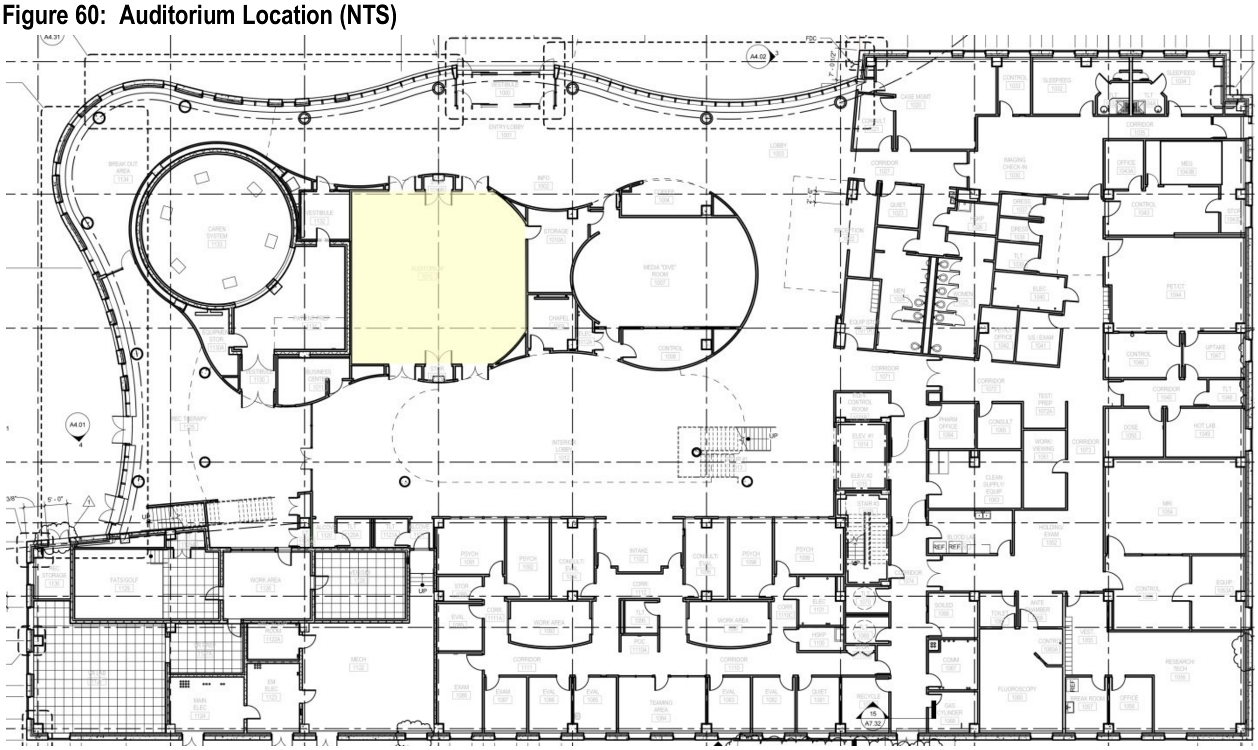


Figure 61: Auditorium Floor Plan (NTS)

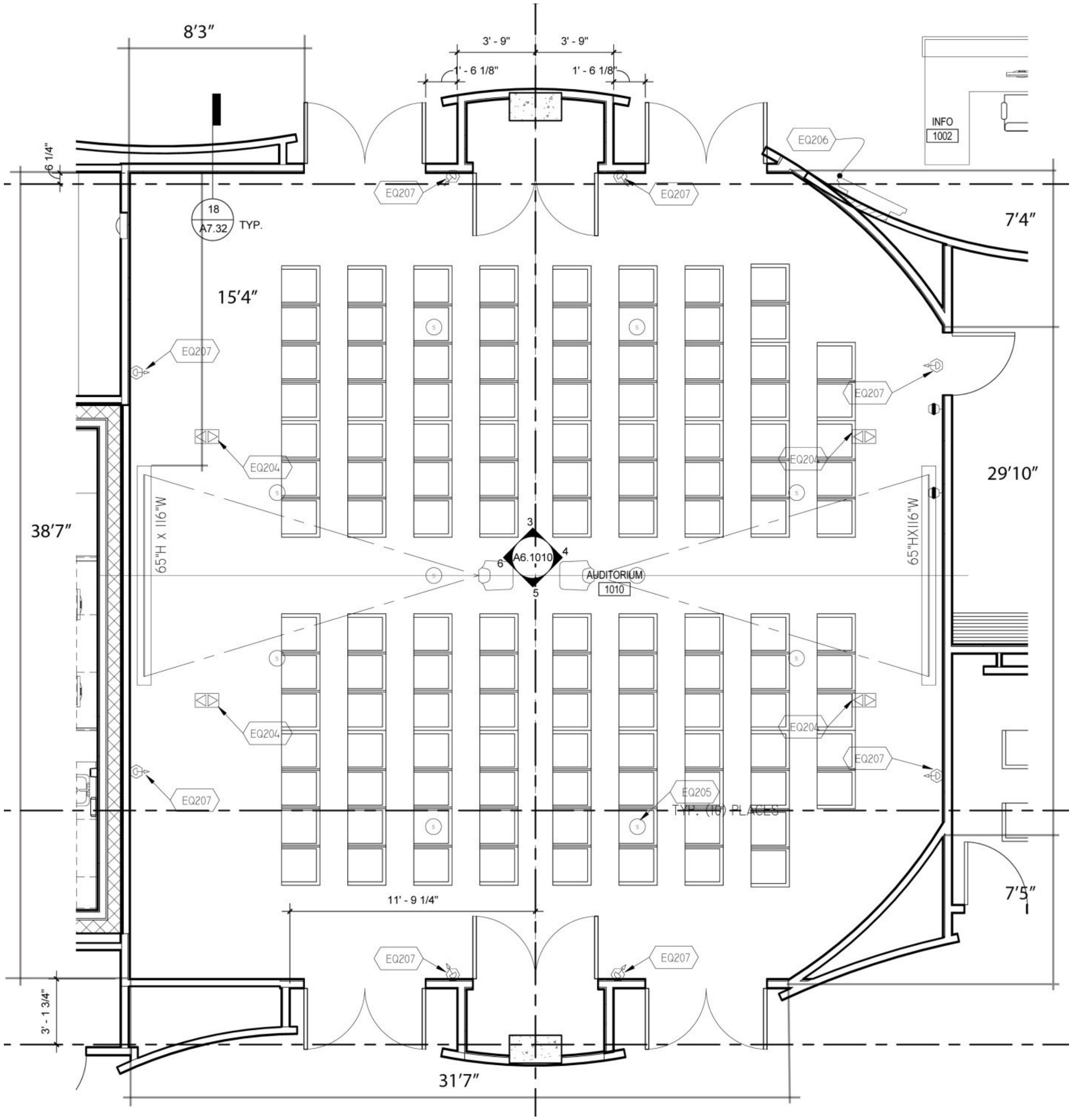


Figure 62: Auditorium Reflected Ceiling Plan (NTS)

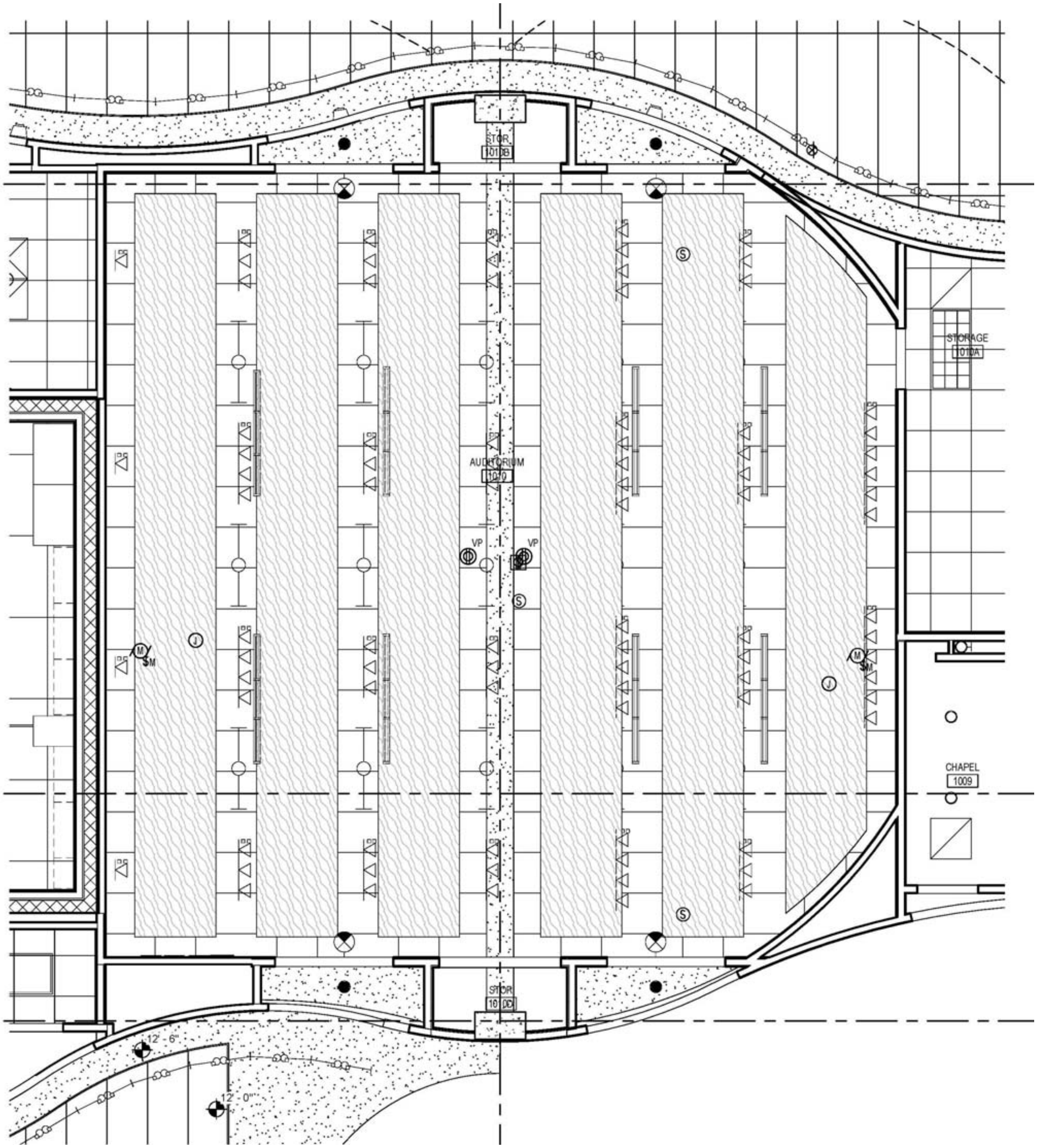


Figure 63: Auditorium Interior Elevation – West Wall (NTS)

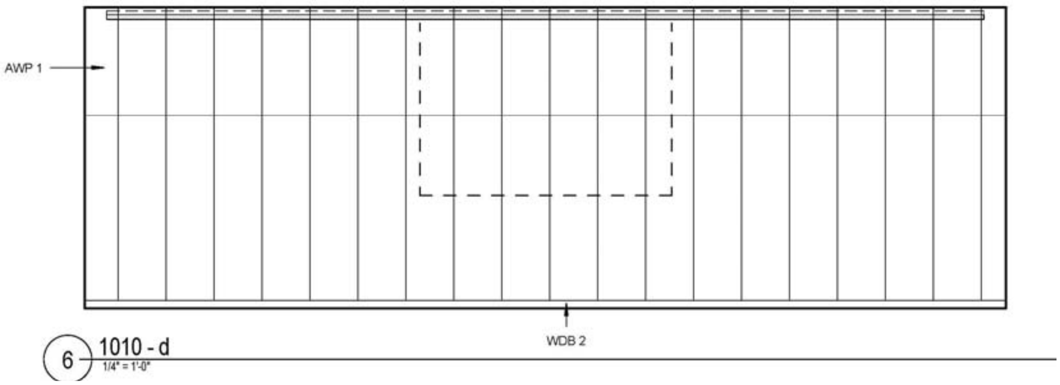


Figure 64: Auditorium Interior Elevation – East Wall (NTS)

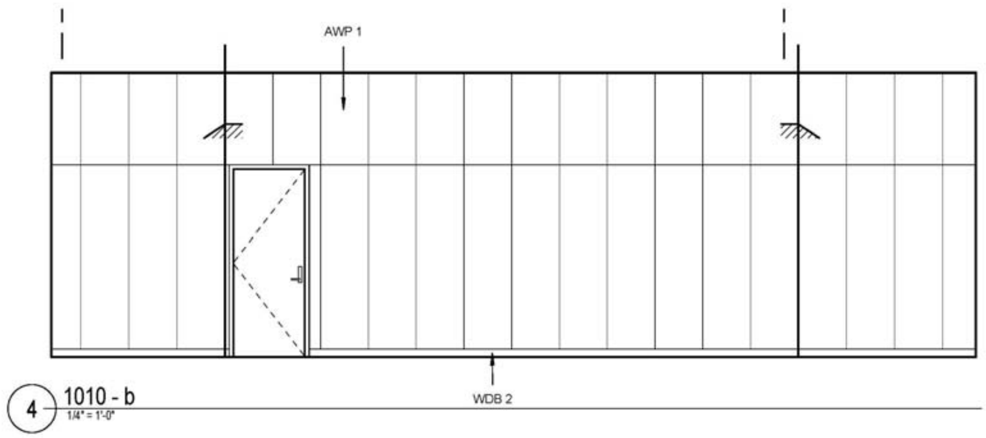


Figure 65: Auditorium Interior Elevation – North Wall (NTS)

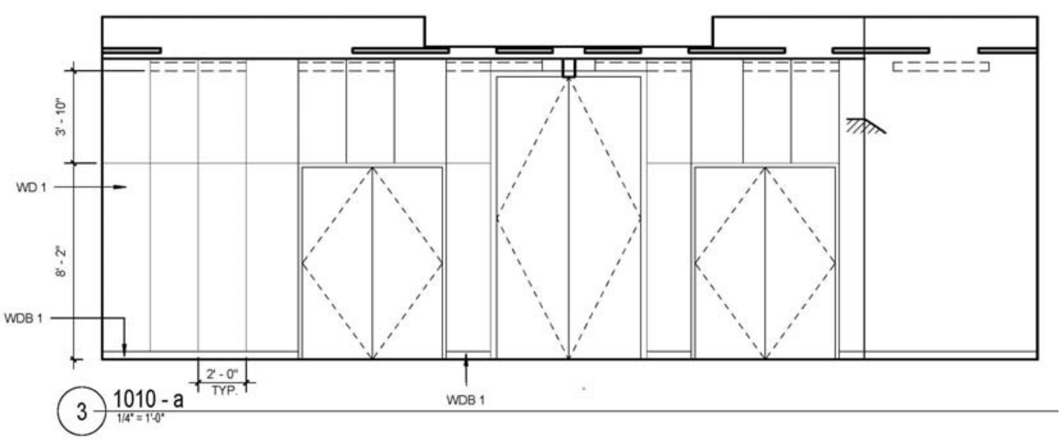


Figure 66: Auditorium Interior Elevation – South Wall (NTS)

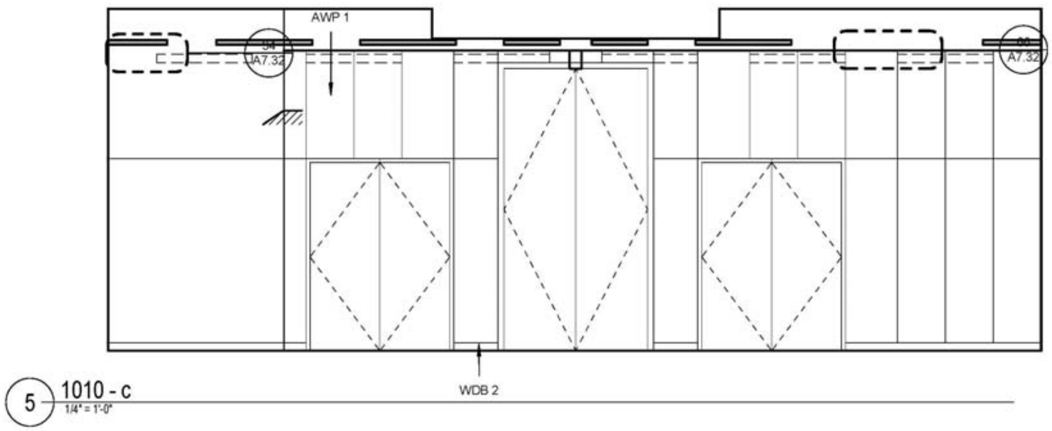
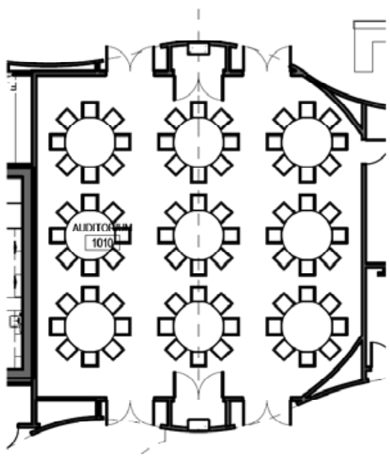


Figure 67: Auditorium Alternate Furniture Layout (NTS)



- **Surface Materials (Existing)**

Floor - The floor is composed of wall to wall carpet tile (CPT-1).

Base - A wood base (WDB-1, 2) is located at the bottom of the wall around the perimeter of the room. It is either mdf painted or has a satined finish to match the adjacent surface materials.

West Wall - The upper portion of the west wall is acoustic wall panel (AWP-1) while the lower part consists of wood wall paneling (WD-1).

East Wall - The upper portion of the west wall is acoustic wall panel (AWP-1) while the lower part consists of wood wall paneling (WD-1). A stained solid core wood door with a painted hollow metal frame is positioned on the north end of the wall.

North Wall - The upper portion of the west wall is acoustic wall panel (AWP-1) while the lower part consists of wood wall paneling (WD-1). Full height solid wood double doors with a painted hollow metal frame conceal the moveable partition in the center of the wall. A set of stained solid core wood double doors with vision lites and a painted hollow metal frame are located on each side of the partition doors.

South Wall - The upper portion of the west wall is acoustic wall panel (AWP-1) while the lower part consists of wood wall paneling (WD-1). Full height solid wood double doors with a painted hollow metal frame conceal the moveable partition in the center of the wall. A set of stained solid core wood double doors with vision lites and a painted hollow metal frame are located on each side of the partition doors.

Ceiling - 12"x48" acoustic wood ceiling tile (ACWP-1) covers the ceiling in strips that run north to south. 24"x48" black acoustic ceiling tile (ACT-6) is placed in between the wood tiles.

Figure 68: Exisiting Material Properties

Material	Color/Style	Reflectance
CPT-1	PRAIRIE 59525 / DRFTWOOD 23750	0.3
WDB-1	WOOD BASE	0.3
WDB-2	WOOD BASE	0.3
AWP-1	ACOUSTICAL PANEL - BEIGE	0.6
WD-1	WOOD WALL PANEL	0.3
ACWP-1	WOODWORKS VECTOR	0.3
ACT-6	BLACK	0
WOOD DOORS	STAINED WOOD	0.2
DOOR FRAME	PAINTED P-1	0.65

Figure 69: New Surface Materials (from Architecture Breadth)

Location	Description	Manufacturer	Style/Color	Reflectance
Floor	Carpet Tile	Shaw	Prairie59525/Driftwood23750	0.3
Wood Base	Wood Base	Algoma Hardwoods	Stained to match adjacent surface	0.4
Lower Wall	Wood Wall Panel	Armstrong	Woodworks Ekos - Light Cherry	0.4
Upper Wall	Acoustic Wall Panel	Knoll	Suprafine Cream	0.6
Doors	Wood Doors	Algoma Hardwoods	Stained Wood - Cherry	0.2
Door Frame	Wood Frame	Algoma Hardwoods	Stained Wood - Cherry	0.2
Lower Ceiling Panels	Acoustic Wood Ceiling Tile	Armstrong	Woodworks Vector - Natural Variations Light Cherry	0.4
Upper Ceiling Panels	Acoustic Wood Ceiling Tile	Armstrong	Suprafine - Cream	0.6

- **Furnishings**
  The space contains a moveable stage platform for use during presentations. It has two possible seating layouts. Chairs can be placed in the center of the space facing east or west, depending on the stage location, and room division. Round tables surrounded by chairs make up the second seating configuration available in the space (see drawings).

- **Activities/Tasks**
  Projection screens are located along the east and west walls for presentations in either or both partitioned areas. Research, clinical, and training sessions, conferences and seminars will be held in this space. The space will be occupied frequently for meetings and discussions. Internet access will be available, so computer usage is probable. Distance learning lectures/seminars will be distributed widely by media or web conference (VTC capabilities).

Design Concept

The auditorium will house a variety of activities, including research/clinical/training sessions, conferences, and seminars. The use of the space for video-teleconferencing increases the importance of adequate light levels. The concept of focus fits well with the functional aspect of the space, and visual clarity is imperative. Uniform distribution on the task plane, indirect lighting, and some peripheral emphasis on the wood walls will ensure that the space is functional as well as comfortable. The moveable partition, projector, and projection screen should all be carefully considered and accounted for when lighting the space. The multi-functionality creates the need for a very versatile lighting design. Specific scenes for conferences/meetings, presentations, and video-teleconferencing is necessary.

Design Criteria

(IESNA Handbook: Auditoriums, Assembly)

- **Appearance of Space and Luminaires** (Somewhat Important)
  The space will be occupied by qualified researchers and presenters, so the space should have a very sophisticated feel. It is likely that donors for the building's construction may be present, so it is important that they are impressed by the space (and building as a whole). Presentations in the space may also be distributed through web conference, so this also makes it important that the space appears to be of high quality.

- **Psychological Impressions**
  Strive for an impression of visual clarity throughout the area (for both the presenter and audience). Implement a uniform lighting mode with some peripheral emphasis, such as lighting on the walls.

- **Color Appearance (and Color Contrast)** (Important)
  It is important that the space contains fixtures with a high CRI. The room is surrounded by wood panels on the walls and ceilings, so a CCT around 3000K will complement the warm wood colors. The space will be occupied by large groups of people, and used for presentations. The warm color temperature will enhance the users' skin tones. Also, the warm light will create a relaxing and stress-free environment, which is especially necessary for TBI patients and presenters. There should be a high CRI of about 90 in order to enhance presentation materials.

- **Daylighting Integration and Control** (Important)
  With its location in the center of the building, there are no windows present in the auditorium. Considerations for daylight integration and control are not necessary.

- **Direct Glare** (Somewhat Important)
  For adequate and comfortable usage of the space, direct glare viewable by the users (audience) should be avoided. Direct glare from the lamp sources should be eliminated with the use of louvers.

- **Flicker (and Strobe)** (Somewhat Important)
  Flicker and strobe should always be avoided; however, there are no fast-paced activities present in the space, so these problems should not be present.

- **Light Distribution on Surfaces**
  As mainly a workspace and interaction area, light distribution should be fairly uniform among all workplane surfaces. However, the peripheral walls should have some non-uniformity. This will create visually interesting surroundings. The wood panels should be lit indirectly to highlight the wood material and achieve a visually stimulating environment.

- **Light Distribution on Task Plane (Uniformity)**
  Light distribution on the task planes in the space must be uniformly lit with appropriate illuminance levels. This lighting must be present at the podium of a speaker on either side of the room and throughout the audience for note-taking. Uniformity must also be present on tables used for meetings and conferences. When using the projection screen for presentations, light on the screen should be avoided.

- **Luminances of Room Surfaces / Surface Characteristics** (Somewhat Important)
  The wood material used for the lower portion of the walls should be highlighted. However, the acoustical wall panels located above should be left at a lower light level. This will enhance the warm feel of the room and emphasize the unique surfaces. The wood ceiling panels should also receive a soft wash of light to highlight the wood tones.

- **Modeling of Faces or Objects** (Somewhat Important)
  It is important that faces and objects throughout the room are easily viewed by all. Interaction during meetings and conferences makes it necessary for participants to accurately view features and expressions. An audience should have the ability to see a presenter in order to fully understand and engage in the lecture or seminar. If web conferencing is also taking place, it is imperative that adequate lighting is available. Lighting from above and from the sides will provide the required vertical illuminance.

- **Point(s) of Interest**
  A main point of interest throughout the space should be on a presenter at a podium. During presentation mode, the speaker will stand to the right of the projection screen. When the space is used for just a lecture, the podium will be centered in the front of the room. There should be adequate light levels for precise viewing of the speaker.

- **Reflected Glare and Source/Task/Eye Geometry**
  Reflected glare should be avoided on all task planes, including the podium (presenter's notes), any presentation boards, the workplane of the audience or general assembly during meetings, and computer monitors used during events. Since the furniture arrangement in the space varies with the events taking place, it is difficult to place fixtures in positions that will reduce reflected glare in specific locations.

- **Shadows**
  There should be no shadows present on the workplane of the presenter and audience, as well as those assembling for a meeting or conference. Adequate ambient lighting should be present in these areas.

- **Sparkle/Desirable Reflected Highlights**
  Some sparkle may be created throughout the room by the use of sconces. Placing this fixture type near the doors will also provide guidance to occupants. These fixtures must be properly shielded to prevent discomfort among the brain injury patients.

- **System Control and Flexibility** (Very Important)
  Since the space is used for many different types of activities, the ability to control the lighting should be easily accessible for users. There should be numerous control settings in the space. There should be an "all on" setting for general movement as well as assemblies, meetings, and conferences. A video conference setting should include adequate vertical light for video cameras. There should be two presentation settings. One should be for the inclusion of a projection screen, where low light levels (dimmed) are on the audience and no light is on the screen. The second presentation setting should be for a case where there is no screen present. Low light levels should be on the audience for note-taking, and high illuminance levels on the speaker at either the east or west walls. An "all off" setting is necessary for when the space is not in use.

  Emergency fixtures should be in the space and powered by the emergency system.

- **Maintenance**
  The large ceiling heights make required maintenance and relamping difficult. Choose fixtures with a long lamp life to decrease the time between relamping as well as replacement costs. The lamps should have color consistency over time.

- **Special Considerations**
  Ensure that when the partition divides the space, there is an adequate amount of light on both sides of the room. The lighting design should be close to symmetrical on both the east and west ends of the space. The fixtures chosen should have dimming capabilities in order to accommodate the various scene settings. The luminaire layout will have to work around AV equipment hung from the walls and ceiling.

- **Horizontal Illuminance** (Important)
  The required horizontal illuminance is as follows (<u>IESNA Handbook</u>):
  - Auditorium, Assembly = 10 fc
  - Conference Room, Meeting = 30 fc

  Deviations: none (assuming middle-age users)

- **Vertical Illuminance**
  The required vertical illuminance is as follows (<u>IESNA Handbook</u>):
  - Conference Room, Meeting = 5 fc
  - Projection Screen = less than 5 fc on screen
  - Web Seminar/Video-Teleconferencing = 30 fc

- **Lighting Ratios (Emax:Emin)** (IESNA Handbook unless otherwise noted)
    - 3:1 or less between paper task and adjacent VDT screen
    - 3:1 or less between task and adjacent dark surroundings
    - 10:1 or less between task and remote (nonadjacent) surfaces
    - 2:1 of key light to fill light on presenter (IESNA-DG-17-05)

- **Power Allowance**

  The allowable power densities are as follows (ASHRAE 90.1 - 2007):
    - Conference/Meeting/Multipurpose = 1.3 W/sq.ft.
    - Decorative = +1.0 W/sq.ft.

Lighting Plans

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

Luminaires

Figure 70: Auditorium Luminaire Schedule

Type		Manufacturer	Product Name	Catalog Number	Description	Lamp	Voltage	Ballast/Power Supply	Watts	Location
A		FOCAL POINT	Louver VERVE III	FV3S-DR2-1T5-1C-277-D-C24-TS-4' Custom Fixture with 1 T5 lamp	-Suspended linear direct/indirect fluorescent with radial parabolic louver -Radial parabolic louver utilizes high-quality low brightness aluminum that provides comfortable direct illumination -One-piece steel housing with 5" die-cast end caps -UL and CUL listed -Pre-wired with factory installed branch circuit wiring and over-molded quick connects	FP28/830/ECO Osram Sylvania: 20868 PENTRON High Performance T5 Lamp	277	ECO-T528-277-1 Lutron Eco-10 277 Volt 3-Wire Dimming Ballast	39	AUDITORIUM - Suspended from ceiling panels 2'
B		WINONA LIGHTING	4614 Triad	4614-F-277V-OA-PC-STD	-UL listed and CUL approved -Custom sizes and finishes available upon request -Polished chrome clips (other options available) -Etched opal acrylic lens	CF13DS/830/ECO Osram Sylvania: 20283 Dulux S Preheat 2-pin Ecologic CFL	277	VH-2B13-TP-BLS ADVANCE CFL Magnetic Ballast	27	AUDITORIUM, LOBBY, OT, THERAPY WAIT - Walls - 6.5' on center
C		Lighting Services Inc.	CP100 SERIES	C100-2G-CC-WL-B	-Sturdy aluminum housing -Rugged steel self-locking yoke allows for horizontal and vertical focusing -On/off safety switch -Integral dimmer available -Various finishes and accessory clips available	35PAR20/HAL/NSP10 Osram Sylvania: 14467 Capsylite PAR 20	120	N/A	35	AUDITORIUM - Ceiling Panels
D		Gotham	4" AFV	AFV-26TRT-4AR-277	-Self-flanged, semi-specular or matte-diffuse reflector -Rugged aluminum lampholder housing -Vertically -mounted, positive-latch, thermoplastic socket -Class P, thermally-protected, high power factor ballast mounted to the junction box	CF26DT/E/827/ECO Osram Sylvania: 20767 DULUX D/E 4-pin Ecologic CFL	277	ICF2S26M1BSQS @277 ADVANCE Electronic Rapid Start Ballast	29	AUDITORIUM - Emergency Lighting

See Appendix B for full luminaire schedule and cut sheets.

Figure 71: Spatial Assumptions

Type	Maintenance Category	Distribution Type	Degree of Dirtiness	Cleaning Cycle	Room Cavity Ratio
A	II	Semi-Direct	Very Clean	12 Months	4.45
B	II	Direct-Indirect	Very Clean	12 Months	4.45
C	IV	Direct	Very Clean	12 Months	4.45
D	IV	Direct	Very Clean	12 Months	4.45

Figure 72: Light Loss Factors

Type	BF	LLD	LDD	RSDD	Total LLF
A	1	0.95	0.97	0.95	0.88
B	0.91	0.86	0.97	0.94	0.71
C	1	0.95	0.95	0.97	0.88
D	1.1	0.86	0.95	0.97	0.87

Controls

As a multi-purpose space, many different scenes are necessary for various activities. A Grafik Eye control system will be utilized. Two of these control devices will be located in the space – one for Auditorium A and one for Auditorium B – for use when the partition is drawn to divide the room. They will control each individual side. However, when the partition is withdrawn, the system will sense that the entire room is in use, and control devices will be capable of controlling the entire space at once. The main Grafik Eye control units will be located on the east and west walls behind the projection screen. Additional wall stations will be located at each doorway for quick access. There will also be occupancy sensors on both sides of the partition to allow for automatic shutoff when the building is not in use.

Figure 73: Auditorium Equipment Schedule

Type	Manufacturer	Product Name	Catalog Number	Description	Location
EQ 1	LUTRON	GRAFIK Eye 4000 Series Control Unit	GRX-4116-T-WH	-Provides pushbutton recall of four preset lightnig scenes, plus Off -Allows setup of lighting scenes using buttons on the Control Unit -Controls virtually any light source via dimming ans switching panels -Provides lockout options to prevent accidental changes -Includes built-in infrared receivre for operation with an optional remote control	AUDITORIUM A & B
EQ 2	LUTRON	Infrared Transmitter/ Receiver Pair	GRX-IRPS-WH	-Detects partition movement and, in conjunction with other Lutron products, coordinates lighting present functions in areas such as partitioned meeting rooms	AUDITORIUM A
EQ 3	LUTRON	Dual Technology Wall Mount Occcupancy Sensor	LOS-WDT-WH	-Ultrasonic combined with passive infrared sensing provide high sensitivity, high noise immunity, and excellent false tripping immunity -Suited for complex environments that are difficult to control with single-technology sensors -Flexible base mounting on wall or ceiling -1600 sq.ft. of coverage	AUDITORIUM A & B
EQ 4	LUTRON	seeTouch Wallstation	SG-4SN-WH-EGN	-Used to select and adjust scenes in GRAFIK Eye Control Units -Can be set up to select scenes in just one Control Unit or a group of up to eight Control Units	AUDITORIUM A & B
EQ 10	Lutron	GP Dimming Panels	GP8-1204ML-20	-Provide power and dimming for up to 144 load circuits and control any light source, including full-conduction non-dim -Panel current ratings are listed for continuous operation -UL-listed specifically for each light source	Storage 1010A
EQ 11	Lutron	GP Dimming Panels	GP8-2774ML-20	-Provide power and dimming for up to 144 load circuits and control any light source, including full-conduction non-dim -Panel current ratings are listed for continuous operation -UL-listed specifically for each light source	Storage 1010A

See Appendix C for full equipment schedule and cut sheets.

The following is the control schedule for each device:

Figure 74: Control Schedule for Auditorium A

PRESET SCENE SCHEDULE									
Schedule For: Auditorium A									
Lighting Zone	Luminaire Type(s)	Load Type	Full Space Meeting	Full Space Presentation	Full Space Lecture	Split Space Meeting	Split Space Presentation	Split Space Lecture	All Off
1	B	CFL	100%	100%	100%	100%	100%	100%	0%
2	A	T5	100%	0%	60%	100%	0%	60%	0%
3	A	T5	100%	60%	60%	100%	60%	60%	0%
4	A	T5	100%	60%	60%	0%	0%	0%	0%
5	A	T5	100%	60%	60%	0%	0%	0%	0%
6	C	HAL	0%	100%	100%	0%	100%	100%	0%
7	C	HAL	0%	100%	50%	0%	100%	50%	0%
8	C	HAL	0%	0%	100%	0%	0%	100%	0%
9	C	HAL	0%	0%	0%	0%	0%	0%	0%
10	C	HAL	0%	0%	0%	0%	0%	0%	0%
11	C	HAL	0%	0%	0%	0%	0%	0%	0%
12	B	CFL	100%	100%	100%	0%	0%	0%	0%

Figure 75: Control Schedule for Auditorium B

PRESET SCENE SCHEDULE									
Schedule For: Auditorium B									
Lighting Zone	Luminaire Type(s)	Load Type	Full Space Meeting	Full Space Presentation	Full Space Lecture	Split Space Meeting	Split Space Presentation	Split Space Lecture	All Off
1	B	CFL	100%	100%	100%	0%	0%	0%	0%
2	A	T5	100%	0%	60%	0%	0%	0%	0%
3	A	T5	100%	60%	60%	0%	0%	0%	0%
4	A	T5	100%	60%	60%	100%	60%	60%	0%
5	A	T5	100%	60%	60%	100%	0%	60%	0%
6	C	HAL	0%	100%	100%	0%	0%	0%	0%
7	C	HAL	0%	100%	50%	0%	0%	0%	0%
8	C	HAL	0%	0%	100%	0%	0%	0%	0%
9	C	HAL	0%	0%	0%	0%	0%	100%	0%
10	C	HAL	0%	0%	0%	0%	100%	50%	0%
11	C	HAL	0%	0%	0%	0%	100%	100%	0%
12	B	CFL	100%	100%	100%	100%	100%	100%	0%

Performance Data

The following are calculation grids and summaries of the various auditorium scenes.

- **Full Space Meeting**

Figure 76: Auditorium – Full Space Meeting Rendering

Figure 77: Auditorium – Full Space Meeting Luminance Pseudo Color Rendering (cd/sq.m.)

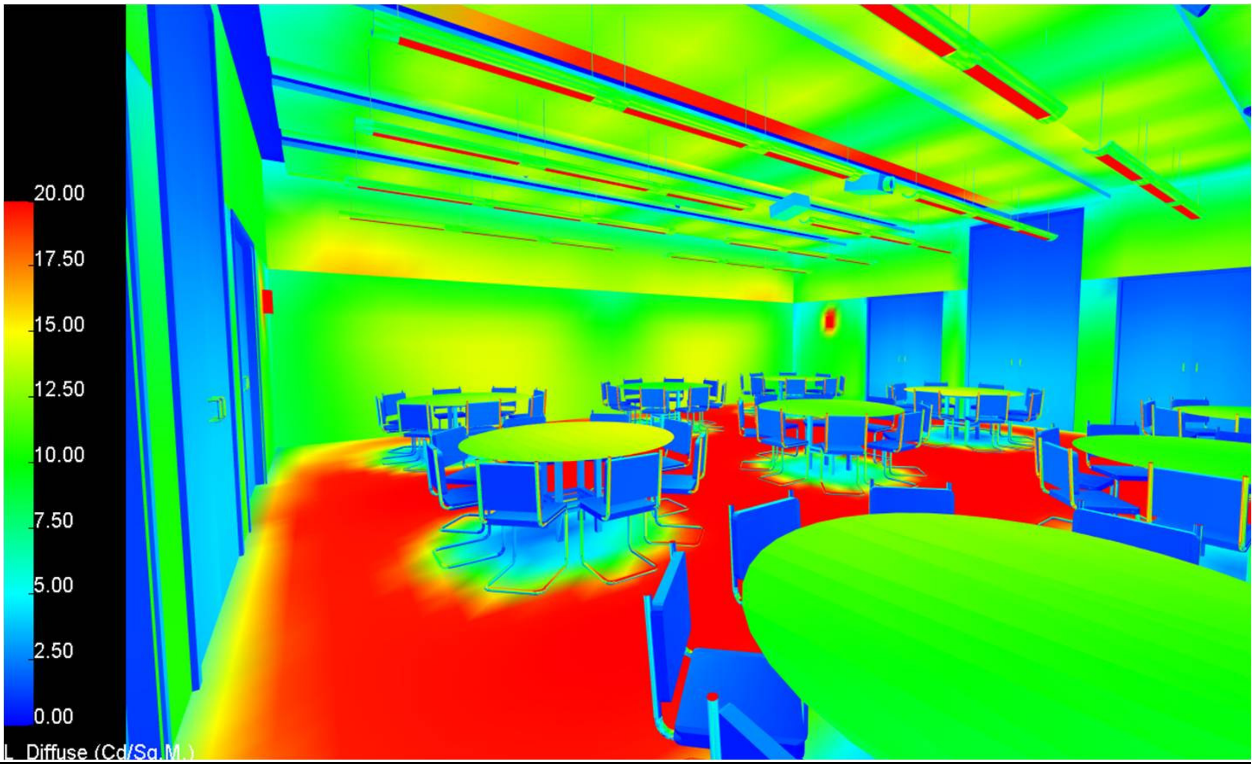


Figure 78: Auditorium – Full Space Meeting Horizontal Illuminance (fc)

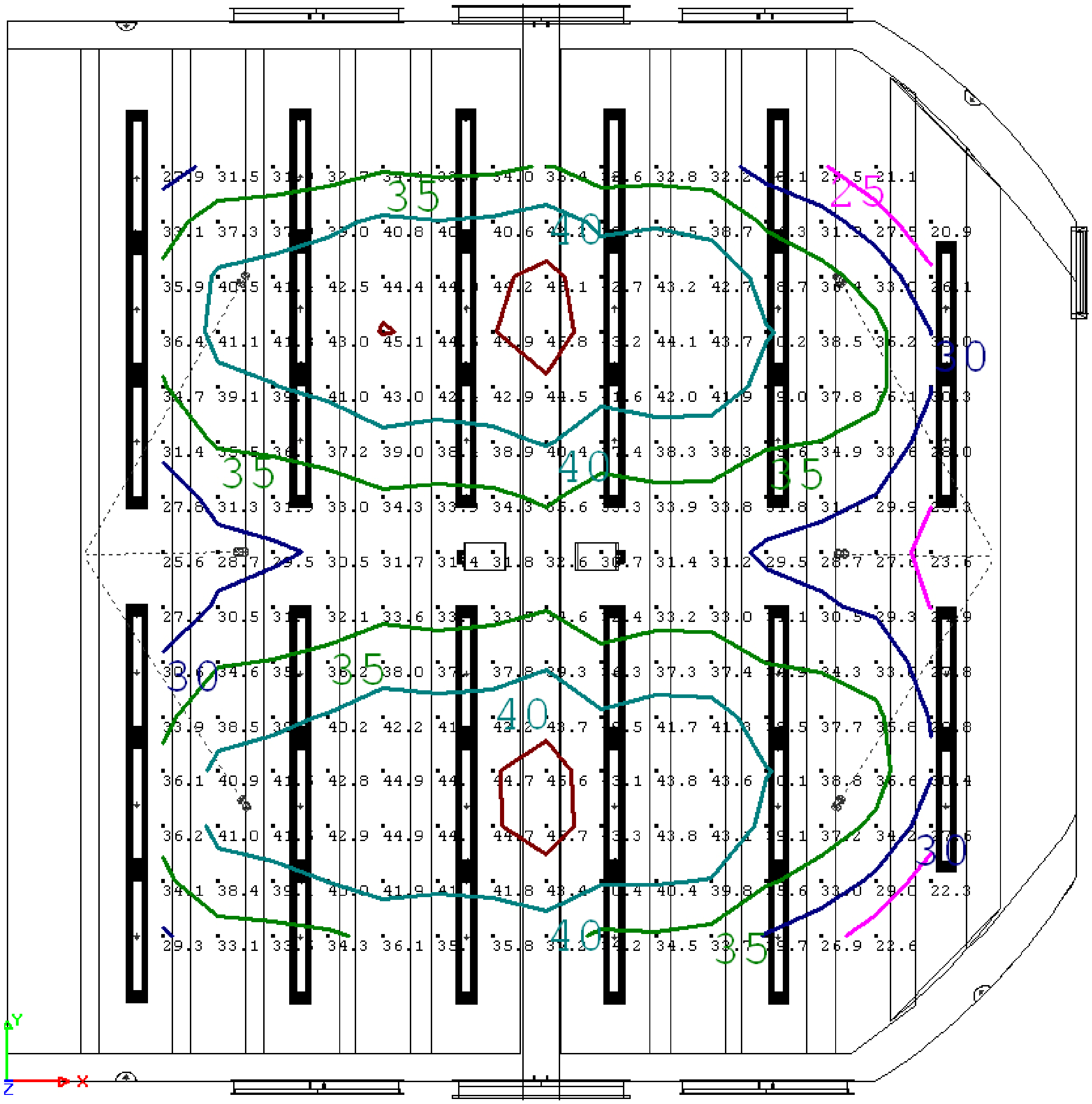
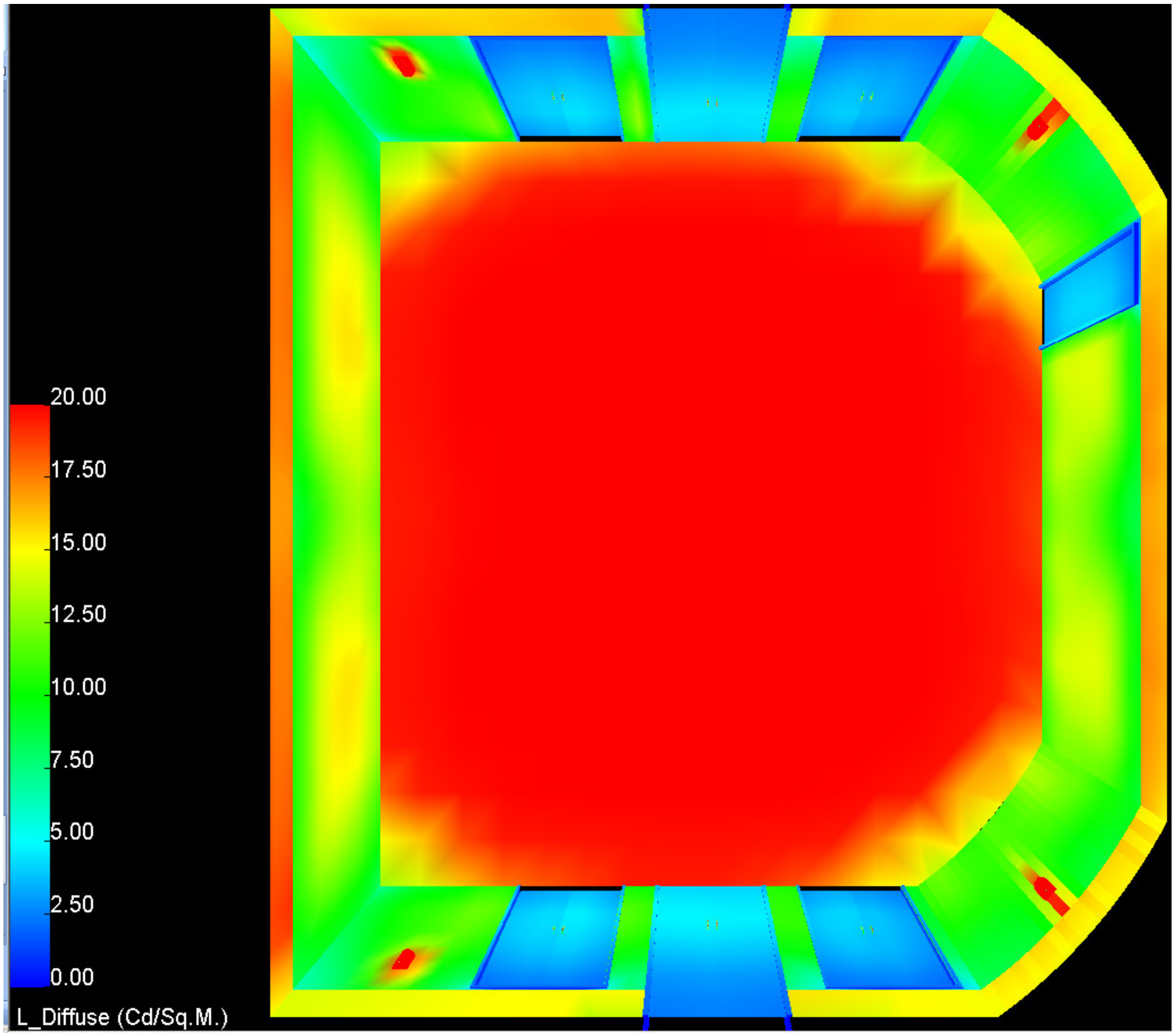


Figure 79: Auditorium – Full Space Meeting Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Workplane (horizontal 2.5' AFF)	36.6	46.8	20.9	2.24

Figure 80: Auditorium – Full Space Meeting Luminance Pseudo Color Rendering (cd/sq.m.)



- **Full Space Presentation**

Figure 81: Auditorium – Full Space Presentation Rendering

Figure 82: Auditorium – Full Space Presentation Luminance Pseudo Color Rendering (cd/sq.m.)

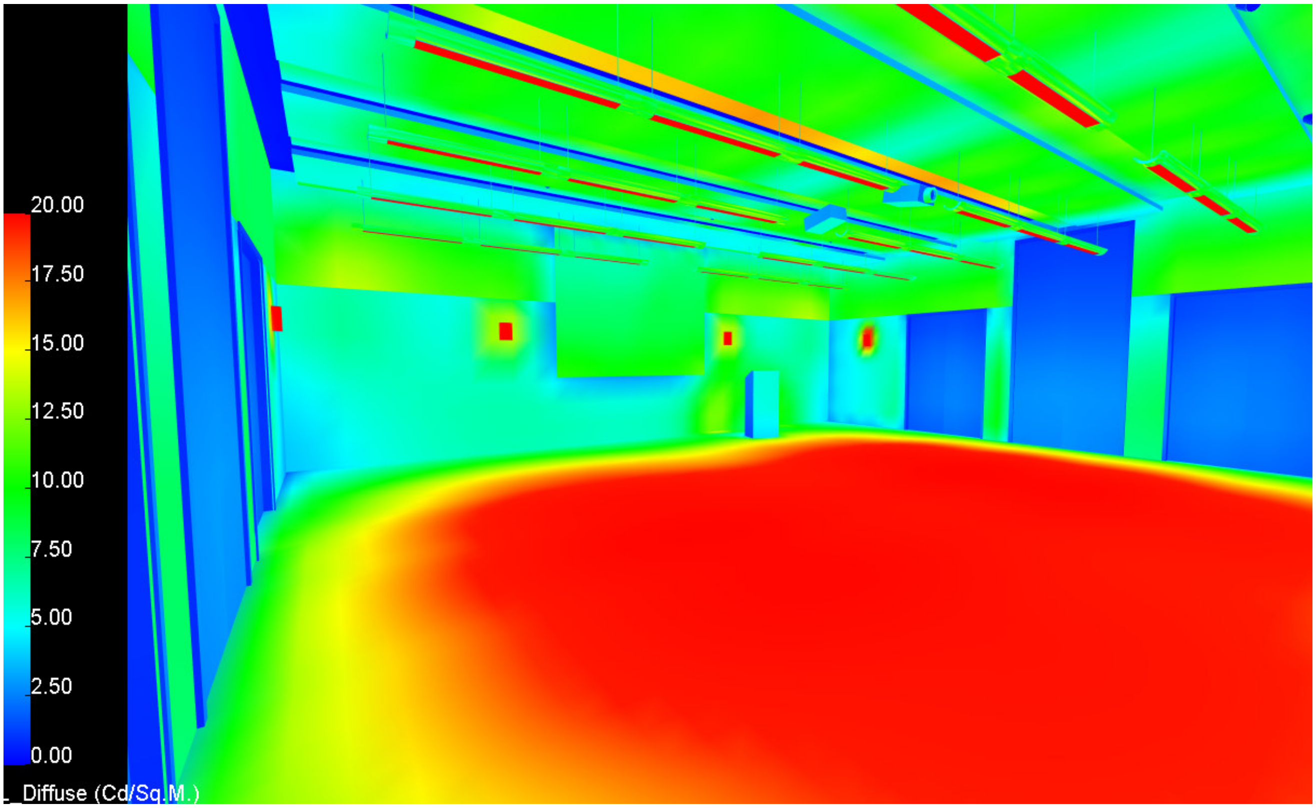


Figure 83: Auditorium – Full Space Presentation Horizontal Illuminance (fc)

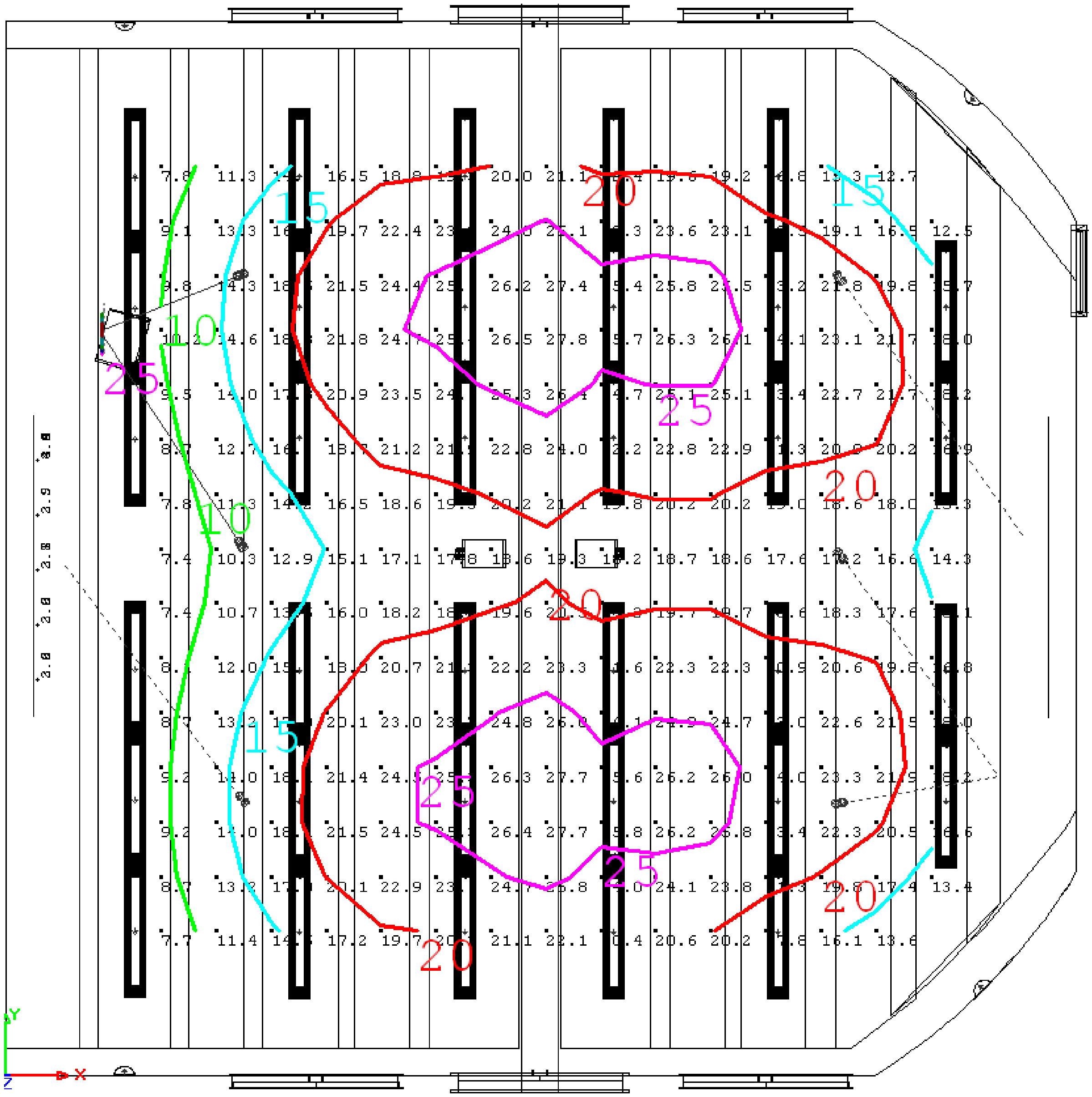
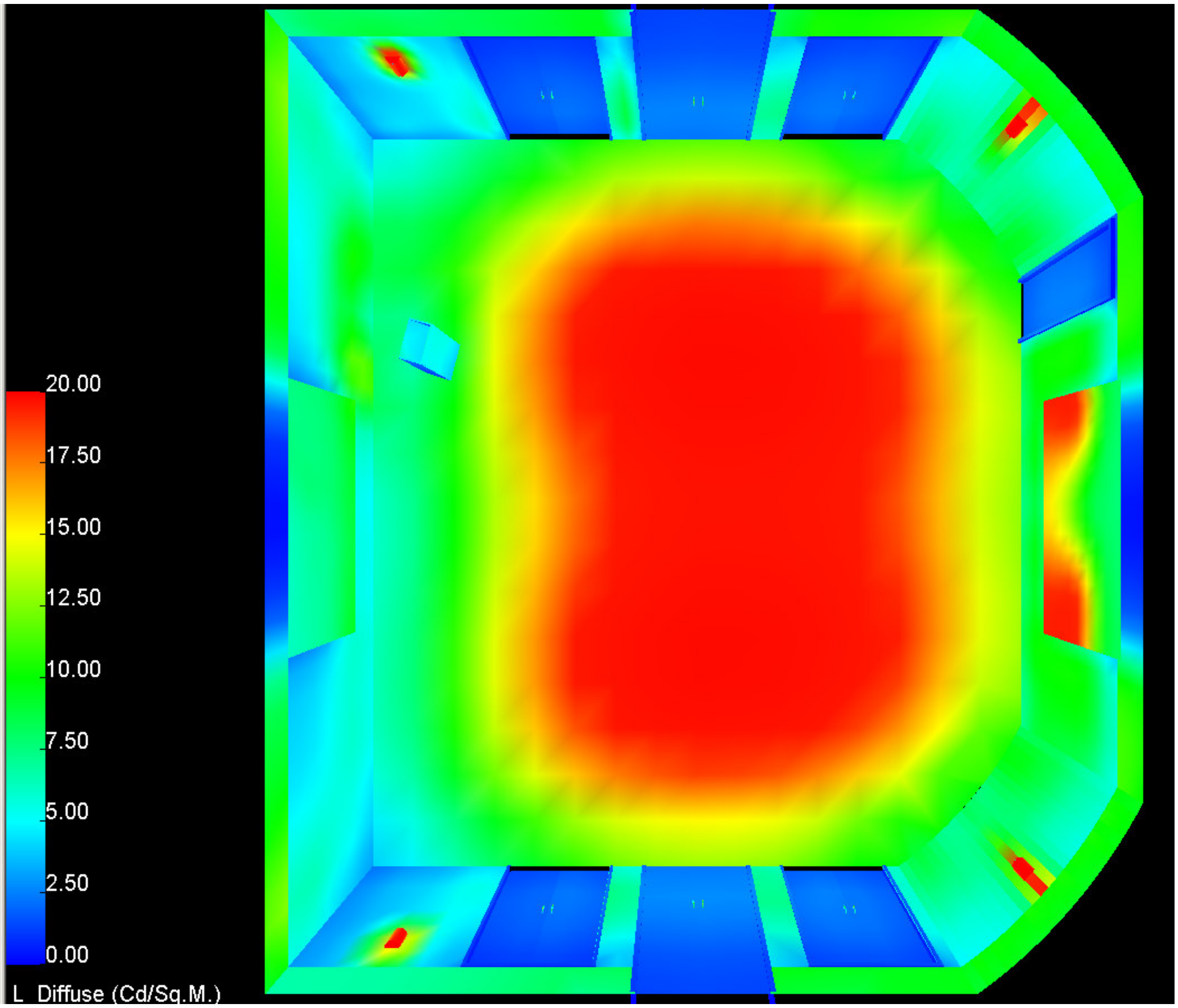


Figure 84: Auditorium – Full Space Presentation Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Workplane (horizontal 2.5' AFF)	19.52	27.8	7.4	3.76
Projection Screen (vertical)	3.3	4	2.6	1.54
Auditorium A Side Podium (vertical)	32.02	48.7	20.8	2.34

Figure 85: Auditorium – Full Space Presentation Luminance Pseudo Color Rendering (cd/sq.m.)



- **Full Space Lecture**

Figure 86: Auditorium – Full Space Lecture Horizontal Illuminance (fc)

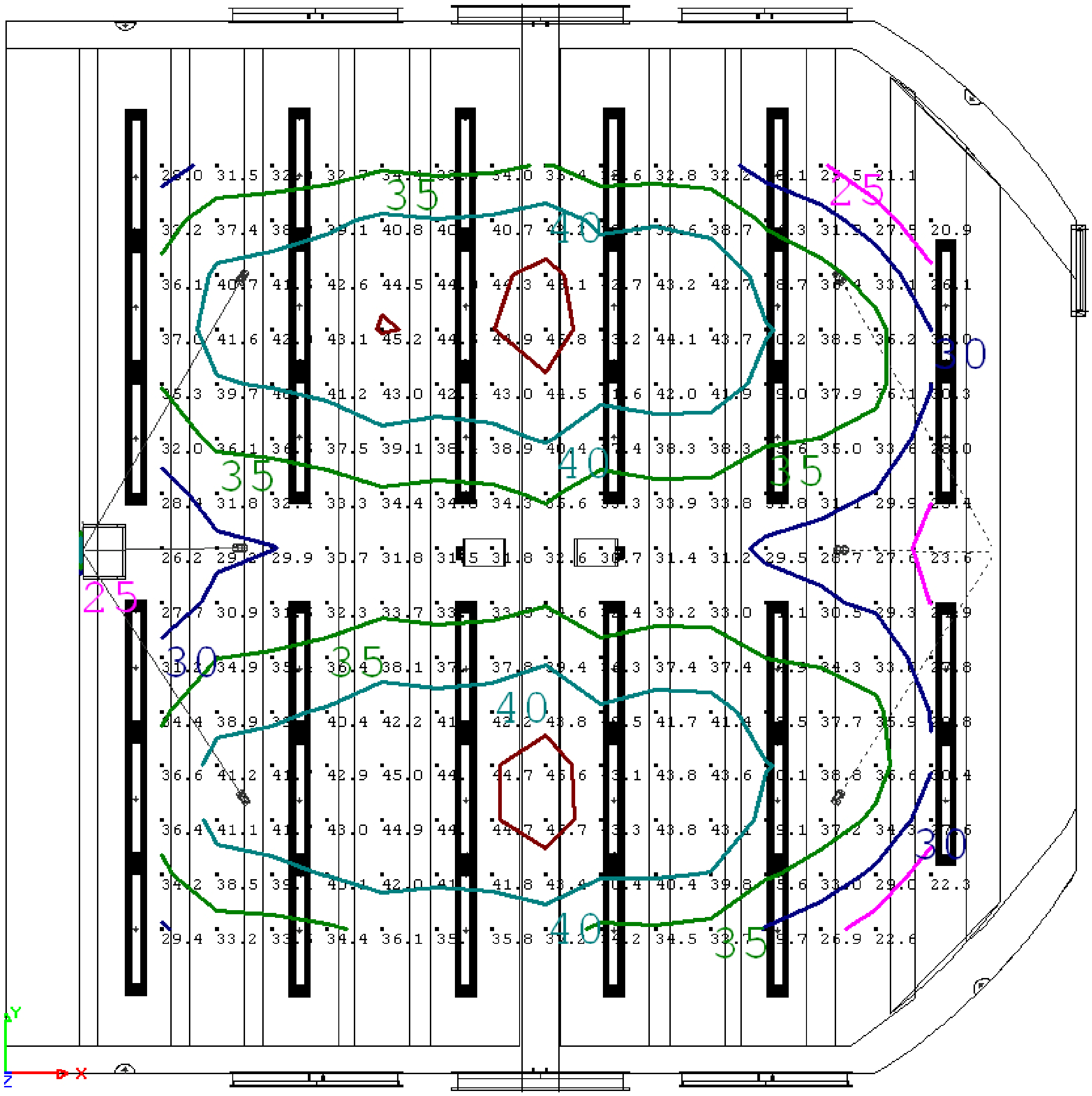
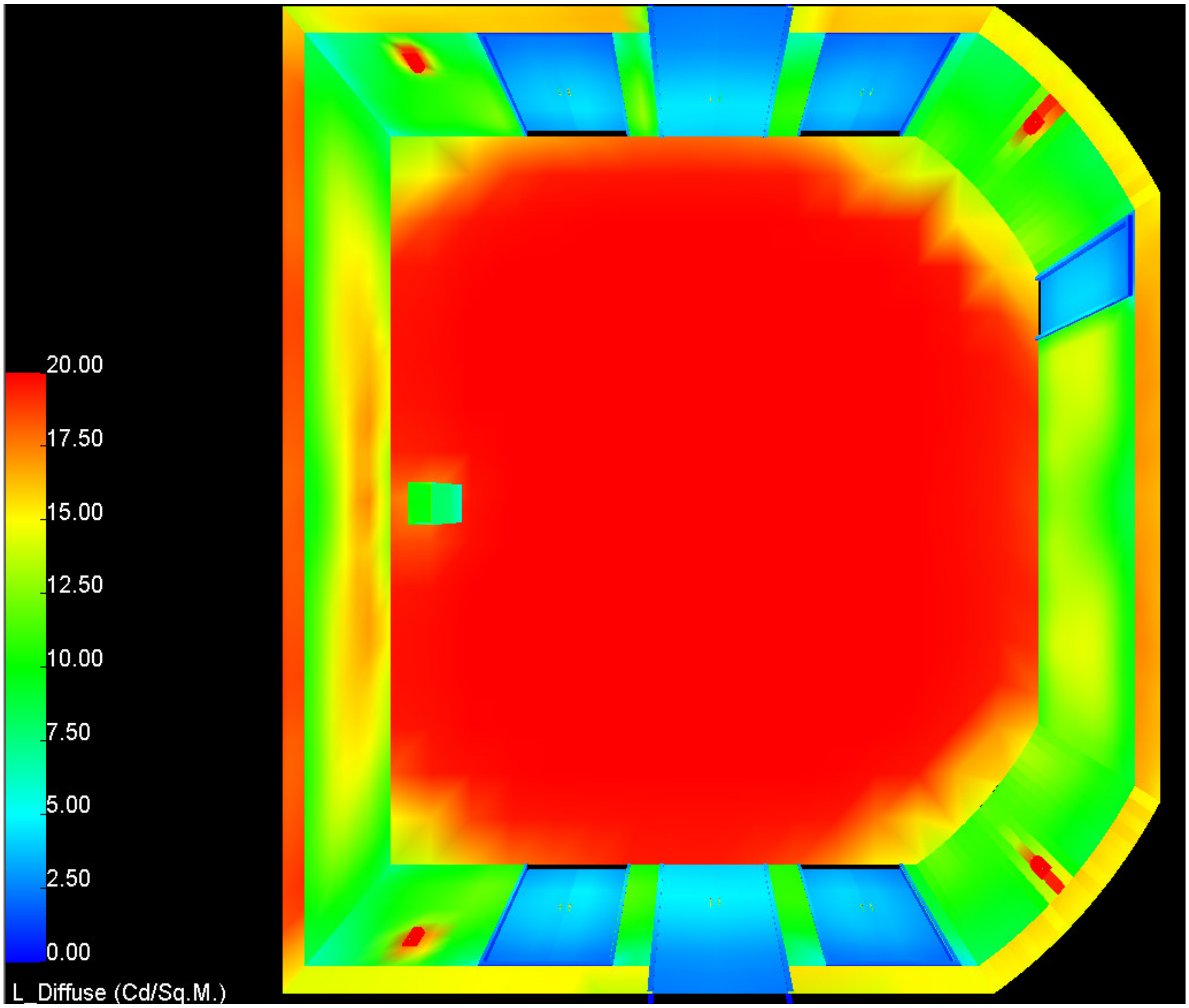


Figure 87: Auditorium – Full Space Lecture Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Workplane (horizontal 2.5' AFF)	36.39	46.8	20.9	2.24
Auditorium A Center Podium (vertical)	30.19	44.4	20.5	2.17

Figure 88: Auditorium – Full Space Lecture Luminance Pseudo Color Rendering (cd/sq.m.)



- **Split Space Meeting**

Figure 89: Auditorium – Split Space Meeting Horizontal Illuminance (fc)

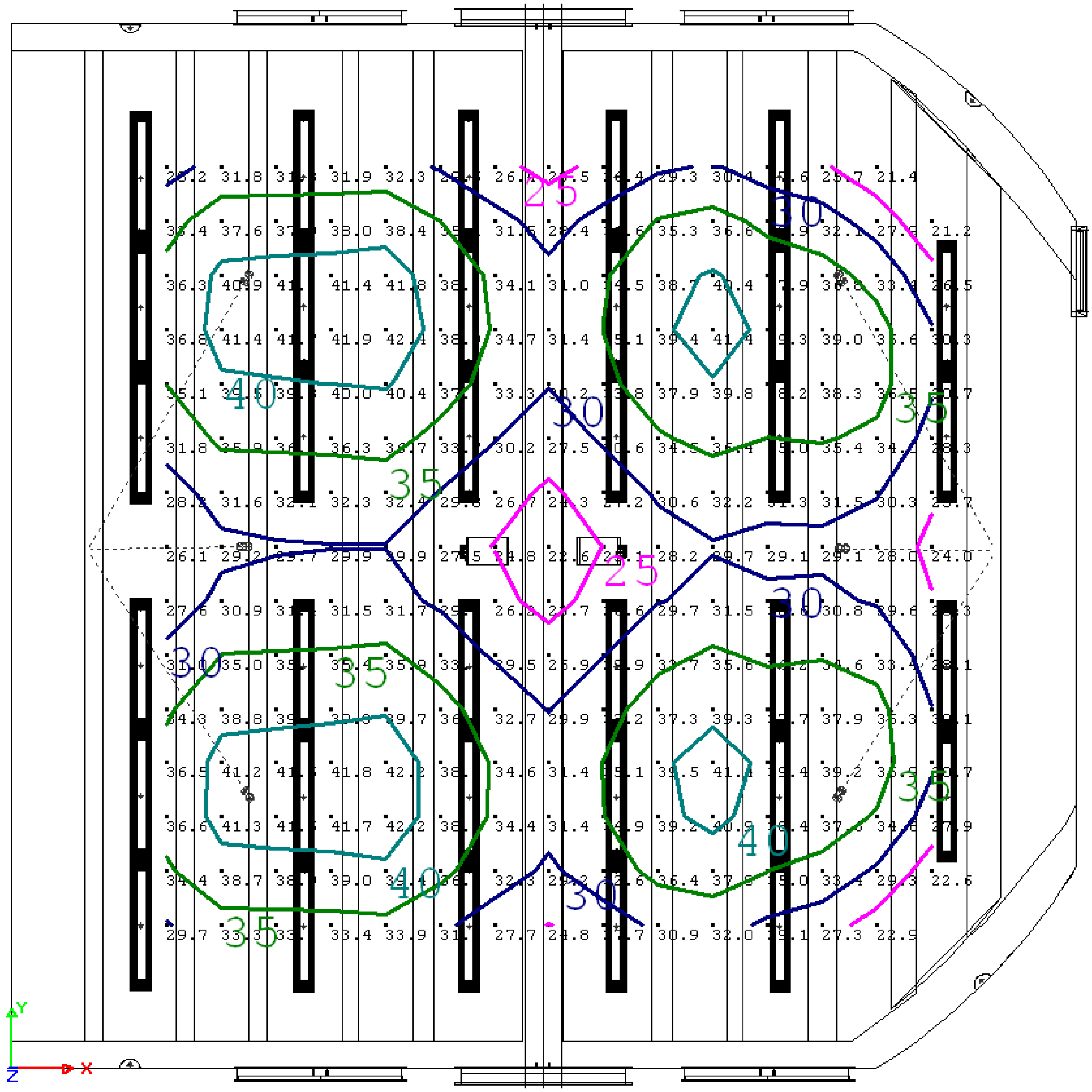
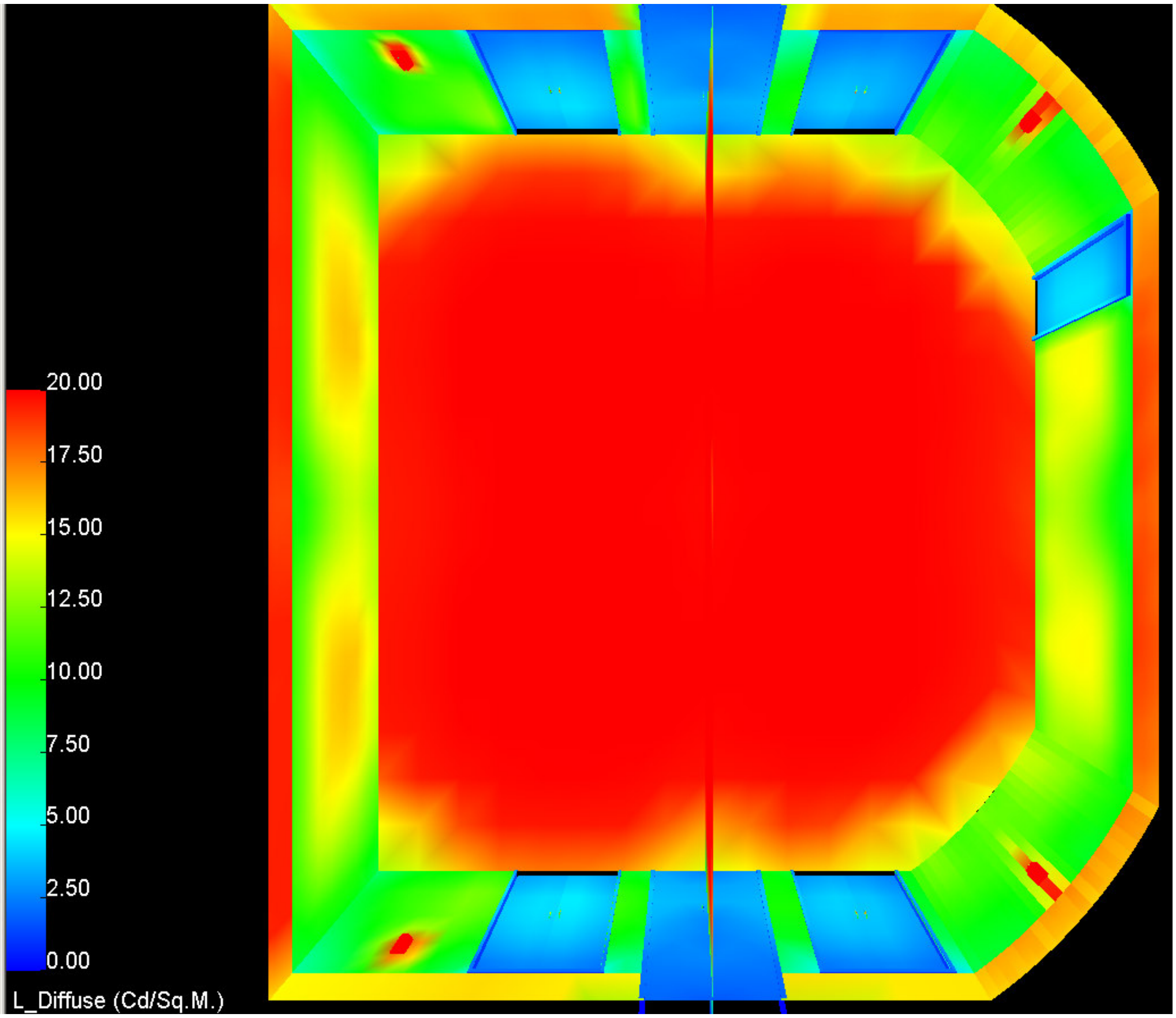


Figure 90: Auditorium – Split Space Meeting Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Workplane (horizontal 2.5' AFF)	33.47	42.4	21.2	2

Figure 91: Auditorium – Split Space Meeting Luminance Pseudo Color Rendering (cd/sq.m.)



- **Split Space Presentation**

Figure 92: Auditorium – Split Space Presentation Horizontal Illuminance (fc)

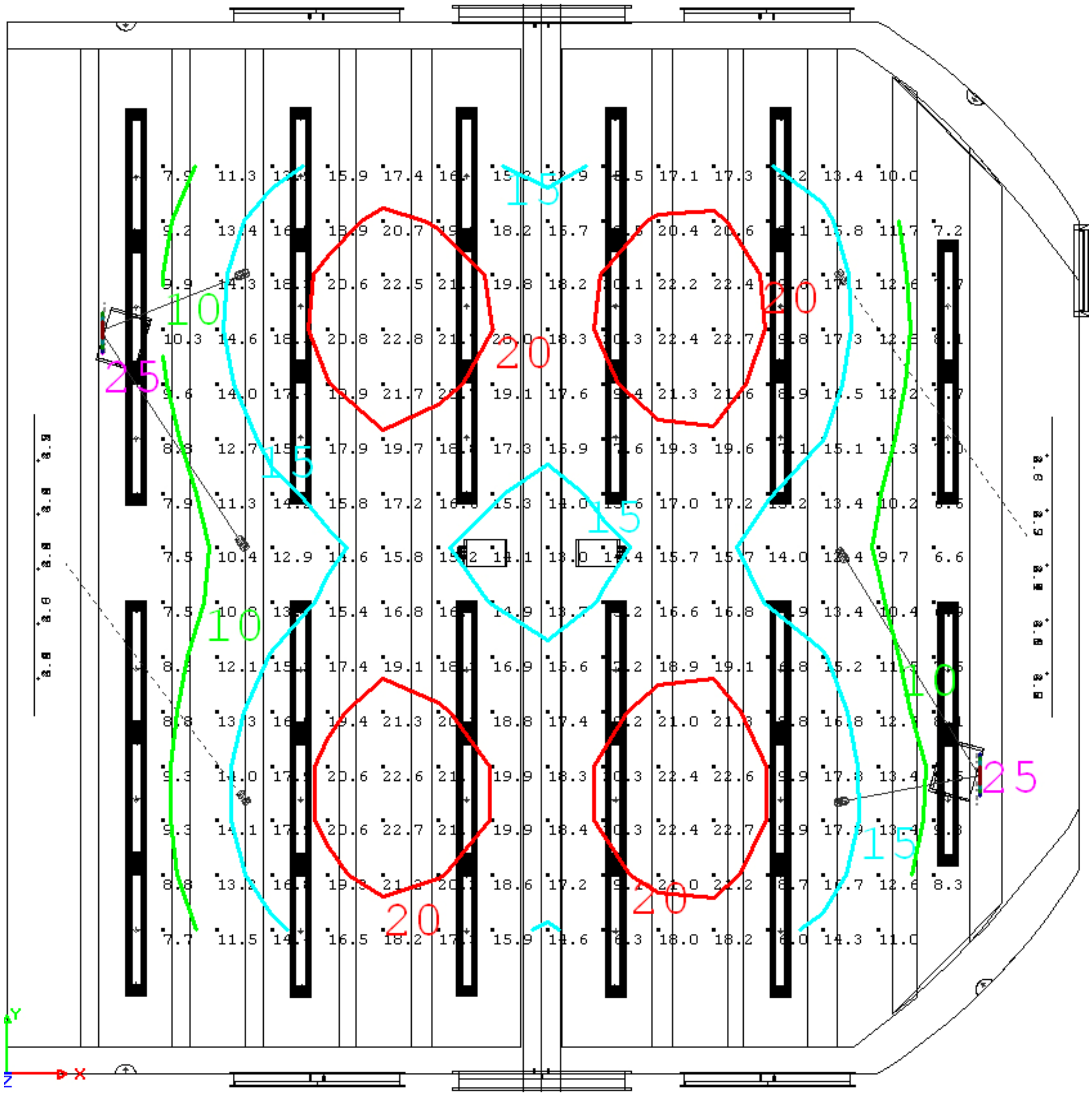
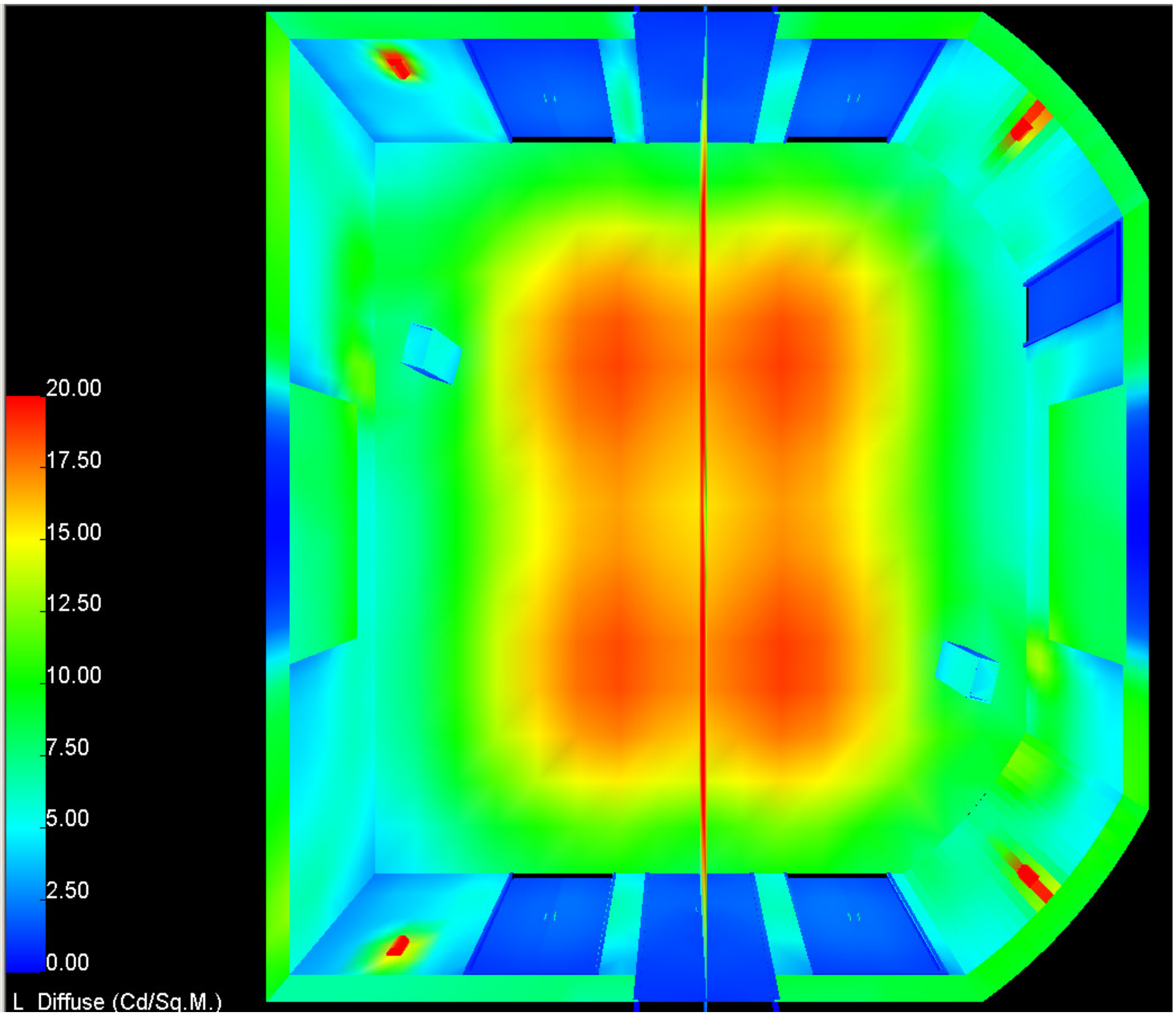


Figure 93: Auditorium – Split Space Presentation Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Workplane (horizontal 2.5' AFF)	15.98	22.8	6.6	3.45
Auditorium A Projection Screen (vertical)	3.65	4.5	2.8	1.61
Auditorium B Projection Screen (vertical)	3.73	4.7	2.8	1.68
Auditorium A Side Podium (vertical)	32.56	49.5	20.9	2.37
Auditorium B Side Podium (vertical)	32.86	48.2	21.1	2.28

Figure 94: Auditorium – Split Space Presentation Luminance Pseudo Color Rendering (cd/sq.m.)



- **Split Space Lecture**

Figure 95: Auditorium – Split Space Lecture Horizontal Illuminance (fc)

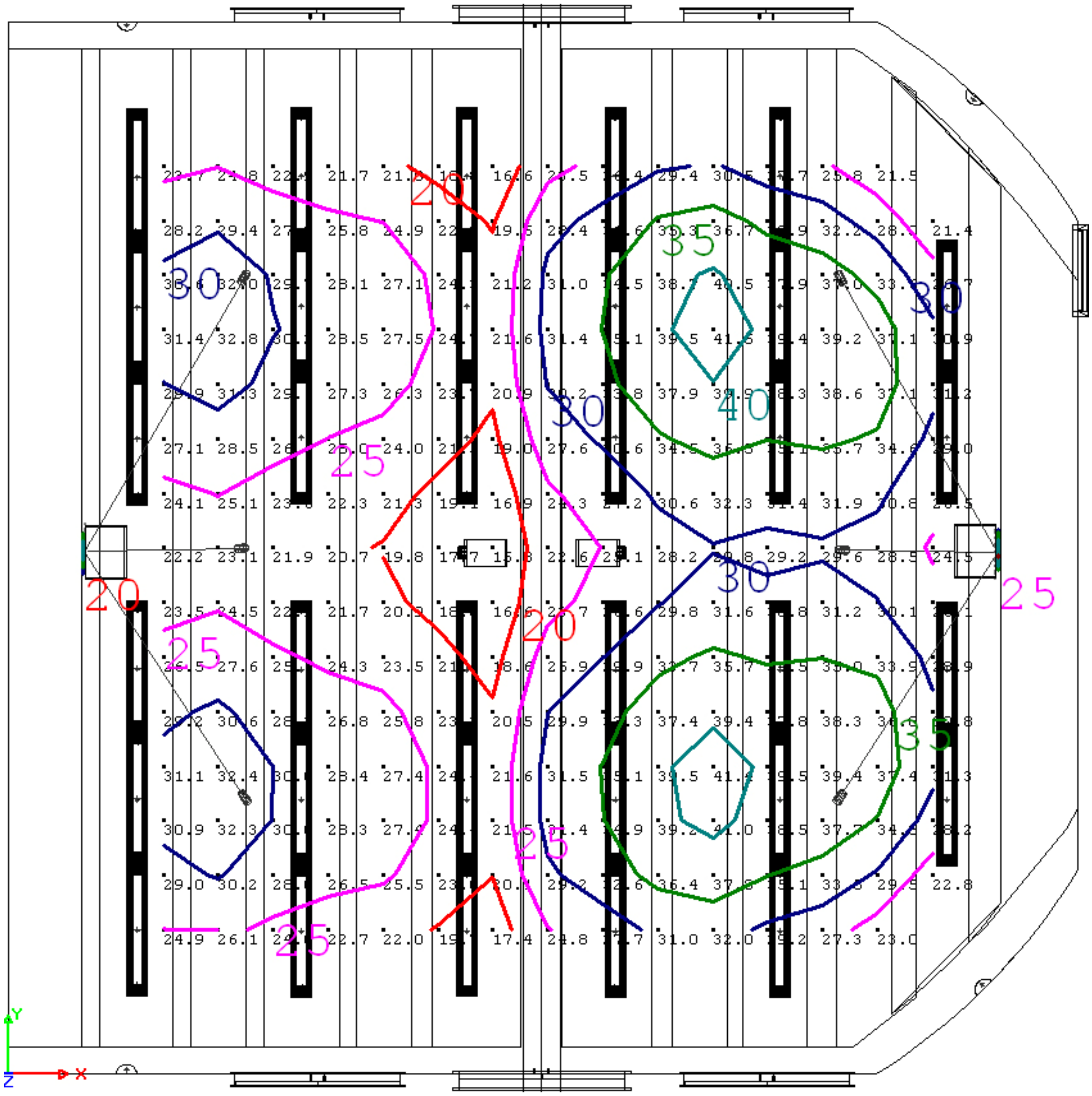
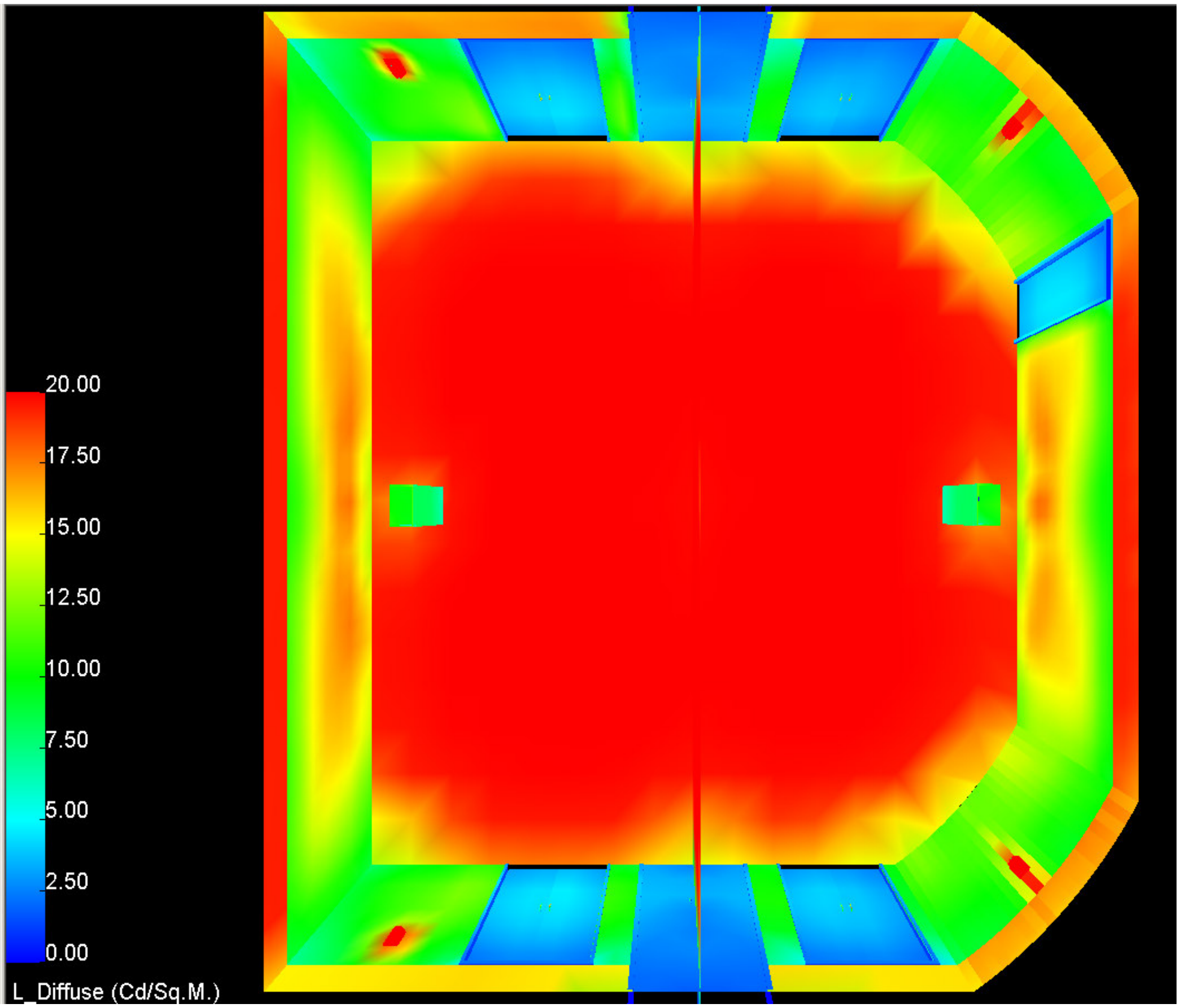


Figure 96: Auditorium – Split Space Lecture Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
Workplane (2.5' AFF)	33.66	42.5	21.4	1.99
Auditorium A Center Podium (vertical)	31.45	45.7	21.3	2.15
Auditorium B Center Podium (vertical)	32.73	45.4	22.5	2.02

Figure 97: Auditorium – Split Space Lecture Luminance Pseudo Color Rendering (cd/sq.m.)



Energy Code Compliance

Figure 98: Energy Code Calculation

ASHRAE Standard 90.1

Space	Total Area (sq.ft)	Allowable Lighting Power Density (W/sq.ft.)	Total Allowable Watts	Total Watts Used
Auditorium	1460	1.3	**1898**	**1536**
Auditorium (decorative)	1460	1	**1460**	**162**

Performance Summary

Overall, the criteria specified above have been met by the new lighting design for the auditorium. The feelings of focus and concentration have been created through visual clarity and interest in the space. The chosen fixtures provide downlight and also create indirect light on the ceiling and walls. The design utilizes high-end fixtures that create a good impression of the facility.

Warm color temperatures allow occupants to feel comfortable in the space while also complementing skin tones and the wood materials. Non-uniformity along the surrounding walls and ceiling provides visual interest within the space, while also accenting the wood tones. The task plane receives adequate illumination for general activities such as reading and writing. Lighting of the space from all directions enhances facial modeling of occupants.

As a space with many uses, a flexible lighting design is very important in providing adequate illuminance levels for various activities, while also making the space visually pleasing. The space will use the Grafik Eye control system with various presets. A partition sensor will also be utilized. When used for full and split space meetings, there is an adequate amount of ambient and task lighting throughout. The light levels are met and there is uniformity at the workplane. In order to accommodate for lectures and presentations, accent fixtures were chosen. Depending on the location of the podium, the fixtures can be manually adjusted, and two or three fixtures (for presentation and lecture modes, respectively) will be used to light the presenter. An adequate amount of vertical illuminace is achieved at the podium with and without the use of video teleconferencing. It is very important that the speaker is adequately illuminated. During the presentation mode, the target value of less than 5 fc on the projection screen is met. By view of the renderings, the space does not only provide adequate lighting as a workspace, but it is also visually interesting. The design also successfully meets the requirements of ASHRAE 90.1.

Electrical Redesign

For a complete spatial description of the auditorium, see page 62.

The auditorium houses a number of different activities, including presentations, meetings, and video teleconferences. Therefore, the lighting is based on the concept of focus and visual clarity in the space, while accommodating for each of the various uses. Adequate light levels are provided on the task plane and on the speaker (depending on the activity taking place). Each of the lighting scenes is designed for situations in which the partition is either open or closed. To highlight the natural materials and architecture of the space, a direct-indirect pendant highlights the wood panels that run the length of the space. Sconces on the perimeter walls provide peripheral emphasis, while also acting as way-finding lights at each doorway.

For the electrical redesign of the space, all of the new lighting will replace the existing lighting circuits on each respective panelboard. The new lighting design uses the Lutron Grafik Eye Control System with various presets (See page 74 for control schedule). Wall stations are located at each door, and the main control units are located on the walls beside the projection screens. The space is divided up into a total of 12 zones, six on each side of the partition wall. When the partition is open, the main control panels will control all of the lighting in the space, however, when the partition is closed, the main control panels will control the lighting on each respective side. All of the fluorescent fixtures are connected to the 277 V dimming panel and then to panel LPA (480Y/277V). The halogen spot lights are connected to the 120V dimming panel and then to panel RPA (208Y/120V). Emergency lights are also necessary for lighting the space in the occurrence of a power outage. Since the general lighting is not conducive with the emergency requirements, small downlights are included throughout. The closest emergency panel is LSLPA, which is rated at 480Y/277V. Therefore, compact fluorescent lights were chosen for this application.

- **Layout of Circuiting**
  See Appendix A for complete lighting plans with all electrical circuiting.

- **Existing Panelboards/Modified Circuits**
  The following are the panelboards that contain the existing light fixtures for the space. The specific circuits to be modified are highlighted.

Figure 99: Existing Panelboard LPA

(21) 20A, 1P, SPARES
(12) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "LPA" (SURFACE MTD IN STORAGE 1010A) - 480Y/277V, 3PH, 4W, BUS RATING 100A, MCB 100A, AIC 42000, TYPE1 ENCL. (42 POLE)

Circuit Number	Load Name	Rating	Apparent Load				Number of Poles	Apparent Current
			Total	Phase A	Phase B	Phase C		
1	Lighting AUDITORIUM 1010	20 A	78 VA	78 VA	0 VA	0 VA	1	0 A
2	Lighting AUDITORIUM 1010	20 A	78 VA	78 VA	0 VA	0 VA	1	0 A
3	Lighting AUDITORIUM 1010	20 A	216 VA	0 VA	216 VA	0 VA	1	1 A
4	Lighting MEDIA "DIVE" ROOM 1007	20 A	324 VA	0 VA	324 VA	0 VA	1	1 A
5	Lighting AUDITORIUM 1010	20 A	468 VA	0 VA	0 VA	468 VA	1	2 A
6	Lighting MEDIA "DIVE" ROOM 1007	20 A	624 VA	0 VA	0 VA	624 VA	1	2 A
7	Lighting AUDITORIUM 1010	20 A	108 VA	108 VA	0 VA	0 VA	1	0 A
8	Lighting AUDITORIUM 1010	20 A	858 VA	858 VA	0 VA	0 VA	1	3 A
9	Lighting AUDITORIUM 1010	20 A	546 VA	0 VA	546 VA	0 VA	1	2 A
Grand total: 9			3300 VA	1122 VA	1086 VA	1092 VA		12 A

Figure 100: Existing Panelboard LSLPA

(11) 20A, 1P, SPARES
(27) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "LSLPA" (SURFACE MTD IN STORAGE 1010A) - 480Y/277V, 3PH, 4W, BUS RATING 100A, MCB 50A, AIC 22000, TYPE1 ENCL. (42 POLE)

Circuit Number	Load Name	Rating	Apparent Load				Number of Poles	Apparent Current
			Total	Phase A	Phase B	Phase C		
1	Lighting AUDITORIUM 1010	20 A	54 VA	54 VA	0 VA	0 VA	1	0 A
2	Lighting AUDITORIUM 1010	20 A	108 VA	108 VA	0 VA	0 VA	1	0 A
3	Lighting AUDITORIUM 1010	20 A	108 VA	0 VA	108 VA	0 VA	1	0 A
5	Lighting MEDIA "DIVE" ROOM 1007	20 A	216 VA	0 VA	0 VA	216 VA	1	1 A
Grand total: 4			486 VA	162 VA	108 VA	216 VA		2 A

- **New Panelboard Worksheets and Schedule**

Figure 101: New Panelboard Worksheet LPA

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->				LPA	Panel Location:			STORAGE 1010A		
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	3	AUD 1010	108	w	0.97	108	111	
2	A	Lighting	3	AUD 1010	234	w	0.95	234	246	
3	B	Lighting	3	AUD 1010	468	w	0.95	468	493	
4	B	Lighting	3	MEDIA "DIVE" ROOM 1007	324	va	0.95	308	324	
5	C	Lighting	3	AUD 1010	468	w	0.95	468	493	
6	C	Lighting	3	MEDIA "DIVE" ROOM 1007	624	va	0.95	593	624	
7	A	Lighting	3	AUD 1010	234	w	0.95	234	246	
8	A	Lighting	3	AUD 1010	54	w	0.97	54	56	
9	B				0	w		0	0	
10	B				0	w		0	0	
11	C				0	w		0	0	
12	C				0	w		0	0	
13	A				0	w		0	0	
14	A				0	w		0	0	
15	B				0	w		0	0	
16	B				0	w		0	0	
17	C				0	w		0	0	
18	C				0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								2.5	2.6	Amps= 3.1

PHASE LOADING							kW	kVA	%	Amps
	PHASE TOTAL	A					0.6	0.7	25%	2.4
	PHASE TOTAL	B					0.8	0.8	31%	2.9
	PHASE TOTAL	C					1.1	1.1	43%	4.0
LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		2.5	2.6	1.00	2.5	2.6	0.95		
4	HID lighting		0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9	unassigned		0.0	0.0		0.0	0.0			
	Total Demand Loads					2.5	2.6			
	Spare Capacity		20%			0.5	0.5			
	Total Design Loads					3.0	3.1	0.95	Amps=	3.7

Figure 102: New Panelboard Schedule LPA

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

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: LPA PANEL LOCATION: STORAGE 1010A PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: (4) #14, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	AUD 1010	108	20A/1P	1	*			2	20A/1P	234	AUD 1010	Lighting
Lighting	AUD 1010	468	20A/1P	3		*		4	20A/1P	308	MEDIA "DIVE" ROOM 1007	Lighting
Lighting	AUD 1010	468	20A/1P	5			*	6	20A/1P	593	MEDIA "DIVE" ROOM 1007	Lighting
Lighting	AUD 1010	234	20A/1P	7	*			8	20A/1P	54	AUD 1010	Lighting
		0		9		*		10		0		
		0		11			*	12		0		
		0		13	*			14		0		
		0		15		*		16		0		
		0		17			*	18		0		
		0		19	*			20		0		
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	0.63	TOTAL DESIGN LOAD (KW)	2.96
CONNECTED LOAD (KW) - B	0.78	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	1.06	TOTAL DESIGN LOAD (AMPS)	3.7

Feeder Size Calculation:

3.7 A * 125% = 4.6A → 100A Bus*, 50A Main*, (4) #14 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4" Conduit

*Minimum Bus size = 100A

*Minimum Main Circuit Breaker size = 50A

Figure 103: New Panelboard Worksheet LSLPA

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					LSLPA	Panel Location:			STORAGE 1010A	
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	3	AUD 1010	348	w	0.95	348	366	
2	A				0	w		0	0	
3	B				0	w		0	0	
4	B	Lighting	3	MEDIA "DIVE" ROOM 1007	216	va	0.95	205	216	
5	C				0	w		0	0	
6	C				0	w		0	0	
7	A				0	w		0	0	
8	A				0	w		0	0	
9	B				0	w		0	0	
10	B				0	w		0	0	
11	C				0	w		0	0	
12	C				0	w		0	0	
13	A				0	w		0	0	
14	A				0	w		0	0	
15	B				0	w		0	0	
16	B				0	w		0	0	
17	C				0	w		0	0	
18	C				0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								0.6	0.6	Amps= 0.7

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					0.3	0.4	63%	1.3
PHASE TOTAL	B					0.2	0.2	37%	0.8
PHASE TOTAL	C					0.0	0.0		0.0

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		0.6	0.6	1.00	0.6	0.6	0.95		
4	HID lighting		0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9	unassigned		0.0	0.0		0.0	0.0			
Total Demand Loads						0.6	0.6			
Spare Capacity			20%			0.1	0.1			
Total Design Loads						0.7	0.7	0.95	Amps=	0.8

Figure 104: New Panelboard Schedule LSLPA

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: LSLPA	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 100A	PANEL LOCATION: STORAGE 1010A	OPTIONS:
SIZE/TYPE MAIN: 50A/3P C/B	PANEL MOUNTING: SURFACE	(4) #14, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	AUD 1010	348	20A/1P	1	*			2	20A/1P	0		
		0		3		*		4	20A/1P	205	MEDIA "DIVE" ROOM 1007	Lighting
		0		5			*	6		0		
		0		7	*			8		0		
		0		9		*		10		0		
		0		11			*	12		0		
		0		13	*			14		0		
		0		15		*		16		0		
		0		17			*	18		0		
		0		19	*			20		0		
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	0.35	TOTAL DESIGN LOAD (KW)	0.66
CONNECTED LOAD (KW) - B	0.21	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	0.00	TOTAL DESIGN LOAD (AMPS)	0.8

Feeder Size Calculation:

0.8 A * 125% = 1A → 100A Bus*, 50A Main*, (4) #14 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4” Conduit

*Minimum Bus size = 100A

*Minimum Main Circuit Breaker size = 50A

Figure 105: New Panelboard Worksheet RPA

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					RPA	Panel Location:			STORAGE 1010A	
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	5	CNTRL 1008	52	va	0.95	49	52	
2	A	VP		AUD 1010	180	va	1.00	180	180	
3	B	VP		AUD 1010	180	va	1.00	180	180	
4	B	RECEPTACLES	1	AUD1010	1440	va	0.85	1224	1440	
5	C	PROJ SCREEN		AUD 1010	1000	va	1.00	1000	1000	
6	C	RECEPTACLES	1	STOR 1010A	1000	va	0.85	850	1000	
7	A	IP RECEPTACLES	1	AUD 1010	360	va	0.85	306	360	
8	A	PROJ SCREEN		AUD 1010	1000	va	1.00	1000	1000	
9	B	IP RECEPTACLES	1	AUD 1010	360	va	0.85	306	360	
10	B				0	w		0	0	
11	C	IP RECEPTACLES	1	AUD 1010, STOR 1010A	360	va	0.85	306	360	
12	C				0	w		0	0	
13	A	IP RECEPTACLES	1	AUD 1010	360	va	0.85	306	360	
14	A	Lighting	5	AUD 1010	35	w	1.00	35	35	
15	B	Lighting	5	AUD 1010	35	w	1.00	35	35	
16	B	Lighting	5	AUD 1010	35	w	1.00	35	35	
17	C	Lighting	5	AUD 1010	35	w	1.00	35	35	
18	C	Lighting	5	AUD 1010	35	w	1.00	35	35	
19	A	Lighting	5	AUD 1010	35	w	1.00	35	35	
20	A	Lighting	5	LOBBY 1003	70	w	1.00	70	70	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								6.0	6.6	Amps= 18.3

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					2.0	2.1	32%	17.4
PHASE TOTAL	B					1.8	2.1	31%	17.1
PHASE TOTAL	C					2.2	2.4	37%	20.3
LOAD CATAGORIES		Connected			Demand				Ver. 1.02
		kW	kVA	DF	kW	kVA	PF		
1 receptacles		3.3	3.9	0.70	2.3	2.7	0.85		
2 computers		0.0	0.0	0.90	0.0	0.0			
3 fluorescent lighting		0.0	0.0	1.00	0.0	0.0			
4 HID lighting		0.0	0.0	1.00	0.0	0.0			
5 incandescent lighting		0.3	0.3	1.00	0.3	0.3	0.99		
6 HVAC fans		0.0	0.0	0.80	0.0	0.0			
7 heating		0.0	0.0	1.25	0.0	0.0			
8 kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9 unassigned		2.4	2.4		2.4	2.4	1.00		
Total Demand Loads					5.0	5.4			
Spare Capacity		20%			1.0	1.1			
Total Design Loads					6.0	6.5	0.92	Amps=	18.0

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 106: New Panelboard Schedule RPA

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: RPA
PANEL LOCATION: STORAGE 1010A
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:
(4) #14, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	CNTRL 1008	49	20A/1P	1	*			2	20A/1P	180	AUD 1010	VP
VP	AUD 1010	180	20A/1P	3		*		4	20A/1P	1224	AUD1010	RECEPTACLES
PROJ SCREEN	AUD 1010	1000	20A/1P	5			*	6	20A/1P	850	STOR 1010A	RECEPTACLES
IP RECEPTACLES	AUD 1010	306	20A/1P	7	*			8	20A/1P	1000	AUD 1010	PROJ SCREEN
IP RECEPTACLES	AUD 1010	306	20A/1P	9		*		10	20A/1P	0	0	0
IP RECEPTACLES	1010, STOR 10	306	20A/1P	11			*	12	20A/1P	0		0
IP RECEPTACLES	AUD 1010	306	20A/1P	13	*			14	20A/1P	35	AUD 1010	Lighting
Lighting	AUD 1010	35	20A/1P	15		*		16	20A/1P	35	AUD 1010	Lighting
Lighting	AUD 1010	35	20A/1P	17			*	18	20A/1P	35	AUD 1010	Lighting
Lighting	AUD 1010	35	20A/1P	19	*			20	20A/1P	70	LOBBY 1003	Lighting
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	1.98	TOTAL DESIGN LOAD (KW)	6.00
CONNECTED LOAD (KW) - B	1.78	POWER FACTOR	0.92
CONNECTED LOAD (KW) - C	2.23	TOTAL DESIGN LOAD (AMPS)	18.0

Feeder Size Calculation:

18 A * 125% = 22.5A → 100A Bus*, 50A Main*, (4) #14 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4” Conduit

*Minimum Bus size = 100A

*Minimum Main Circuit Breaker size = 50A

Large Workspace - Physical Therapy / Occupational Therapy / Therapy Waiting

Spatial Summary

- **Description**

  The large workspace is centrally located on the second floor of the northern portion of the building. It is a total of 4130 square feet, and is an irregular shape with mostly curved walls.

  The therapy waiting room is entered from the general therapy info space and consists of seating for patients. It is adjacent to and accessible by the office and exam spaces located in the "bar" section of the building.

  The Physical Therapy space extends along the northern facade curtainwall. Exercise equipment is located along the exterior wall for excellent outside views. Evaluation rooms, the art/music space, and Central Park can be accessed from this area.

  The circular shaped occupational therapy room contains no north wall, creating a large, open transition space to the PT room. The area includes many pieces of furniture, equipment, and kitchen space. Large glass windows are located on the southern wall area, looking down onto the first floor interior lobby.

- **Drawings**

Figure 107: PT/OT Location (NTS)

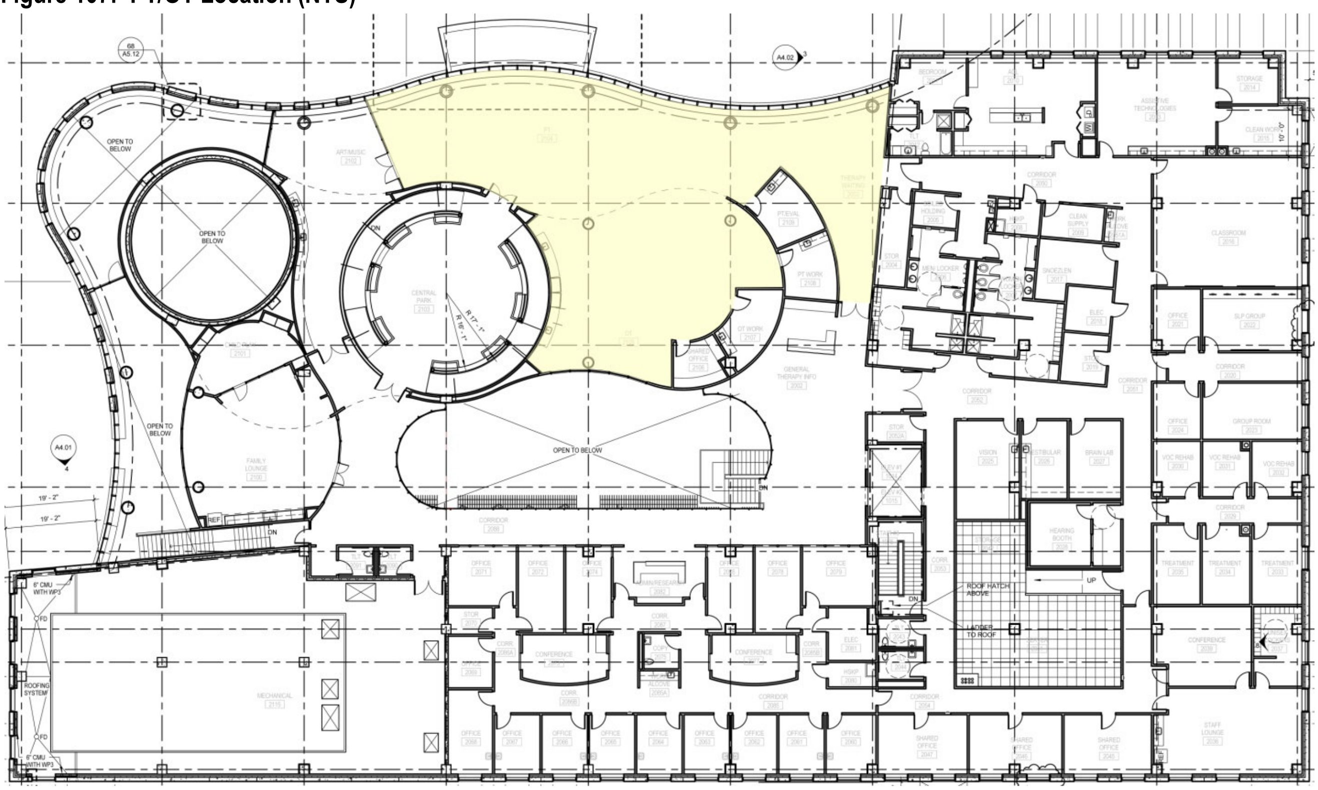


Figure 108: PT/OT Floor Plan (NTS)

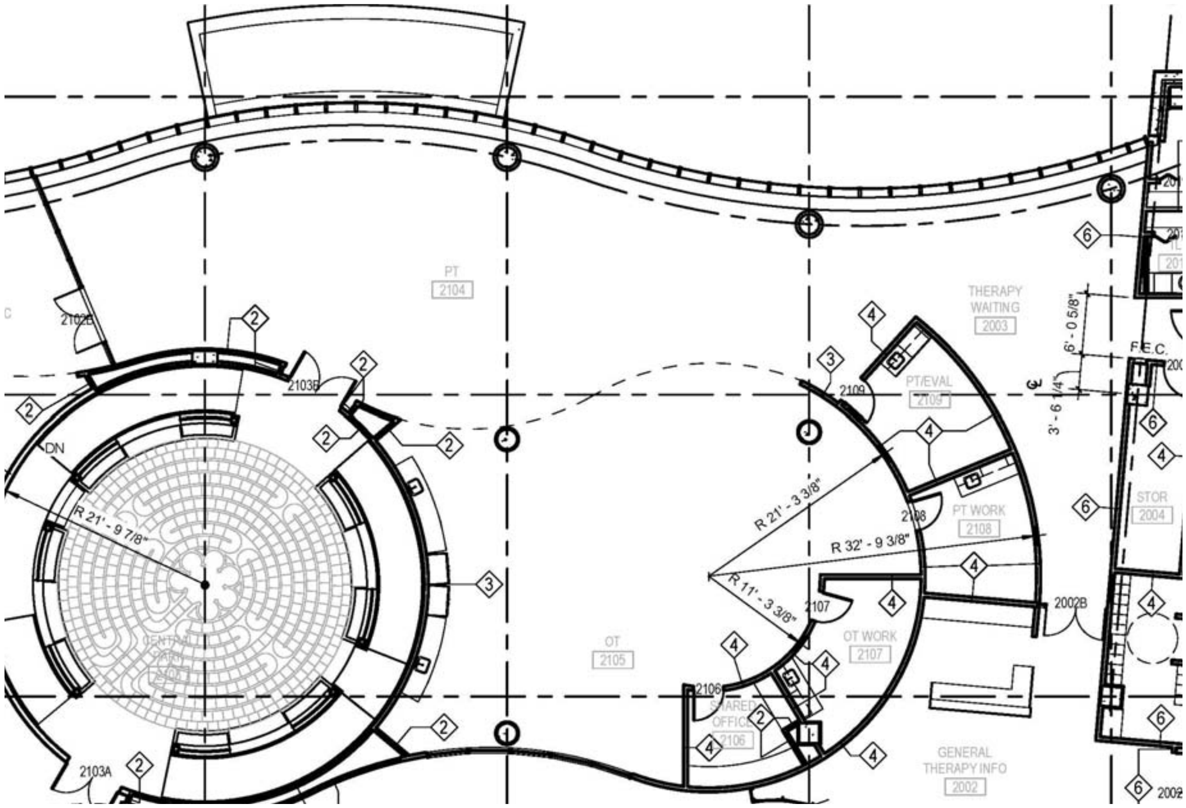


Figure 109: PT/OT Reflected Ceiling Plan - Second Floor (NTS)

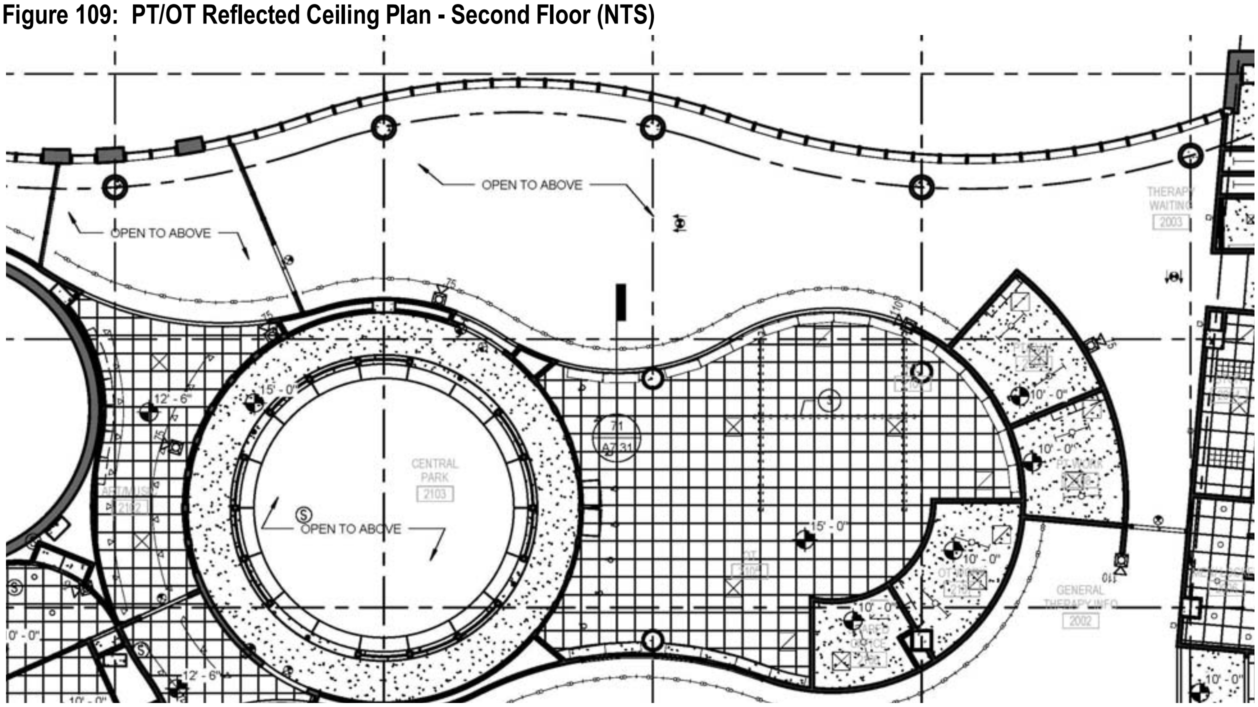


Figure 110: PT/OT Reflected Ceiling Plan - Low Roof (NTS)

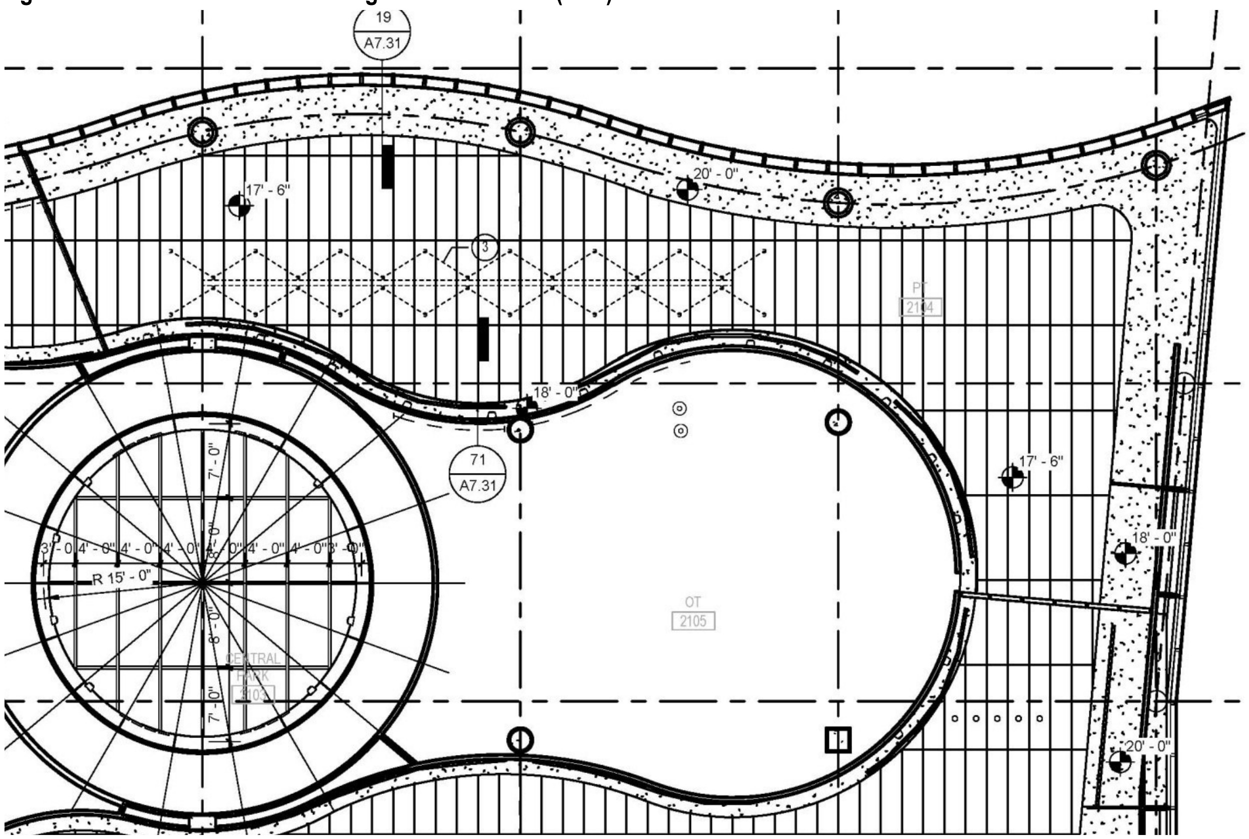


Figure 111: PT/OT Equipment and Furniture Locations (NTS)

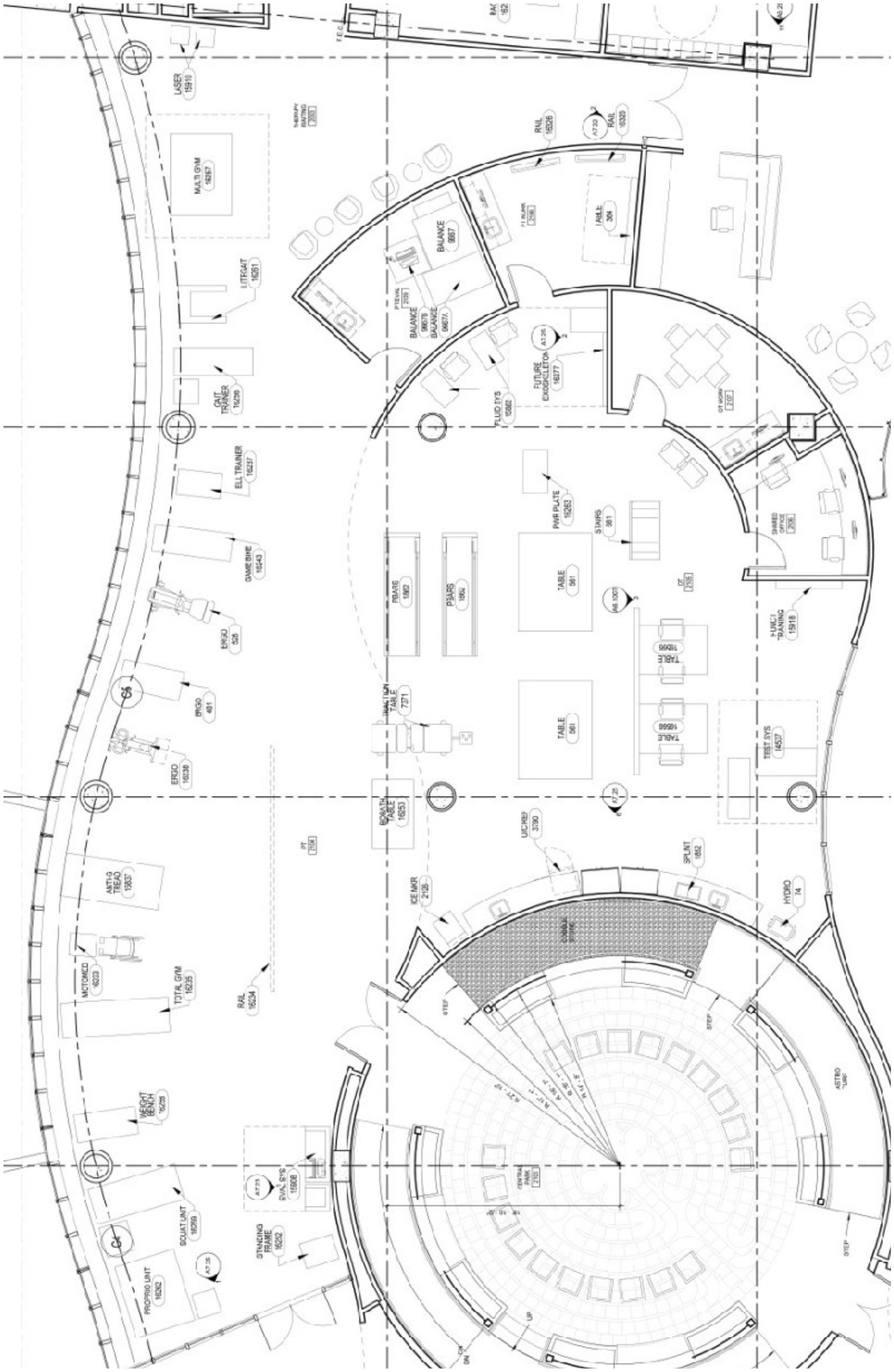


Figure 112: PT/OT Interior South Elevation (NTS)

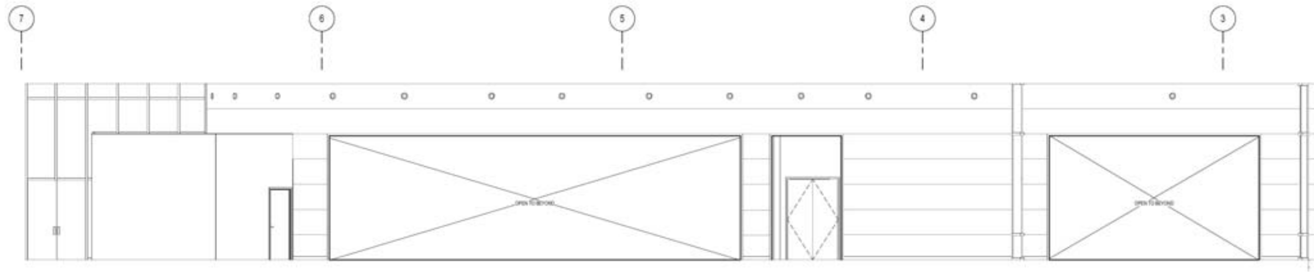
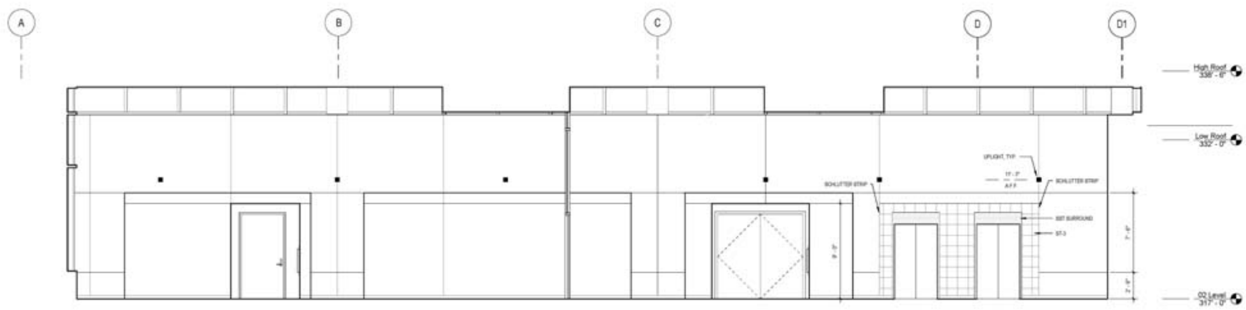


Figure 113: PT/OT Interior East Elevation (NTS)



- **Surface Materials**

  <u>*Therapy Waiting*</u>

  Floor - The floor consists of two types of rubber sport floor (RF-2,3).

  Base - A mdf painted wood base (WDB-2) is utilized along with a 4" linoleum rubber base (RB-2) in some areas.

  Walls - Most of the interior wall surfaces consist of a wood veneer wall covering (WC-1) with painted (P-1,10) aluminum at the raised ceiling along the perimeter wall. A 6.5 foot east-facing clerestory is located at the top of the east wall. The upper section is spandrel glass and the lower is composed of clear vision glass. Double aluminum doors with vision lites and a surrounding storefront wall act as a partition between the general therapy info space.

  Ceiling - The center of the space consists of 24"x96" acoustic ceiling tile (ACT-3) while the raised ceiling along the perimeter wall is painted gypsum wall board (GWB-1).

  <u>PT</u>

  Floor - The floor consists of three types of rubber sport floor (RF-1,2,3). A narrow horizontal strip through the center of the space presents a unique pattern on the ground.

  Base - A mdf painted wood base (WDB-2) lines the perimeter of the lower wall.

  Walls - Most of the interior wall surfaces consist of a wood veneer wall covering (WC-1) with painted (P-1) aluminum at the raised ceiling along the perimeter wall. Painted accents are also present (P-15). The exterior wall is comprised of a curtainwall system with aluminum framing. The glass is vision glass with ceramic frit with small sections of spandrel and clear vision glass lining the top portion. Double stainless steel clad aluminum doors lead into the art/music space. Stained solid core double doors with a painted hollow metal frame provide access into Central Park. A stained solid core door with a narrow lite and a painted hollow metal frame provides entrance into the PT/EVAL room.

Ceiling - The center of the space consists of 24"x96" acoustic ceiling tile (ACT-3) while the raised ceiling along the perimeter wall is painted gypsum wall board (GWB-1).

<u>OT</u>

Floor - The floor consists of three types of rubber sport floor (RF-2,3,4).

Base - A mdf painted wood base (WDB-2) is continued around the perimeter.

Walls - The walls are painted (P-1) with alternate color accents (P-15). Cabinetry is also present in this space. The southern wall curve contains a clear vision glass window overlooking the first floor Interior Lobby. Stained solid core doors with a narrow lite and a painted hollow metal frame provide entrance into smaller adjacent rooms.

Ceiling - The center of the space consists of 24"x24" acoustic ceiling tile (ACT-2) while the raised ceiling along the perimeter wall is painted gypsum wall board (GWB-1).

Figure 114: Material Properties

Material	Color/Style	Reflectance
RF-1	20 CHARCOAL	0.1
RF-2	BEIGE	0.4
RF-3	RED	0.3
RF-4	DARK BLUE	0.2
WDB-2	WOOD BASE	0.3
RB-2	20 CHARCOAL	0.1
WC-1	WOOD COVERING	0.3
P-1	CREAM	0.65
P-10	DARK RED	0.4
P-15	BLUE	0.6
ACT-2	ULTIMA WHITE	0.8
ACT-3	OPTIMA WHITE	0.8
GWB-1	PAINTED P-11	0.8
ALUMINUM DOORS	ALUMINUM	0.86
WOOD DOORS	STAINED WOOD	0.2
DOOR FRAME	PAINTED P-1	0.65

Figure 115: Glass Properties

Material	Description	Transmittance	SHGCC	Shading Coefficient	Winter U-value	Outdoor Reflectance
IGU-1	CLEAR VISION GLASS WITH LGU-1	63%	0.27	0.31	0.28	12%
IGU-2*	VISION GLASS WITH CERAMIC FRIT (40% COVERAGE) WITH LGU-1 (LAMINATED GLASS) ON INTERIOR	63% FOR GLASS 16% FOR DOTS	0.27 (FOR GLASS)	0.31 (FOR GLASS)	0.28 (FOR GLASS)	12% (FOR GLASS)
IGU-3	SPANDREL GLASS WITH LGU-2 (LAMINATED GLASS) ON INTERIOR	0% (FLOOR STRUCTURE)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
	MEDIUM STILE GLASS (DOORS AND INTERIOR GLASS)	90% (ASSUME SINGLE PANE CLEAR)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE

*NOT ALL INFORMATION PROVIDED, SO ASSUMPTIONS MADE FROM COMPARISON TO OTHER PRODUCTS

- **Furnishings**
  Chairs and end tables are located throughout the therapy waiting room. Numerous pieces of exercise equipment occupy the PT area. The OT space contains several tables/desks and various types of therapy equipment.

- **Activities/Tasks**
  The PT space provides an area for large movement activities and requisite equipment. Exercises and activities will take place throughout the area. Patients will be evaluated on their abilities and progress completing various movements. People will be moving around the space from one machine to another, conversing, and possibly reading forms or directions.

  The OT space is used to evaluate a patient's cognitive abilities. Tasks such as screening patients, which includes an interview and a basic evaluation of functional abilities, will take place.

  The Therapy Waiting area will be used for patients and their families to sit and wait for treatment. They will most likely be reading or conversing among one another.

Design Concept

This workspace consists of three different areas. The therapy waiting area is comprised of seating for patients waiting for treatment. The physical therapy space provides for large movement activities and exercises. The occupational therapy area includes locations for screening and evaluating patients' abilities. Visual clarity and relaxation are important impressions in these types of rooms. Through a lighting concept of strength, occupants should feel encouraged and uplifted while in this space. The unique architectural surfaces and solid structure should be highlighted. Lights located along the curtainwall should be dimmable and controlled with photsensors that are dependent on the amount of daylight that enters the space throughout the day. All other lighting should be on a time clock. At night, only lights highlighting the interior curved wall should be on. These controls should mimic those of the lobby for nighttime exterior views to the inside.

Design Criteria

(IESNA Handbook: Health Care Facilities, Occupational Therapy, Work Areas, General / Physical Therapy Departments, Gymnasiums)

- **Appearance of Space and Luminaires** (Very Important)
  Located on the second level, the physical therapy (PT), occupational therapy (OT), and therapy waiting areas are not one of the first spaces that one sees upon entering the building. While it will still be a highly occupied space, only certain patients will use it. Well known researchers and officials will not enter the space as frequently. Therefore, the appearance of the space and luminaires is not as critical, in terms of high end fixtures. However, the space should still convey similar qualities to that of the lobby at night. When lights can be seen from the outside in the dark, the two levels should look comparable in terms of lighting types/fixtures. The lighting design should also be functional and provide adequate lighting for numerous tasks. It should not be extremely bright or have high contrast in order to accommodate for the sensitivities of traumatic brain injury patients.

- **Psychological Impressions**
  The impression of relaxation should be present throughout the space for patients undergoing treatment and analysis. Non-uniform lighting on the peripheral walls should be implemented. Visual clarity is also important for proper and safe use of machines and equipment. A uniform lighting mode with some peripheral emphasis is suggested.

  Many of the visitors in the space will be patients coming for treatment or analysis. The mood should be very calm and relaxing to ease nerves or tension.

- **Color Appearance (and Color Contrast)** (Very Important)
  As mentioned above, when viewed from the outside at night, both the lobby and PT spaces should complement one another in terms of color appearance. A low CCT would naturally enhance the wood walls throughout the space; however, there is also a lot of natural daylight (cooler CCT) that enters the room. In order to accommodate for both of these features, an average CCT of about 3500K is desirable. This will accent skin tones as well as the concentrated wall colors throughout the space. A high CRI is important in order to accurately view the exercise equipment and for carrying out therapy exams and assessments. There are also many colors throughout the space that are integrated into the wall and floor materials.

- **Daylighting Integration and Control** (Very Important)
  The curtainwall system lining the northern wall of this space provides a large amount of light during the day. Since the glass faces north and a majority of it consists of ceramic frit, direct sun angles are easily avoided. The abundance of light allows for little electric light to be needed in the space during the daytime. Photosensors are necessary to control ambient electric lighting through dimming the fixtures. The time of day and amount of light present in the space determines the necessary dimming levels. Daylight studies should be implemented in order to determine how far the light actually penetrates into the space.

- **Direct Glare** (Important)
  For adequate and comfortable usage of the space there should be no direct glare viewable by the users. This is especially important for patients with traumatic brain injuries because they are extremely sensitive to brightness. Direct glare from the lamp sources should be eliminated by integrating the fixtures within the architecture.

- **Flicker (and Strobe)** (Very Important)
  As a facility for patients with traumatic brain injury, the users are very sensitive to brightness and contrast, so flicker and strobe from lights should be avoided at all costs. Although the movement in the exercise space will be slow, light sensitive patients may notice the changes.

- **Light Distribution on Surfaces** (Important)
  Light distribution on the wood walls should be horizontally uniform, but vertically transition from bright to dark. Non-uniformity across other vertical surfaces and the ceiling will create visual interest. Lighting on the walls of the Physical Therapy space should mimic that of the lobby, since both of these areas will be visible from the exterior at night.

- **Light Distribution on Task Plane (Uniformity)** (Important)
  There are several task planes throughout the space, which include the seating area, PT exercise machines and floor spaces, countertops, tabletops (reading, writing, and analysis), and floor (walking). The locations should include uniform light distribution that provides the recommended light levels.

- **Luminances of Room Surfaces / Surface Characteristics** (Very Important)
  Highlight the curved wood walls throughout the space through wall grazing. The elevated ceilings along the interior curved wall provide a built-in cove that will easily house fixtures to illuminate and emphasize the beautiful texture of the material. As previously mentioned, the materials are similar to those in the lobby, and should implement similar techniques. Round columns are scattered throughout the space and provide an interesting architectural features that exposes some of the building's structural content. Keeping these elements dark at night will enable them to contrast with and stand out against the lighted wood wall in the background.

- **Modeling of Faces or Objects** (Important)
  While in use, there will be constant interaction between people. Doctors and nurses will use body motions to demonstrate equipment and assist patients in training. Facial expressions and hand motions are necessary for successful communication. Appropriate light levels will enable TBI patients to easily interact with others. Some direct downlighting as well as sidelight from the windows or sconces are appropriate for vertical illumination.

- **Point(s) of Interest**
  One of the main points of interest in the space is the exercise equipment. Located along the curtainwall glazing, during the day, there is adequate illumination. However, in the evenings and at night, there needs to be a source of light for the area. A form of indirect lighting will prevent direct glare of those using equipment in which they must lay down.

  In the occupational therapy space, there is additional exercise and assessment equipment, tables, and countertops that require adequate light levels.

  The waiting area that contains chairs should be a comfortable and relaxing place for patients to wait for therapy. The space should have a lower lighting level than the main circulation area so that visitors feel at ease and not in the spotlight.

- **Reflected Glare and Source/Task/Eye Geometry** (Somewhat Important)
  Avoid reflected glare from windows and tabletops. The abundance of windows throughout the space makes it imperative for one to ensure that luminaires are not placed close to or aimed at the glass. Tabletops may have a glossy finish, so use a majority of indirect lighting to avoid reflected glare.

- **Shadows**
  Shadows should be avoided on the task planes, such as the exercise equipment, around the seats in the waiting area, tables/desks, countertops, and floor. However, the absence of light on certain parts of the ceiling or walls would be visually interesting. The raised ceiling near the curtainwall provides a very unique and mysterious feature to the space, as one wonders what is above.

- **Sparkle/Desirable Reflected Highlights**
  Large amounts of sparkle will try to be avoided. The brain injury patients are sensitive to high light levels and contrast. However, sconces without very bright sources can be utilized along the walls around doorways to adjacent spaces. This creates an additional functional quality as a circulation symbol.

- **System Control and Flexibility**
  With the abundance of daylight in the space, some fixtures should be dimmed through the use of photosensors to save energy during the day. There should also be some fixtures that remain on all the time, even at night to create a please visual effect from the exterior. This will also act as a security measure. All other fixtures in the space should be on an automatic time clock and programmed to shut off at the end of each work day.

- **Maintenance**
  The large ceiling heights make required maintenance and relamping difficult. Choose fixtures with a long lamp life to decrease the time between relamping as well as replacement costs.

- **Special Considerations** (Very Important)
  There is an abundance of not only exterior, but also interior glass throughout the space. In addition to the added illumination from daylight, adjacent spaces will provide some spill light as well. The points of interest should be well lit, and a path of light should guide occupants from one area to another.

- **Horizontal Illuminance** (Important)
  The required horizontal illuminance is as follows (IESNA Handbook):
  - Occupational Therapy = 30 fc (Work Areas, General)
  - Physical Therapy = 30 fc (Gymnasium)
  - Waiting Area = 10 fc (General)

  Deviations: none

- **Vertical Illuminance** (Important)
  The required vertical illuminance is as follows (IESNA Handbook):
  - Occupational Therapy = 5 fc (Work Areas, General)
  - Physical Therapy = 5 fc (Gymnasium)
  - Waiting Area = 3 fc (General)

  Deviations: none

- **Power Allowance**

  The allowable power densities are as follows (ASHRAE 90.1 - 2007):
  - Physical Therapy = 0.9 W/sq.ft.
  - Exam/Treatment = 1.5 W/sq.ft.
  - Lounge (waiting area) = 0.8 W/sq.ft.
  - Decorative = +1.0 W/sq.ft.

Lighting Plans

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

Luminaires

Figure 116: PT/OT/Therapy Waiting Luminaire Schedule

Type		Manufacturer	Product Name	Catalog Number	Description	Lamp	Voltage	Ballast/Power Supply	Watts	Location
B		WINONA LIGHTING	4614 Triad	4614-F-277V-OA-PC-STD	-UL listed and CUL approved -Custom sizes and finishes available upon request -Polished chrome clips (other options available) -Etched opal acrylic lens	CF13DD/830/ECO Osram Sylvania: 20705 Dulux D Preheat 2-pin Ecologic CFL	277	VH-2B13-TP-BLS ADVANCE CFL Magnetic Ballast	27	AUDITORIUM, LOBBY, OT, THERAPY WAIT - Walls - 6.5' on center
J		Elliptipar	Style 306	F-306-A132-S-00-V-000	-Compact and flexible - effective slot and valance lighting using T5 for precise optical or widely utilized T8 -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Integral electronic ballast thru wiring for easy installation -Durable - all parts are aluminum or stainless steel	FO32/835/XPS/ECO Osram Sylvania: 21697 Octron 800 XPS Lamp	277	ICN-3P32-SC@277V ADVANCE 2 Lamp Electronic Ballast	2 lamps: 65	PT - Interior curved wall
K3a		Elliptipar	Style 305	F-305-T139-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP39/835/HO/ECO Osram Sylvania: 20933 Pentron High Output, High Performance T5 Lamp	277	ECO-T539-277-2 Lutron Hi-Lume, Compact SE, Eco-10 3-Wire Dimming Ballast	2 lamps: 85.87	PT - Ceiling cove
K3b		Elliptipar	Style 305	F-305-T139-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP39/835/HO/ECO Osram Sylvania: 20933 Pentron High Output, High Performance T5 Lamp	277	ICN-2S39@277V ADVANCE Electronic Programmed Start Ballast	43	OT - Ceiling cove
K4a		Elliptipar	Style 305	F-305-T154-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP54/835/HO/ECO Osram Sylvania: 20904 Pentron High Output, High Performance T5 Lamp	277	ECO-T554-277-1 Lutron Hi-Lume, Compact SE, Eco-10 3-Wire Dimming Ballast	69.25	LOBBY - Ceiling cove PT - Ceiling cove
K4b		Elliptipar	Style 305	F-305-T154-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP54/835/HO/ECO Osram Sylvania: 20904 Pentron High Output, High Performance T5 Lamp	277	ECO-T554-277-2 Lutron Hi-Lume, Compact SE, Eco-10 3-Wire Dimming Ballast	2 lamps: 124.65	PT - Ceiling cove
K4c		Elliptipar	Style 305	F-305-T154-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP54/835/HO/ECO Osram Sylvania: 20904 Pentron High Output, High Performance T5 Lamp	277	ICN-2S54@277V ADVANCE 1 Lamp Electronic Programmed Start Ballast	62	PT - Ceiling cove
K4d		Elliptipar	Style 305	F-305-T154-S-00-V-000	-T5 fluorescent - precise optical control for unequaled projection of light from perimeter coves -Adjustable - all reflectors in a row join and aim together; rotation locking screws secure position -Only 2-5/8" high - fits in low profile coves -Integral electronic ballast, thru wiring for easy installation	FP54/835/HO/ECO Osram Sylvania: 20904 Pentron High Output, High Performance T5 Lamp	277	ICN-2S54@277V ADVANCE 2 Lamp Electronic Programmed Start Ballast	2 lamps: 117	PT - Ceiling cove
L		LIGHTOLIER	FP01 Vetro Architectural Decorative	FP1-PM32SA-PG01-26CFL-277V-SK01	-Satin machined aluminum and hand-blown opal glass -Handsome proportion of materials engineered to provide a functional design element and an efficient luminaire -Brushed and clear lacquer finish	CF26DT/E/830/ECO Osram Sylvania: 20880 Dulux T/E/IN Amalgam 4-Pin Ecologic Compact Fluorescent Lamp	277	ICF2S26H1LDQS @277 ADVANCE Programmed Start Ballast	29	OT - countertop
N		Gotham Lighting	8" AF Lensed Reflector Compact Fluorescent Downlights	AF-2/42TRT-8AR-T73-277-ADEZ	-Fluted vertical upper section works in conjunction with Bounding Ray Optical Principle design to provide lamp before lamp image and smooth transition from top of reflector to bottom -Minimum flange matches reflector finish -Semi-specular clear upper reflector -Lens position at optical break provides optimal visual comfort and improved aperture aesthetics	CF42DT/E/835/ECO Osram Sylvania: 20871 Dulux T/E/IN Amalgam 4-Pin Ecologic Compact Fluorescent Lamp	277	VEZ-2T42-M3-LD ADVANCE Electronic Dimming Ballast	2 lamps: 98	PT

See Appendix B for full luminaire schedule and cut sheets.

Figure 117: PT/OT/Therapy Waiting Spatial Assumptions

Type	Maintenance Category	Distribution Type	Degree of Dirtiness	Cleaning Cycle	Room Cavity Ratio
B	II	Direct-Indirect	Clean	12 Months	5.12
J	III	Direct-Indirect	Clean	12 Months	5.12
K3a	IV	Indirect	Clean	12 Months	5.12
K3b	IV	Indirect	Clean	12 Months	4.25
K4a	IV	Indirect	Clean	12 Months	5.12
K4b	IV	Indirect	Clean	12 Months	5.12
K4c	IV	Indirect	Clean	12 Months	5.12
K4d	IV	Indirect	Clean	12 Months	5.12
L	II	Semi-Direct	Clean	12 Months	4.25
N	V	Direct	Clean	12 Months	5.12

Figure 118: PT/OT/Therapy Waiting Light Loss Factors

Type	BF	LLD	LDD	RSDD	Total LLF
B	0.91	0.86	0.95	0.94	0.70
J	1.01	0.95	0.9	0.92	0.79
K3a	0.91	0.93	0.89	0.87	0.66
K3b	1.02	0.93	0.89	0.88	0.74
K4a	0.91	0.93	0.89	0.87	0.66
K4b	0.91	0.93	0.89	0.87	0.66
K4c	1.02	0.93	0.89	0.87	0.73
K4d	1	0.93	0.89	0.87	0.72
L	1.1	0.86	0.94	0.94	0.84
N	1	0.86	0.89	0.97	0.74

Controls

During the day, the recessed downlights (fixture type N) and linear cove lights along the outer perimeter of the ceiling (fixture types K3, K4a, and K4b) will be on photosensors. They will be dimmed depending on the amount of daylight that enters the space. These fixtures will also be connected to a time clock for automatic-off during after hours. The interior wall grazing lights (fixture type J) will be on both during the day and at night for security and safety measures. All other fixtures will be on a general time clock. They will only be on throughout normal operating hours during the day. It was decided not to place the OT lights on photosensors because the amount of daylight that enters the space throughout the day varies depending on the location within the room.

Figure 119: PT/OT/Therapy Waiting Equipment Schedule

Type	Manufacturer	Product Name	Catalog Number	Description	Location
EQ 5	Watt Stopper	MSC-100 Astronomic Time Clock	MSC-100	-Five-channel clock used with Watt Stopper's wireless RF lighting control systems -Provides ON/OFF control signals based on time of day, day of week, holiday, and calculated sunrise/sunset (astronomic) time	Electrical Room 2081
EQ 7	Watt Stopper	LightSaver LS-290C Photosensor	LS-290C	-Provides the daylight data necessary for operation of LCD-203 daylighting control system -Utilizes a photodiode element to continuously measure ambient light levels -Positioned to "see" incoming daylight from either a window or skylight without seeing electrical light -Users select the applicable footcandle range by a jumper beneath the front cover	PT 2104 and Lobby 1001
EQ 8	Watt Stopper	LightSaver LCD-203 Dimming Controller	LCD-203	-Provides automatic dimming control for fluorescent and HID fixtures -Open loop controller providing up to three zones of control from a single photocell -Simplified setup and calibration -Seven individually adjuatable parameters for each chanel -Automatic internal calculation for dimming requirements of individual channels for simplified setup	Electrical Room 2018
EQ 9	Watt Stopper	LightSaver BT-203 Power Pack	BT-203	-Powers the LightSaver LCD-203 control module -Connects via a quick connect cable -Has three normally open relays used to switch line voltage in response to signals from the connected controller -Automatically resetting fuse	Electrical Room 2018

See Appendix C for full equipment schedule and cut sheets.

Performance Data

The following are calculation grids and numerical summaries in the Physical Therapy, Occupational Therapy, and Therapy Waiting areas:

Figure 120: PT/OT/Therapy Waiting Rendering

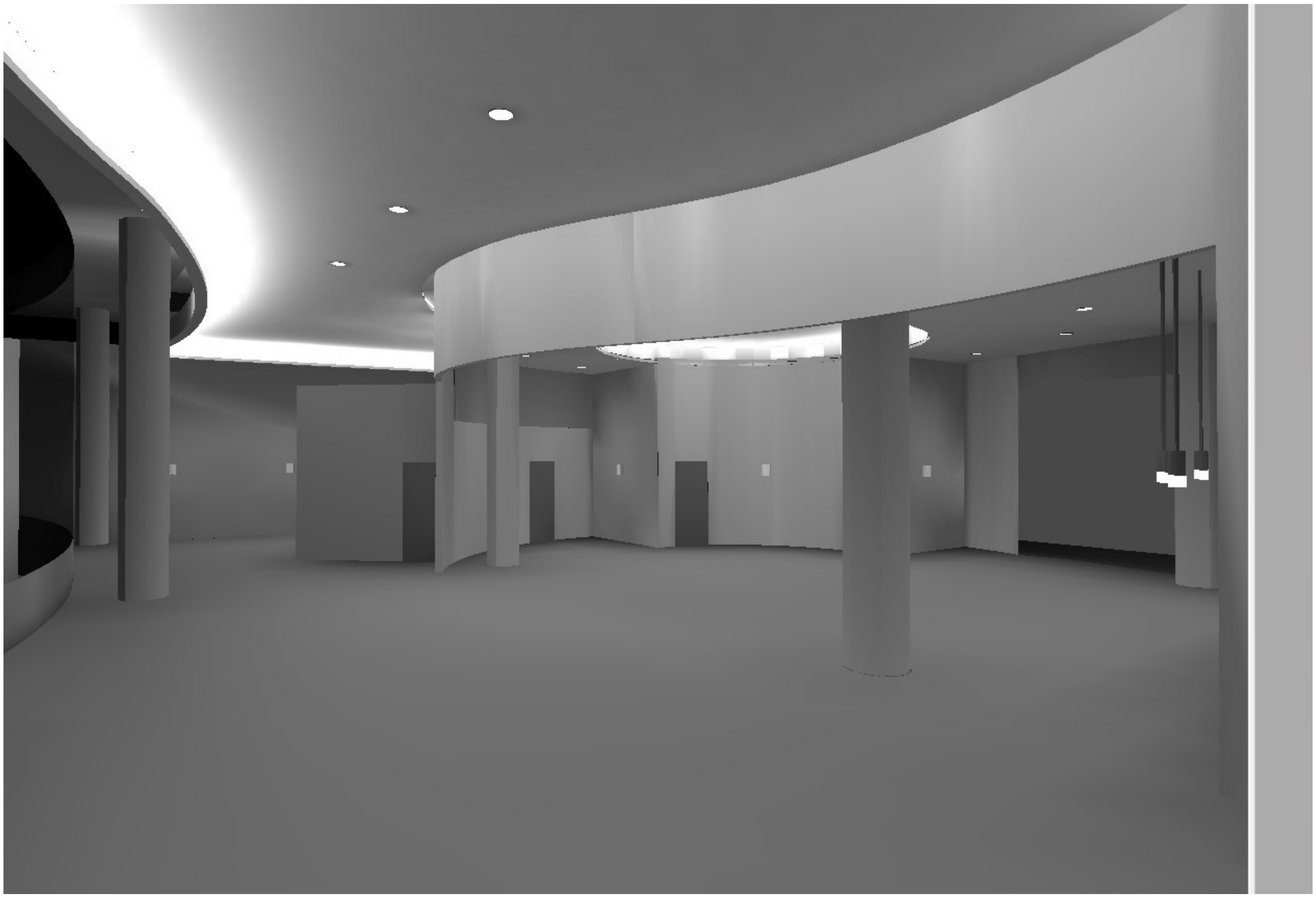


Figure 121: PT/OT/Therapy Waiting Luminance Pseudo Color Rendering (cd/sq.m.)

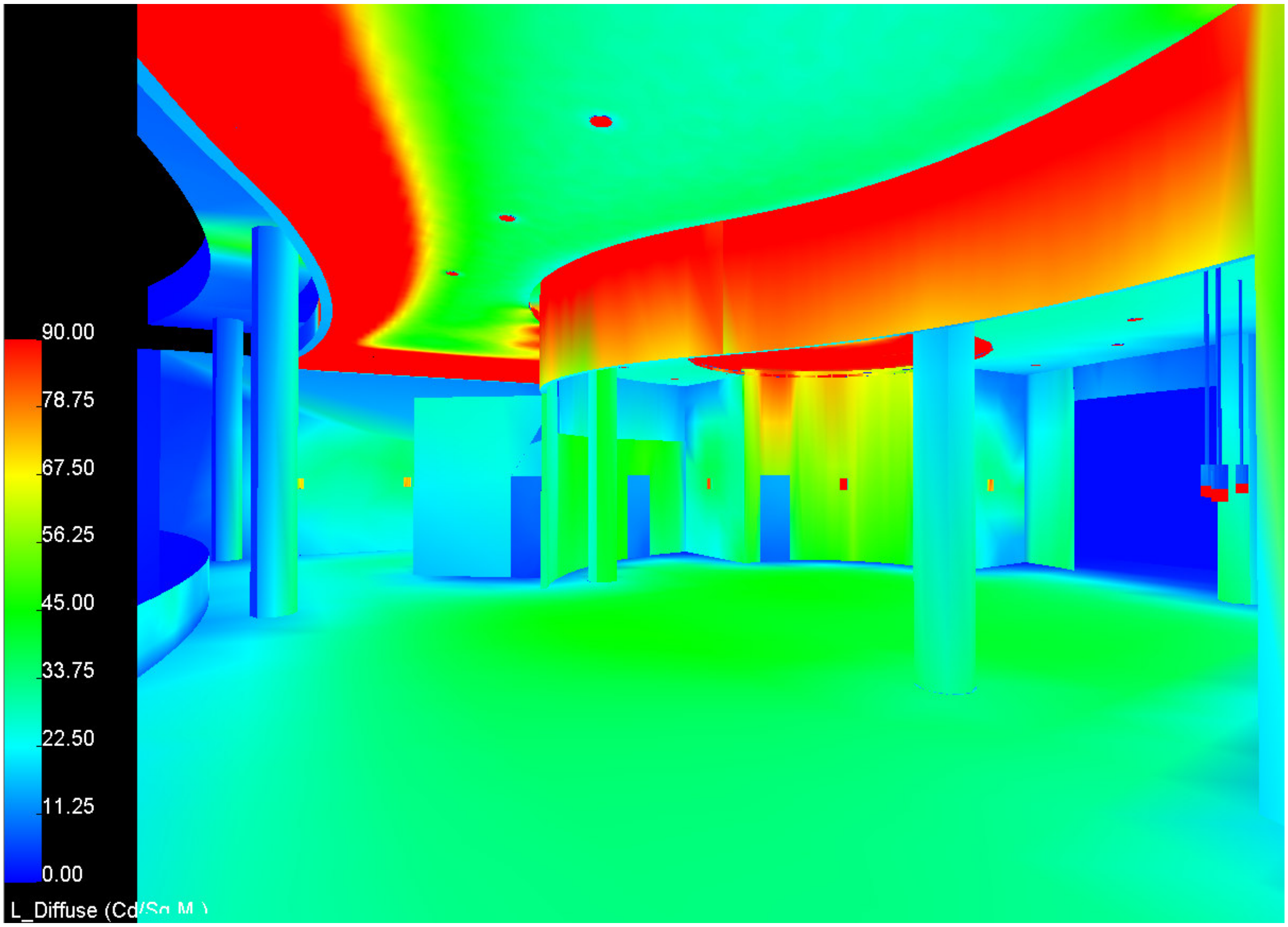


Figure 122: PT/OT/Therapy Waiting Horizontal Illuminance (fc)

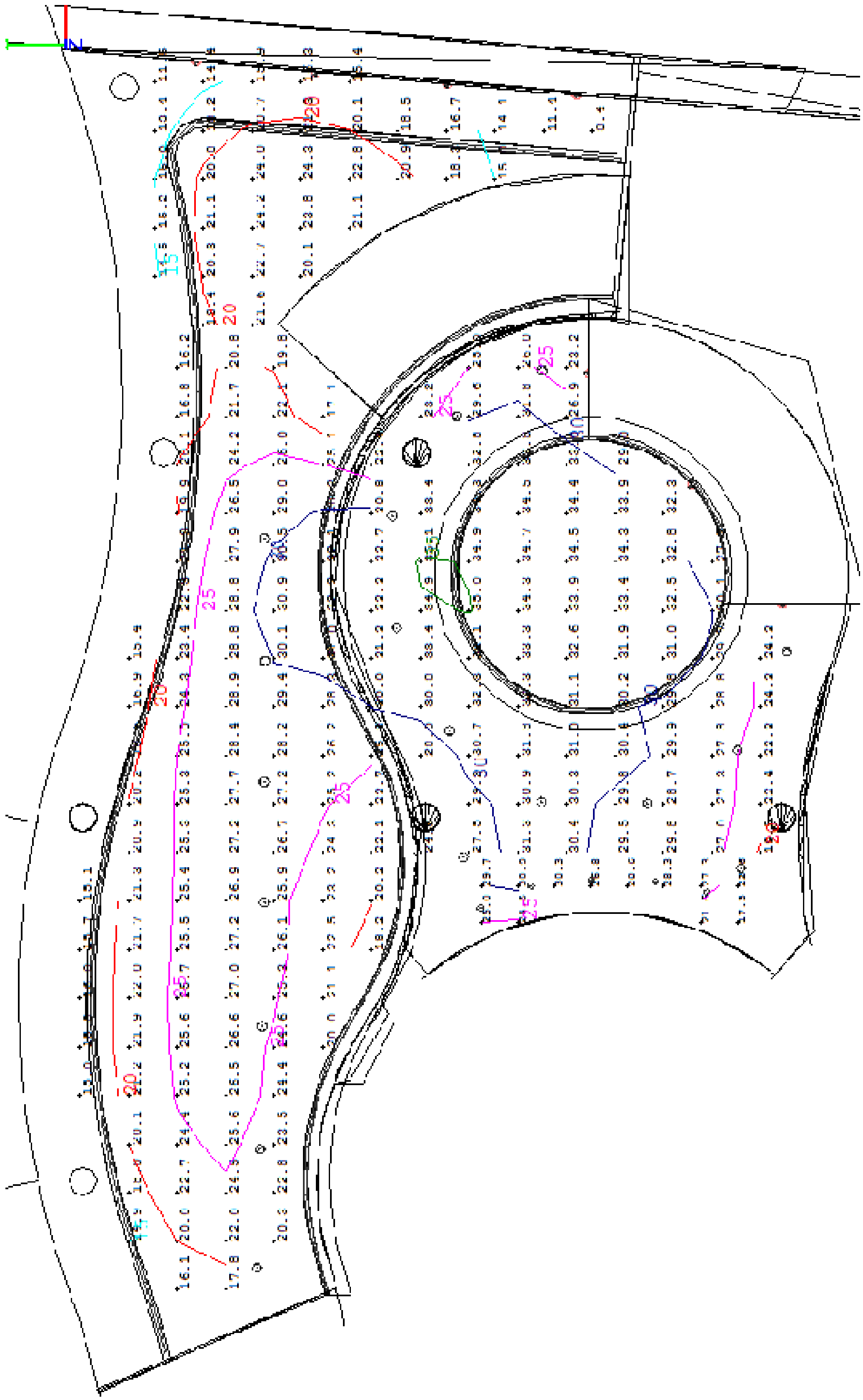


Figure 123: PT/OT/Therapy Waiting Illuminance Levels

Grid Name	Average (fc)	Max (fc)	Min (fc)	Max/Min
PT/OT Workplane (horizontal 2.5' AFF)	26.53	35.1	14.9	2.36
PT Vertical	11.7	12.4	10.9	1.14
OT Vertical	16.24	17.5	15	1.17
OT Countertop (horizontal 3.5' AFF)	26.08	30.9	17.3	1.79
Therapy Waiting Area (horizontal 2.5' AFF)	18.28	24.3	8.4	2.89
Therapy Waiting Area Vertical	8.32	10.2	6.5	1.57

Energy Code Compliance

Figure 124: Energy Code Calculations

ASHRAE Standard 90.1

Space	Total Area (sq.ft)	Allowable Lighting Power Density (W/sq.ft.)	Total Allowable Watts	Total Watts Used
Physical Therapy	1970	0.9	1773	2518
Occupational Therapy	1520	1.5	2280	2263
Therapy Waiting Area	640	0.8	512	1081
		Total	**4565**	**5862**

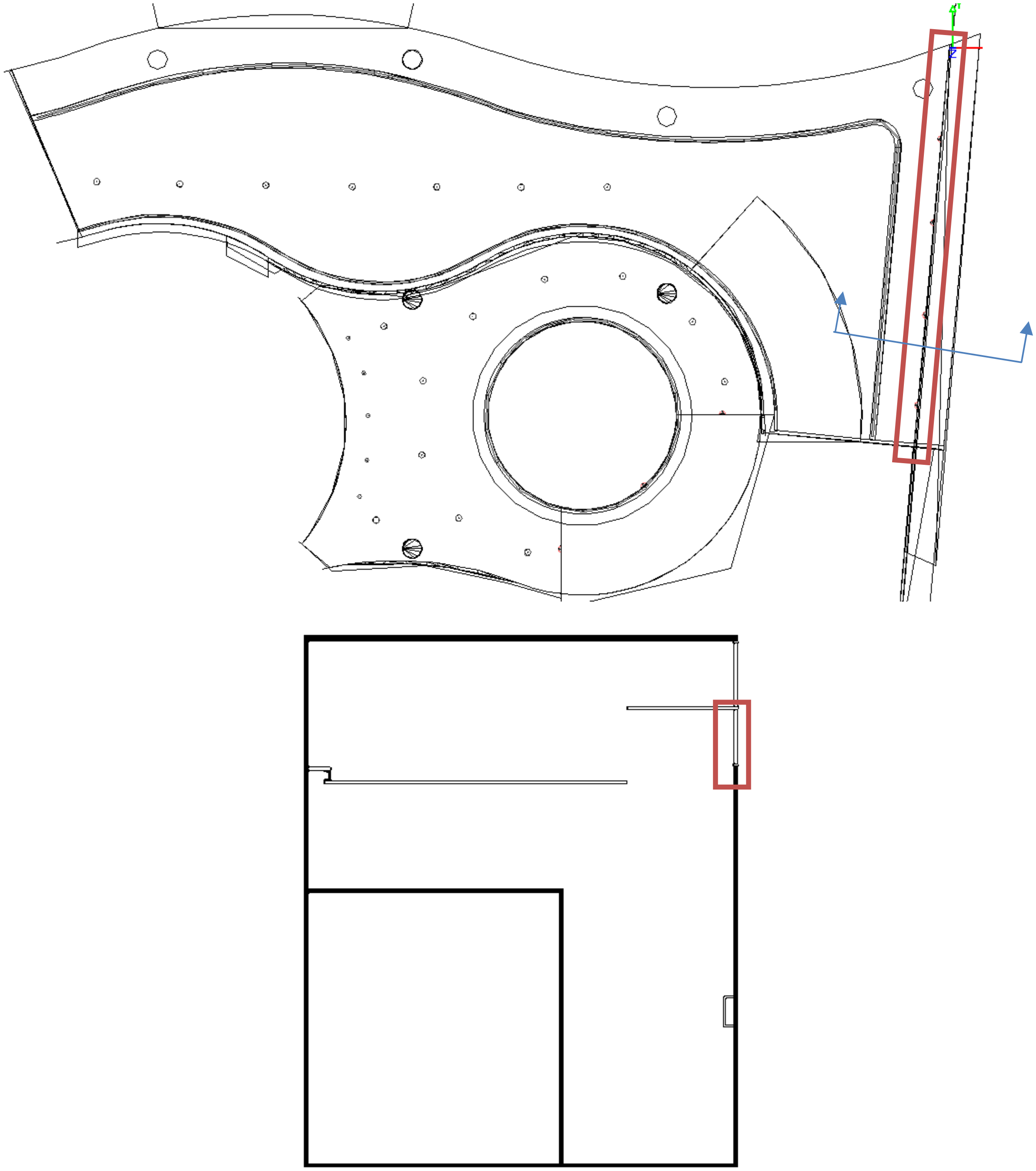
Occupational Therapy (decorative)	1520	1	1520	81
Therapy Waiting Area (decorative)	640	1	640	108

The total watts used is slightly higher than that allowed for the space. However, the other redesigned spaces were under their respective total allowable watts, which compensates for this space's excess. Also, most of the lighting is indirect to accommodate for the visual sensitivities of the building's occupants.

Clerestory Daylight Study

There is a 2.5' tall clerestory that spans the length of the east side of the therapy waiting area. It extends from above the 17.5' dropped ceiling to 20' above the floor (see diagram below). As a result of its location and orientation, a daylight study was completed to determine whether there is a sufficient amount of daylight actually reaching the workplane of each space. Calculations during overcast and clear sky conditions on January 21, March 21, and May 21 aided in the analysis. All electric lighting was turned off for true results. The analysis was run by calculating the daylight illuminance levels without the clerestory and subtracting those from the levels with the windows in place.

Figure 125: Clerestory Location (Plan and Section View)



The following are the calculation grids for the daylight contribution in the space without the clerestory, as well as the daylight contribution of just the clerestory.

Figure 126: Calculations for January 21, Clear Sky

Date	Sky	Condition	Average (fc)
21-Jan	Clear	Clerestory	75.34
		No Clerestory	70.84
Clerestory Contribution			**4.50**

Curtainwall Contribution (no clerestory)

			74	154.5	155	155.2	155.2	152.6													
127.8	132.9	129.3	86.3	130.6	134.1	134.3	132.8	123.3	96.3	139.3	140.1	100.3								133.9	141.4
81.6	99	101.4	101.1	106.9	110.3	110.8	109.4	106	104.9	113.1	119.5	123.3	125.7	129.4	142.9	129.3	126.4	122.7	117.8	110.5	73.9
	73.7	83.8	89	92.6	93.8	93.9	93	91.8	92.1	94.8	98.1	100.4	99.3	93.9	90	101.5	104.7	101.6	96.7	90.6	80.9
	58.7	74.2	82.6	85.1	83.2	82.3	80.6	79.3	78.9	79.2	79.5	79.8	80	81.6	85.3	91.7	88.7	84.3	79.4	74.5	70.9
					70.5	74.3	69.9	67.6	67	65.1	63.6	63	63.3	65.6	81.4			67.3	64.8	61.2	61.7
							53.1	53.9	61	51.6	50.2	49.6	49.2	46.8	20				50.1	48.8	
							37.5	35.4	28.8	38.2	39.2	39.3	37.9	31.6	15.5	12.3			31	36.2	
								26.3	27.4	29.7	31.3	32	30.3	26.2	19.9	13.6				24.2	
								21.2	22.7	24.5	26.1	26.7	26.1	24.3	22.9	16.7				14.5	
								17	19	20.2	21.7	23.4	24.9	25.7							
							11.4	14.1	16.1	16.9	18	20.4	25.6								
							10.9	11	16.9	13.2	14.7	16.1									
												18.6									

Clerestory Contribution Only

			0	0.1	0	0	0.1	0.2													
0.1	0	0	0.2	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.6	0.5								16.7	7
0	0	0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.5	0.7	1	1	5.5	7.1	10.3	14.8	20.3	24.6	25.4
	0	0	0.1	0	0.2	0.1	0.2	0.2	0.3	0.4	0.5	0.8	1.4	2.2	3.8	7	11.8	17.4	24.8	31.1	28.1
	0	0.1	0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.7	1.1	1.6	2.4	3.4	12.4	19.8	28.7	35.8	30.3
					0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.7	1	1.2			23.6	31.7	38.2	30.2
							0.1	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0				34	38.8	
							0	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0	-0.1			32.6	36.7	
								0.1	0	0	0	0	0	0	0	0				31.7	
								0	0.1	0	0	0	0	0	-0.1	-0.1				24.6	
								0.1	0.1	0.1	0	0	0	-0.1							
							0	0.1	0.1	0	0	-0.1	-0.1								
							0.1	0.2	0.1	0.2	0.1	0									
												0									

Figure 127: Calculations for March 21, Clear Sky

Date	Sky	Condition	Average (fc)
21-Mar	Clear	Clerestory	96.53
		No Clerestory	90.94
Clerestory Contribution			**5.58**

Curtainwall Contribution (no clerestory)

			104.9	202.2	203.7	204.6	205.2	202.8													
161.4	169	164.4	120.8	170.9	175.6	176.1	174.2	161.2	135.2	184.6	186.4	138.1								171.1	178.3
103.6	125.3	130	132.4	139.8	144.1	144.8	143.2	139.8	140.3	149.9	157.6	162.2	164.8	167.9	185.5	167.2	163.1	157.7	150.6	139.8	97.1
	93.1	107.1	115.4	120.8	123.1	123.5	122.6	121.5	122	124.9	128.4	130.8	128.9	122.2	119.5	131.2	133.4	128.9	122.2	113.9	100.3
	73.4	93.4	105	109.6	108.9	108.5	106.9	105.3	104.7	104.5	103.9	103.3	103	105	109.6	115.4	107.3	105.2	100	93.9	86.1
					90.3	96.5	92.1	89.4	88.3	85	81.7	79.8	79.6	82.1	100.6			81.4	81.1	77.1	73.8
							68.3	69.6	77.6	65.5	62.4	60.4	59.1	55.4	24.5				62.1	61.2	
							46.3	43.8	36	46.4	47.2	46.7	44.6	37.1	19.5	15.3			38.6	45.1	
								31.7	33	35.4	37.1	37.7	35.6	30.9	23.9	16.8				29.7	
								25.2	27	29	30.8	31.5	30.9	28.8	26.5	19.4				17.6	
								20.2	22.5	23.9	25.6	27.7	29.4	30							
							13.6	16.7	19	19.9	21.2	23.8	29.3								
							12.9	12.9	19.5	15.6	17.2	18.4									
												20.9									

Clerestory Contribution Only

			0.1	0.1	0.1	0.1	0	0.2													
0	0.1	0	0.2	0.1	0.1	0.2	0.2	0.2	0.9	0.6	0.7	0.7								20.3	9.3
0	0	0	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.9	1.2	1.3	6.8	8.5	12.1	17.4	23.8	29.1	30.5
	0	0.1	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.6	0.7	1	1.8	2.8	4.9	8.5	13.7	20.2	28.8	36.5	33.5
	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7	1	1.4	2.1	3.1	4	14.5	23.1	33.6	42.5	36.6
					0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.7	0.8	1.2	1.5			28.1	38.5	47.2	37.8
							0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.2	0				43.1	50.2	
							0	0.1	0.1	0.2	0.2	0.1	0.1	0	0	0			42.7	49.4	
								0.1	0.1	0.1	0.1	0	0.1	0	0	0				44.3	
								0.1	0.1	0.1	0	0.1	0	0	0	-0.1				35.5	
								0.1	0.1	0.1	0.1	0	0.1	0							
							0	0.1	0.1	0.1	0.1	0.1	0								
							0.1	0.3	0.2	0.3	0.2	0.1									
												0									

Figure 128: Calculations for May 21, Clear Sky

Date	Sky	Condition	Average (fc)
21-May	Clear	Clerestory	124.24
		No Clerestory	119.26
Clerestory Contribution			**4.98**

Curtainwall Contribution (no clerestory)

			147.3	276.3	279.1	281	282.5	280.7													
218.3	227.7	219.8	166.9	230	236	237.4	236.3	219.9	192.9	258.2	263.6	201.9								237.8	239
138.8	165.2	169.9	173.3	182.6	187.9	189.3	188.2	185.7	190.5	206.1	218.6	226.7	231	234.1	258.3	234.6	229.1	220.8	209.1	190.6	131.1
	119.4	136.3	146.4	153	156.2	157.3	157.2	157.7	160.8	166.9	173.4	178.1	177.1	168.6	167.3	181.9	183.1	176	165.4	150.9	129
	91.2	115	128.9	134.7	134.7	135	134.1	133.6	134.6	136	136.8	137.1	137.4	140.3	146.4	152.2	140.5	138.9	131.8	121.9	107.9
					109.2	117.3	113.2	111	110.7	107.7	104.3	102.6	102.6	105.9	127.4			103	103.7	97.8	89.8
							82.5	84.6	94.4	80.6	76.7	74.1	72.4	66.9	29.3				77.3	75.9	
							54.9	51.7	43.5	55.4	56	55	52.2	43.1	22.9	17.9			47.5	54.8	
								37	38.5	41.2	43	43.3	40.7	35.1	27.3	19.4				35.3	
								29.2	31.1	33.3	35.1	35.8	34.9	32.4	29.4	21.5				20.6	
								23.1	25.6	27.2	29.1	31.2	33	33.3							
							15.5	18.9	21.5	22.5	23.9	26.6	32.1								
							14.6	14.6	21.8	17.5	19.2	20.1									
												22.5									

Clerestory Contribution Only

			0	0.2	0.2	0.2	0.2	0.2													
0	0	0	0.2	0.1	0.2	0.2	0.2	0.4	0.9	0.7	0.7	0.7								20.6	10
0	0.1	0	0	0.1	0.2	0.1	0.2	0.2	0.4	0.5	0.7	0.9	1.3	1.2	6.8	7.8	10.7	15.5	21.8	27.1	29.5
	0	0	0.1	0.1	0.2	0.1	0.2	0.2	0.4	0.5	0.6	1.1	1.8	2.8	4.8	7.6	11.2	16.7	24.6	33.3	32.4
	0.1	0	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.7	1	1.4	2.1	3.1	4	11	18.1	27.8	37.4	34.2
					0.2	0.1	0.2	0.3	0.3	0.3	0.5	0.6	0.9	1.2	1.5			21.6	31.1	40.5	34.5
							0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.2	0.1				34.8	43.1	
							0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1			35.3	43.9	
								0.1	0.1	0.1	0	0.1	0.1	0.1	0	0				41.5	
								0	0.1	0.1	0.1	0.1	0.1	0	0	0				34.8	
								0.1	0.1	0.1	0	0.1	0.1	0.1							
							0	0.1	0.1	0.1	0.1	0.1	0								
							0.1	0.3	0.2	0.3	0.2	0.1									
												0									

Figure 129: Calculations for May 21, Overcast Sky

Date	Sky	Condition	Average (fc)
21-May	Overcast	Clerestory	143.63
		No Clerestory	142.14
Clerestory Contribution			**1.50**

Curtainwall Contribution (no clerestory)

			172	415.4	415	414.8	414.5	407													
361.1	364.4	345.5	191.2	325.5	331.9	332.3	331.4	308.2	236.1	369.4	375.5	268.9								361.4	343.3
207.3	242.3	231	216.7	225.6	232.2	233.2	231.5	224.8	230.6	265.1	292.7	311.1	325	338.3	363.7	343.8	336.6	324.9	305.7	275	146.4
	149.5	159	160.6	163.4	164.9	165.8	166	167	174.1	188.8	205.1	218.4	222.5	207.5	196.8	233.4	242.9	233.2	214.8	186.2	149.3
	98.2	116.1	124.3	125.8	123.6	123.3	123.2	124.5	128.7	134.7	141.6	147.4	150.1	151.9	156.9	169.4	174	160.1	145.8	127.2	114.9
					91.8	95	92.6	92.8	95.6	97.4	99.5	101.9	104.2	106.8	124.7			110.2	100	89.2	86.7
							64.4	66.6	76.3	69.7	70.4	71.1	71.4	67.2	22.9				67.8	62.8	
							41.7	40.5	35	47	49	49.7	48.1	38.9	16.5	12.6			37.2	41.8	
								28.2	30.3	33	35.1	35.6	33.4	27.9	20.1	13				25.3	
								21.6	23.5	25.3	26.7	26.8	25.7	23	21.1	15.1				14.2	
								16.3	18.3	19.5	20.6	21.6	22.1	22							
							10.1	12.6	14.5	15.2	16	17.5	20.9								
							9	9.3	13.8	11.2	12.2	12.9									
												13.7									

Clerestory Contribution Only

			0.1	0	0.1	0	0.1	0.1													
0.1	0.1	0	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.2								5.5	2.5
0	0	0	0	0.1	0	0.1	0	0.1	0.2	0.2	0.2	0.3	0.4	0.4	3.2	3.4	3.5	4.5	6.4	7.8	8.3
	0	0.1	0	0	0.1	0	0.1	0.1	0.2	0.2	0.2	0.5	0.7	1.2	2.5	3.5	3.8	5.3	7.6	9.7	9.2
	0.1	0	0	0	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.9	1.5	1.6	3.9	5.8	8.6	10.9	9.8
					0	0	0.1	0	0.1	0.2	0.2	0.2	0.4	0.5	0.5			6.9	9.4	11.8	9.9
							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0				10.2	12	
							0	0	0.1	0	0	0.1	0.1	0.1	0	0			10.1	11.8	
								0	0.1	0.1	0.1	0.1	0	0	0	0.1				10.6	
								0	0.1	0	0.1	0.1	0	0	0.1	0.1				8.5	
								0	0.1	0	0	0	0	0							
							0	0	0	0	0	0	0.1								
							0.1	0	0.1	0	0.1	0									
												0									

As can be seen from the previous calculation grids, the clerestory along the east side of the space is only providing daylight to the Therapy Waiting area. While daylight contribution from these windows meets or exceeds the required level (10 fc), there is also plenty of daylight protruding deep into the space from just the curtainwall system (without the clerestory). Comparatively, the clerestory does not make much of an impact. Therefore, it is unnecessary for this daylight element to be present within the space. Throughout various times of the year, all spaces will receive adequate daylight without the presence of the clerestory.

Performance Summary

The redesign of the lighting for the Physical Therapy, Occupational Therapy, and Therapy Waiting areas adequately meets the stated design criteria. It uniquely follows the concept of strength through the solid structural emphasis. In the PT and waiting areas, light is integrated into the architecture highlighting the solid interior wood wall. On the opposite side of each space, along the curtainwall, the lighting is integrated into soffit that extends from the ceiling. Fixtures wash the ceiling, mimicking daylight entering the space. Occupants feel protected by these rigid surroundings, as well as uplifted and encouraged to make the most of one's own strength. Sconces in all spaces accentuate the peripheral walls and provide way-finding light to the space's entrances and exits. Allowing the interior wall lighting to remain on at night reinforces the building's strong interior. The columns were left unlit in order to make them standout as a structural element. Other fixtures provide visual clarity and interest necessary in this type of exercise workspace.

All of the fixtures are either integrated into the surroundings or contain a prismatic or frosted lens to avoid direct glare. A mid to low CCT and high CRI enhance skin tones and materials while also rendering colors well. Uniform lighting on the workplane enables task completion; however, non-uniform peripheral emphasis creates visual interest. The unique materials throughout the space are also accentuated.

As shown in the calculation grid and summary, the lighting successfully meets the IESNA light level requirements. Although the calculation summary values may seem slightly low for some locations, the grid shows that there is adequate lighting in the necessary work areas. There is an adequate amount of light available in the therapy waiting area, so occupants can easily interact and move around the space. The OT space receives enough lighting for occupant screening and testing, as well as countertop usage. There is also ample light available for exercising and movement within the PT space. A majority of the lighting is indirect to prevent glare during various activities. Vertical illuminance levels enable precise viewing of faces and objects.

Throughout the day, there is also a significant daylight contribution in all spaces. The large curtainwall along the north side of the space provides a large amount of daylight. The use of an open-loop dimming photosensor will control the fixtures lighting the ceiling as well as the downlights in the PT space. This will provide an energy-saving way to take advantage of the natural light.

The controls used in the space enable an efficient use of daylight to save energy. They also follow the automatic lighting shutoff requirements of ASHRAE 90.1.

Electrical Redesign

For a complete spatial description of the physical therapy, occupational therapy, and therapy waiting areas, see page 100.

The therapy spaces house a number of different activities, including the use of exercise equipment, face-to-face interaction, movement around the space, and patient screening. Therefore, the lighting is based on the concept of strength and visual clarity, which provides an uplifting environment to encourage occupants. Adequate light levels are provided on the task planes of each area, which includes desk/table height and countertop height (depending on the location). A large amount of indirect lighting is used in the PT and therapy waiting spaces to avoid direct glare. Light grazes the interior wood wall to accent the material and curved architecture. A ceiling cove is used to house a fixture that lights the ceiling along the exterior curtainwall. This mimics daylight entering the space. General downlights are used in the OT space to provide functional lighting for visual clarity. Wall sconces along the peripheral walls are used to create some visual interest.

For the electrical redesign of the space, all of the new lighting will replace the existing lighting circuits on each respective panelboard. All sconces in the waiting area and all lighting in the OT space will be on a time clock. The wall grazing fixtures will be on at all times of the day for security purposes. These fixtures are also located on the normal/emergency system. The ceiling cove lights and downlights in the PT space will be on photosensors during the day, and then switched off at night. All fixtures are run on 277V panelboards that are located in either Electrical Room 2081 or 2018. These spaces also house the time clocks and photosensor controls.

- **Layout of Circuiting**
  See Appendix A for complete lighting plans with all electrical circuiting.

- **Existing Panelboards/Modified Circuits**
  The following are the panelboards that contain the existing light fixtures for the space. The specific circuits to be modified are highlighted.

Figure 130: Existing Panelboard L2A

(8) 20A, 1P, SPARES
(00) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "L2A" (SURFACE MTD IN ELEC RM 2081 - 480Y/277V, 3PH, 4W, BUS RATING 225A, MCB 225A, AIC 42000, TYPE1 ENCL. (42 POLE)

Circuit Number	Load Name	Rating	Apparent Load Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting PT 2104	20 A	60 VA	60 VA	0 VA	0 VA	1	0 A
2	Lighting CENTRAL PARK 2103	20 A	576 VA	576 VA	0 VA	0 VA	1	2 A
3	Lighting CHILD PLAY 2101	20 A	1042 VA	0 VA	1042 VA	0 VA	1	4 A
4	Lighting OFFICE 2069	20 A	3270 VA	0 VA	3270 VA	0 VA	1	12 A
5	Lighting CORR. 2086A	20 A	75 VA	0 VA	0 VA	75 VA	1	0 A
6	Lighting OT 2105	20 A	1431 VA	0 VA	0 VA	1431 VA	1	5 A
7	Lighting GENERAL THERAPY INFO 2002	20 A	623 VA	623 VA	0 VA	0 VA	1	2 A
8	Lighting OFFICE 2069	20 A	654 VA	654 VA	0 VA	0 VA	1	2 A
10,12,14	RPU-1, SERVER 2041	20 A	1800 VA	600 VA	600 VA	600 VA	3	2 A
11	Lighting CORRIDOR 277	20 A	2474 VA	0 VA	0 VA	2474 VA	1	9 A
13	Lighting	20 A	2459 VA	2459 VA	0 VA	0 VA	1	9 A
15,17,19	EF-2, ROOF	15 A	2800 VA	933 VA	933 VA	933 VA	3	3 A
16,18,20	EF-6, ROOF	15 A	6300 VA	2100 VA	2100 VA	2100 VA	3	8 A
21,23,25	EF-7, ROOF	15 A	6300 VA	2100 VA	2100 VA	2100 VA	3	8 A
22,24,26	T75 (R2A1 & R2A2)	125 A	75000 VA	25000 VA	25000 VA	25000 VA	3	90 A
Grand total: 15			104864 VA	35105 VA	35045 VA	34713 VA		157 A

Figure 131: Existing Panelboard L2B

(12) 20A, 1P, SPARES
(12) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "L2B" (SURFACE MTD IN ELEC RM 2018 - 480Y/277V, 3PH, 4W, BUS RATING 225A, MCB 225A, AIC 42000, TYPE1 ENCL. (42 POLE)

Circuit Number	Load Name	Rating	Apparent Load Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting CORR. 2053	20 A	120 VA	120 VA	0 VA	0 VA	1	0 A
2	Lighting ART/MUSIC 2102	20 A	363 VA	363 VA	0 VA	0 VA	1	1 A
3	Lighting CONFERENCE 2039	20 A	2828 VA	0 VA	2828 VA	0 VA	1	10 A
4	Lighting CLASSROOM 2016	20 A	3354 VA	0 VA	3354 VA	0 VA	1	12 A
5	Lighting	20 A	288 VA	0 VA	0 VA	288 VA	1	1 A
6	Lighting PT 2104	20 A	1329 VA	0 VA	0 VA	1329 VA	1	5 A
7	Lighting	20 A	678 VA	678 VA	0 VA	0 VA	1	2 A
8	Lighting CORRIDOR 2054	20 A	980 VA	980 VA	0 VA	0 VA	1	4 A
11	Lighting ART/MUSIC 2102	20 A	1554 VA	0 VA	0 VA	1554 VA	1	6 A
12	Lighting STOR 2004	20 A	2954 VA	0 VA	0 VA	2954 VA	1	11 A
13	Lighting TLT 2012	20 A	1303 VA	1303 VA	0 VA	0 VA	1	5 A
14	Lighting	20 A	2756 VA	2756 VA	0 VA	0 VA	1	10 A
15,17,19	EF-1, ROOF	15 A	4000 VA	1333 VA	1333 VA	1333 VA	3	5 A
16,18,20	T112.5	175 A	112500 VA	37500 VA	37500 VA	37500 VA	3	135 A
Grand total: 14			135007 VA	45033 VA	45015 VA	44958 VA		207 A

Figure 132: Existing Panelboard LSL2B

(13) 20A, 1P, SPARES
(27) SPACES
100% NEUTRAL, EQUIPMENT GROUND

PANEL "LSL2B" (SURFACE MTD IN ELEC RM 2018) - 480Y/277V, 3PH, 4W, BUS RATING 100A, MCB 50A, AIC 22000, TYPE1 ENCL. (42 POLE)

Circuit Number	Load Name	Rating	Apparent Load Total	Phase A	Phase B	Phase C	Number of Poles	Apparent Current
1	Lighting CORRIDOR 2054	20 A	560 VA	560 VA	0 VA	0 VA	1	2 A
3	Lighting PT 2104	20 A	691 VA	0 VA	691 VA	0 VA	1	2 A
Grand total: 2			1251 VA	560 VA	691 VA	0 VA		5 A

- **New Panelboard Worksheets and Schedules**

Figure 133: New Panelboard Worksheet L2A

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					L2A	Panel Location:		ELECTRICAL ROOM 2081		
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	9	PT 2104	40	w	1.00	40	40	
2	A	Lighting	3	CENTRAL PARK 2103	576	va	0.95	547	576	
3	B	Lighting	3	CHILD PLAY 2101	1042	va	0.95	990	1042	
4	B	Lighting	3	OFFICE 2069	3270	va	0.95	3107	3270	
5	C	Lighting	3	CORRIDO R 2086A	75	va	0.95	71	75	
6	C	Lighting	3	OT 2105	1078	w	0.98	1078	1100	
7	A	Lighting	3	GENERAL THERAPY INFO 2002	623	va	0.95	592	623	
8	A	Lighting	3	OFFICE 2069	654	va	0.95	621	654	
9	B				0	w		0	0	
10	B	RPU-1	6	SERVER 2041	600	va	0.90	540	600	
11	C	Lighting	3	CORRIDO R 277	2042	va	0.95	1940	2042	
12	C	RPU-1	6	SERVER 2041	600	va	0.90	540	600	
13	A	Lighting	3		2459	va	0.95	2336	2459	
14	A	RPU-1	6	SERVER 2041	600	va	0.90	540	600	
15	B	EF-2	6	ROOF	933	va	0.90	840	933	
16	B	EF-6	6	ROOF	2100	va	0.90	1890	2100	
17	C	EF-2	6	ROOF	933	va	0.90	840	933	
18	C	EF-6	6	ROOF	2100	va	0.90	1890	2100	
19	A	EF-2	6	ROOF	933	va	0.90	840	933	
20	A	EF-6	6	ROOF	2100	va	0.90	1890	2100	
21	B	EF-7	6	ROOF	2100	va	0.90	1890	2100	
22	B	T75 (R2A1 & R2A2)	9	ELEC RM 2081	25000	va	0.95	23750	25000	
23	C	EF-7	6	ROOF	2100	va	0.90	1890	2100	
24	C	T75 (R2A1 & R2A2)	9	ELEC RM 2081	25000	va	0.95	23750	25000	
25	A	EF-7	6	ROOF	2100	va	0.90	1890	2100	
26	A	T75 (R2A1 & R2A2)	9	ELEC RM 2081	25000	va	0.95	23750	25000	
27	B	Lighting	3	PT 2104	732	w	0.99	732	739	
28	B	Lighting	3	OT 2105	998	w	0.98	998	1018	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								99.8	105.8	Amps= 127.4

PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL		A						33.0	35.1	33%	126.7
PHASE TOTAL		B						34.7	36.8	35%	132.9
PHASE TOTAL		C						32.0	34.0	32%	122.6
LOAD CATAGORIES			Connected			Demand					Ver. 1.02
			kW	kVA	DF	kW	kVA	PF			
1	receptacles		0.0	0.0	0.70	0.0	0.0				
2	computers		0.0	0.0	0.90	0.0	0.0				
3	fluorescent lighting		13.0	13.6	1.00	13.0	13.6	0.96			
4	HID lighting		0.0	0.0	1.00	0.0	0.0				
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0				
6	HVAC fans		15.5	17.2	0.80	12.4	13.8	0.90			
7	heating		0.0	0.0	1.25	0.0	0.0				
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0				
9	unassigned		71.3	75.0		71.3	75.0	0.95			
Total Demand Loads						96.7	102.4				
Spare Capacity			20%			19.3	20.5				
Total Design Loads						116.0	122.9	0.94	Amps=	147.9	

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 134: New Panelboard Schedule L2A

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 200A/3P C/B

PANEL TAG: L2A
PANEL LOCATION: ELECTRICAL ROOM 2081
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:
(4) 2/0, (1) #6 G, 2" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	PT 2104	40	20A/1P	1	*			2	20A/1P	547	CENTRAL PARK 2103	Lighting
Lighting	CHILD PLAY 2101	990	20A/1P	3		*		4	20A/1P	3107	OFFICE 2069	Lighting
Lighting	CORRIDOR 2086A	71	20A/1P	5			*	6	20A/1P	1078	OT 2105	Lighting
Lighting	GENERAL THERAPY INFO 2002	592	20A/1P	7	*			8	20A/1P	621	OFFICE 2069	Lighting
0	0	0		9		*		10	20A/1P	540	SERVER 2041	RPU-1
Lighting	CORRIDOR 277	1940	20A/1P	11			*	12	20A/1P	540	SERVER 2041	RPU-1
Lighting	0	2336	20A/1P	13	*			14	20A/1P	540	SERVER 2041	RPU-1
EF-2	ROOF	840		15		*		16		1890	ROOF	EF-6
EF-2	ROOF	840	15A/3P	17			*	18	15A/3P	1890	ROOF	EF-6
EF-2	ROOF	840		19	*			20		1890	ROOF	EF-6
EF-7	ROOF	1890		21		*		22		23750	ELEC RM 2081	T75 (R2A1 & R2A2)
EF-7	ROOF	1890	15A/3P	23			*	24	125A/3P	23750	ELEC RM 2081	T75 (R2A1 & R2A2)
EF-7	ROOF	1890		25	*			26		23750	ELEC RM 2081	T75 (R2A1 & R2A2)
Lighting	PT 2104	732	20A/1P	27		*		28	20A/1P	998	OT 2105	Lighting
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	33.05		TOTAL DESIGN LOAD (KW)	116.02
CONNECTED LOAD (KW) - B	34.74		POWER FACTOR	0.94
CONNECTED LOAD (KW) - C	32.00		TOTAL DESIGN LOAD (AMPS)	147.9

Feeder Size Calculation:

147.9 A * 125% = 184.8A → 225A Bus, 200A Main, (4) 2/0 AWG Cu THWN, (1) #6 AWG Cu Ground, 2" Conduit

Figure 135: New Panelboard Worksheet L2B

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->				L2B	Panel Location:			ELECTRICAL ROOM 2018		
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	3	CORRIDOR 2053	120	va	0.95	114	120	
2	A	Lighting	3	ART/ MUSIC 2102	363	va	0.95	345	363	
3	B	Lighting	3	CONF. 2039	2828	va	0.95	2687	2828	
4	B	Lighting	3	CLASSRM. 2016	3354	va	0.95	3186	3354	
5	C	Lighting	3	-	288	va	0.95	274	288	
6	C	Lighting	3	PT 2104	337	va	0.95	320	337	
7	A	Lighting	3		678	va	0.95	644	678	
8	A	Lighting	3	CORRIDOR 2054	980	va	0.95	931	980	
9	B				0	w		0	0	
10	B				0	w		0	0	
11	C	Lighting	3	ART/ MUSIC 2102	402	va	0.95	382	402	
12	C	Lighting	3	STORAGE 2004	2954	va	0.95	2806	2954	
13	A	Lighting	3	TLT 2012	1303	va	0.95	1238	1303	
14	A	Lighting	3	-	2756	va	0.95	2618	2756	
15	B	EF-1	6	ROOF	1333	va	0.90	1200	1333	
16	B	T112.5	9	ELEC 2018	37500	va	0.95	35625	37500	
17	C	EF-1	6	ROOF	1333	va	0.90	1200	1333	
18	C	T112.5	9	ELEC 2018	37500	va	0.95	35625	37500	
19	A	EF-1	6	ROOF	1333	va	0.90	1200	1333	
20	A	T112.5	9	ELEC 2018	37500	va	0.95	35625	37500	
21	B	Lighting	3	PT 2104	686	w	0.98	686	700	
22	B	Lighting	3	PT 2104	1247	w	0.91	1247	1370	
23	C	Lighting	3	PT 2104 & THERAPY WAITING	474	w	0.91	474	521	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								128.4	135.5	Amps= 163.0

PHASE LOADING							kW	kVA	%	Amps
	PHASE TOTAL	A					42.7	45.0	33%	162.6
	PHASE TOTAL	B					44.6	47.1	35%	170.0
	PHASE TOTAL	C					41.1	43.3	32%	156.4
LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		18.0	19.0	1.00	18.0	19.0	0.95		
4	HID lighting		0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		3.6	4.0	0.80	2.9	3.2	0.90		
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9	unassigned		106.9	112.5		106.9	112.5	0.95		
	Total Demand Loads					127.7	134.7			
	Spare Capacity		20%			25.5	26.9			
	Total Design Loads					153.2	161.6	0.95	Amps=	194.4

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 136: New Panelboard Schedule L2B

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 400A
SIZE/TYPE MAIN: 250A/3P C/B

PANEL TAG: L2B
PANEL LOCATION: ELECTRICAL ROOM 2018
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:
(4) #4/0, (1) #4 G, 2 1/2" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	CORRIDOR 2053	114	20A/1P	1	*			2	20A/1P	345	ART/ MUSIC 2102	Lighting
Lighting	CONF. 2039	2687	20A/1P	3		*		4	20A/1P	3186	CLASSRM. 2016	Lighting
Lighting	-	274	20A/1P	5			*	6	20A/1P	320	PT 2104	Lighting
Lighting	0	644	20A/1P	7	*			8	20A/1P	931	CORRIDOR 2054	Lighting
0	0	0	20A/1P	9		*		10	20A/1P	0	0	0
Lighting	ART/ MUSIC 2102	382	20A/1P	11			*	12	20A/1P	2806	STORAGE 2004	Lighting
Lighting	TLT 2012	1238	20A/1P	13	*			14	20A/1P	2618	-	Lighting
EF-1	ROOF	1200		15		*		16		35625	ELEC 2018	T112.5
EF-1	ROOF	1200	15A/3P	17			*	18	175A/3P	35625	ELEC 2018	T112.5
EF-1	ROOF	1200		19	*			20		35625	ELEC 2018	T112.5
Lighting	PT 2104	686	20A/1P	21		*		22	20A/1P	1247	PT 2104	Lighting
Lighting	PT 2104 & THERAPY WAITING	474	20A/1P	23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	42.71	TOTAL DESIGN LOAD (KW)	153.25
CONNECTED LOAD (KW) - B	44.63	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	41.08	TOTAL DESIGN LOAD (AMPS)	194.4

Feeder Size Calculation:

194.4 A * 125% = 243A → 400A Bus, 250A Main, (4) 4/0 AWG Cu THWN, (1) #4 AWG Cu Ground, 2 1/2" Conduit

Figure 137: New Panelboard Worksheet LSL2B

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					LSL2B	Panel Location:			ELECTRICAL ROOM 2018	
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	3	CORRIDOR 2054	560	va	0.95	532	560	
2	A	Lighting	9	PT 2104	97	va	1.00	97	97	
3	B	Lighting	3	PT 2104	780	w	0.99	780	788	
4	B				0	w		0	0	
5	C				0	w		0	0	
6	C				0	w		0	0	
7	A				0	w		0	0	
8	A				0	w		0	0	
9	B				0	w		0	0	
10	B				0	w		0	0	
11	C				0	w		0	0	
12	C				0	w		0	0	
13	A				0	w		0	0	
14	A				0	w		0	0	
15	B				0	w		0	0	
16	B				0	w		0	0	
17	C				0	w		0	0	
18	C				0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								1.4	1.4	Amps= 1.7

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					0.6	0.7	45%	2.4
PHASE TOTAL	B					0.8	0.8	55%	2.8
PHASE TOTAL	C					0.0	0.0		0.0
LOAD CATAGORIES		Connected			Demand				Ver. 1.02
		kW	kVA	DF	kW	kVA	PF		
1 receptacles		0.0	0.0	0.70	0.0	0.0			
2 computers		0.0	0.0	0.90	0.0	0.0			
3 fluorescent lighting		1.3	1.3	1.00	1.3	1.3	0.97		
4 HID lighting		0.0	0.0	1.00	0.0	0.0			
5 incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6 HVAC fans		0.0	0.0	0.80	0.0	0.0			
7 heating		0.0	0.0	1.25	0.0	0.0			
8 kitchen equipment		0.0	0.0	0.80	0.0	0.0			
9 unassigned		0.1	0.1		0.1	0.1	1.00		
Total Demand Loads					1.4	1.4			
Spare Capacity		20%			0.3	0.3			
Total Design Loads					1.7	1.7	0.98	Amps=	2.1

Default Power Factor = 0.80
Default Demand Factor = 1.00

Figure 138: New Panelboard Scheadule LSL2B

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

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: LSL2B PANEL LOCATION: ELECTRICAL ROOM 2018 PANEL MOUNTING: SURFACE	MIN. C/B AIC: 10K OPTIONS: (4) #14, (1) #10 G, 3/4" conduit

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	CORRIDOR 2054	532	20A/1P	1	*			2	20A/1P	97	PT 2104	Lighting
Lighting	PT 2104	780	20A/1P	3		*		4		0		
		0		5			*	6		0		
		0		7	*			8		0		
		0		9		*		10		0		
		0		11			*	12		0		
		0		13	*			14		0		
		0		15		*		16		0		
		0		17			*	18		0		
		0		19	*			20		0		
		0		21		*		22		0		
		0		23			*	24		0		
		0		25	*			26		0		
		0		27		*		28		0		
		0		29			*	30		0		
		0		31	*			32		0		
		0		33		*		34		0		
		0		35			*	36		0		
		0		37	*			38		0		
		0		39		*		40		0		
		0		41			*	42		0		

CONNECTED LOAD (KW) - A	0.63	TOTAL DESIGN LOAD (KW)	1.69
CONNECTED LOAD (KW) - B	0.78	POWER FACTOR	0.98
CONNECTED LOAD (KW) - C	0.00	TOTAL DESIGN LOAD (AMPS)	2.1

Feeder Size Calculation:

2.1 A * 125% = 2.7A → 100A Bus*, 50A Main, (4) 2/0 AWG Cu THWN, (1) #10 AWG Cu Ground, 3/4" Conduit

*Minimum Bus size = 100A

*Minimum Main Circuit Breaker Size = 50A

M.A.E. Focus

The first floor lobby and second floor PT/OT/therapy waiting spaces are all located along the northern building façade, which consists of a glass curtainwall system with ceramic frit. As a result, daylight plays a prominent role. This resource is a valuable tool that can greatly increase energy savings and occupant satisfaction. A daylight study of the existing spatial conditions was conducted to analyze the amount and extent of daylight penetration into each space. A photosensor dimming system will be used to control the amount of electric light used during the day in both the lobby, physical therapy, and therapy waiting areas along the curtainwall. The inner most part of the therapy waiting area (toward the building interior) receives considerably less daylight than the spaces along the windows. Therefore, the fixtures lighting this inner area are controlled by a timeclock throughout the day. However, because of the need for precise light levels in the spaces and the absence of other daylighting tools (shades, etc.) it was difficult to determine whether a closed or open loop system would be the most beneficial. A study was completed to determine the type of photosensor that would provide optimum efficiency and control of the space.

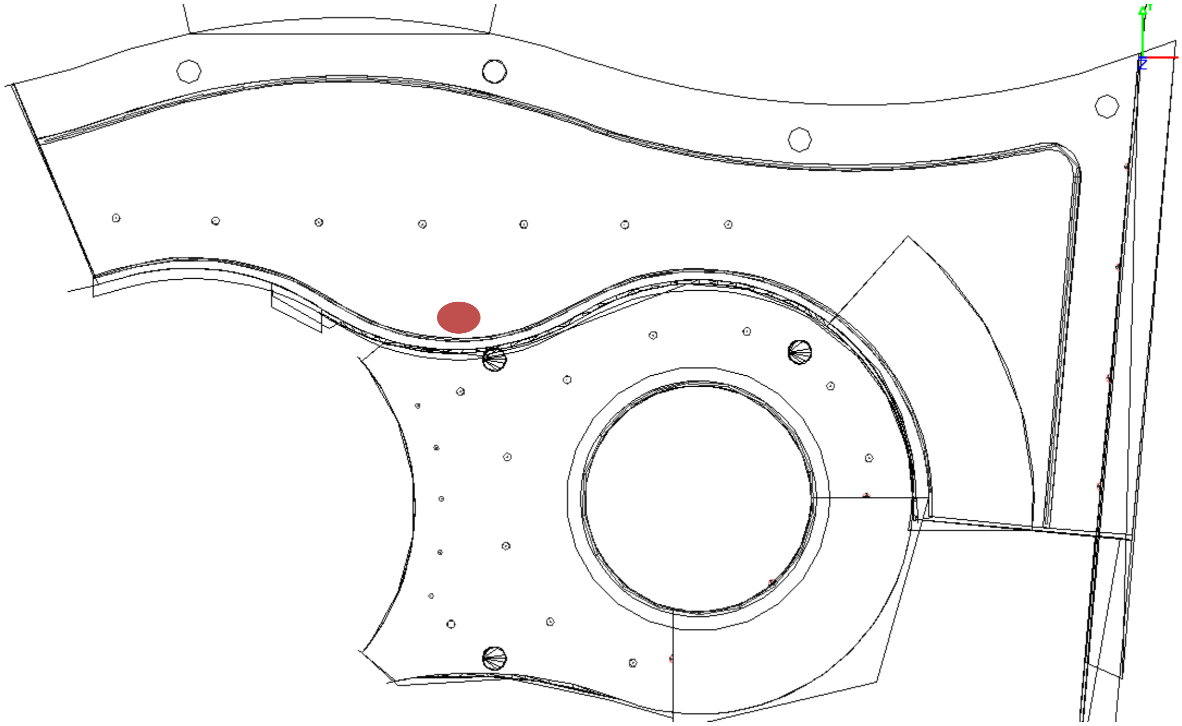
The lobby and physical therapy spaces are very similar, so the study was only completed on one area, the PT space, because of its greater need for precise light levels. First, the critical point was calculated to see which point in the space needed the most amount of light to reach its target illuminance during the day. This point was determined by calculating the dimmed level (how much light electric light each point needs to get to its target level) during clear and overcast skies on January 21, March 21, and May 21 at 8:15 am and 12 pm.

The dimmed level was calculated using the following equation:

Dimmed Level = (Target Level - Daylight Contribution - Fixtures that are always On) / (Fixtures that are Dimmed)

The highlighted point in the diagram below is the critical point determined for the space. The critical point was chosen by looking at values at least 3' away from the walls and choosing the highest number. This ensured that the point was not too close to the walls or corners. The value determines the percentage of light output needed in order to reach the target illuminance. The position of the point slightly varied depending on the sky condition, however, the point shown below was the same for several trials.

Figure 139: Critical Point Location



A one-point calculation grid was placed at workplane height at the location of the critical point. The amount of light at this location was determined at various sky conditions.

Two other one-point calculation grids were used to act as closed and open loop photosensors. To mimic an open loop sensor, a point was placed on the curtainwall and faced toward the exterior. This ensured that the point will only receive daylight, and no electric light. To portray the closed loop photosensor, a point was placed on the dropped ceiling (facing the floor) about 6 feet away from the curtainwall. A 15% reflective cylinder was place around the calculation point. The appropriate cutoff angle determined the cylinder height of about 7.9" in order to ensure that the sensor only saw the floor plane and not a part of the exterior.

The sensor to illuminance (at the critical point) ratios were calculated for both the open and closed loop points at each sky condition. These ratios were then graphed to evaluate the consistency, and therefore, the effectiveness of each sensor type for a variety of sun and sky conditions. The results are as follows:

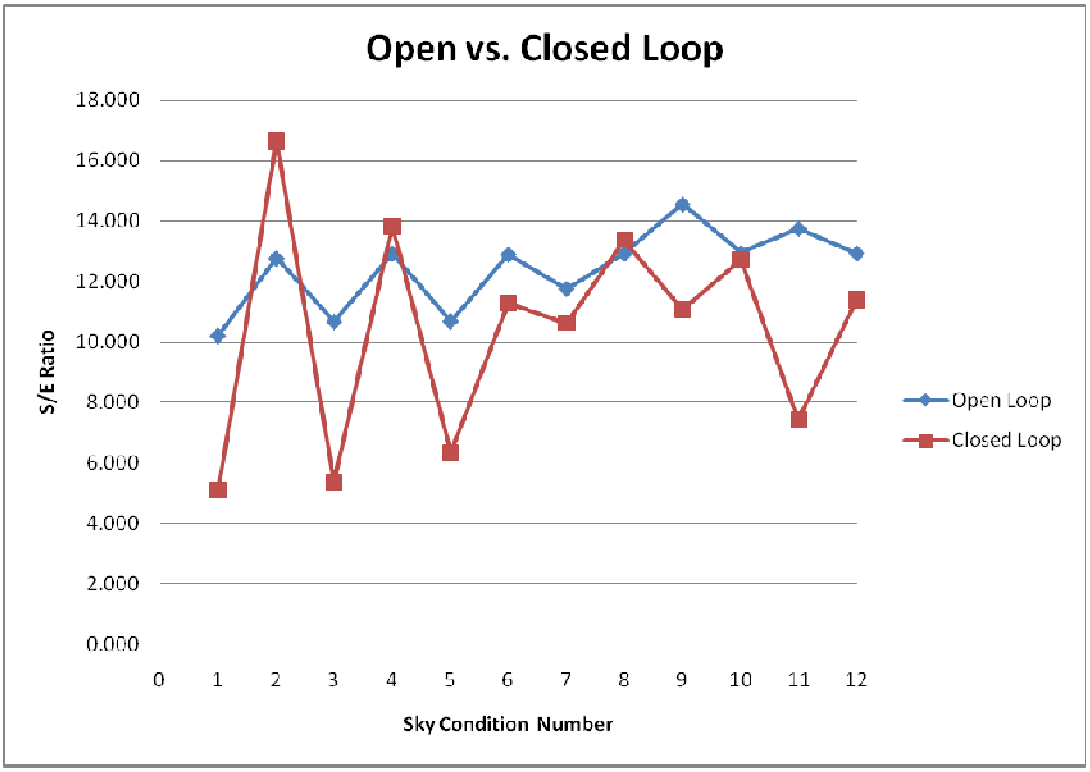
Figure 140: Open Loop Photosensor Results

Sky Condition Number	Sky Condition	Sensor Illuminance (fc)	Workplane Illuminance (fc)	S/E Ratio
1	January 21, 8:15 am, Clear	140	13.7	10.219
2	January 21, 8:15 am, Overcast	23	1.8	12.778
3	January 21, Noon, Clear	576	53.9	10.686
4	January 21, Noon, Overcast	458	35.4	12.938
5	March 21, 8:15 am, Clear	522	48.8	10.697
6	March 21, 8:15 am, Overcast	240	18.6	12.903
7	March 21, Noon, Clear	819	69.6	11.767
8	March 21, Noon, Overcast	696	53.8	12.937
9	May 21, 8:15 am, Clear	1327	91.1	14.566
10	May 21, 8:15 am, Overcast	457	35.3	12.946
11	May 21, Noon, Clear	1164	84.6	13.759
12	May 21, Noon, Overcast	862	66.6	12.943

Figure 141: Closed Loop Photosensor Results

Sky Condition Number	Sky Condition	Sensor Illuminance (fc)	Workplane Illuminance (fc)	S/E Ratio	Scaled Up By 10
1	January 21, 8:15 am, Clear	0.7	13.7	0.051	5.109
2	January 21, 8:15 am, Overcast	0.3	1.8	0.167	16.667
3	January 21, Noon, Clear	2.9	53.9	0.054	5.380
4	January 21, Noon, Overcast	4.9	35.4	0.138	13.842
5	March 21, 8:15 am, Clear	3.1	48.8	0.064	6.352
6	March 21, 8:15 am, Overcast	2.1	18.6	0.113	11.290
7	March 21, Noon, Clear	7.4	69.6	0.106	10.632
8	March 21, Noon, Overcast	7.2	53.8	0.134	13.383
9	May 21, 8:15 am, Clear	10.1	91.1	0.111	11.087
10	May 21, 8:15 am, Overcast	4.5	35.3	0.127	12.748
11	May 21, Noon, Clear	6.3	84.6	0.074	7.447
12	May 21, Noon, Overcast	7.6	66.6	0.114	11.411

Figure 142: Comparison of Open and Closed Loop Consistency



As you can see, the open loop photosensor provides the most consistent graph with the smallest variation between sky conditions. It is the most precise for determining the amount of dimming necessary. The fairly constant ratio shows that the sensor can accurately track the change in daylight throughout the day. It will be the most effective in providing constant light levels in the space.

A dimming photosensor will be used instead of switching because of the patients' sensitivity to contrast. A gradual change in light levels will be more conducive to the occupants.

Electrical Depth

NICoE's overall electrical system is a radial system with one point of service entrance at the southwest corner. It is powered by a 2500kVA transformer that steps down the voltage from 13.8kV to a 480Y/277V, 3P, 4W voltage system. A 3000A switchboard provides power to all equipment loads. Transformers feed a 208Y/120V, 3P, 4W system to receptacles and some lighting devices. An exterior emergency generator rated at 400kW, 480Y/277V, 3P, 4W provides backup power to both life safety and equipment branches. A UPS battery backup system is also utilized for Server Room emergency power.

The lighting in the National Intrepid Center of Excellence was redesigned in the following four spaces:

1. Exterior Façade
2. Lobby
3. Auditorium
4. Physical Therapy/Occupational Therapy/Therapy Waiting

As a facility for veterans with traumatic brain injury, the overall lighting design for each space follows concepts that are characteristic of a soldier. Providing adequate light levels and a visually pleasing environment is important. The avoidance of glare and high contrast in each space was also considered. The ASHRAE 90.1 energy code also influenced the layout and type of fixtures used in each space.

Cost Benefit Analysis of Wire Upsizing

A study was performed to compare the amount and cost of energy lost through the upsizing of feeder sizes. While the initial cost of using the minimum wire size required by code will be less, impedance is greater, and therefore, more energy is lost during electrical transmission. By gathering the first cost of varying wire sizes and calculating the total amount and cost of energy lost for identical run lengths, a conclusion was made as to which is more economical and cost-effective.

Process

The existing feeders located in the National Intrepid Center of Excellence were displayed by calculating the total length and load on each. The feeders to the generator and some of the life safety branches were not included because they are not located on the normal/emergency electrical system. The loads were calculated by using the design loads (in A) listed on the panelboard schedules and an assumed percentage as the average load. Since the building is still under construction, there is no history of utility bills and the peak and service entrance demand loads are unknown. Therefore, based on conversations with consultants, average loads were calculated at 30%, 50%, and 70%, of the available design load. The transformer loads were not included. The voltage drop for each feeder was calculated to determine the total energy lost by each feeder size. The equation used to determine these values was taken from the Eaton 2006 Consulting Application Guide Table 1.3-13:

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

The calculated voltage drop was then multiplied by the average load current to determine the total energy loss from each feeder. By using the utility rate, and assuming use 24 hours a day for 365 days, the annual cost of energy lost from each feeder was determined. The energy rates from Pepco (utility service provider) are as follows:

Generation (10/01/08-5/31/09)
$0.12201 per kwh

Transmission
June to October - $0.00342 per kwh
November to May - $0.00342 per kwh

Distribution Service
June to October - $0.003367 per kwh
November to May - $0.01780 per kwh

For this study, only the energy loss was calculated, and the reduction in demand was not considered.

Using the RSMeans Construction Data for Electrical systems, the total cost of labor, materials, overhead, and profit per linear foot was determined for the conductors and conduit. This provided the initial cost of the wires used. The process was completed for the existing feeder sizes (not including the feeder from the utility to the switchboard).

The feeder wire sizes were then increased by 1, 2, and 3 sizes and a total energy and initial cost was calculated for each. These results were analyzed through a series of graphs and tables shown below. The data was compared based on the wire size difference and the percentage of the design load used to calculate the average load. A payback period was also determined for each scenario.

The main feeder from the utility to the switchboard was considered separately from the other building feeders. This was done because the existing size is 500 KCMIL, which, according to good engineering practice, is the largest wire size to feasibly use on a project. Therefore, instead of increasing the wire size, the number of sets was increased. Results of these calculations are also shown below.

Figure 143: Initial Cost vs. Energy Cost Savings (not including feeder from utility)

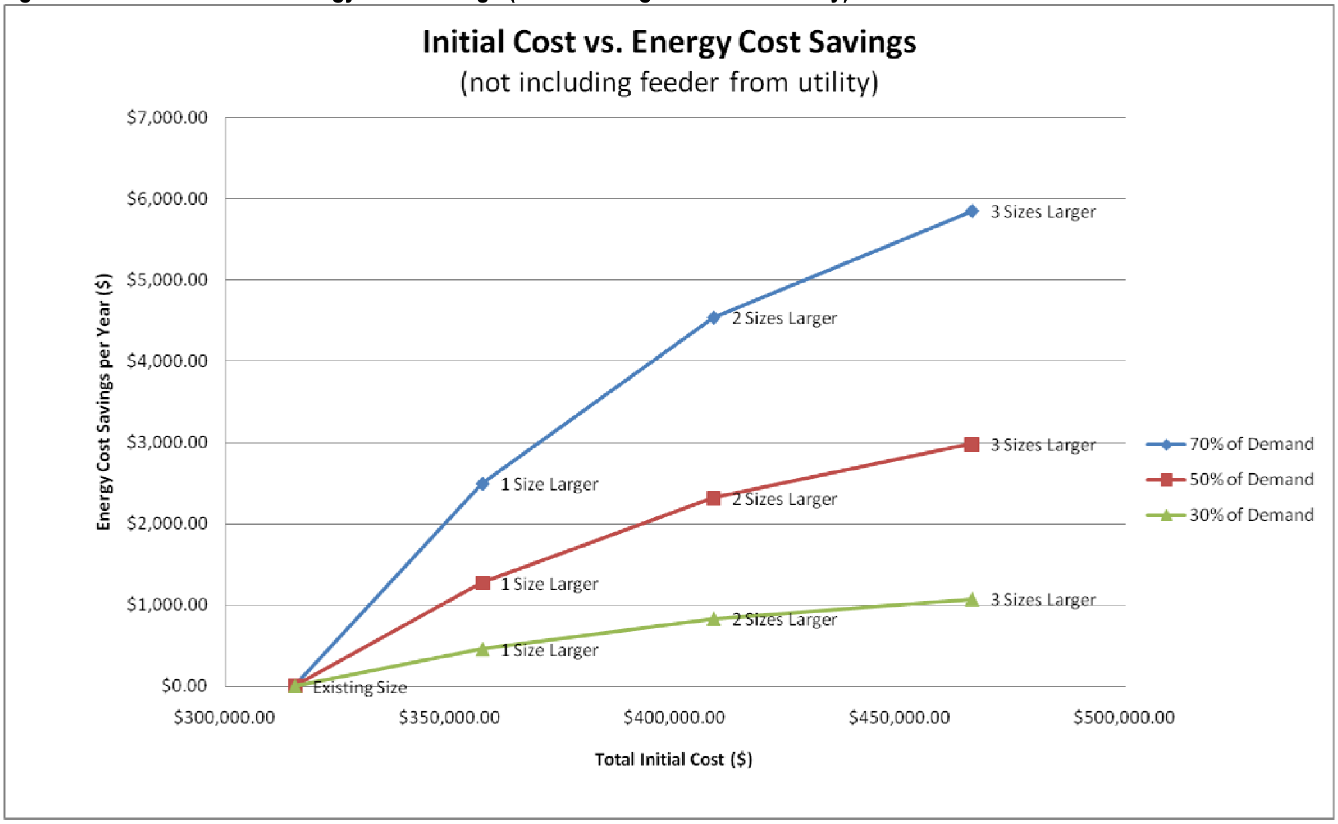


Figure 144: Cost Analysis Results (not including feeder from utility)

COST ANALYSIS at 30% of Demand Load - EXISTING VS. NEW SIZE				
	Existing Wire Size	1 Size Larger	2 Sizes Larger	3 Sizes Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$3,485.14	$3,027.46	$2,651.85	$2,410.84
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$457.68	$833.28	$1,074.30
TOTAL INITIAL COST ($)	$315,344.03	$357,063.29	$408,483.59	$465,924.97
TOTAL INITIAL COST INCREASE ($)	$0.00	$41,719.26	$93,139.56	$150,580.94
SIMPLE PAYBACK PERIOD (YEARS)	N/A	91.15	111.77	140.17

COST ANALYSIS at 50% of Demand Load - EXISTING VS. NEW SIZE				
	Existing Wire Size	1 Size Larger	2 Sizes Larger	3 Sizes Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$9,680.94	$8,409.61	$7,366.26	$6,696.78
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$1,271.33	$2,314.68	$2,984.15
TOTAL INITIAL COST ($)	$315,344.03	$357,063.29	$408,483.59	$465,924.97
TOTAL INITIAL COST INCREASE ($)	$0.00	$41,719.26	$93,139.56	$150,580.94
SIMPLE PAYBACK PERIOD (YEARS)	N/A	32.82	40.24	50.46

COST ANALYSIS at 70% of Demand Load - EXISTING VS. NEW SIZE				
	Existing Wire Size	1 Size Larger	2 Sizes Larger	3 Sizes Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$18,974.63	$16,482.84	$14,437.87	$13,125.69
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	$2,491.80	$4,536.77	$5,848.94
TOTAL INITIAL COST ($)	$315,344.03	$357,063.29	$408,483.59	$465,924.97
TOTAL INITIAL COST INCREASE ($)	$0.00	$41,719.26	$93,139.56	$150,580.94
SIMPLE PAYBACK PERIOD (YEARS)	N/A	16.74	20.53	25.74

Figure 145: Initial Cost vs. Energy Cost Savings (feeder from utility)

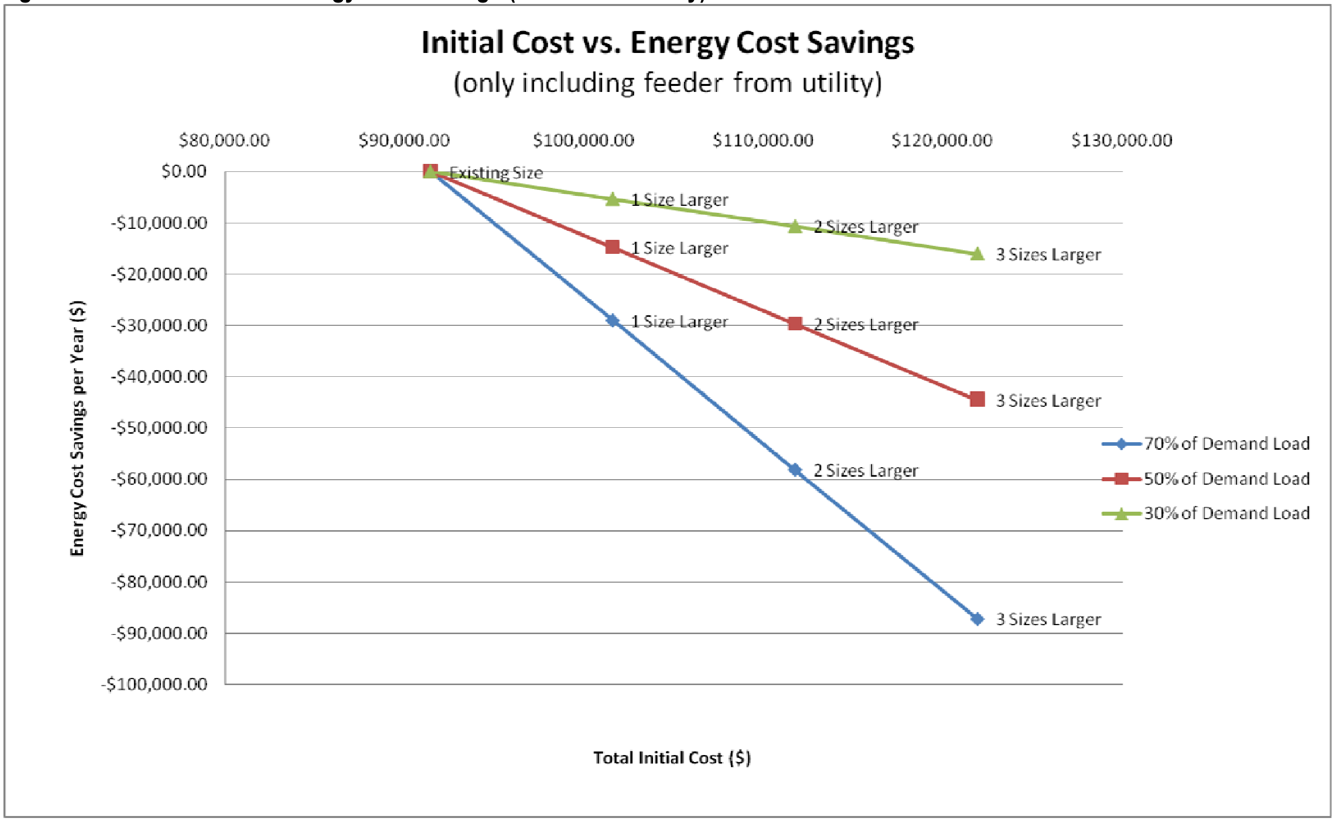


Figure 146: Cost Analysis Results (feeder from utility)

COST ANALYSIS at 30% of Demand Load - EXISTING VS. NEW SIZE				
	Existing Wire Size	1 Size Larger	2 Sizes Larger	3 Sizes Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$48,042.25	$53,380.28	$58,718.30	$64,056.33
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	-$5,338.03	-$10,676.06	-$16,014.08
TOTAL INITIAL COST ($)	$91,435.54	$101,595.05	$111,754.55	$121,914.06
TOTAL INITIAL COST INCREASE ($)	$0.00	$10,159.50	$20,319.01	$30,478.51
SIMPLE PAYBACK PERIOD (YEARS)	N/A	-1.90	-1.90	-1.90

COST ANALYSIS at 50% of Demand Load - EXISTING VS. NEW SIZE				
	Existing Wire Size	1 Size Larger	2 Sizes Larger	3 Sizes Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$133,450.69	$148,278.55	$163,106.40	$177,934.25
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	-$14,827.85	-$29,655.71	-$44,483.56
TOTAL INITIAL COST ($)	$91,435.54	$101,595.05	$111,754.55	$121,914.06
TOTAL INITIAL COST INCREASE PER LN.FT. ($)	$0.00	$10,159.50	$20,319.01	$30,478.51
SIMPLE PAYBACK PERIOD (YEARS)	N/A	-0.69	-0.69	-0.69

COST ANALYSIS at 70% of Demand Load - EXISTING VS. NEW SIZE				
	Existing Wire Size	1 Size Larger	2 Sizes Larger	3 Sizes Larger
TOTAL COST OF ENERGY LOSS PER YEAR ($)	$261,563.35	$290,625.95	$319,688.54	$348,751.14
TOTAL COST SAVINGS IN ENERGY PER YEAR ($)	$0.00	-$29,062.59	-$58,125.19	-$87,187.78
TOTAL INITIAL COST ($)	$91,435.54	$101,595.05	$111,754.55	$121,914.06
TOTAL INITIAL COST INCREASE ($)	$0.00	$10,159.50	$20,319.01	$30,478.51
SIMPLE PAYBACK PERIOD (YEARS)	N/A	-0.35	-0.35	-0.35

See Appendix D for full calculation spreadsheets.

From the results above, many useful conclusions can be made. The total initial cost is the sum of both the conductors and conduit. The total cost savings per year was calculated by subtracting the total cost of energy loss per year of each larger wire size from that of the existing wire size. A similar calculation was completed for the total initial cost increase per linear foot. As expected, as the wire sizes increase, the energy cost savings increase (energy loss per year decreased), lowering the cost of energy wasted. The increase in initial cost as the wire size increases is obvious. From the graph and tables, it can be seen that there is a reasonable amount of savings as the wire sizes get larger. The savings are not as significant as expected; however, any cost reduction is always beneficial.

The payback period for each wire size at each load percentage was calculated to see if the upsizing is a reasonable decision. The total initial cost increase per linear foot for each wire size was divided by the total energy cost savings per year to determine how many years it would take for the investment to be beneficial. With the cost increase acting as the investment, and the energy savings as the return on the investment, the payback time indicates how long it will take for the added cost to be paid off. Beyond the estimated period, the cost of energy saved will be a direct benefit to the owner. The results show that the payback period increases as the wire size increases. Therefore, it would be the most economically beneficial to go with the wire size that provides the shortest payback period, which is when the feeders are increased by 1 size.

The pattern of change in cost as the percentage of demand load increases is also very interesting. As the load gets larger, the costs savings also increase per year. This shows that as more electricity is used by the building, more energy is saved. This is reasonable because energy and money cannot be saved unless a portion is actually consumed. There are many panels in the building that very little (or not any) load at all. This greatly increases the initial cost of the system; therefore, increasing the payback period. Consolidating some of the circuits will save a great deal of money on the project. In addition, obviously the feeders with the greatest length will benefit the most from the wire size increase.

It is determined that the benefit of increasing the wire size greatly depends on the percentage of demand load used. If a fairly large amount of load is consumed (as shown in the 70% demand load study), it would be very beneficial in terms of cost for the wires to be upsized. Although this study only looks at a maximum of 70% demand load, the benefit at 100% demand would be even greater. The large amount of computers, mechanical devices, and other equipment will most likely be running all of the time, which will increase the cost savings and decrease the payback period. Once again, based on all of the data, and previous analysis, it would be best to increase the wire size by 1 size. Increasing the sizes any higher would produce payback periods that may last longer than the actual building lifetime. As long as the building remains in constant operation to withstand the electric load around 70% (or higher), the upsize will remain economically feasible.

When looking at the results for just the feeder from the utility to the switchboard, the values are drastically different from the rest of the feeders in the building, however, they are reasonable. By increasing the number of sets, the energy loss is not reduced; it is just increased according to the set number. The total cost increases through the amount of energy lost in transmission as well as in the initial cost of the wires. The cost of the energy lost also increases with the demand load. It would not be recommended to increase the number of sets of wires from the utility to the building power system. Money is only saved when increasing the actual size of the wire.

SKM Analysis

SKM Power Tools is a valuable resource used to ensure the economic feasibility and safety of the designed electrical system. By performing a short circuit analysis, arc fault study, and protective device coordination for the entire distribution system, it was determined whether the designed system is sufficient for the existing loads. The evaluation began at the service entrance and continued to all panelboards. The existing electrical system designed for the National Intrepid Center of Excellence was examined and constructed in the SKM software program. Each of the major system components, including the utility, transformers, protection devices, panelboards, etc. were inserted. Professional electrical consultants were also used as a resource to provide assistance with using the software.

Since the SKM program is very detailed and complex, the lack of field experience in working with such systems made some aspects of the process difficult. There were many parameters and properties of the various electrical components that were unknown and unable to be gathered from the construction documents and project specifications. Therefore, with the guidance of electrical consultants, the following assumptions were made:

- The software library was used to determine all necessary properties for most components. The information was linked to the corresponding manufacturers' data.
- All unknown information was kept as the default software inputs.
- Utility initial operating voltage is 1.0 pu and 0 degrees. There was no access to utility zero sequence impedance, so an average X/R ratio of 5.75 was used. The line to ground contribution was 0 MVA (per SKM and consultant recommendations). Assumed a base/rated contribution of 100 MVA.
- Generator is rated at 4-pole, 400kW with a 0.9 power factor. Initial operating conditions were at 1.0 pu and 0 degrees.
- Low voltage copper cable was selected as the standard cable for all runs. Duct material was magnetic with PVC insulation, and TW insulation class. Feeder lengths were measured from electrical drawings.
- Transformers are dry-type with a 1.00 capacity factor.
- Circuit breaker properties were assigned based on manufacturer data in the library. Static trip low voltage breakers were used. Sensor and plug sizes were assumed to be equal to frame size specified.
- The UPS control panel (CP-UPS) was counted as one bus instead of broken up into the separate power distribution units. These were consolidated to remain below the 100 bus limit.
- Assumed a PF of 0.8 and efficiency of 0.9 for the UPS. Line and load side voltages of the component were given the same values. According to SKM and electrical consultants, the three phase contribution for the UPS was 100% of the UPS kVA rating, and the line to ground was 0% of the UPS kVA rating. However, in order to avoid errors within the system, a line to ground value of 1% had to be specified.
- The initial switch condition for the automatic transfer switches was set to the normal setting.

Upon completion of system inputs, several analyses were run, including a short circuit analysis, arc fault study, and protective device coordination. Several reports were generated and showed the results of each study. The full single line diagram and reports can be found in Appendix E.

The short circuit analysis report provides basic information about each of the components and devices in the electrical system. It provides the maximum allowable fault current for the safe and efficient operation of the distribution system. The voltage, initial symmetric fault current, impedance, impedance ratio, and RMS voltage, interrupting amps, and faulted current is some of the included information. A fault analysis summary at the end of the document provides the available fault current (3 phase) and impedance ratio for each element. The output provides the maximum available short circuit current at various points throughout the system.

The arc flash evaluation includes a full report of the incident energy and arc flash boundary for each location in the electrical system. The arc fault current through the protective devices and time duration of the arc is available. The required protective clothing category is also stated, depending on the incident energy. The results received from the included studies indicate mostly Category 0 or Category 1, with the switchboard rated as Category 3. This shows that most of the power equipment in NICoE is not extremely dangerous.

The final study completed was the protective device coordination. It aids in assuring that the power system is capable of clearing a fault in the minimum amount of time to limit the impact to the system. Coordination was checked between the switchboard circuit breaker and each of its branch circuit breakers that feed other devices (except for TVSS). Several other studies were completed through various runs in the power system. Most of the studies proved that the downstream circuit breakers will trip prior to those before them, which is the desirable outcome. However, in specific cases where a protective device does not trip before the upstream breaker, the SKM software can be used to fix the problem. The circuit breaker trip times can be manually changed. This will also reduce the incident energy number. For this exercise, the goal was to examine the existing system and SKM software, so such changes were not made.

Overall, the use of the SKM software was a great learning experience. It exhibited the large amount of detail that is necessary in designing electrical power systems. It was a great way to learn intricacies of the system and a new analysis tool.

Over-Current Device Coordination Study

A protective device coordination study ensures the safe, efficient, and economical operation of the distribution system. This type of study helps to isolate faults at a specific protection device to avoid injury or equipment damage. It guarantees a properly designed system in which downstream breakers will trip before those higher in the system, minimizing disruptions in the electrical operation.

For this study, a single-path through NICoE's distribution system was tested. It runs from the utility, to the main switchboard, to distribution panel DP1, to lighting panel LPA, and finally through a branch lighting circuit. The location of the path can be found in the single line diagrams below. The circuit breakers were specified from the Eaton website and the time current curves were overlayed to examine the coordination.

From the graphs, it can be seen that the electrical protective devices are coordinated fairly well. The 400A circuit breaker will be the last to trip in the case of an arc fault. It does not interfere with either of the first two curves. The 20A and 100A curves, however, slightly overlap. This intersection is at the maximum curve for the 20A breaker and the minimum curve for the 100A breaker. It would probably be the best decision to choose alternate devices for a more precise coordination. It would ensure the prevention of any unnecessary disruption to the entire distribution system.

Figure 147: Location of Protective Device Coordination Path

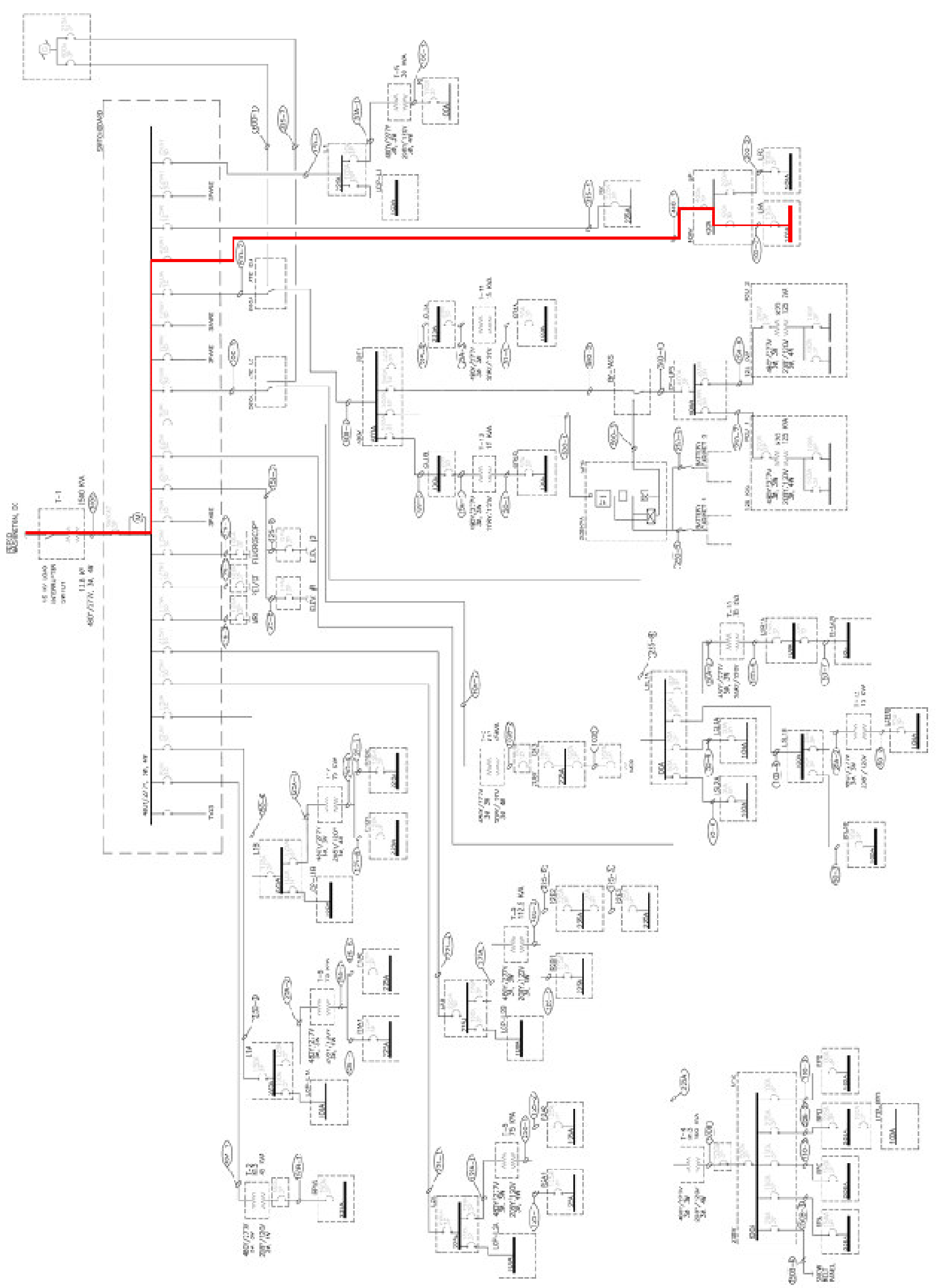


Figure 148: Simplified Protective Device Coordination Path

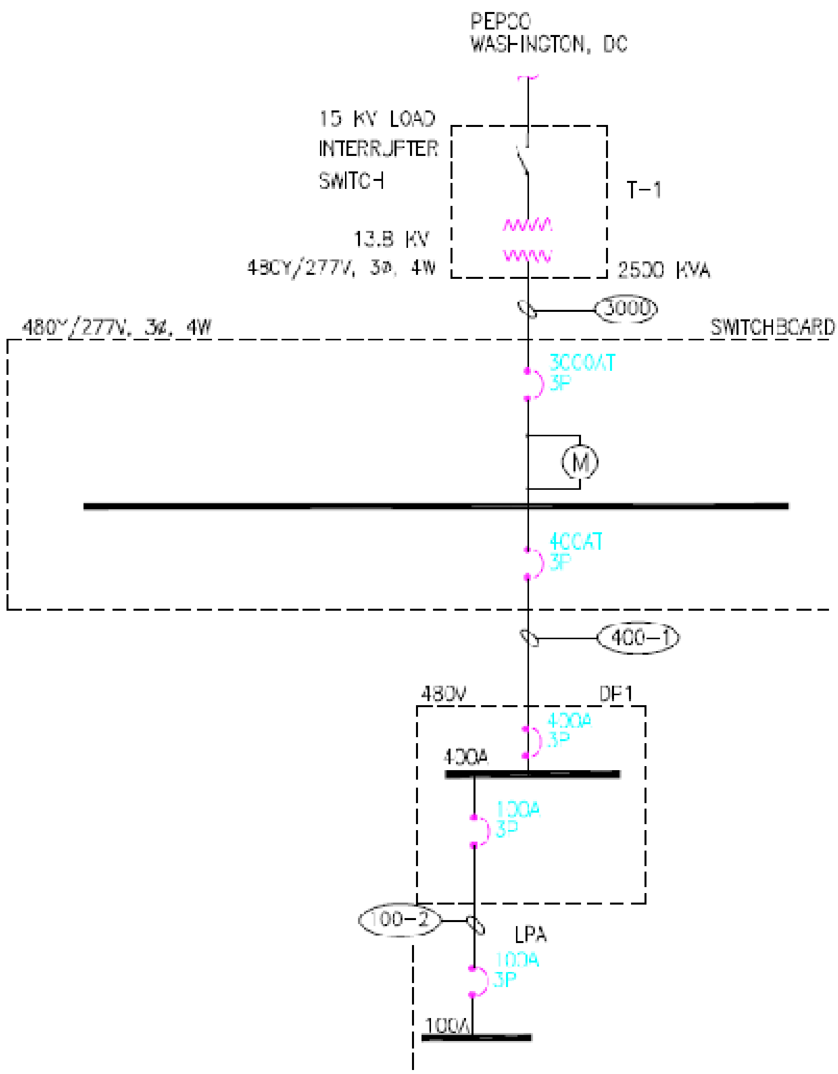
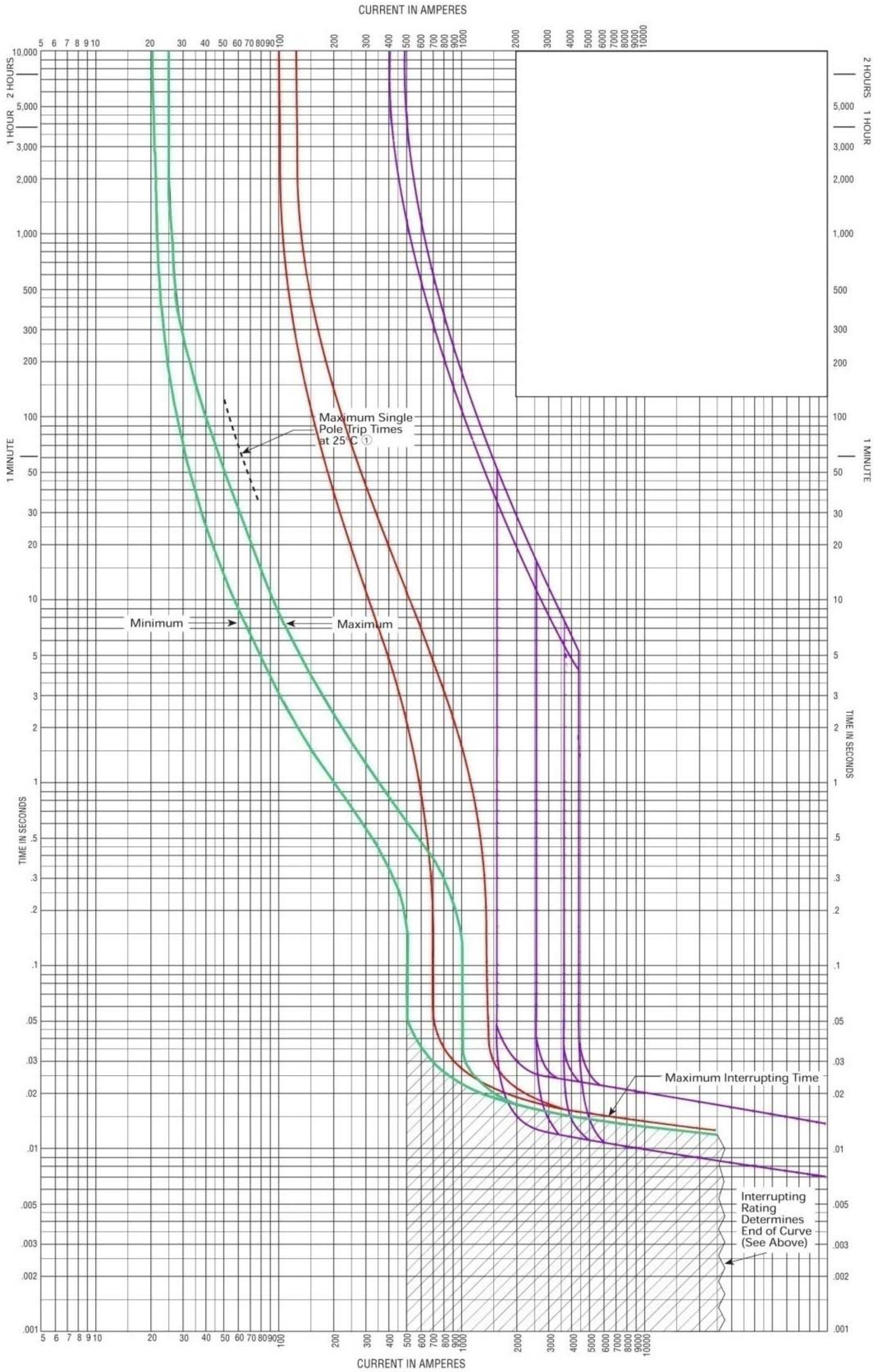


Figure 149: Trip Curves

Black - Series C, F-Frame Type FDB: 20A
Red - Series C, F-Frame Type FD: 100A
Purple - AB DE-ION Tri Pac Type LA: 400A



Short Circuit Analysis

The following short circuit analysis allows one to predict the maximum available fault current at various points in the electrical system. It ensures that there are proper interruption ratings at each component. The path shown in the coordination study above was used for this calculation. The short circuit at the utility, transformer, switchboard, distribution panel, and lighting panel are included. The per unit method was used. All values were from NICoE's existing electrical system design. However, the building has not yet been constructed, so the utility s.c. is unknown. Therefore, the value is assumed to be 100,000 kVA.

The following tables provide all calculation details for the analysis. A summary table of the ratings fault current and standard breaker sizes is also included.

Figure 150: Short Circuit Analysis Calculations

Short Circuit Analysis (per unit mentod)							
		System Voltage	480				
		Base kVA	2500				
		Utility Company Available Fault (kVA)	100000	**∑ X**	**∑ R**	**∑ Z**	**I_{sc} (A)**
Utility Primary							
		$X_{(p.u.)}$ = (KVA_{base}) / (Utility S.C. KVA)	= 0.025	0.025	0	0.025	**120281.3**
Transformer Secondary							
%Z =	5.5	$X_{(p.u.)}$ = (%X * KVA_{base}) / (100 * KVA_{xfrmr})	= 0.0548	0.0798	0.00457	0.079931	**37620.47**
X/R =	12	$R_{(p.u.)}$ = (%R * KVA_{base}) / (100 * KVA_{xfrmr})	= 0.0046				
%X =	5.48						
%R =	0.457						
kVA =	2500						
Switchboard							
Wire =	500	$X_{(p.u.)}$ = (L * X_L * kVA_{base})/ (1000^2 * Sets * kV^2)	= 0.0077	0.087544	0.009455	0.088053	**34150.37**
Length =	107.2	$R_{(p.u.)}$ = (L * R * kVA_{base})/ (1000^2 * Sets * kV^2)	= 0.0049				
Sets =	7						
X =	0.0466						
R =	0.0294						
Distribution Panel DP1							
Wire =	3/0	$X_{(p.u.)}$ = (L * X_L * kVA_{base})/ (1000^2 * Sets * kV^2)	= 0.051	0.138509	0.088505	0.164371	**18294.16**
Length =	181	$R_{(p.u.)}$ = (L * R * kVA_{base})/ (1000^2 * Sets * kV^2)	= 0.0791				
Sets =	2						
X =	0.0519						
R =	0.0805						
Panelboard LPA							
Wire =	1	$X_{(p.u.)}$ = (L * X_L * kVA_{base})/ (1000^2 * Sets * kV^2)	= 0.0277	0.166186	0.166196	0.23503	**12794.25**
Length =	44.75	$R_{(p.u.)}$ = (L * R * kVA_{base})/ (1000^2 * Sets * kV^2)	= 0.0777				
Sets =	1						
X =	0.057						
R =	0.16						

Figure 151: Short Circuit Analysis Summary

Short Circuit Analysis Summary		
Location	**Available Fault (A)**	**Standard Breaker Rating (A)**
Utility Company Transformer Secondary	37620	65,000
Switchboard	34150	35,000
Distribution Panel DP1	18294	25,000
End Use Panel LPA	12794	14,000

Architecture Breadth

Overview

The auditorium has many unique architectural features. As a space for meetings, presentations, and web conferencing, it must be functionally versatile as well as visually pleasing. Located on the first floor near the main entrance, it is a space that will be frequently used and must portray a high-tech quality. Currently, the room consists of acoustically treated walls (wood and beige colors). The floor is a carpet tile, and there are wood doors throughout the space. The ceiling consists of staggered continuous acoustic ceiling panels. The lower panels are of wood material, while the upper panels consist of black tiles. Mechanical diffusers and light fixtures are located within the black tiles. There are projection screens that extend from the ceiling on the east and west end of the space. Projectors also extend from the center ceiling tiles and are aimed at the respective screen. A full-height partition that runs in the north-south direction is also accessible to divide the space into two separate areas.

Redesign

In order to fully utilize the potential of the auditorium space, all of the building systems must be considered. A redesign of the ceiling space was completed in order to fully integrate and optimize all of the building systems.

The ceiling geometry is especially important in terms of the lighting layout. In order to accommodate for a lighting design that is both functional and visually pleasing, the ceiling details were slightly modified. Some thought was put into rotating the panels 90 degrees to provide better lighting for the occupants (based on the furniture layout). However, it is very important to also follow the main goals of the space architecturally. Rotating the panels would cause them to be divided up by the partition, creating an unpleasant discontinuity in the ceiling. The current orientation of the panels acts as a way finding characteristic, as they span between entrances in the space. Also, the furniture layout in the space is not permanent, so designing all features to tailor toward seating would not be practical. The spacing and dimensions of the wood ceiling panels were altered in order to accommodate for the lighting layout. The spacing and number of fixtures was adequate to provide uniform lighting at the appropriate levels. The partition in the middle of the space made this task particularly challenging, however, a solution for providing adequate light levels was determined.

The fixtures were also strategically placed among the ceiling elements. The spot lights were tucked in between the upper and lower panels in order to keep them out of occupant view, instead of allowing them to protrude below the ceiling plane. In addition, the projector had to be placed so that fixtures and other architectural features were not blocking the projection path. The appropriate cutoff angle was calculated to ensure that there was enough space between the projection beam and light fixtures.

In order to accent the beautiful wood material on the ceiling panels, a pendant fixture that provides 80% downlight (for ambient and task lighting in the space) and 20% uplight was chosen. The small amount of indirect light will highlight the wood panels while also making the space feel more comfortable. The existing panel layout called for black acoustical ceiling tile between (and 6" above) the wood panels. The light distribution from the indirect component of the fixtures will allow some light to extend beyond the wood panels and land on those (black) panels in between. However, when light hits the black material, it will not be reflected back into the space as usable light. This makes the existing dark color very inefficient. Therefore, the material of the black panels was changed to a lighter cream color that matches the color of the upper walls. This light color will cause any spill light to be reflected back into the auditorium. Also, to make the panels more visually appealing, they will be a continuous panel and not separated into 2' tiles.

The new placement of the ceiling panels also affects the location of the mechanical equipment for the space. The diffusers are placed within the new light colored acoustical ceiling panels. This will allow them to remain functional, but also discrete without interfering with other systems.

The following are plans, sections, and renderings of the new and existing spatial design for the auditorium:

Figure 152: Existing Reflected Ceiling Plan (NTS)

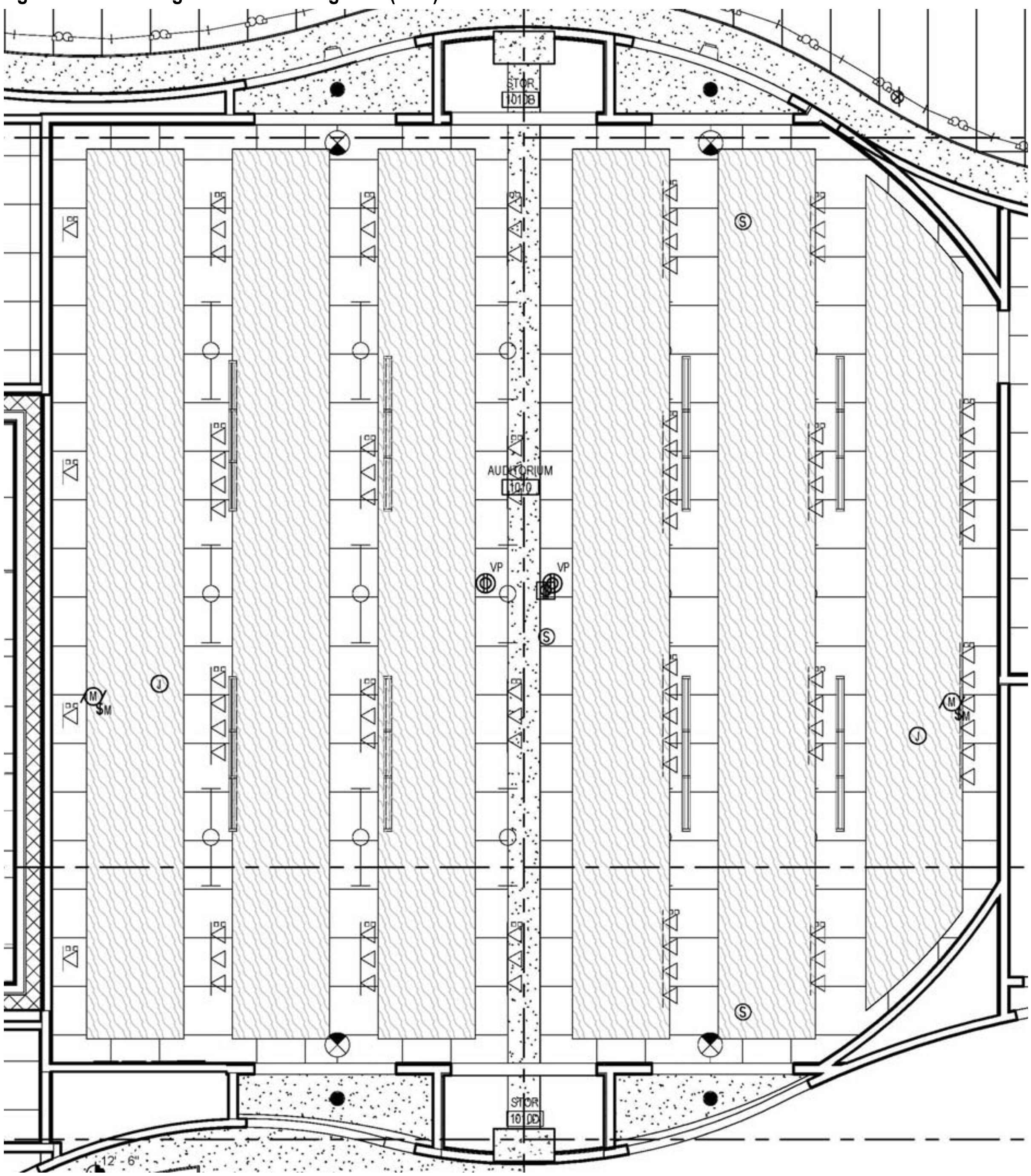


Figure 153: New Reflected Ceiling Plan (NTS)

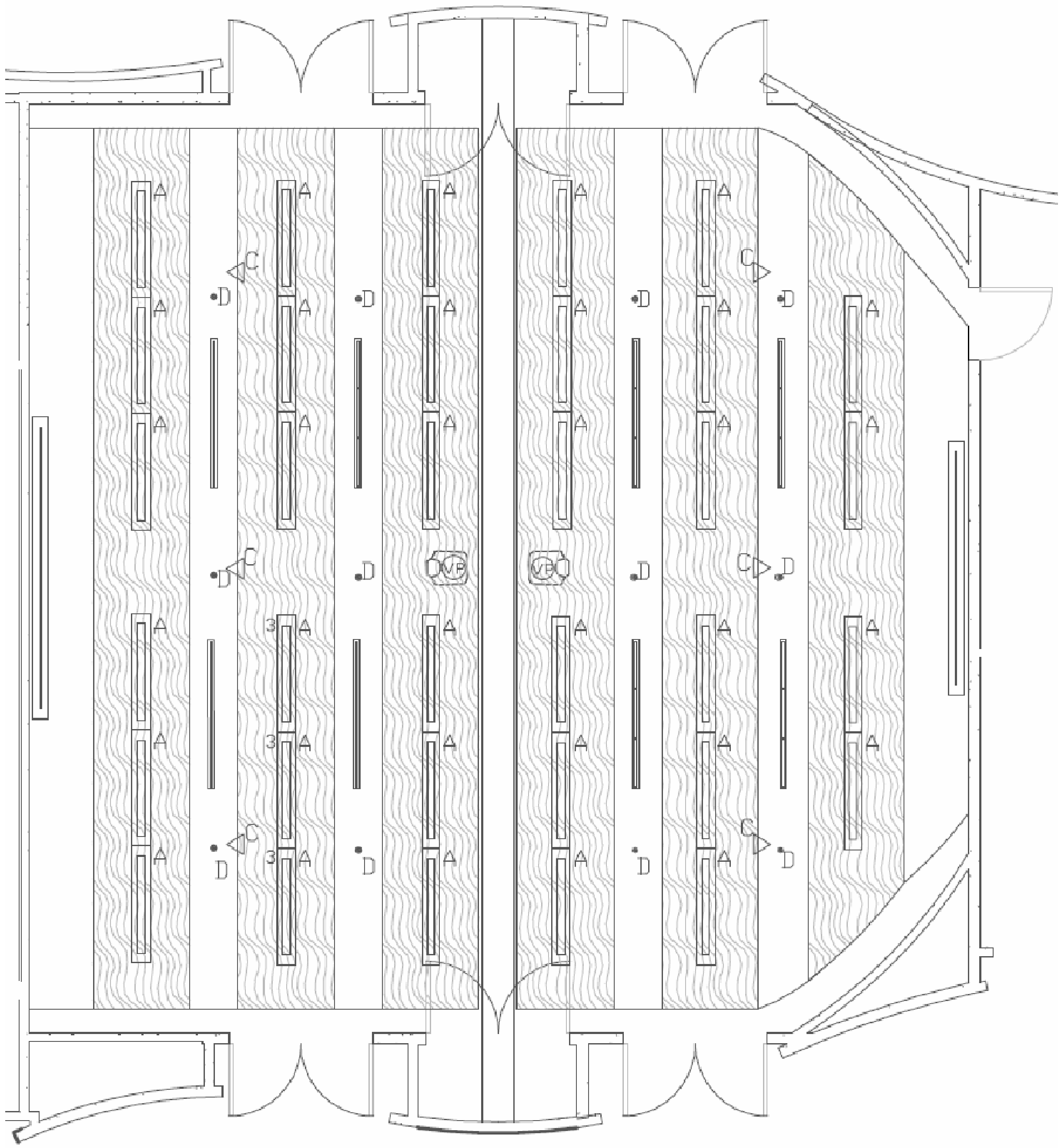


Figure 154: New Section (NTS)

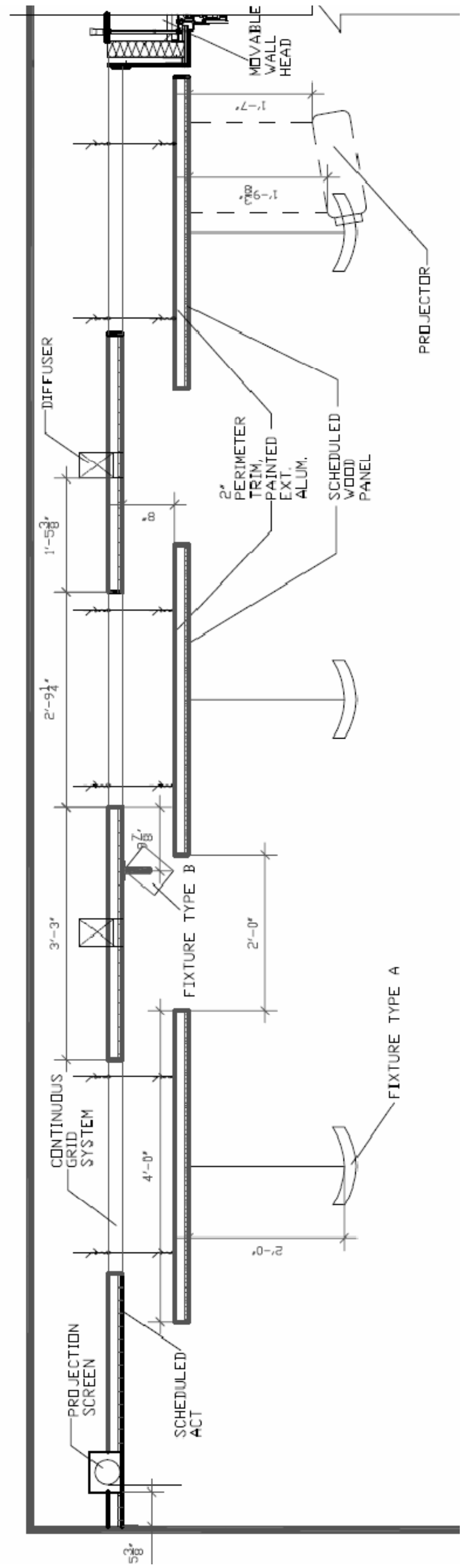


Figure 155: New Materials

Location	Description	Manufacturer	Style/Color	Reflectance
Floor	Carpet Tile	Shaw	Prairie59525/Driftwood23750	0.3
Wood Base	Wood Base	Algoma Hardwoods	Stained to match adjacent surface	0.4
Lower Wall	Wood Wall Panel	Armstrong	Woodworks Ekos - Light Cherry	0.4
Upper Wall	Acoustic Wall Panel	Knoll	Suprafine Cream	0.6
Doors	Wood Doors	Algoma Hardwoods	Stained Wood - Cherry	0.2
Door Frame	Wood Frame	Algoma Hardwoods	Stained Wood - Cherry	0.2
Lower Ceiling Panels	Acoustic Wood Ceiling Tile	Armstrong	Woodworks Vector - Natural Variations Light Cherry	0.4
Upper Ceiling Panels	Acoustic Wood Ceiling Tile	Armstrong	Suprafine - Cream	0.6

Figure 156: Existing Spatial Design - Rendering

Figure 157: New Spatial Design – Rendering

Conclusions

Overall, the changes made in the Auditorium give the space a more comfortable, relaxing, and high-tech feel. The new panel layout and materials allows the lighting to be better integrated into the space and accommodate for various activities taking place. The natural materials in the room are highlighted, and the room feels more spacious. The room looks very well put together and there is a clear sense of direction. There is a more efficient use of lighting, and all systems work well together functionally and visually.

Mechanical Breadth

Overview

The second floor therapy waiting area contains a 2.5' tall clerestory that spans the length of the east side of the space. It extends from above the 17.5' dropped ceiling to 20' above the floor (see diagram on page 118). As a result of its location and orientation, a daylight study was previously completed (see page 117 for complete analysis and results) to determine whether there is a sufficient amount of daylight actually reaching the workplane. It was found that at some times during the day there is adequate daylight present; however, there is also plenty of daylight protruding deep into the space from just the curtainwall system along the north façade (without the clerestory). Therefore, the clerestory's presence is unnecessary. The glass will be replaced with the typical wall system of gypsum wall board, back with insulation, and enclosed by concrete panels. To further analyze this alteration, an energy study was completed to determine the amount of energy saved by changing the wall composition from glass to a concrete wall system.

In addition, to fully analyze the energy usage within the space and the amount saved from eliminating the glass, a calculation of the other contributors to the total cooling load was completed.

Process

After speaking with faculty consultants, it was decided that the best way to evaluate this situation is to use the CLTD/SCL/CLF (Cooling Load Temperature Difference/Solar Cooling Load/Cooling Load Factor) Calculation Procedure from the 1997 ASHRAE Fundamentals Handbook. It is based on the transfer function method and is used to approximate the cooling load corresponding to conductive heat gain through windows, walls, and roofs; solar heat gain through fenestrations; and internal heat gain from lights, people, and equipment. It is also applicable in determining the cooling load from infiltration and ventilation.

The following provides the applicable conversion factors used in the calculations. The month of July is used in applicable tables and data because this time period will present the worst case scenario. Also, the known conditions that are applicable to the National Intrepid Center of Excellence are also stated. The source for each piece of information is provided. Some of the information was found in the specifications and drawings, while others were gathered from websites or referenced tables in the 1997 ASHRAE Fundamentals Handbook. The complete calculations for each part are also included with all necessary assumptions.

Conversion Factors

1 meter = 3.281 feet

1 kwh = 3421 Btu

K = (F + 460) * 5/9

1 Btu/(h * sq.ft.* ºF) = 5.678 W/(sq.m * K)

Known Conditions

Area of applicable space, A (window) = 35.43 sq.m - *construction documents*

Design heat transfer coefficient for window, U (window) = 1.59 W/(sq.m * K) - *specifications*

Inside temperature, t_i = 22 ºC

Mean outdoor temperature, t_m = max outdoor temp - daily range/2 = 25.5 ºC - *www.weather.com*

Shading Coefficient, SC = 0.31 - *specifications*

Thermal Resistance, R (concrete, 6.75") = 0.951 (sq.m * K)/W - *www.coloradoenergy.org*

Thermal Resistance, R (rigid insulation) = 1.41 (sq.m * K)/W - *specifications*

Thermal Resistance, R (gypsum wall board, 5/8") = 0.986 (sq.m * K)/W - *www.coloradoenergy.org*

Wall type for concrete = C10, 200mm high density concrete - *Table 11*

Wall type for insulation = B25, 85mm insulation - *Table 11*

Wall type for gypsum wall board = E1, 20mm plaster or gypsum - *Table 11*

Part 1: Total Energy Load Comparison

The first part of this study is comparing the cooling loads through a window and wall surface. While a general load calculation would consider the energy from lights, people, and equipment, in the intended analysis, these values will be the same in both situations. Therefore, the contribution from these factors is negligible and will not influence the results. In addition, it is assumed that the room air pressure is positive, so the loads from ventilation and infiltration air are considered to equal 0 (concluded from discussion with consultant).

In order to thoroughly analyze the cooling load throughout the day, the loads were calculated for all 24 hours.

Window Cooling Load Contribution

– Conduction through the glass

Q = U*A*CLTD

U = 1.59 W/(sq.m * K)

A = 35.34 sq.m

CLTD Values from Table 34: Cooling Load Temperature Differences (CLTD) for Conduction through Glass

C1 = 25.5 - t_i = 25.5 - 22 =3.5

C2 = t_m - 29.4 = 25.5 - 29.4 = -3.9

Corrected CLTD = CLTD + C1 + C2

Figure 158: Wall Conduction Load

Time	CLTD (K)	C1	C2	Corrected CLTD	Q (Watts)
8:00 AM	0	3.5	-3.9	-0.4	-22
9:00 AM	1	3.5	-3.9	0.6	34
10:00 AM	2	3.5	-3.9	1.6	90
11:00 AM	4	3.5	-3.9	3.6	202
12:00 PM	5	3.5	-3.9	4.6	258
1:00 PM	7	3.5	-3.9	6.6	371
2:00 PM	7	3.5	-3.9	6.6	371
3:00 PM	8	3.5	-3.9	7.6	427
4:00 PM	8	3.5	-3.9	7.6	427
5:00 PM	7	3.5	-3.9	6.6	371
6:00 PM	7	3.5	-3.9	6.6	371
7:00 PM	6	3.5	-3.9	5.6	315
8:00 PM	4	3.5	-3.9	3.6	202
9:00 PM	3	3.5	-3.9	2.6	146
10:00 PM	2	3.5	-3.9	1.6	90
11:00 PM	2	3.5	-3.9	1.6	90
12:00 AM	1	3.5	-3.9	0.6	34
1:00 AM	1	3.5	-3.9	0.6	34
2:00 AM	0	3.5	-3.9	-0.4	-22
3:00 AM	-1	3.5	-3.9	-1.4	-79
4:00 AM	-1	3.5	-3.9	-1.4	-79
5:00 AM	-1	3.5	-3.9	-1.4	-79
6:00 AM	-1	3.5	-3.9	-1.4	-79
7:00 AM	-1	3.5	-3.9	-1.4	-79
				TOTAL	**3394**

– Solar load through the glass

Q = A*SC*SCL

A = 35.34 sq.m

SC = 0.31

Zone Type for Glass Solar = A - *Table 35B*

SCL values from Table 36: July Solar Cooling Load for Sunlit Glass 40ºNorth Latitude (North-Facing) (NICoE is located at 38ºN latitude, but text states a loss of accuracy of table for latitudes lower than 24ºN latitude.)

Figure 159: Solar Radiation Load

Time	SCL (W/sq.m)	Q (Watts)
8:00 AM	583	6387
9:00 AM	576	6310
10:00 AM	485	5313
11:00 AM	334	3659
12:00 PM	211	2312
1:00 PM	167	1830
2:00 PM	142	1556
3:00 PM	123	1348
4:00 PM	104	1139
5:00 PM	82	898
6:00 PM	57	624
7:00 PM	22	241
8:00 PM	9	99
9:00 PM	6	66
10:00 PM	3	33
11:00 PM	0	0
12:00 AM	0	0
1:00 AM	0	0
2:00 AM	0	0
3:00 AM	0	0
4:00 AM	0	0
5:00 AM	6	66
6:00 AM	293	3210
7:00 AM	495	5423
	TOTAL	**40513**

Wall Cooling Load Contribution

– Conduction through the wall

Q = U*A*CLTD

Design heat transfer coefficient for wall, U (wall) = 1 / (R (concrete) + R (insulation) + R (gypsum wall board))

R (concrete, 6.75") = 0.951 (sq.m * K)/W

R (rigid insulation) = 1.41 (sq.m * K)/W

R (gypsum wall board, 5/8") = 0.986 (sq.m * K)/W

U (wall) = 1 / (0.951 + 1.41 + 0.986) = 0.3 W/(sq.m * K)

A = 35.34 sq.m

CLTD:

Wall Number = 16 - Table 33C, Wall Types, Mass Located Outside Insulation (wall type C10 not listed, so chose a wall parameter with a similar R value and characteristics)

CLTD from Table 32

Corrected C1 and C2 values from above.

Figure 160: Wall Conduction Load

Time	CLTD (K)	C1	C2	Corrected CLTD	Q (Watts)
8:00 AM	6	3.5	-3.9	5.6	59
9:00 AM	6	3.5	-3.9	5.6	59
10:00 AM	7	3.5	-3.9	6.6	70
11:00 AM	8	3.5	-3.9	7.6	81
12:00 PM	11	3.5	-3.9	10.6	112
1:00 PM	12	3.5	-3.9	11.6	123
2:00 PM	14	3.5	-3.9	13.6	144
3:00 PM	16	3.5	-3.9	15.6	165
4:00 PM	17	3.5	-3.9	16.6	176
5:00 PM	17	3.5	-3.9	16.6	176
6:00 PM	17	3.5	-3.9	16.6	176
7:00 PM	18	3.5	-3.9	17.6	187
8:00 PM	18	3.5	-3.9	17.6	187
9:00 PM	17	3.5	-3.9	16.6	176
10:00 PM	17	3.5	-3.9	16.6	176
11:00 PM	16	3.5	-3.9	15.6	165
12:00 AM	15	3.5	-3.9	14.6	155
1:00 AM	14	3.5	-3.9	13.6	144
2:00 AM	13	3.5	-3.9	12.6	134
3:00 AM	12	3.5	-3.9	11.6	123
4:00 AM	11	3.5	-3.9	10.6	112
5:00 AM	9	3.5	-3.9	8.6	91
6:00 AM	8	3.5	-3.9	7.6	81
7:00 AM	7	3.5	-3.9	6.6	70
				TOTAL	**3142**

The following is a summary of the total cooling load generated from a window (clerestory) or a wall in the space.

Figure 161: Total Cooling Load

Time	Window Load (W)	Window Load (Btu/hr)	Wall Load (W)	Wall Load (Btu/hr)
8:00 AM	6365	21716	59	203
9:00 AM	6344	21646	59	203
10:00 AM	5403	18436	70	239
11:00 AM	3861	13175	81	275
12:00 PM	2570	8769	112	383
1:00 PM	2200	7508	123	420
2:00 PM	1927	6573	144	492
3:00 PM	1775	6055	165	564
4:00 PM	1566	5345	176	600
5:00 PM	1269	4331	176	600
6:00 PM	995	3396	176	600
7:00 PM	556	1896	187	637
8:00 PM	301	1027	187	637
9:00 PM	212	723	176	600
10:00 PM	123	419	176	600
11:00 PM	90	307	165	564
12:00 AM	34	115	155	528
1:00 AM	34	115	144	492
2:00 AM	-22	-77	134	456
3:00 AM	-79	-268	123	420
4:00 AM	-79	-268	112	383
5:00 AM	-13	-44	91	311
6:00 AM	3131	10684	81	275
7:00 AM	5344	18235	70	239
TOTAL	**43907**	**149811**	**3142**	**10722**

SAVINGS **40765 W** **139089 Btu/hr**

This results in a 93% savings in energy.

Part 2: Additional Cooling Loads

The second part of this study focuses on the remaining load contributions from other sources in the space. This includes the remaining exterior curtainwall, lighting, and people occupying the space. There are no appliances present in the room, so there will be no load contribution from such items. As previously mentioned, since the space is pressurized, there are no ventilation and infiltration loads. All known values were previously presented.

Exterior Curtainwall Load Contribution

– Conduction through the glass

Q = U*A*CLTD

U = 1.59 W/(sq.m * K)

A = 200 sq.m

CLTD Values from Table 34: Cooling Load Temperature Differences (CLTD) for Conduction through Glass

C1 = 25.5 - t_i = 25.5 - 22 =3.5

C2 = t_m - 29.4 = 25.5 - 29.4 = -3.9

Corrected CLTD = CLTD + C1 + C2

Figure 162: Curtainwall Conduction Load

Time	CLTD (K)	C1	C2	Corrected CLTD	Q (Watts)
8:00 AM	0	3.5	-3.9	-0.4	-127
9:00 AM	1	3.5	-3.9	0.6	191
10:00 AM	2	3.5	-3.9	1.6	509
11:00 AM	4	3.5	-3.9	3.6	1145
12:00 PM	5	3.5	-3.9	4.6	1463
1:00 PM	7	3.5	-3.9	6.6	2099
2:00 PM	7	3.5	-3.9	6.6	2099
3:00 PM	8	3.5	-3.9	7.6	2417
4:00 PM	8	3.5	-3.9	7.6	2417
5:00 PM	7	3.5	-3.9	6.6	2099
6:00 PM	7	3.5	-3.9	6.6	2099
7:00 PM	6	3.5	-3.9	5.6	1781
8:00 PM	4	3.5	-3.9	3.6	1145
9:00 PM	3	3.5	-3.9	2.6	827
10:00 PM	2	3.5	-3.9	1.6	509
11:00 PM	2	3.5	-3.9	1.6	509
12:00 AM	1	3.5	-3.9	0.6	191
1:00 AM	1	3.5	-3.9	0.6	191
2:00 AM	0	3.5	-3.9	-0.4	-127
3:00 AM	-1	3.5	-3.9	-1.4	-445
4:00 AM	-1	3.5	-3.9	-1.4	-445
5:00 AM	-1	3.5	-3.9	-1.4	-445
6:00 AM	-1	3.5	-3.9	-1.4	-445
7:00 AM	-1	3.5	-3.9	-1.4	-445
				TOTAL	**19207**

– Solar load through the glass

Q = A*SC*SCL

A = 200 sq.m

SC = 0.31

Zone Type for Glass Solar = A - Table 35*:* Zone Types for Use with SCL and CLF Tables (4 walls, carpet, gypsum, no inside shade)

SCL values from Table 36: July Solar Cooling Load for Sunlit Glass 40ºNorth Latitude (South-Facing) (NICoE is located at 38ºN latitude, but text states a loss of accuracy of table for latitudes lower than 24ºN latitude.)

Figure 163: Solar Radiation Load

Time	SCL (W/sq.m)	Q (Watts)
8:00 AM	79	4898
9:00 AM	129	7998
10:00 AM	202	12524
11:00 AM	268	16616
12:00 PM	306	18972
1:00 PM	302	18724
2:00 PM	265	16430
3:00 PM	198	12276
4:00 PM	132	8184
5:00 PM	98	6076
6:00 PM	63	3906
7:00 PM	25	1550
8:00 PM	13	806
9:00 PM	6	372
10:00 PM	3	186
11:00 PM	0	0
12:00 AM	0	0
1:00 AM	0	0
2:00 AM	0	0
3:00 AM	0	0
4:00 AM	0	0
5:00 AM	0	0
6:00 AM	28	1736
7:00 AM	54	3348
	TOTAL	**134602**

Occupant (People) Load Contribution

The cooling load generated from people in the space consists of sensible and latent loads.

It is assumed that there is an average of 15 people in the space. The building is open for 12 hours from 8:00 am to 8:00 pm.

– Sensible Cooling Load

$Q_s = N * SHG_p * CLF_p$

Number of people in space, N = 15

Sensible Heat Gain per Person,SHG_p = 80 W - Table 3*:* Rates of Heat Gain from Occupants of Conditioned Spaces

Assumed degree of activity is similar to light bench work (real activity consists of weightlifting and other physical therapy activities).

Zone Type for People = B - Table 35*:* Zone Types for Use with SCL and CLF Tables (4 walls, carpet, gypsum, no inside shade)

Cooling Load Factor for People, CLF_p = Table 37: Cooling Load Factors for People and Unhooded Equipment

– Latent Cooling Load

$Q_l = N * LHG_p$

Number of people in space, N = 15

Latent Heat Gain per Person, LHG_p = 140 W - *Table 3:* Rates of Heat Gain from Occupants of Conditioned Spaces

Assumed degree of activity is similar to light bench work (real activity consists of weightlifting and other physical therapy activities).

Figure 164: Occupant Load

Time	Number of People	Hours in Space	Hours after Entry	SHG_p	LHG_p	CLF_p	Sensible Cooling Load (W)	Latent Cooling Load (W)
8:00 AM	15	12	24	80	140	0.02	24	2100
9:00 AM	15	12	1	80	140	0.66	792	2100
10:00 AM	15	12	2	80	140	0.76	912	2100
11:00 AM	15	12	3	80	140	0.81	972	2100
12:00 PM	15	12	4	80	140	0.86	1032	2100
1:00 PM	15	12	5	80	140	0.89	1068	2100
2:00 PM	15	12	6	80	140	0.92	1104	2100
3:00 PM	15	12	7	80	140	0.94	1128	2100
4:00 PM	15	12	8	80	140	0.95	1140	2100
5:00 PM	15	12	9	80	140	0.96	1152	2100
6:00 PM	15	12	10	80	140	0.97	1164	2100
7:00 PM	15	12	11	80	140	0.98	1176	2100
8:00 PM	15	12	12	80	140	0.98	1176	2100
9:00 PM	15	12	13	80	140	0.34	408	2100
10:00 PM	15	12	14	80	140	0.24	288	2100
11:00 PM	15	12	15	80	140	0.19	228	2100
12:00 AM	15	12	16	80	140	0.14	168	2100
1:00 AM	15	12	17	80	140	0.11	132	2100
2:00 AM	15	12	18	80	140	0.08	96	2100
3:00 AM	15	12	19	80	140	0.06	72	2100
4:00 AM	15	12	20	80	140	0.05	60	2100
5:00 AM	15	12	21	80	140	0.04	48	2100
6:00 AM	15	12	22	80	140	0.03	36	2100
7:00 AM	15	12	23	80	140	0.02	24	2100
						TOTAL	**14400**	**50400**

Lighting Load Contribution

It is assumed that the cooling load system operates 24 hours/day. The space cooling load from lighting is:

$Q_{el} = W * F_{ul} * F_{sa} * CLF_{el}$

Total Watts, W = 6051 W

780 W are on 24 hours/day

5271 W are on for 12 hours/day (8:00 am to 8:00 pm)

Lighting use factor, F_{ul} = 1.00 - assuming lights are at full output (Some lights are on dimming photosensors, but the dimming levels throughout the day vary and are unknown. Therefore, the worst case would be a day where the lights are all at full output.)

Lighting special allowance factor, F_{sa} = 1.25 for fluorescent lights

Zone Type for People = B - Table 35*:* Zone Types for Use with SCL and CLF Tables (4 walls, carpet, gypsum, no inside shade)

Lighting Cooling Load Factor, CLF_{el} = Table 38: Cooling Load Factors for Lights

CLF_{el} = 1.0 for lights that remain on for 24 hours/day

Figure 165: Lighting Load

			Lamp Watts		Heat Gain (W)		CLF_{ef}		
Time	Hours in Space	Hours after Entry	Timed	Always On	Timed	Always On	Timed	Always On	Cooling Load (W)
8:00 AM	12	24	5271	780	6589	975	0.03	1	1173
9:00 AM	12	1	5271	780	6589	975	0.76	1	5982
10:00 AM	12	2	5271	780	6589	975	0.86	1	6641
11:00 AM	12	3	5271	780	6589	975	0.91	1	6971
12:00 PM	12	4	5271	780	6589	975	0.93	1	7103
1:00 PM	12	5	5271	780	6589	975	0.95	1	7234
2:00 PM	12	6	5271	780	6589	975	0.95	1	7234
3:00 PM	12	7	5271	780	6589	975	0.96	1	7300
4:00 PM	12	8	5271	780	6589	975	0.96	1	7300
5:00 PM	12	9	5271	780	6589	975	0.97	1	7366
6:00 PM	12	10	5271	780	6589	975	0.97	1	7366
7:00 PM	12	11	5271	780	6589	975	0.97	1	7366
8:00 PM	12	12	5271	780	6589	975	0.97	1	7366
9:00 PM	12	13	5271	780	6589	975	0.24	1	2556
10:00 PM	12	14	5271	780	6589	975	0.14	1	1897
11:00 PM	12	15	5271	780	6589	975	0.09	1	1568
12:00 AM	12	16	5271	780	6589	975	0.09	1	1568
1:00 AM	12	17	5271	780	6589	975	0.05	1	1304
2:00 AM	12	18	5271	780	6589	975	0.05	1	1304
3:00 AM	12	19	5271	780	6589	975	0.04	1	1239
4:00 AM	12	20	5271	780	6589	975	0.04	1	1239
5:00 AM	12	21	5271	780	6589	975	0.03	1	1173
6:00 AM	12	22	5271	780	6589	975	0.03	1	1173
7:00 AM	12	23	5271	780	6589	975	0.03	1	1173
								TOTAL	**102597**

Figure 166: Total Additional Cooling Loads

Time	Total Curtainwall Load (W)	Total Curtainwall Load (Btu/hr)	Occupant Load (W)	Occupant Load (Btu/hr)	Lighting Load (W)	Lighting Load (Btu/hr)
8:00 AM	4771	16278	2124	7247	1173	4001
9:00 AM	8189	27940	2892	9868	5982	20412
10:00 AM	13033	44468	3012	10277	6641	22660
11:00 AM	17761	60600	3072	10482	6971	23784
12:00 PM	20435	69724	3132	10686	7103	24234
1:00 PM	20823	71047	3168	10809	7234	24683
2:00 PM	18529	63220	3204	10932	7234	24683
3:00 PM	14693	50132	3228	11014	7300	24908
4:00 PM	10601	36170	3240	11055	7300	24908
5:00 PM	8175	27892	3252	11096	7366	25133
6:00 PM	6005	20488	3264	11137	7366	25133
7:00 PM	3331	11365	3276	11178	7366	25133
8:00 PM	1951	6656	3276	11178	7366	25133
9:00 PM	1199	4090	2508	8557	2556	8722
10:00 PM	695	2371	2388	8148	1897	6474
11:00 PM	509	1736	2328	7943	1568	5350
12:00 AM	191	651	2268	7738	1568	5350
1:00 AM	191	651	2232	7616	1304	4451
2:00 AM	-127	-434	2196	7493	1304	4451
3:00 AM	-445	-1519	2172	7411	1239	4226
4:00 AM	-445	-1519	2160	7370	1239	4226
5:00 AM	-445	-1519	2148	7329	1173	4001
6:00 AM	1291	4404	2136	7288	1173	4001
7:00 AM	2903	9904	2124	7247	1173	4001
TOTAL	**153809**	**524797**	**64800**	**221098**	**102597**	**350060**

Conclusions

The results from Part 1 show that there was a significant difference between the window and concrete wall material. The wall clearly produces a lower cooling load than the window. It was interesting to see that the window conduction load was very similar to the wall conduction load. The window conduction load at night actually consisted of negative values. This is because of the high U-value of the glass, allowing the cool night to penetrate into the space. The lower U-value of the wall helps to keep the space at a more consistent temperature throughout the day. As expected, the solar radiation load for the window was the greatest. This is because of the large amount of daylight that enters the space. Since the window is east-facing, the largest amount of solar radiation enters the space in the morning (greatest at 8:00 am), and decreases throughout the day. Overall, it is very beneficial to change the glass clerestory to a standard wall composition, resulting in a significant energy savings (40,765 W, 139,089 Btu/hr). This will reduce the load on the HVAC system, decreasing the amount of energy used and resulting in a lower impact on the environment. A reduced use in energy will also be beneficial to the building owners. The cost to run the mechanical systems will be greatly reduced.

Part 2 also provided interesting results. It presents the remaining loads present in the space from other sources, including the exterior curtainwall, people in the space, and lighting. Once again, the largest load contribution was from the solar radiation through the south-facing curtainwall. Its orientation provides an even more significant impact of daylight in the space. The effect of the electric lighting was also surprising. There is a large contribution from these fixtures. There will actually be a reduced lighting load throughout the day as a result of dimming, but for simplicity, this study provides the worst case. Overall, these loads have a significant effect and make up a large portion of the design load for HVAC equipment.

Shown below is an overall comparison of the total cooling loads with and without the clerestory window. Replacing the window with the wall system creates 11.16% in energy savings throughout the day, which is quite significant.

Figure 167: Total Cooling Load for 1 Day in July

	Clerestory Window		**Wall**	
Load Type	Total Load (W)	Total Load (Btu/hr)	Total Load (W)	Total Load (Btu/hr)
Exterior Clerestory	43907	149811	-	-
Exterior Wall	-	-	3142	10722
Exterior Curtainwall	153809	524797	153809	524797
Occupants	64800	221098	64800	221098
Lighting	102597	350060	102597	350060
TOTAL	**365113**	**1245765**	**324348**	**1106677**

SAVINGS: **11.16%** TOTAL COOLING LOAD WITHIN SPACE

Summary & Conclusions

Overall, great effort was exercised to provide fully functional and appealing designs for all of the relevant systems in the National Intrepid Center of Excellence (NICoE). The lighting design for each of the four spaces closely follows the "qualities of a soldier" concept. The exterior fixtures uniquely pull the different parts of the façade together as one. It enables the entire building to work in unison and unite everything within. Upon entering the lobby, occupants are lead from one location to another by way-finding light. The auditorium presents a high-tech feel that provides visual clarity so that users are able to focus on presentations and meetings. The second floor physical therapy and occupational therapy spaces encompass a lighting design that portrays strength to encourage patients throughout their time in the facility. The lighting design in each space also meets the required light levels and specified criteria.

Analysis of the existing daylight features in the space proved that the east-facing clerestory in the physical therapy and occupational therapy space was not providing sufficient light into the space throughout the day, making it an unnecessary feature. In the same space, it was determined that an open-loop photosensor would be the best solution for controlling the cove lights. This type of sensor will adjust appropriately with the changing light levels.

The alterations to the electrical system adequately accommodate for the new lighting design in each space. The existing panelboards are fully utilized to power the appropriate fixtures. A short circuit and coordination study proves that the system will perform properly. Through the voltage drop calculations and wire size analysis, the results show that the increase in wire size may be unreasonable for some sizes and demand loads. However, increasing by one size may be beneficial in energy and cost savings for larger demand loads. Using the SKM software was a very beneficial exercise that provides an enhanced understanding of electrical systems and components. Although all of the information necessary to provide a precise analysis with the computer program is not available, it clearly exhibits how the electrical system operates.

The architectural integration design in the auditorium uniquely optimizes each system within the room. The materials, geometry, and spacing of the wood ceiling panels create a more efficient and visually pleasing lighting design. The direct indirect fixtures highlight the beautiful wood materials that would have otherwise gone unnoticed. Other lighting fixtures and mechanical diffusers are also integrated into the architectural features to maximize the operational capabilities.

The mechanical breadth clearly shows the advantages to eliminating the clerestory in the occupational and physical therapy space. Changing the glass to the standard concrete panels (backed by insulation and gypsum wall board) saves a considerable amount of energy that would have been used to meet the required cooling load. The total calculation of other loads in the space proves that this load savings will have a significant impact.

The research and new designs presented in this report will enable NICoE to remain a state of the art building not only for its outstanding contribution in the medical field, but also for its high performance in building engineering. The successful integration of architecture and building systems enables the composition of both functional and visual effect.

References

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

Adobe Photoshop CS3

AGI-32

Autodesk AutoCAD 2009

Autodesk Revit Architecture & MEP 2009

SKM Power Tools

The following are references used in completing the research and design for this senior thesis:

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