Penn State University

Final Report

The HUB Addition

John C Keyes
4-8-2016

The Hetzel Union Building

John Keyes | L/E Option

Building Statistics

Location | University Park, State College, PA 16801

Size | 107,000 S.F.

Stories | Three stories above grade and two basement levels

Construction Dates | May 2013 – May 2015

Estimated Building Cost | $44,600,000

Project Delivery Method | Design-Bid-Build

Owner | Penn State University

Architect | Gund Partnership

Construction Manager | Gilbane Building Company

Landscape Architect | Andropogon Associates, Ltd.

MEP Engineer | Vanderweil Engineers

Civil Engineer | Sweetland Engineering and Assoc.

Structural Engineer | LeMessurier Consultants

Lighting Consultant | HLB Lighting Design

Interior of Atrium (*Credit to Gund Partnership for all renders)

Architectural

The HUB addition created an open gathering space for students and provided a gateway to the rest of the building from the east side of campus. The terracotta brick relates to the existing building, while still giving the addition its own identity. The roof top over the atrium creates an organic form that adds interest to the space.

The HUB will also be the first building on the campus to feature an occupiable green roof. Other green building practices were implemented, such as using recycled and local materials.

Structural

Composite decking consists of light weight concrete on top of 1.5"-3" galvanized steel deck. These are supported by wide-flange steel beams. Normal weight concrete makes up the footings, columns, and floor slabs on grade. 10 exposed HSS trusses support the steel deck roof in the main atrium.

Lighting/Electrical

The lighting consists almost entirely of LED fixtures. The overall impression created is a public, spacious, and visually clear space. Occupancy sensors, solar cells, and time clocks control the lighting to ensure that the maximum energy savings is achieved. Large glazing allows for daylight harvesting throughout most of the space, while shading devices ensure minimal glare.

The building receives power at medium voltage from the campus and a transformer steps the voltage down to 480Y/277V. A 1600A switch gear, located in the basement, feeds two 600A and two 800A panel boards. A second connection from campus provides emergency power for the building..

Mechanical

7 air handling units supply the building with conditioned air. AHU-1 and 2 supply the bookstore at 16,000 CFM each. AHU-3 and 4 supply the atrium areas at 18,000 CFM each. The campus loop provides the chilled water for cooling and steam for heating throughout the building.

EXECUTIVE SUMMARY

The following report is a detailed record of the work and analysis performed for AE senior thesis AE897G. This thesis contains redesigned lighting schemes for four spaces, an electrical depth, and an integrated study combining a MAE daylighting depth, mechanical breadth, and a construction management breadth. The main purpose of senior thesis is to show an understanding of topics taught in the various AE disciples, as well as an advanced knowledge of the students chosen option.

The four spaces that were subject to a lighting redesign were the outdoor entryways, atrium, bookstore, and flex theater. The details of each solution can be found in the lighting section of the report.

To reflect the new lighting designs, branch circuits were changed and eliminated accordingly. A panelboard resizing study was also performed on eight panelboards. More appropriate demand factors were applied to each panelboard to see if it was able to be downsized. In the end, five of the eight were able to be downsized, leading to a cost savings of $18,000 with materials and labor included.

The integrated study first looked at daylighting within the atrium space. An initial illuminance study was performed and 16 potential daylighting solutions were narrowed down to 4 for a more in-depth study. These four went through an annual daylighting study, as well as an annual mechanical study to assess the daylighting and mechanical performance of each option. A cost analysis was then done to provide the final metric for each design. Based on the metrics of the three disciples, one solution was found to be the optimal case. This would add $100,000 to the project, but this cost is offset by the $300 a year savings in energy loads and provide a more comfortable space year round.

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BUILDING OVERVIEW

Name | The Hetzel Union Building (HUB)

Location | University Park, State College, PA 16801

Occupant Type | Something

Size | 107,000 S.F.

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PROJECT TEAM

Owner: Penn State University

Construction Manager: Gilbane Building Company

Architect: Gund Partnership

Landscape Architect: Andropogon Associates, Ltd.

MEP Engineer: Vanderweil Engineers

Civil Engineer: Sweetland Engineering and Assoc.

Structural Engineer: LeMessurier Consultants

Acoustic Consultant: Acentech Incorporated

AV/IT Consultant: Vantage Technology Group

Lighting Consultant: Horton Lees Brogden Lighting Design

GENERAL BUILDING INFORMATION

The design of the HUB addition both compliments and stands apart from the rest of the HUB. The terra cotta shell is reminiscent of the masonry brick façade on the older portions of the building, but maintains a strong identity as a newer and improved space. The large use of glass helps to create a lighter feel both visually and structurally to the addition as a whole.

There are a variety of spaces within the HUB, including the campus bookstore, various food vendors, THON offices, and various gathering spaces. The bookstore features a design that is both inviting and open. The first story acts as the main store, while the mezzanine level connects to the main floor of the HUB and is more of a study space and casual reading area. The main atrium is the main pathway through the building, connecting the new addition to the old HUB. The main floor also functions as a seating area for the food court. A main stair is positioned in the center of the space that is both for bleacher style seating and a means of getting onto the mezzanine level. The mezzanine is a ring that spans the perimeter of the atrium and is lined with conference rooms and offices that take advantage of the abundance of daylighting with curtain wall like glazing.

FACADES

The three main building facades for the building are terra cotta, curtain wall, and masonry brick. A large portion of the atrium and attached spaces is clad in terra cotta panels, which vary in texture from smooth to corrugate. The masonry brick is the main façade of the bookstore. These bricks vary in color considerably, from a rich crimson to a much lighter rose color. Behind the masonry is 2.5" cavity wool insulation and 8" metal studs that are 16" on center to hold everything up.

The two main curtain wall facades, made up of low-e reflective glazing, provide daylight to the bookstore and to the main atrium space. The upper panels of glass in the atrium space also have frit to help control the amount of direct sunlight that enters the space. In addition to the curtain wall there is also a skylight like system in the atrium space with a metal scrim over top of triangular glass panels.

Lighting Design Depth

LIGHTING DESIGN DEPTH

In this section the final lighting design solutions for the HUB Addition are explained. Each subsection will describe one of the four spaces chosen for redesign. The four spaces include:

Flex Theater

Atrium

Site

Bookstore

CONCEPT – CONNECTIONS

The HUB addition is an appropriate name as it fits the function of the building perfectly. People come in and out filtering through the space to their destinations. The building serves many purposes and house a variety of spaces such as eating areas, gather and study spaces, conference rooms, and concert halls, to name a few. The new addition shares many of these uses and provides both large and small spaces for the student body to use for whatever they'd like. One of the main reasons behind the renovation was to provide better access to the building from the HUB parking deck, to the east, and the east and south sides of campus.

Each of the spaces within the HUB was meant to connect people to something. This could be to the building itself or a specific function of the space. This led me to the concept of connections and using lighting to help promote these connections.




OUTDOOR SPACE | SURROUNDING AREA

EXISTING CONDITIONS

The HUB addition has two main access points, one to the East and South. These are connected to campus through various pedestrian walkways. A 50' elevation change occurs between the two entrances and stairs are needed to get from one elevation to the next. The south façade of the bookstore frames the southern entrance, adding some architectural interest to the area through materials and forms.

DIMENSIONS

Area of grounds – 7000 ft^2

FINISHES AND GLAZING

The façade consists of two materials, terracotta bricks and aluminum curtain wall. The terracotta bricks are one of two kinds, smooth or grooved. The pavers that make up the occupiable area are made of granite and the sitting walls are poured concrete. The curtain wall glazing is the same low-e glass as the atrium space (see atrium finishes). The pedestrian walkways are also made of concrete.

Site Materials				
Surface	Material	Descrption	Color	Reflectance
Exterior Walls	Terra/ACW	Terracotta panels and aluminum curtain wall	Red	0.41
Site	Concrete	Poured concrete	Gray	0.4

SITE PLAN

Sheet: E1.00

PLANTINGS

There are a variety of plantings that will be used throughout the site and on the green roof. The main types of trees that will be planted are the blackgum, eastern redbud, and pagoda dogwood trees. The green roof will be home to stonecrop, gold sedum, dragon's blood sedum, and southern stonecrop to name a few.

TASKS

Way-finding and security in the evening hours are very important on the pathways. The outdoor lighting should ensure that pedestrians can not only navigate the area, but feel safe while doing so. The entrances into the space should also be made apparent through lighting.

DESIGN CRITERIA/CONSIDERATIONS

QUALITATIVE CRITERIA

Very Important

- Adequate lighting of area
  - Lighting the area to appropriate levels to ensure safety and security of the building and pedestrians

Important

- Provide interest to the space
  - Lighting some of the architectural features on the façade may add interest to the area and enhance the visual experience of bystanders
- Continuity of existing lighting
  - To ensure a smooth transition from outside areas fixtures specified should comply with campus codes and design practices

QUANTITATIVE CRITERIA

Recommended Horizontal Illuminance

- Classification – Common Applications
  - Building Entries, Canopied entries/exit, medium activity, LZ2
    - Category F: 10 lux at ground
    - Avg/Min: 2:1

Recommended Vertical Illuminance

- Classification – Common Applications
  - Building Entries, Canopied entries/exit, medium activity, LZ2
    - Category D: 6 lux

LEED

SSC: Light Pollution Reduction

- Meet uplight and light trespass requirements, using either the backlight-uplight-glare (BUG) method (Option 1) or the calculation method (Option 2). Projects may use different options for uplight and light trespass

Meet these requirements for all exterior luminaires located inside the project boundary (except those listed under "Exemptions"), based on the following:

- the photometric characteristics of each luminaire when mounted in the same orientation and tilt as specified in the project design; and
- the lighting zone of the project property (at the time construction begins). Classify the project under one lighting zone using the lighting zones definitions provided in the Illuminating Engineering Society and International Dark Sky Association (IES/IDA) Model Lighting Ordinance (MLO) User Guide.

EAP: Minimum Energy Performance Required

- Comply with the mandatory and prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1–2010, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.).

EAC: Optimize Energy Performance (Major Renovation)

- Reduce overall energy consumption by 4% - 40% for 1 – 16 points.

Model Lighting Ordinance

Energy Allowances

The following table shows the energy allowance for the outdoor space according to ASHRAE 2013 Table 9.4.2-2.

Energy Allowance			
Space	Area (SF)	W/SF	Allowable Wattage
Site	7000	0.16	1120

ASHRAE 2013 Standards

9.4.1.4

DESIGN CRITERIA SELECTED

1) Create a safe outdoor environment with proper lighting
2) Meet ASHRAE energy code requirements
3) Limit uplight to comply with MLO and limit light pollution
4) Meet LEED requirements

DESIGN DEVELOPMENT

SUMMARY

Pole mounted fixtures are used to provide the general area illumination away from the building and along the pathways. These fixtures follow the campus standard to match the surrounding areas. Within the immediate vicinity of the building, these are replaced with wall-mounted flood lights. This is to create a shift in how the area is being lit that marks the transition from outside to inside. The goal is to provide light without the sources being apparent. This also helps to draw more attention to the Light Tape ™ that is placed in the joints between the terracotta panels on the bookstore's southern façade. This subtle decorative layer of light not only draws attention and provides visual interest to the area, but also mimics the atrium terracotta wall. The layout of the Light Tape ™ represents nature reaching into the building through the many curtain walls of the addition, forming a connection between the interior and exterior and breaking the barrier between nature and the built environment.

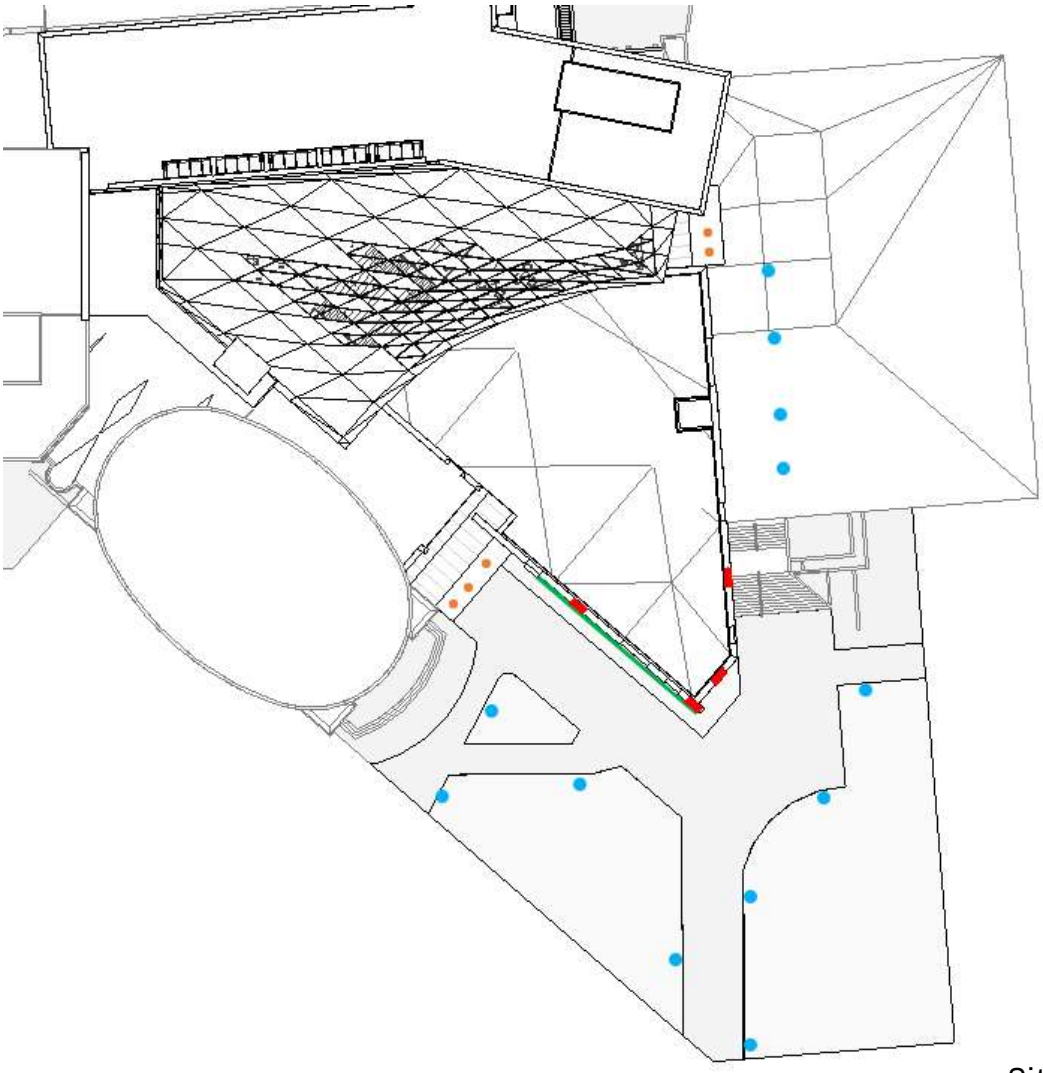
Southern Entrance

The final layer of light is provided by recessed downlights in the overhangs above the entryways. This provides adequate light to the area, while also acting as a beacon of light drawing people inside the building.

South Eastern View

FIXTURE & EQUIPMENT SELECTION

The light fixtures used to light the outdoor space are comprised entirely of LEDs. Cut sheets can be found in appendix A and detailed fixture schedules can be found in appendix B.



Site Plan

Fixture Schedule				
Type	Symbol	Image	Description	Manufacturer
L7			Electroluminescent thin strip light	Light Tape
L12			LED area conical pole light	Louis Poulson
L13			Recangular LED 150W CMH replacment	RAB
L14			2" recessed wet rated outdoor LED downlight	Juno

Fixture Calculations							Lightloss Factors			
Type	Quantity	W/fixture	Total Wattage	PF	Va/fixture	Total VA		LLD	LDD	Total
L7	5352 in^2	0.016 W/in^2	86	1	0.016 W/in^2	86	L7	0.8	0.96	0.77
L12	12	44	528	1	44	528	L12	0.8	0.96	0.77
L13	4	39	156	1	39	156	L13	0.8	0.96	0.77
L14	5	5	25	1	5	25	L14	0.8	0.96	0.77

CONTROLS STRATEGY

All lighting will be on a time clock and photo sensor to ensure that fixtures won't be placed on when not needed, but would provide light when there is insufficient daylight. The time clock would ensure that all decorative lighting would be extinguished by 12:00 AM to conform to MLO 2011 standards.

CALCULATION SUMMARY

The table below summarizes the calculations for the space. For more in-depth analysis, refer to the pseudo color renderings.

Outdoor Illuminance Criteria					
Category		Horizontal Illuminance (lux)		Vertical Illuminance (lux)	
Space	Metric	Recommended	Achieved	Recommended	Achieved
Site	Average	10	13	6	9
	Avg/Min	2:1	5:1	--	--
Entry	Average	10	29	6	19
	Avg/Min	2:1	1.4:1	--	--

EVALUATION

SUMMARY

The new site lighting design provides an even amount of light throughout the site. Some hot spots exist under the pole lights, but they are unavoidable and due to the spacing aren't an issue. The flood lighting on top of the southern bookstore wall help fill in the surrounding area with light, as well as light the pathway near the building evenly. The downlights under the entrance canopies give light levels three times the surrounding to ensure that they add emphasis and draw people toward the entrances to the building. Finally, the Light Tape ™ provides a nice glow on the southern bookstore wall, drawing people's attention without being overbearing. Although the decorative lighting isn't normal for Penn State, I feel that it adds to the architecture, while not using a considerable amount of wattage. Due to the mounting location between the joints of the brick along with the color of the tape, it should be undetectable to anyone not actively looking for it during the day. This is important, as it doesn't change the daytime aesthetic of the building.

This design fulfilled the design goals set for the area. The required light levels were met, visual interest and emphasis was added, and energy codes were met. Additionally, a safe and secure feeling area was established through uniform light levels and adequate vertical illuminances.

ASHRAE/IESNA

The proposed design is 29% better than the ASHRAE standards. The system uses 795 watts at full brightness giving an overall power density of 0.11 W/SF. The decorative portion of the lighting only uses 86 watts of power as well, which accounts for less than a tenth of the total wattage. The use of LEDs and flood lighting allowed for a modest power usage that complies with Penn States rule of thumb to be at least 25% better than ASHRAE standards.

Energy Usage (ASHRAE/IESNA) - Outdoor		
Category	Allowable	Calculated
Area (SF)	--	7000
Input Wattage	1120	795
Power Density (W/SF)	0.16	0.11

CIRCULATION SPACE | LARGE ATRIUM

EXISTING CONDITIONS

The atriums primary use is seating, for the food area, and circulation. This space connects the east entrances as well as the parking deck traffic to the rest of the HUB. There is also a gathering space that connects the 1st floor to the mezzanine level, which features both stairs and bleacher style seating. At times of lower traffic, it could act as a gathering space as well for various clubs or other student activities. There is an abundance of daylight through the exterior gazing and skylight aperture.

DIMENSIONS

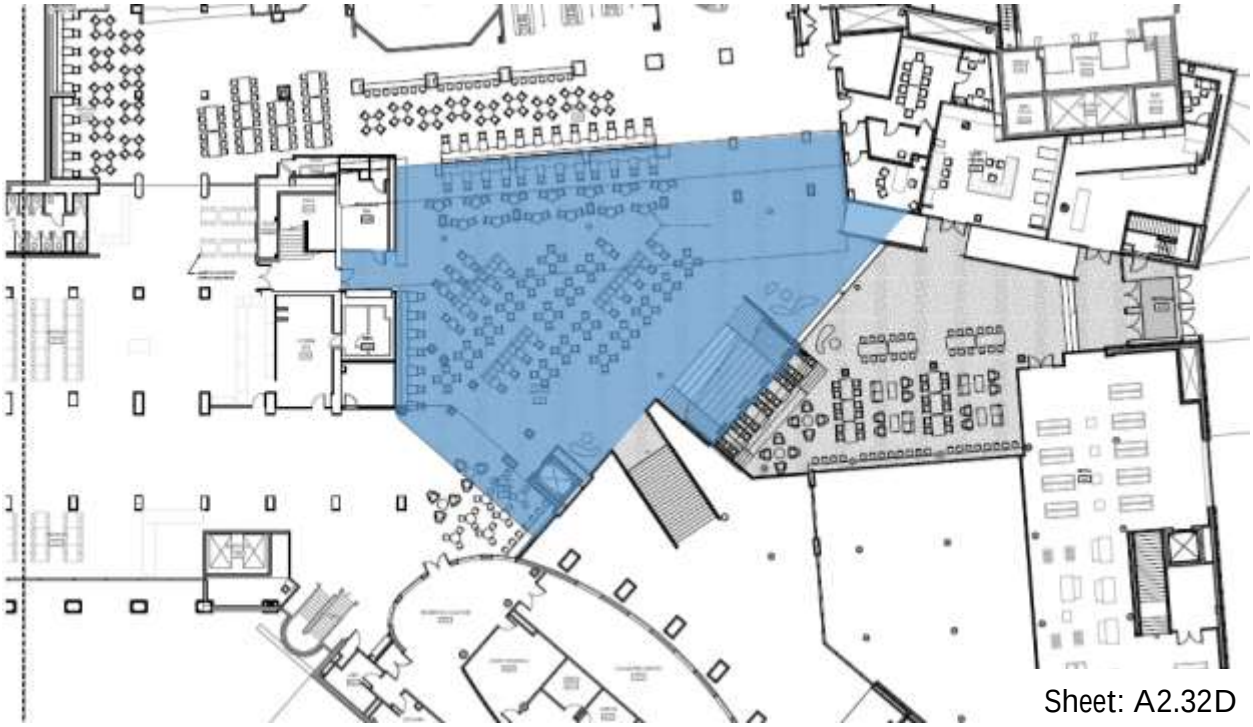
Area – 9300 ft^2

Approximate width – 78 ft.

Approximate length – 165 ft.

Approximate ceiling height – 38 ft.

1ST FLOOR PLAN



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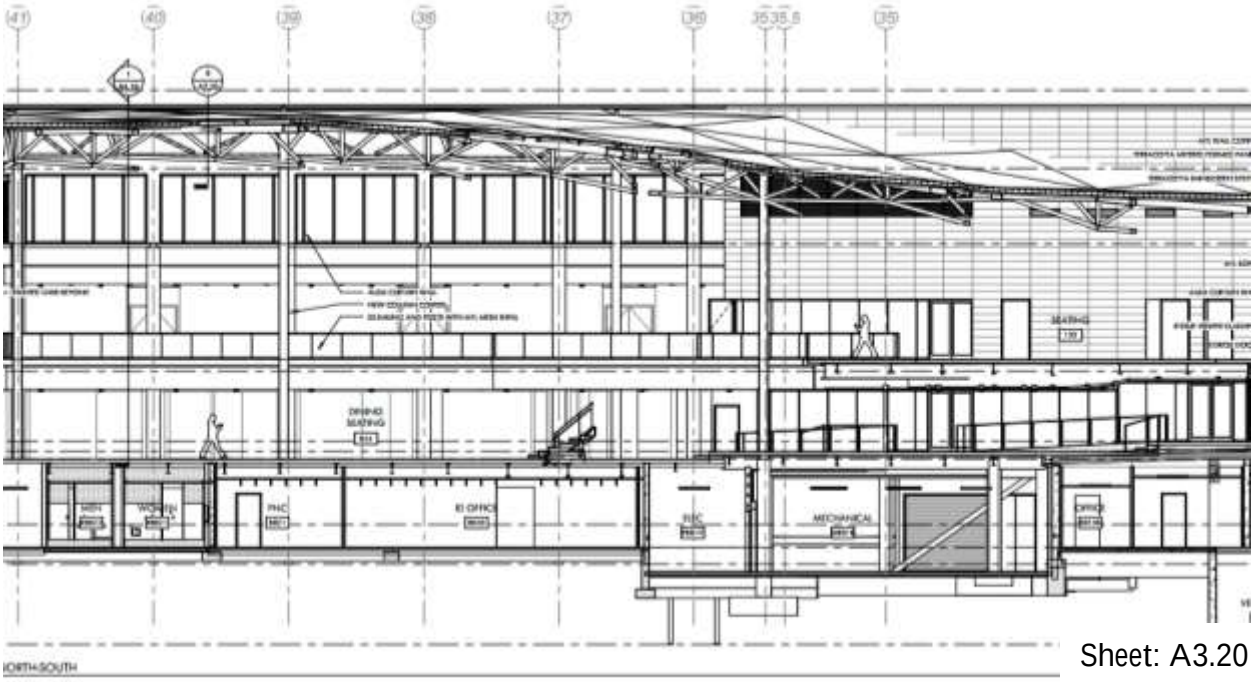
2ND FLOOR PLAN

NORTH SOUTH SECTION



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FINISHES

The floors are made up of terrazzo tiles that have a high reflectance to aid daylights contribution deep in the space. The walls are primarily painted gypsum wall board, but also consist of terracotta and glazing. The terracotta blocks vary from smooth to grooved at a ratio of 4:1. The curtain walls range in opacity from completely clear to partially obscured due to the presence of frit on the upper panels. The ceiling is exposed steel panels mixed with glass skylight panels, which also contain frit.

Atrium Materials				
Surface	Material	Descrption	Color	Reflectance
Ceiling	GSRD	3" Galvanized steel roof deck	Eggshell	0.85
Wall	GWB/PTD, GCW	Painted gypsum and aluminum fromed curtain wall	Eggshell	0.9
Floor	Terr	Terrazzo Flooring	Eggshell	0.85

GLAZING

The glazing spanning the north, west, and south side is comprised of low-E glass. Frit is introduced in the panels on the mezzanine floor and increases in density as they get closer to the ceiling. The visibility ranges from roughly 70% to 50% transmittance.

FURNITURE & EQUIPMENT

This area needs to accommodate a wide variety of uses, from collaboration space to dining areas. The solution was to have mobile furniture to allow this to be a dynamic space, shaped by its occupants. Most of the tables and chairs are free to move about the space with the exception of a few fixed raised restaurant style benches. On the north western end of the space is a line of fixed benches that act to separate this space from the food court area.

TASKS

The atrium's main purpose is a transition space and entrance to the building, linking several entrances to the main portion of the building. Because of this way-finding is paramount in this area. Reading and eating will also be occurring within the atrium, as well as general conversation.

DESIGN CONCEPT & GOALS

Within the atrium, there are a lot of different activities that happen. These range from eating and conversation to studying or watching a demonstration. These activities share a common thread of being centered on people their interactions. This is where I drew the inspiration for the lighting, connecting people to people. The lighting in the space should promote and reinforce making these connections by highlighting areas of interest and adding some visual interest to the space.

Navigation| The atrium is a large junction connecting different areas of the old and new HUB. It is likely that this will be one of the first spaces that people come to upon entering the building. The lighting should help limit confusion and guide people to areas of interest, as well as the different paths they can take to other areas.

Promote Interaction| This space is all about interpersonal connections and reinforcing them. The lighting should highlight areas that house these interactions and draw people to them.

Daylighting| There is an extensive use of curtain walls and skylights in the atrium, as such daylighting controls need to be put into place to react to the dynamic nature of the sun. The controls would regulate the amount of incoming daylight and dim electric lighting according to current conditions.

DESIGN CRITERIA

QUALITATIVE CRITERIA

Most Important

- Way-Finding
  - Since this is a major entrance area to the building it might be difficult for occupants to orient themselves at first. The lighting should help alleviate this as much as possible.
- Daylighting Controls
  - Since daylighting is so abundant throughout the space, the lighting within the space should respond accordingly, allowing for increased energy savings.
- Overall Appearance of Space
  - The lighting should enhance the architecture and provide a nice environment for occupants to come into as they enter the building.
- Glare Control
  - Due to the extensive use of glass in the space, it is imperative that glare from the sun be controlled. This is especially important for the southern and southwestern facades.

Important

- Color Rendering
  - The light sources in the space should render colors in a natural and pleasing manner.

PSYCHOLOGICAL IMPRESSION

The Flynn mode that I feel is most appropriate for a redesign of this space would be one of spaciousness and clarity.

QUANTITATIVE CRITERIA

Recommended Horizontal Illuminance

- Classification – Common Applications
  - Reading / Writing HB Pencil
    - Category P: 300 lux at work plane
    - Avg/Min: 2:1

Recommended Vertical Illuminance

- Classification – Common Applications
  - Reading / Writing HB Pencil
    - Category L: 75 lux at work plane

LEED

EAP: Minimum Energy Performance Required

- Comply with the mandatory and prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1–2010, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.).

EAC: Optimize Energy Performance (Major Renovation)

- Reduce overall energy consumption by 4% - 40% for 1 – 16 points.

EQC: Interior Lighting

- For at least 90% of individual occupant spaces, provide individual lighting controls that enable occupants to adjust the lighting to suit their individual tasks and preferences, with at least three lighting levels or scenes (on, off, midlevel). Midlevel is 30% to 70% of the maximum illumination level (not including daylight contributions). For all shared multi-occupant spaces, meet all of the following requirements.

- Have in place multizone control systems that enable occupants to adjust the lighting to meet group needs and preferences, with at least three lighting levels or scenes (on, off, midlevel).
- Lighting for any presentation or projection wall must be separately controlled.
- Switches or manual controls must be located in the same space as the controlled luminaires. A person operating the controls must have a direct line of sight to the controlled luminaires.

EQC: Daylight

- Demonstrate through annual computer simulations that spatial daylight autonomy300/50% (sDA300/50%) of at least 55%, 75%, or 90% is achieved. Use regularly occupied floor area. Healthcare projects should use the perimeter area determined under EQ Credit Quality Views.

EQC: Quality Views

- Achieve a direct line of sight to the outdoors via vision glazing for 75% of all regularly occupied floor area. View glazing in the contributing area must provide a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance.

Additionally, 75% of all regularly occupied floor area must have at least two of the following four kinds of views:

- multiple lines of sight to vision glazing in different directions at least 90 degrees apart;
- views that include at least two of the following: (1) flora, fauna, or sky; (2) movement; and (3) objects at least 25 feet (7.5 meters) from the exterior of the glazing;
- unobstructed views located within the distance of three times the head height of the vision glazing; and
- views with a view factor of 3 or greater, as defined in "Windows and Offices; A Study of Office Worker Performance and the Indoor Environment."

Energy Allowances

The following table shows the energy allowance for the atrium according to ASHRAE 2013 space by space method.

Energy Allowance			
Space	Area (SF)	W/SF	Allowable Wattage
Atrium	9300	1.8	16740

ASHRAE 2013 Standards

9.4.1.1(a),(b),(d),(e),(f),(h)

DESIGN CRITERIA SELECTED

1) Meet ASHRAE Standards
2) Implement daylighting controls
3) Control glare
4) Create a visually pleasing environment

DESIGN DEVELOPMENT

SUMMARY

The fixtures within the atrium are all 3500K to create a space that was neither cool nor warm. The ambient layer of light is provided by a series of high output pendants mounted on the ceiling. Most of the fixtures were mounted below the structural trusses to avoid scalloping. These provide a uniform base layer of light on the main floor and the mezzanine level, with the exception of the main stair were a slightly higher light level was used to provide emphasis.

Main Stair from Mezzanine Balcony

Several layers of light serve to highlight four areas within the space. The first are linear wall washers used to wash the wall north of the old HUB junction. This was to provide a beacon to that path, as well as add visual interest to the space and promote the use of the adjacent seating areas. The next are decorative pendants above the main seating area on the main floor. They serve to provide a decorative glow and mark the seating area. The cascading circular forms of the pendant itself represents the many personal connections that we make. The final layer is also Light Tape ™ that is placed within the horizontal grooves of the terra cotta wall.

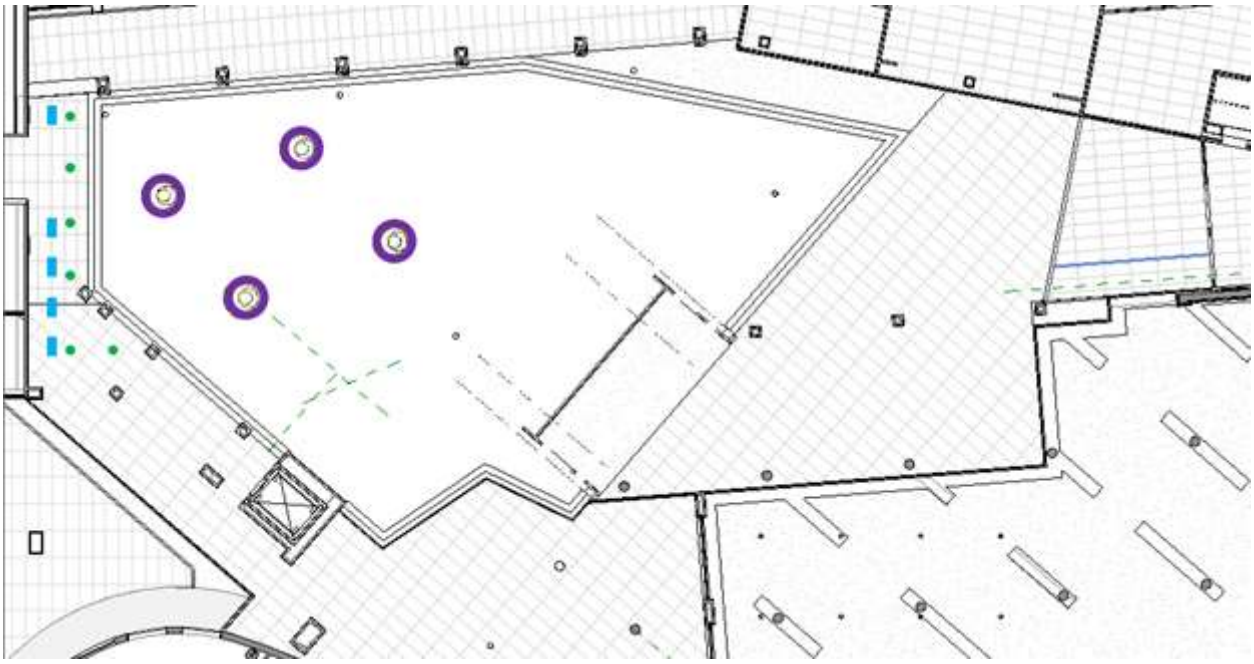
East Mezzanine Seating Toward Theater

East Entrance to Old HUB

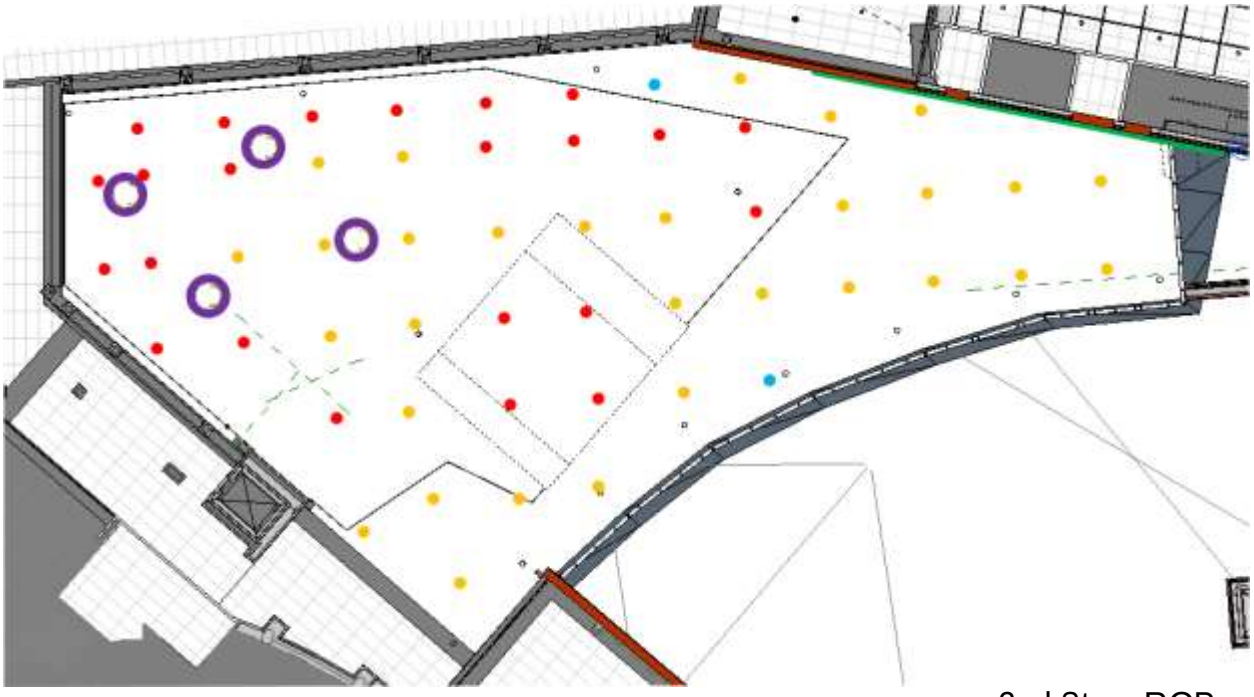
FIXTURE & EQUIPMENT SELECTION

The lighting with the atrium is entirely LED. Cut sheets can be found in appendix A and detailed fixture schedules can be found in appendix B.

Fixture Schedule				
Type	Symbol	Image	Description	Manufacturer
L1			9000 lumen 45° HO LED pendant	Prescolite
L2			6000 lumen 45° HO LED pendant	Prescolite
L3			3000 lumen 45° HO LED pendant	Prescolite
L4			6" 1100 lumen 45° recessed LED downlight	Prescolite
L5			Recessed 2' LED linear wall washer	Lighting Quotient
L6			LED circular decorative pendant	Sattler
L7			Electroluminescent thin strip light	Light Tape



1st Story RCP



2nd Story RCP

East West Elevation

Fixture Calculations							Lightloss Factors			
Type	Quantity	W/fixture	Total Wattage	PF	Va/fixture	Total VA		LLD	LDD	Total
L1	22	99	2178	1	99	2178	L1	0.8	0.96	0.77
L2	30	66.5	1995	1	66.5	1995	L2	0.8	0.96	0.77
L3	2	33.9	67.8	1	33.9	67.8	L3	0.8	0.96	0.77
L4	6	14	84	1	14	84	L4	0.8	0.96	0.77
L5	5	48	240	1	48	240	L5	0.8	0.96	0.77
L6	4	255	1020	1	255	1020	L6	0.8	0.96	0.77
L7	1572.5 in^2	0.016 W/in^2	25.2	1	0.016 VA/in^2	25.2	L7	0.8	0.96	0.77

CONTROLS STRATEGY

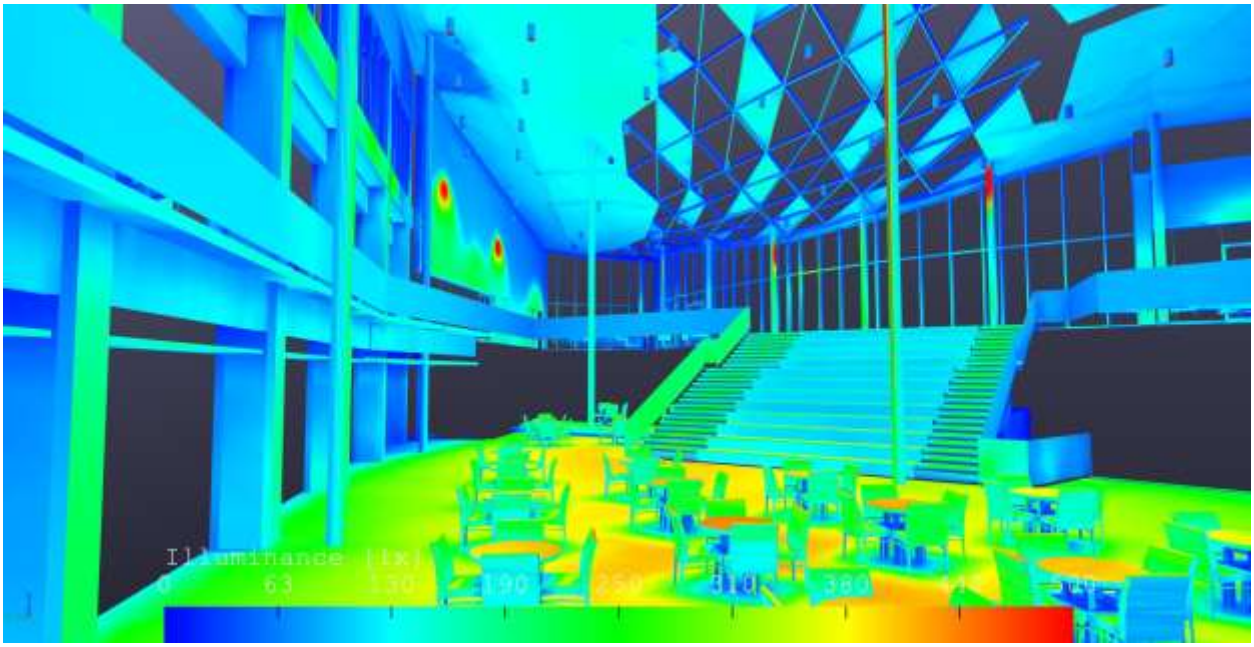
All lighting within the atrium space are on a time clock that dims the entire system during the evening hours. L1–L3 are also controlled by daylight sensors, dimming them when there is sufficient daylight. Lighting is keyed from the public to prevent tampering.

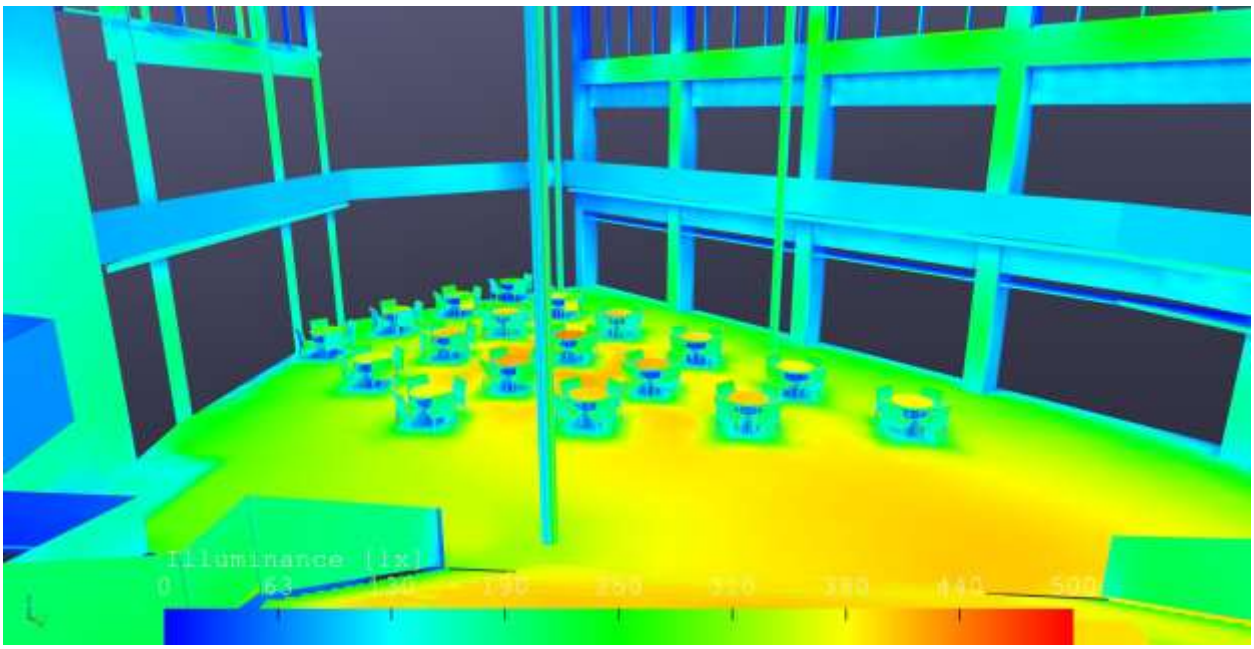
CALCULATION SUMMARY

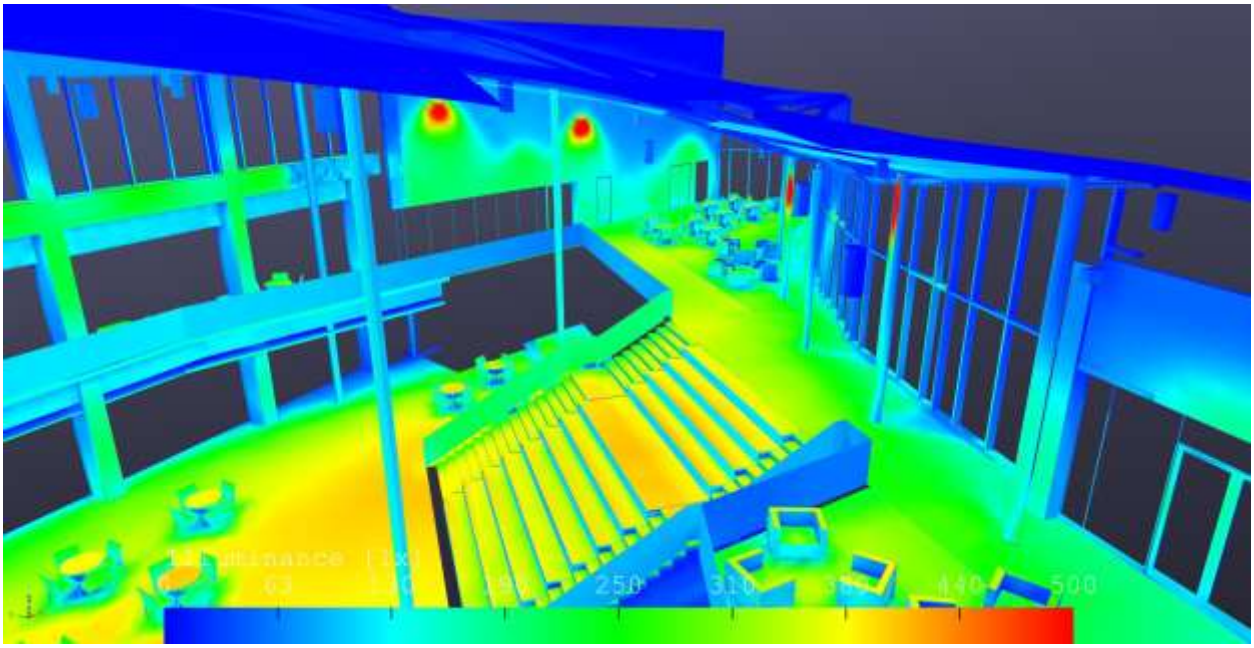
The table below summarizes the calculations for the space. For more in-depth analysis, refer to the pseudo color renderings.

Atrium Illuminance Criteria					
Category		Horizontal Illuminance (lux)		Vertical Illuminance (lux)	
Space	Metric	Recommended	Achieved	Recommended	Achieved
Main Floor	Average	300	346	150	190
	Avg/Min	2:1	1.7:1	--	--
West Seating	Average	300	332	150	313
	Avg/Min	4:1	1.6:1	--	--
Main Stair	Average	300	375	150	120
	Avg/Min	4:1	1.6:1	--	--
West Mezz Seating	Average	300	319	150	100
	Avg/Min	4:1	1.7:1	--	--
East Mezz Seating	Average	300	281	150	120
	Avg/Min	4:1	2.4:1	--	--
Mezz Corridor	Average	50	268	30	110
	Avg/Min	2:1	2:1	--	--

KEY (LUX)							
0-60	60-120	120-180	180-240	240-300	300-370	370-440	440-500







EVALUATION

SUMMARY

The lighting provides a uniform light level throughout the space, providing a sense of spaciousness and clarity. Spots of emphasis are used to attract occupants to social areas, such as the main seating and main stair. These spots are created mainly by the decorative lighting .These also help to create a visual hierarchy, helping to separate transition areas from gathering spots and navigate the space. These highlights add a level of visual interest to the space beyond the general lighting.

This design fulfilled the design goals set for the space. The required light levels were met, visual interest was created, daylight works in tandem with electric lighting, and energy codes were met.

ASHRAE/IESNA

The proposed design is currently 66% better than the ASHRAE requirements. The system as a whole is using 5610 watts when at full brightness. Due to the daylighting controls and the dimmed state that the decorative lighting will be in, this number will actually be lower, further increasing the energy savings. The extensive use of LED lighting is responsible for the substantial energy reduction.

Energy Usage (ASHRAE/IESNA) - Atrium		
Category	Allowable	Calculated
Area (SF)	--	9300
Input Wattage	16740	5610
Power Density (W/SF)	1.80	0.60

LARGE WORK SPACE | BOOKSTORE

EXISTING CONDITIONS

The bookstore is a large open retail area. The entrance is open to the second story, creating a clear entryway into the space. Most of the products are on the first floor with the book section in a separate space in the back. The mezzanine level has a small library and reading area. The southern façade sports floor to ceiling windows that have solar shading louvers attached to the outside.

DIMENSIONS

Area – 22000 ft^2

Approximate width – 136 ft.

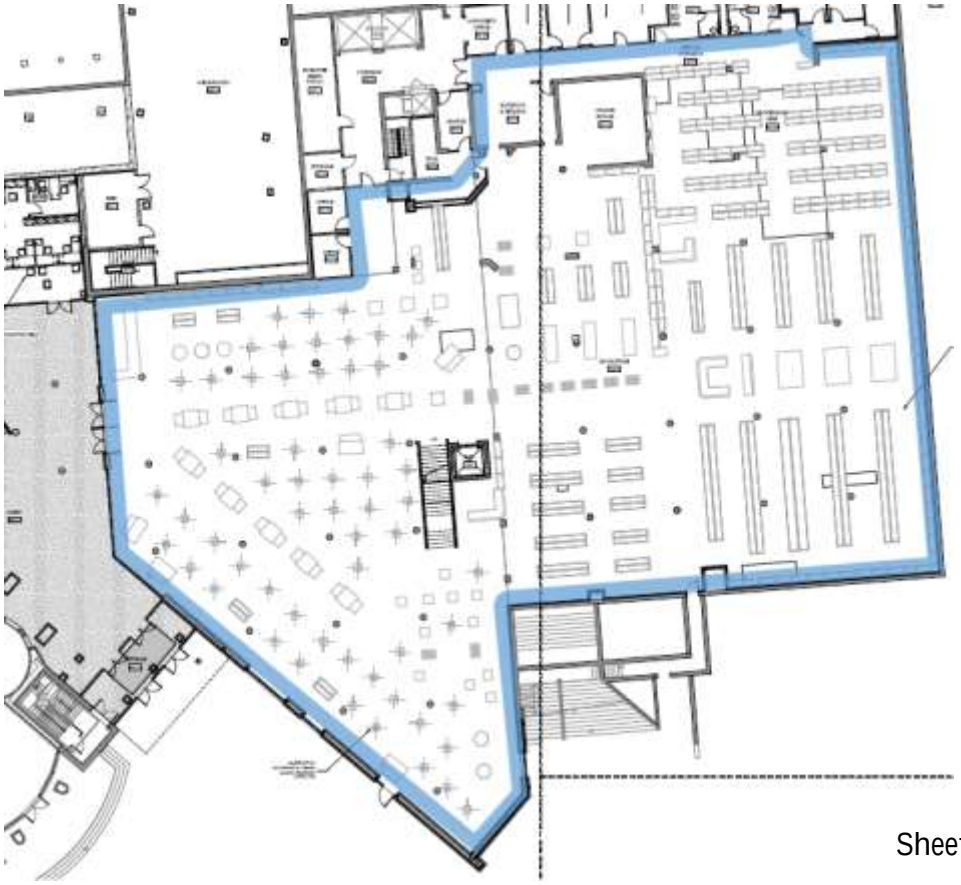
Approximate length – 200 ft.

Approximate height – 20 ft. from 1st to ceiling and 9 ft. from 1st to mezzanine

FLOOR PLAN

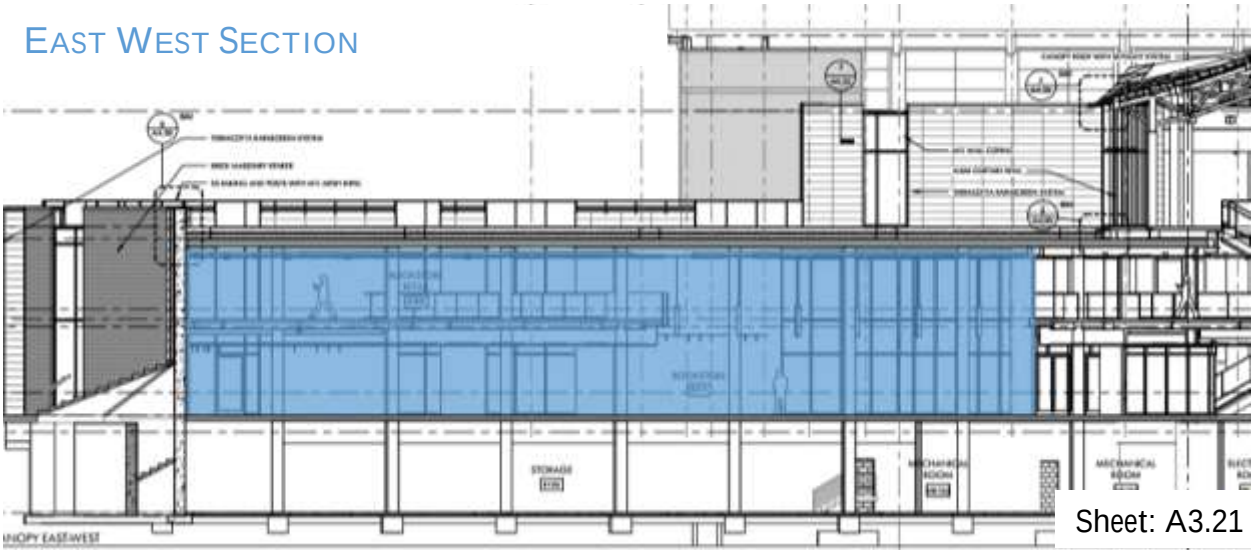
Sheet: A2.11D

ENLARGED FLOOR/FURNITURE PLAN



Sheet: A2.11D

EAST WEST SECTION



Sheet: A3.21

FINISHES

The bookstore has two levels, the main level and mezzanine. Both floors have a mix of carpet, wood, and tile flooring. The walls are a grey painted GWB and glazing. The ceiling is made up entirely of acoustic ceiling tile for both the main and mezzanine floor.

Bookstore Materials				
Surface	Material	Descrption	Color	Reflectance
Ceiling	ACT-1	2' x 4' Acoustic ceiling tile	Eggshell	0.8
Wall	GWB/PTD	Painted gypsum wallboard	Eggshell	0.9
Floor	CPT TILE, WD, LIN	Carpet tile, wood, and linoleum	Grey, white	0.19*

*This is a combination of all floor materials

GLAZING

The glazing consists of floor to ceiling low-e clear insulated glass. These units have a visibility of 74%. The upper third of the windows have solar shading louvers that help project light deeper into the space, while preventing direct glare.

FURNITURE/EQUIPMENT

The majority of furniture in the main retail area are racks and shelves for apparel, supplies, and other Penn State merchandise. The bookstore portion has a main counter and shelves for books. The mezzanine level furniture is similar to the bookstore.

TASKS

The bookstore is primarily a retail space, so browsing and shopping will be the two major tasks in the space. The clerks will need to be able to read and write, as well as use computers.

DESIGN CONCEPT AND GOALS

The bookstore is mainly devoted to retail of various Penn State merchandise, school supplies, and, of course, books. The layout of the store creates a pathway through all the other wares to the books. This was most likely a strategy used by Barnes and Noble to get customers to buy more than the books that they ultimately needed. I saw an opportunity to play on this by treating it as a pathway to knowledge. Based on the Blooms Taxonomy, the steps would include remembering, comprehension and analysis, and end with synthesis and evaluation.

Encourage Movement| People won't buy anything if they don't know what's there. The lighting should reinforce movement through all areas of the space. By highlighting key displays on the sales floor, occupants would be drawn off of the main path to the back of the store.

Visual interest| In addition to providing adequate light levels, the lighting should also add a layer of interest to the space. Possibly through patterns, forms, and layouts of the fixtures themselves.

DESIGN CRITERIA

QUALITATIVE CRITERIA

Important

- Aesthetics
  - The fixtures in the space should add to and enhance the architecture, rather than take away from it. Clutter should be avoided and overall fixture appearance should be considered.
- Hierarchy
  - It may be desired to highlight merchandise using light, making it stand out from the surroundings.

PSYCHOLOGICAL IMPRESSION

The bookstore is a public space and the psychological impression should reflect that. The lighting redesign will focus on making this space feel spacious by providing uniform high levels of general illumination.

QUANTITATIVE CRITERIA

Recommended Horizontal Illuminance

- Classification – Retail
  - General Retail
    - Category R: 500 lux (50 fc) at 2.5'
    - Avg/Min: 3:1

Recommended Vertical Illuminance

- Classification – Retail
  - General Retail
    - Category M: 100 lux (10 fc)
    - Avg/Min: 6:1

LEED

EAP: Minimum Energy Performance Required

- Comply with the mandatory and prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1–2010, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.).

EAC: Optimize Energy Performance (Major Renovation)

- Reduce overall energy consumption by 4% - 40% for 1 – 16 points.

EQC: Interior Lighting

- For at least 90% of individual occupant spaces, provide individual lighting controls that enable occupants to adjust the lighting to suit their individual tasks and preferences, with at least three lighting levels or scenes (on, off, midlevel). Midlevel is 30% to 70% of the

maximum illumination level (not including daylight contributions). For all shared multioccupant spaces, meet all of the following requirements.

- Have in place multizone control systems that enable occupants to adjust the lighting to meet group needs and preferences, with at least three lighting levels or scenes (on, off, midlevel).
- Lighting for any presentation or projection wall must be separately controlled.
- Switches or manual controls must be located in the same space as the controlled luminaires. A person operating the controls must have a direct line of sight to the controlled luminaires.

EQC: Daylight

- Demonstrate through annual computer simulations that spatial daylight autonomy300/50% (sDA300/50%) of at least 55%, 75%, or 90% is achieved. Use regularly occupied floor area. Healthcare projects should use the perimeter area determined under EQ Credit Quality Views.

EQC: Quality Views

- Achieve a direct line of sight to the outdoors via vision glazing for 75% of all regularly occupied floor area. View glazing in the contributing area must provide a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance.

Additionally, 75% of all regularly occupied floor area must have at least two of the following four kinds of views:

- multiple lines of sight to vision glazing in different directions at least 90 degrees apart;
- views that include at least two of the following: (1) flora, fauna, or sky; (2) movement; and (3) objects at least 25 feet (7.5 meters) from the exterior of the glazing;
- unobstructed views located within the distance of three times the head height of the vision glazing; and

- views with a view factor of 3 or greater, as defined in "Windows and Offices; A Study of Office Worker Performance and the Indoor Environment."

Energy Allowances

The following table shows the energy allowance for the bookstore according to ASHRAE 2013 space by space method.

Energy Allowance			
Space	Area (SF)	W/SF	Allowable Wattage
Bookstore	22000	1.44	31680

ASHRAE 2010 Standards

9.4.1.1(a), (b), (d), (e), (f), (i)

DESIGN CRITERIA SELECTED

1) Meet ASHRAE Standards
2) Create a hierarchy within the space
3) Control glare and daylight
4) LEED credits

DESIGN DEVELOPMENT

SUMMARY

Following the previous spaces, the fixtures are a consistent 3500K. Starting at the front of the store, decorative circular pendants represent the base ideas and concepts we learn. These are mounted at a height so they are level with the bottom of the mezzanine floor and kept at a glow, rather than providing substantial light to the work plane. The spot light accents attached to the circular fixture, highlighting floor displays, embody the individual perceptions that make these experiences our own.

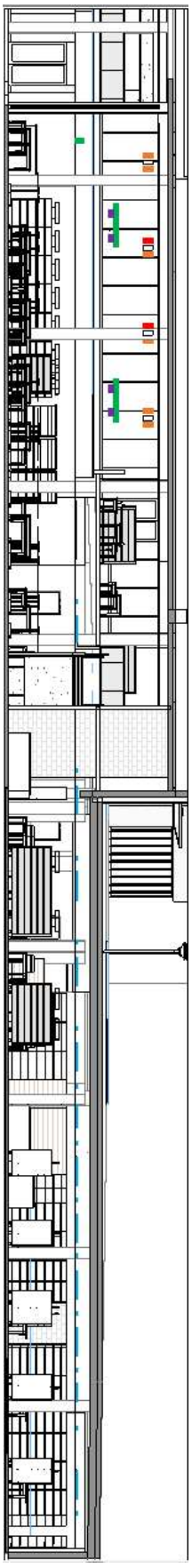
Bookstore Mezz to Sale Floor

Main Sale Floor to Back of Store

The general lighting will be provided by LED downlights mounted on the ceiling. As you move through the store under the mezzanine level, the focus becomes more specialized on school related products. In this area the general lighting is created by linear fixtures that are placed to converge on the center path. This layer represents the comprehension of what you've learned by relating it to past knowledge and experiences. At the end of the path lies the book section which is illuminated by the same linear fixtures as under the mezzanine, but are arranged to circle back on themselves, representing synthesis of ideas and creation of new knowledge.

FIXTURE & EQUIPMENT SELECTION

Following the theme of previous spaces, the bookstore is lit entirely by LEDs. Cut sheets can be found in appendix A and detailed fixture schedules are in appendix B



Fixture Schedule				
Type	Symbol	Image	Description	Manufacturer
L2			9000 lumen 45° HO LED pendant	Prescolite
L8			12000 lumen 45° HO LED pendant	Prescolite
L4			6" 1100 lumen 45° recessed LED downlight	Prescolite
L9			10000 lumen 5' circular pendant	Sattler
L10			1000 lumen 36° LED spot connected to L8	Sattler
L11			8' linear 3500 lumen HO recessed LED fixture	LumenPulse

Fixture Calculations							Lightloss Factors			
Type	Quantity	W/fixture	Total Wattage	PF	Va/fixture	Total VA		LLD	LDD	Total
L1	5	99	495	1	99	495	L1	0.8	0.96	0.77
L4	4	14	56	2	14	56	L4	0.8	0.96	0.77
L8	15	132	1980	1	132	1980	L8	0.8	0.96	0.77
L9	4	110	440	1	110	440	L9	0.8	0.96	0.77
L10	16	15	240	1	15	240	L10	0.8	0.96	0.77
L11	268	48	12864	2	48	12864	L11	0.8	0.96	0.77

CONTROLS STRATEGY

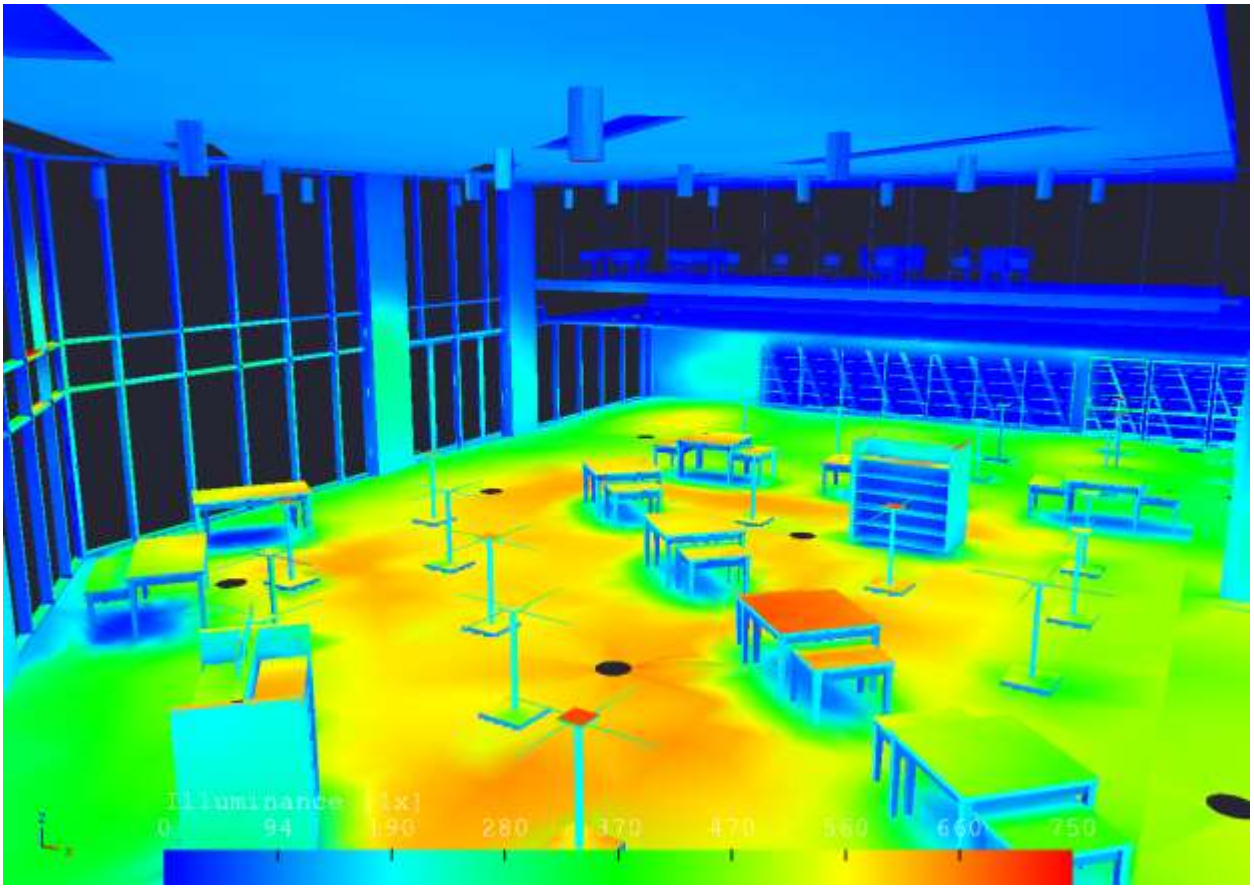
The L11 fixtures near the windows will be a dimmable and controlled by daylight sensors. This will allow part of the system to dim when adequate daylighting is present within the space.

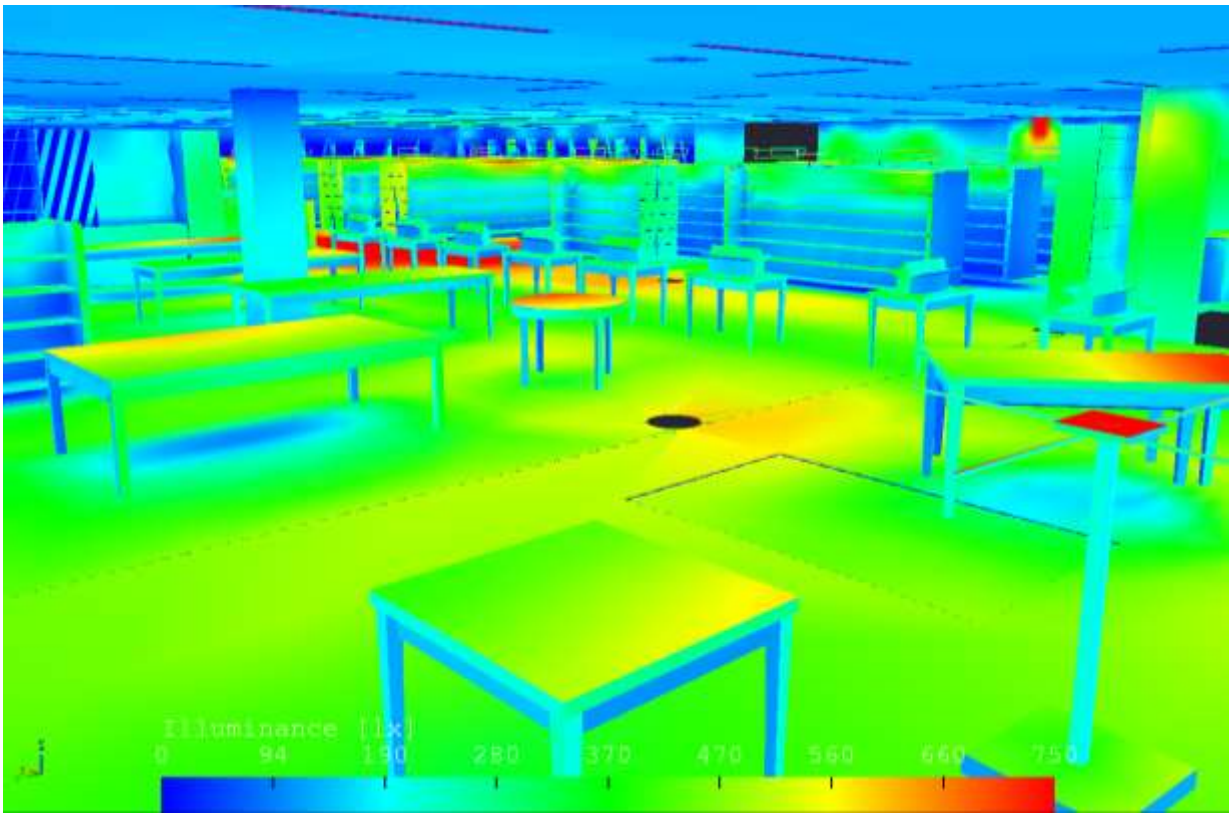
CALCULATION SUMMARY

The table below summarizes the calculations for the space. For more in-depth analysis, refer to the pseudo color renderings.

Bookstore Illuminance Criteria					
Category		Horizontal Illuminance (lux)		Vertical Illuminance (lux)	
Space	Metric	Recommended	Achieved	Recommended	Achieved
Retail space	Average	500	499	100	200
	Avg/Min	3:1	1.7:1	--	--

KEY (LUX)							
0-100	100-190	190-280	280-370	370-470	470-560	560-660	660-750




Illuminance [lx]
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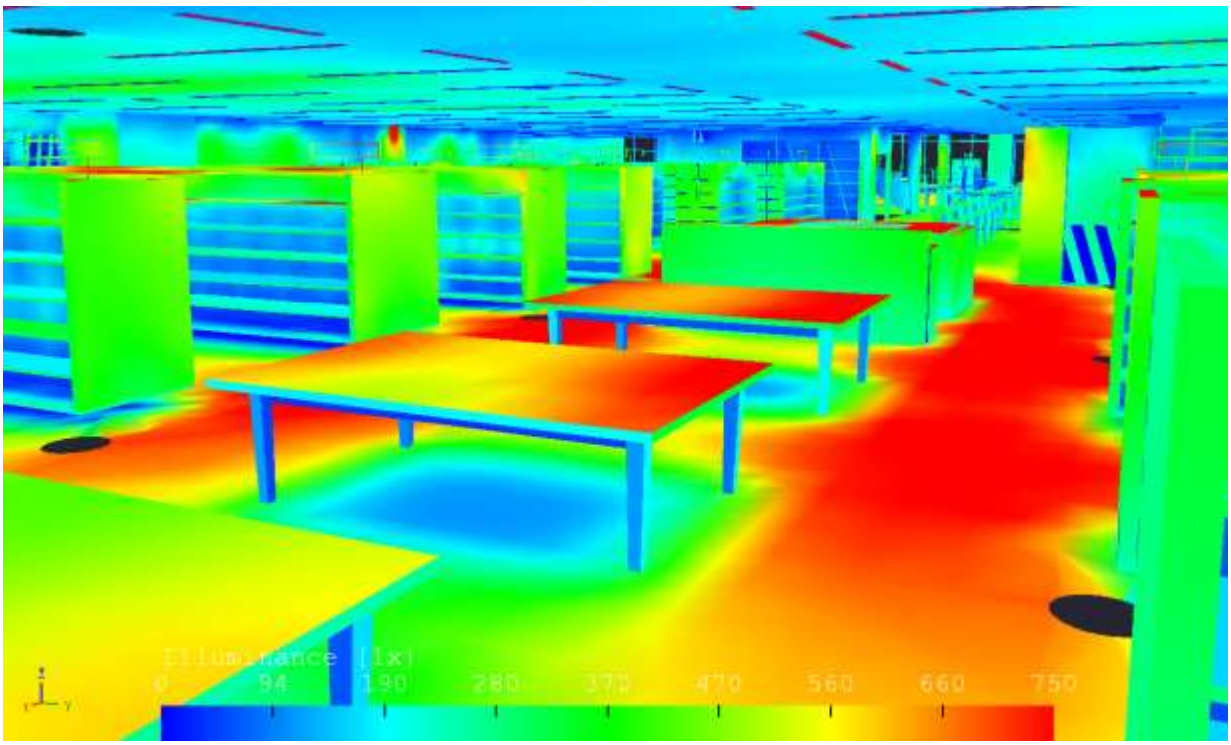
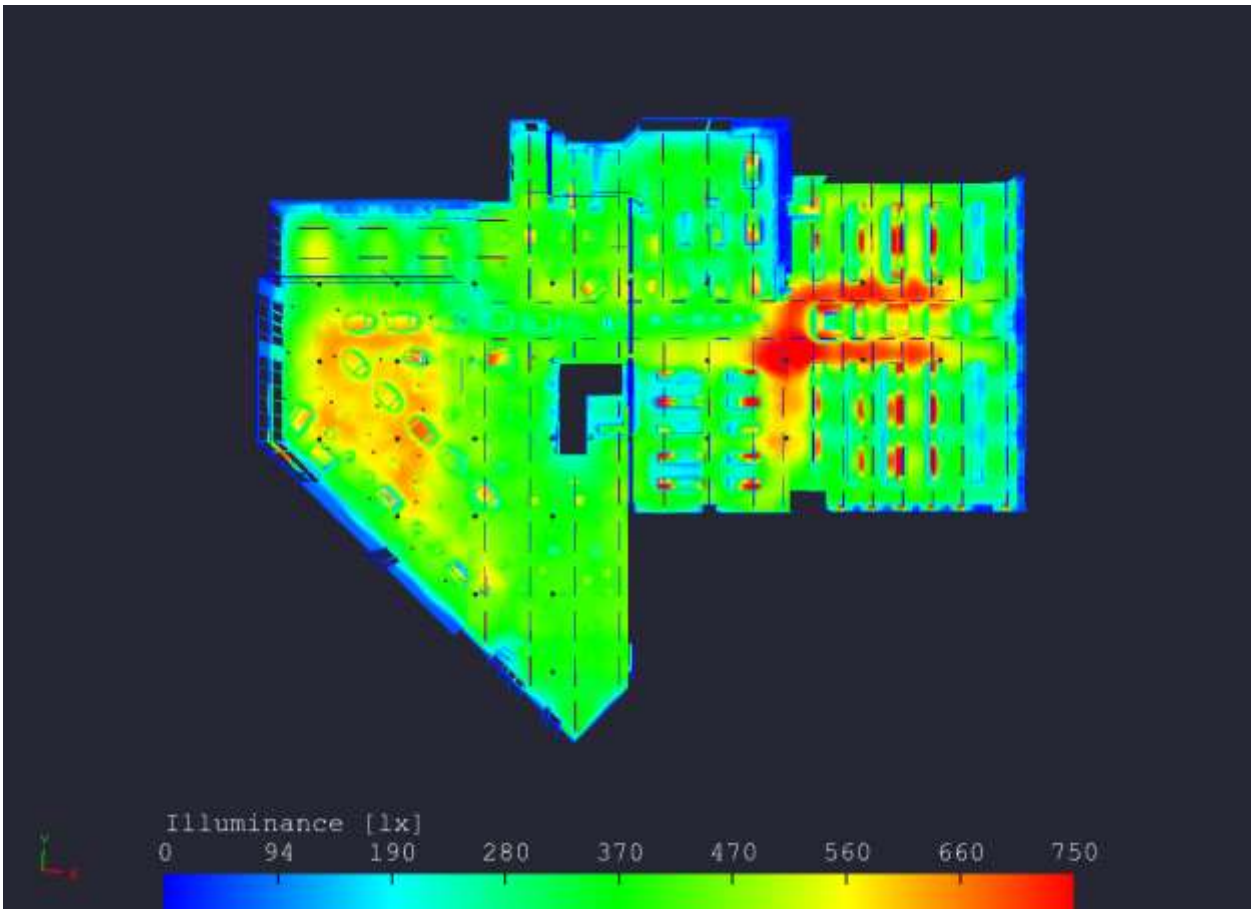

Illuminance [lx]
0 94 190 280 370 470 560 660 750



EVALUATION

SUMMARY

The general lighting provides a consistent light level throughout the space, allowing for ample visibility and helps reinforce a feeling of spaciousness within the space. Using different fixtures and layouts allowed for variation within the space, signifying different areas and adding interest to the space. The layout of the linear fixtures encourages patrons to explore the space, while always drawing them back to the main pathway from the front of the store to the back.

This design fulfilled the design goals for the space. The required light levels were met with a visually interesting design. Daylighting controls allow energy savings, while natural light is allowed to supplement the electric lighting. Energy codes were met and exceeded as well.

ASHRAE/IESNA

This design is 49% better than the standards set by ASHRAE, using only 16000 of the 31680 allowable watts. Daylighting controls will help lower this number even further when the space is in use. In addition, the dimmed state that the decorative fixtures will be in will also decrease the total wattage used. The use of LED lighting is the main reason that such a low LPD was achieved.

Energy Usage (ASHRAE/IESNA) - Bookstore		
Category	Allowable	Calculated
Area (SF)	--	22000
Input Wattage	31680	16075
Power Density (W/SF)	1.44	0.73

SPECIAL PURPOSE SPACE | FLEX THEATER

EXISTING CONDITIONS

DIMENSIONS

Area – 2000 ft^2

Approximate width – 38 ft.

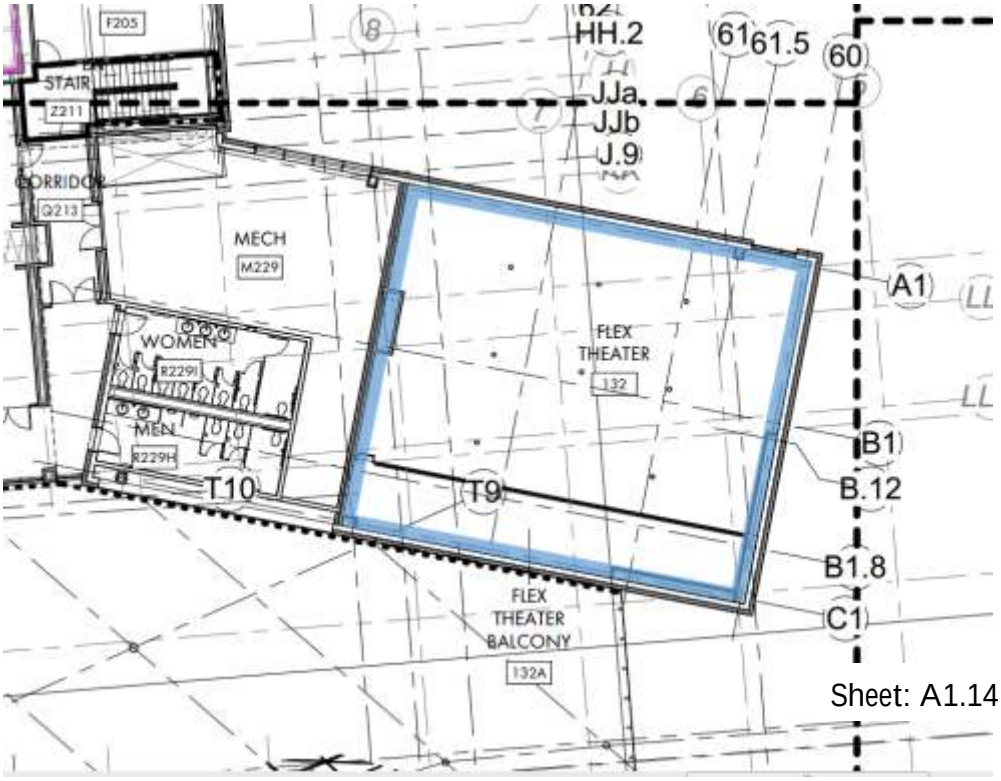
Approximate length – 55 ft.

Ceiling Height – 21 ft., 18 ft. to suspended ceiling

FLOOR PLAN

Sheet: A1.14

ENLARGED FLOOR PLAN



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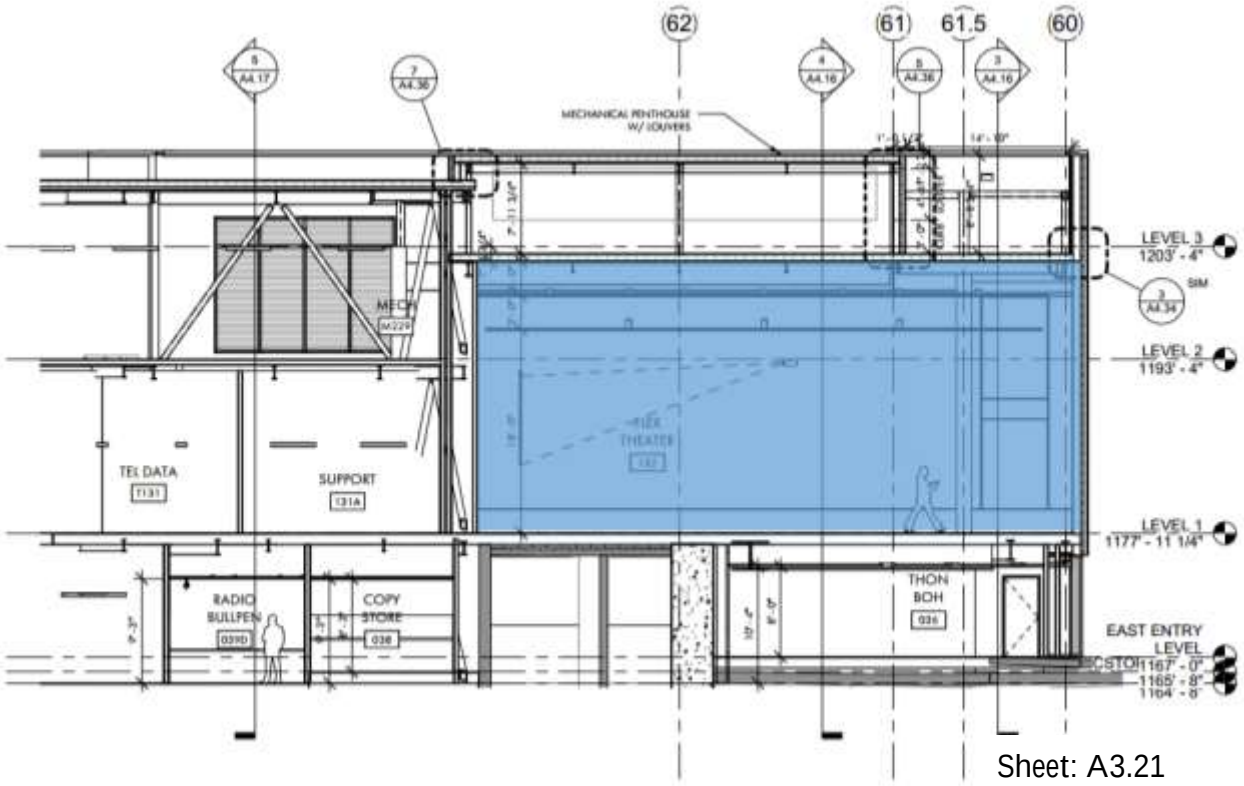
EAST WEST SECTION



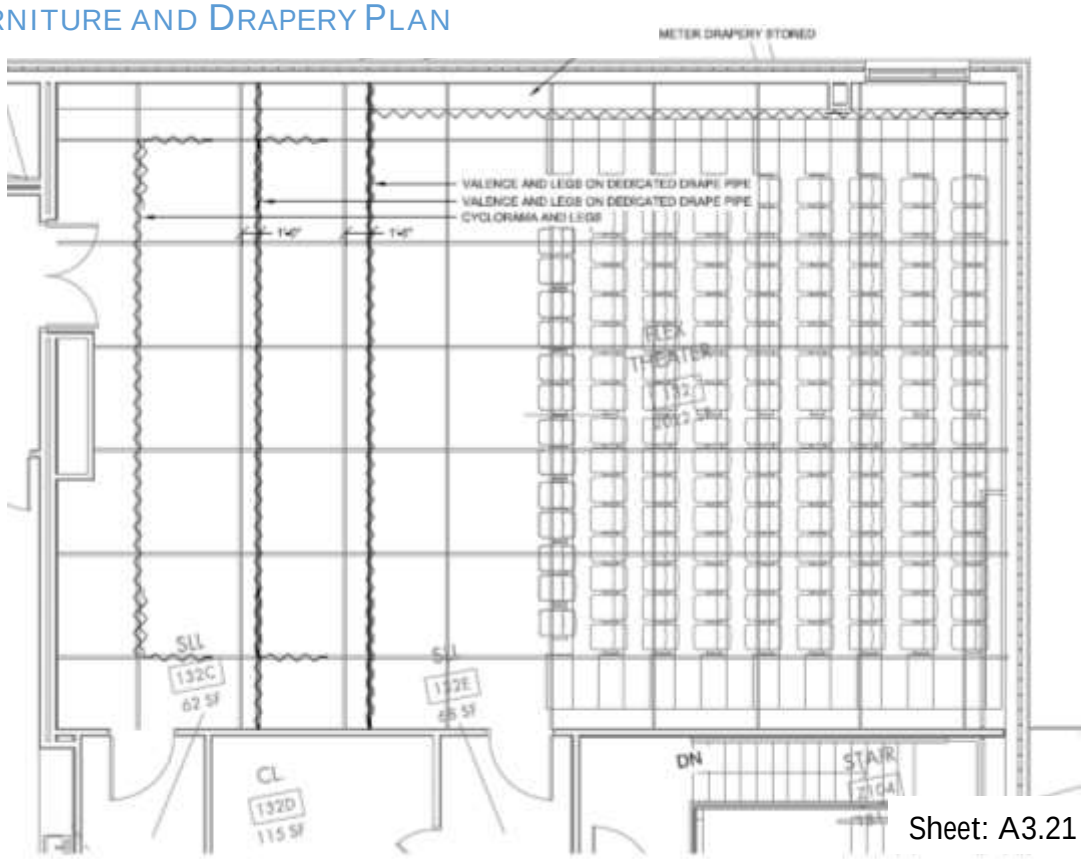
Sheet: A3.21

FINISHES

The floors are clad in ebony wood paneling which have a low reflectance. The walls are painted gypsum wall board. The ceiling is acoustic ceiling tile that is dyed black to absorb as much light as possible. The space as a whole is very absorptive to keep the audience portion of the theater dim and the focus on the stage.

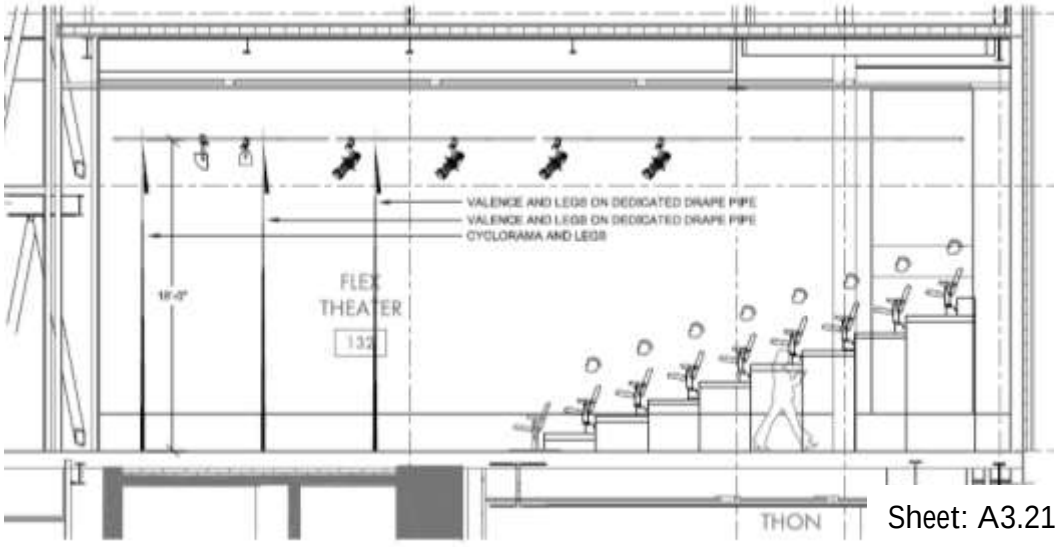
Theater Materials				
Surface	Material	Descrption	Color	Reflectance
Ceiling	ACT-2	Fine fissured #1729 black 2x4, min NRC 0.55 & CAC35	Black	0.2
Wall	GWB/PTD	Painted gypsum wallboard	Grey	0.5
Floor	WD	Robbins bio-channel classic - white oak w/ ebony stain	Ebony	0.15

FURNITURE AND DRAPERY PLAN



Sheet: A3.21

FURNITURE SECTION



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FURNITURE & EQUIPMENT

The theater has a capacity to seat 142 people in fixed theater seating. There is one projector that is placed on the centerline of the room. It can project on the projection screen located at the front of the room. There are also several layers of drapes to accommodate various stage areas and backdrops.

TASKS

The primary tasks in the space consist of acting and media viewing, as well as seeing the stage. This space could also be used to give presentations and the lighting redesign should account for that. In the case of presentations, it may be desired to take notes on what's being presented. The possibility of the projection screen being used as a presenting tool should also be considered and an effort to ensure adequate viewing of the speaker and screen during such time should be made.

DESIGN CONCEPT & GOALS

A theater is a space that was created to convey emotion through a variety of mediums. These performances connect people to emotions in ways that can even transcend words. For this space I've opted to layout the theatrical lighting rig that would be used to create these scenes of drama and passion, as well as the house lighting. The system itself should be flexible enough to be used for many different functions ranging from a performance to a gathering space for organizations on campus. The controls of the system should be advanced enough allow a theatrical designer to have the control they need, while also being simple enough for a student to operate part of the system if needed.

DESIGN CRITERIA

QUALITATIVE CRITERIA

Most Important

- Lighting the Stage
  - Actors should be adequately illuminated when on stage
  - Presenters faces should be lit so that they are seen from the back of the room
- Glare

- Occupants of the theater should not be exposed to glare from fixtures, since this would detract from the overall experience of a performance or presentation

❖ Controls

- The control system should be advanced enough for a seasoned designer to make full use of the system
- The control system should allow for limited functionality for any user of the space.
- The controls should be able to communicate with the theatrical fixtures, to the point that various cues could be set and compiled into a production

❖ Dimming Levels

- Specified fixtures should be able to provide adequate light levels for occupants to navigate through the space while a performance is ongoing, while not detracting from the show itself

Not Applicable

❖ Daylighting

- There are no daylight portals in the space, therefore daylighting is a nonfactor.

QUANTITATIVE CRITERIA

Recommended Horizontal Illuminance

❖ Classification – Hospitality and Entertainment

- During Production
  - Category B: 2 lux at floor
  - Avg/Min: 2:1
- Pre/Post-show, Intermission
  - Category M: 100 lux at floor
  - Avg/Min: 2:1
- Auditoria, Exhibition
  - Category P: 300 lux at 2' 6"
  - Avg/Min: 3:1

Recommended Vertical Illuminance

- Classification – Hospitality and Entertainment
  - During Production
    - Category A: 1 lux at 5'
    - Avg/Min: 2:1
  - Pre/Post-show, Intermission
    - Category I: 30 lux at 5'
    - Avg/Min: 2:1
  - Auditoria, Exhibition
    - Category O: 200 lux at 5'
    - Avg/Min: 3:1

LEED

EAP: Minimum Energy Performance Required

- Comply with the mandatory and prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1–2010, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.).

EAC: Optimize Energy Performance (Major Renovation)

- Reduce overall energy consumption by 4% - 40% for 1 – 16 points.

EQC: Interior Lighting

- For at least 90% of individual occupant spaces, provide individual lighting controls that enable occupants to adjust the lighting to suit their individual tasks and preferences, with at least three lighting levels or scenes (on, off, midlevel). Midlevel is 30% to 70% of the maximum illumination level (not including daylight contributions). For all shared multioccupant spaces, meet all of the following requirements.
  - Have in place multizone control systems that enable occupants to adjust the lighting to meet group needs and preferences, with at least three lighting levels or scenes (on, off, midlevel).
  - Lighting for any presentation or projection wall must be separately controlled.

- Switches or manual controls must be located in the same space as the controlled luminaires. A person operating the controls must have a direct line of sight to the controlled luminaires.

Energy Allowances

The following table shows the energy allowance for the flex theater space according to ASHRAE 2013 space by space method.

Energy Allowance			
Space	Area (SF)	W/SF	Allowable Wattage
Theater	2000	2.43	4860

ASHRAE 2013 Standards*

9.4.1.1(a),(b),(d),(e),(f),(h)

*See Appendix A for code description.

DESIGN CRITERIA SELECTED

1) Meet ASHRAE Energy Code requirements
2) Control light to meet various demands of the space
3) Provide adequate light on stage to illuminate actors and presenters
4) Meet LEED requirements

DESIGN DEVELOPMENT

SUMMARY

The house lighting consists of surface mounted LED downlights. Three outputs, 3000 lumens, 6000 lumens, and 9000 lumens were used to ensure uniformity and adequate light levels in the center and corners of the space.

The theatrical rig is made up of a nine by six pipe grid that has three types of fixtures. All fixtures mounted on rig would be approximately 18' off the ground. The first are 26° RGB-Lime LED spot lights, which light the front of the performers. The space itself was broken up into six zones, three wide by two deep. Each zone measures 11' in diameter, covering an area of 26' by 20'. The optimal angle for front lighting is 45° from vertical and 45° off the center of the zone on either side. This lights up a performer evenly, eliminating shadows on the face. Due to the size of the space some fixtures could not be placed at 45° from vertical, namely the fixtures on pipes 1 and 6. These were able to be placed 56°, which should still be adequate for the application. Additionally, those same fixtures were placed at 42° from the center of their respective zones. All other front fixtures were place 45° from the center of their zones and 50° from vertical.

To supplement the front lights, back lighting is also needed. The back lighting was achieved using 25° RGB-Lime LED par lights. These zones split the space into 12 zones, four wide by three deep. Each zone is 9' in diameter, covering an area of 30' by 21'. To get a nice glow around a figures frame a vertical angle of no more than 65° is recommended. These fixtures were placed 9' 6" from the center of their zones, providing light at a vertical angle of 62°.

The next layer of light is provided by 7-color LED array linear fixtures. These allow the designer to wash the backdrop with colored or white light. A variety of different beam spreads could be applied to the fixtures, using lenses, to allow more area to be washed with light. These range from 20° to 80°.

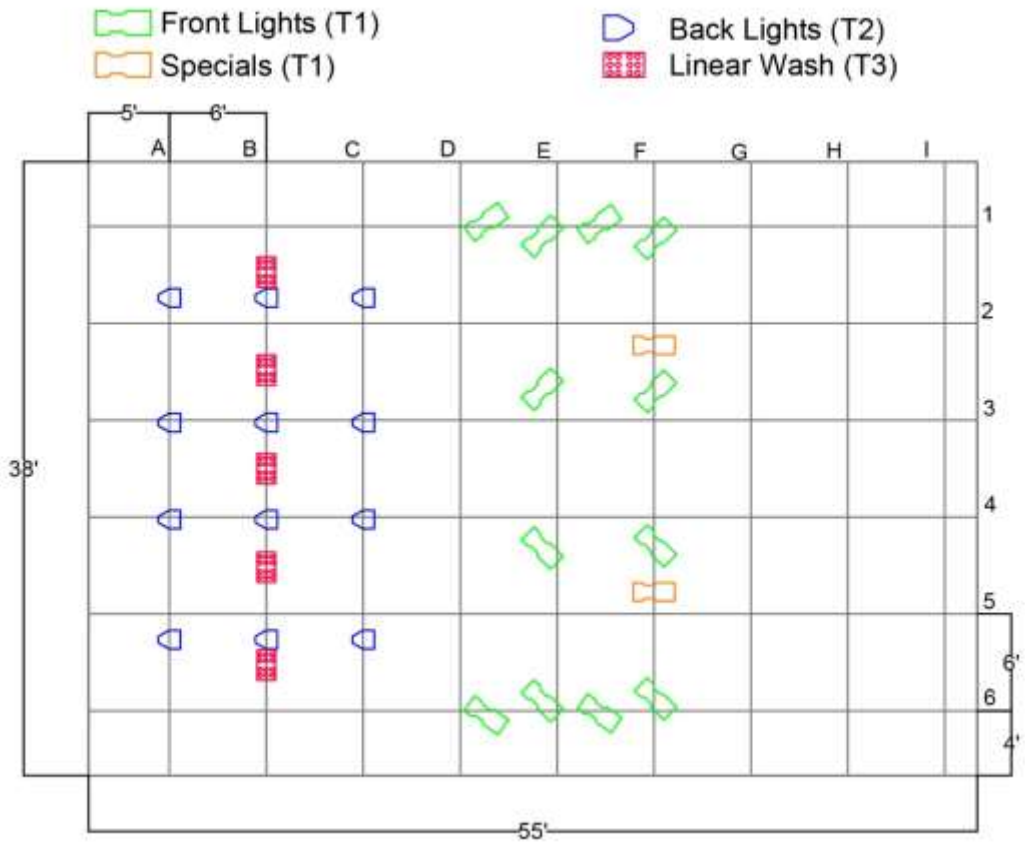
The final layer of light is provided by two 26° RGB-Lime LED spots mounted with the front lighting. These act as specials that can provide additional light where needed. This could be in the form of colored light or with a gobo installed a pattern.

Check appendix C for theatrical layout and mounting

FIXTURE & EQUIPMENT SELECTION

All fixtures in the theater are LED fixtures. Cut sheets can be found in appendix A and detailed fixtures schedules can be found in appendix B.

1st Story RCP



Fixture Schedule				
Type	Symbol	Image	Description	Manufacturer
L1			9000 lumen 45° HO LED pendant	Prescolite
L2			6000 lumen 45° HO LED pendant	Prescolite
L3			3000 lumen 45° HO LED pendant	Prescolite

Fixture Calculations							Lightloss Factors			
Type	Quantity	W/fixture	Total Wattage	PF	Va/fixture	Total VA		LLD	LDD	Total
L1	1	99	99	1	99	99	L1	0.8	0.93	0.74
L2	11	66.5	731.5	1	66.5	731.5	L2	0.8	0.93	0.74
L3	4	33.9	135.6	1	33.9	135.6	L3	0.8	0.93	0.74
T1	14	148	2072	1	148	2072	T1	--	--	--
T2	12	90	1080	1	90	1080	T2	--	--	--
T3	5	250	1250	1	250	1250	T3	--	--	--

CONTROLS STRATEGY

Theatrical fixtures will be controlled primarily through an ETC Element 60-250 console. This allows up to 250 DMX channels to be addressed. With 31 DMX fixtures in the space, 26 will take up 4 channels each and five that take up seven channels each, for a total of 139 channels in use. This leaves plenty of room for additional fixtures to be added on the console if desired.

An ETC Inspire E1006 will act as an entry switch. This can handle up to four preset scenes in addition to basic on off functionality. This would allow anyone to be able to set the house lighting to the level desired. An additional wall switch would be located near the console to allow control of the house lights on the mezzanine level.

The final control device will be a Flow7 FHD wall-mounted touchscreen tablet with power over Ethernet. This could be hardwired into the system or connect via Wi-Fi. Using an EchoAccess interface, occupants could connect to the system using the EchoAccess app, giving more control over the system than a wall switch, without needing to know how to use a theatrical console. This would allow up to eight theatrical fixtures and all house lighting to be changed as desired, including hue and intensity. All presets present on the entry switch would also be accessible from the wall-mounted tablet. Specified personnel could also access the system using a smartphone or mobile device if desired.

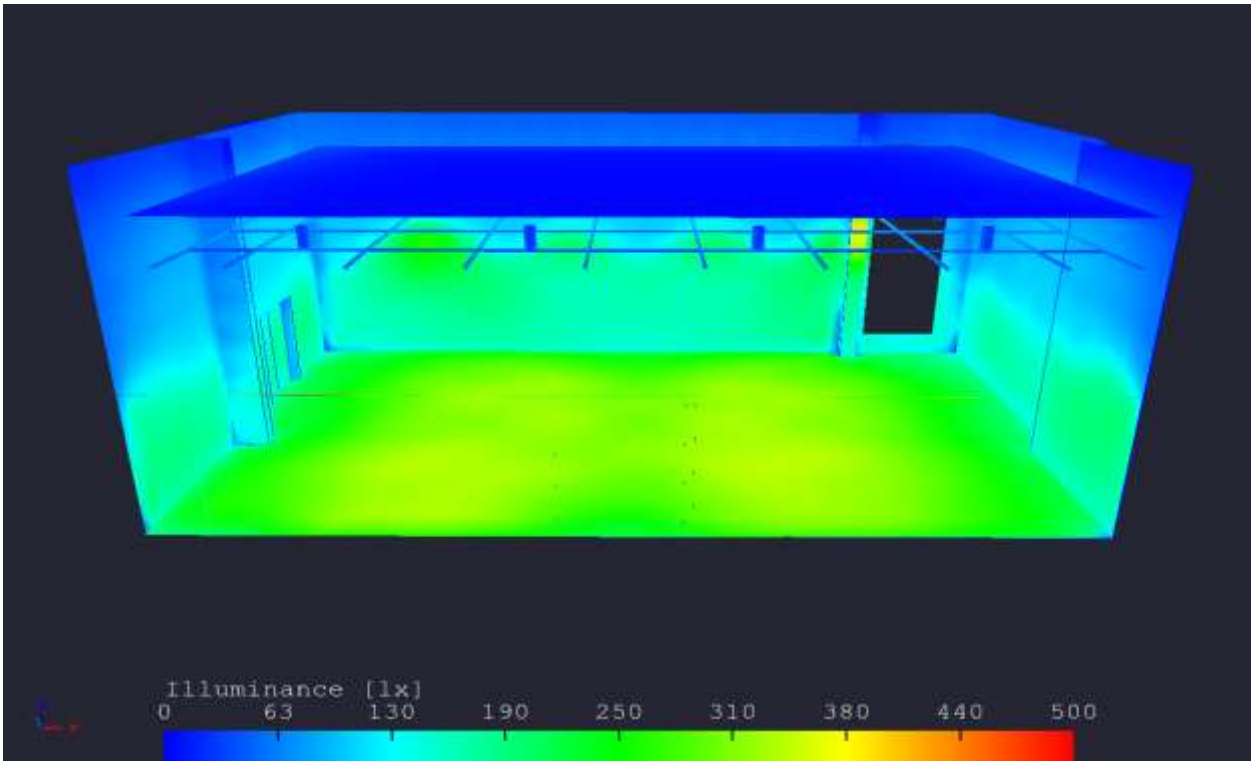
To prevent unwanted tampering during a performance, the wall-mounted touchscreen would be under key access. A DMX input toggle switch would also be located at the console to cut off the DMX signal for the theatrical fixtures from the touchscreen panel while the console is in use. These three levels of control would allow any user to be able to access the system according to their needs and level of knowledge. This allows for the optimal usability and flexibility for the space.

For more information and one-line diagram, refer to appendix C.

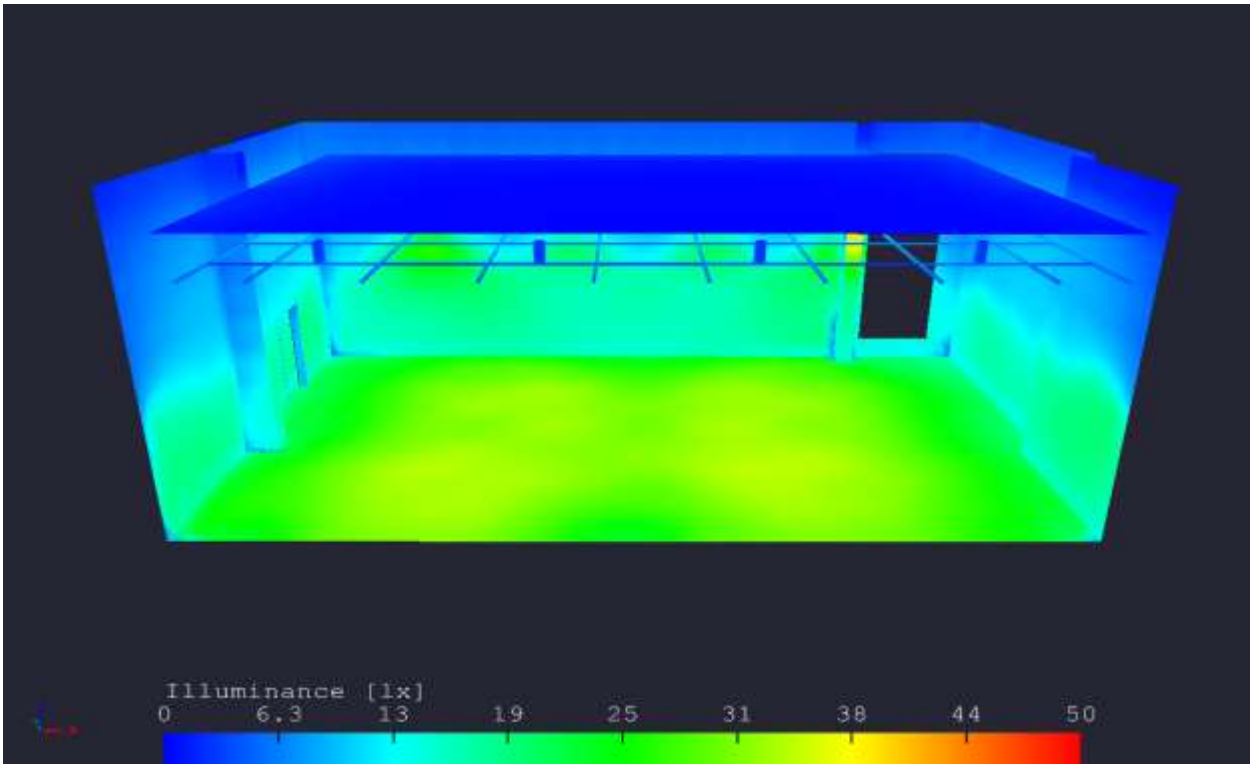
CALCULATION SUMMARY

The table below summarizes the calculations for the space. For more in-depth analysis, refer to the pseudo color renderings.

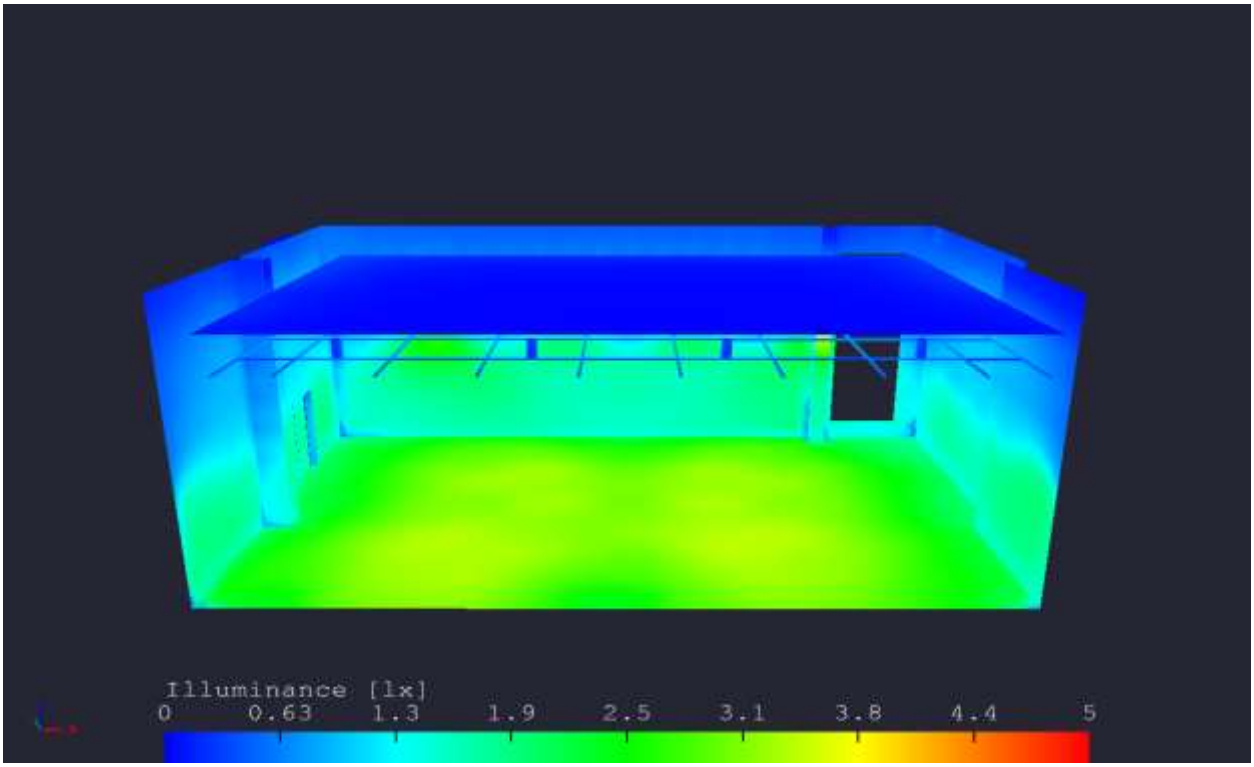
Theater Illuminance Criteria					
Category		Horizontal Illuminance (lux)		Vertical Illuminance (lux)	
Space	Metric	Recommended	Achieved	Recommended	Achieved
House Lighting Performance	Average	2	3	1	1.8
	Avg/Min	2:1	1.6:1	--	--
House Lighting Per/Post	Average	30	30	30	22
	Avg/Min	2:1	1.6:1	--	--
Genearl Use	Average	300	299	30	150
	Avg/Min	2:1	1.6:1	--	--



Exhibition Preset



Intermission Preset



During Show Preset

EVALUATION

SUMMARY

The house lighting achieves a uniform illuminance within the space. The use of dimming and presets allows for flexible scene control. The light levels are sufficient to accommodate general use, as well as lighting during a theatrical performance. The theatrical fixtures provide optimal stage lighting to 520 sqft of the space. Nearly all fixtures are within the ideal range for both vertical and horizontal angles for lighting a performer. With three levels of control, ranging from push button presets and touchscreen controls to a theatrical console, this space allows any user to get the most out of the fixtures within the space.

The design fulfilled the design goals set for the space. The required light levels were met, proper mounting angles allow for near-ideal stage lighting conditions, multiple levels of control maximize usability for any user of the space, and energy codes were met.

ASHRAE/IESNA

The proposed design is currently 78% better than the minimum ASHRAE requirements. This calculation only includes the house lighting and not the theatrical fixtures due to no NEC requirements for stage lighting

Energy Usage (ASHRAE/IESNA) - Theater		
Category	Allowable	Calculated
Area (SF)	--	2100
Input Wattage	4680	997
Power Density (W/SF)	2.46	0.47

Electrical Depth

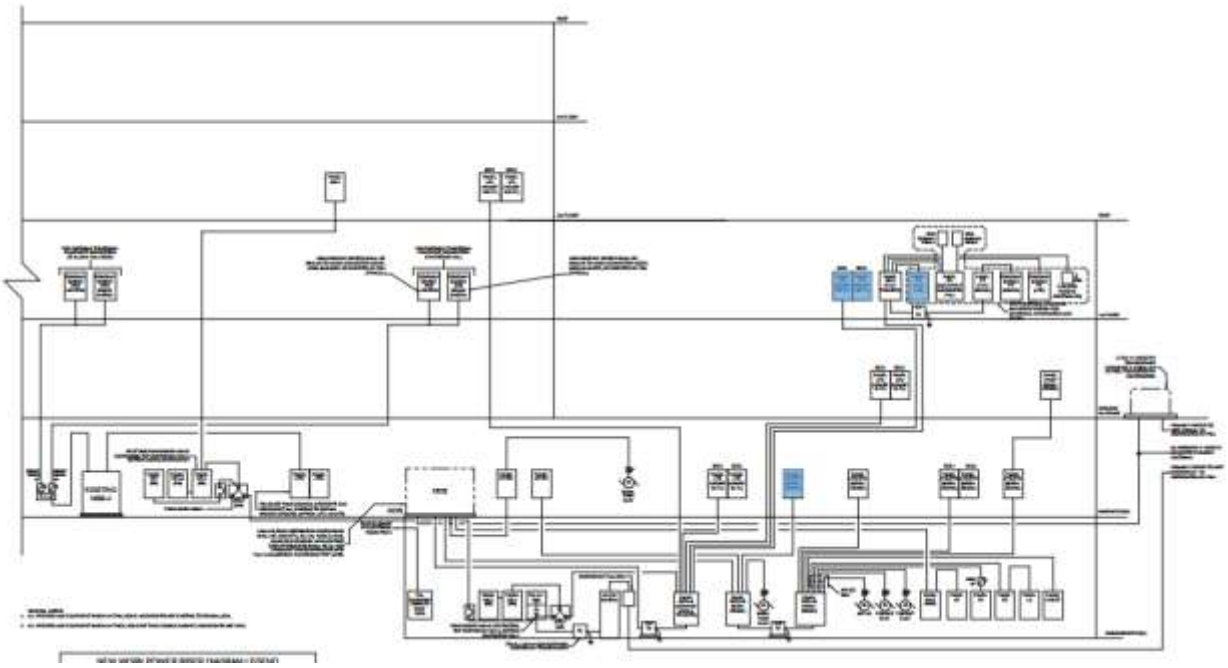
ELECTRICAL DEPTH

In this section the electrical system update is explained. This includes a branch circuit redesign in response to the new lighting designs for the four spaces described in the previous section. As an additional study, several panelboards and their respective feeder wiring were also resized in an effort to trim unnecessary extra capacity from the system.

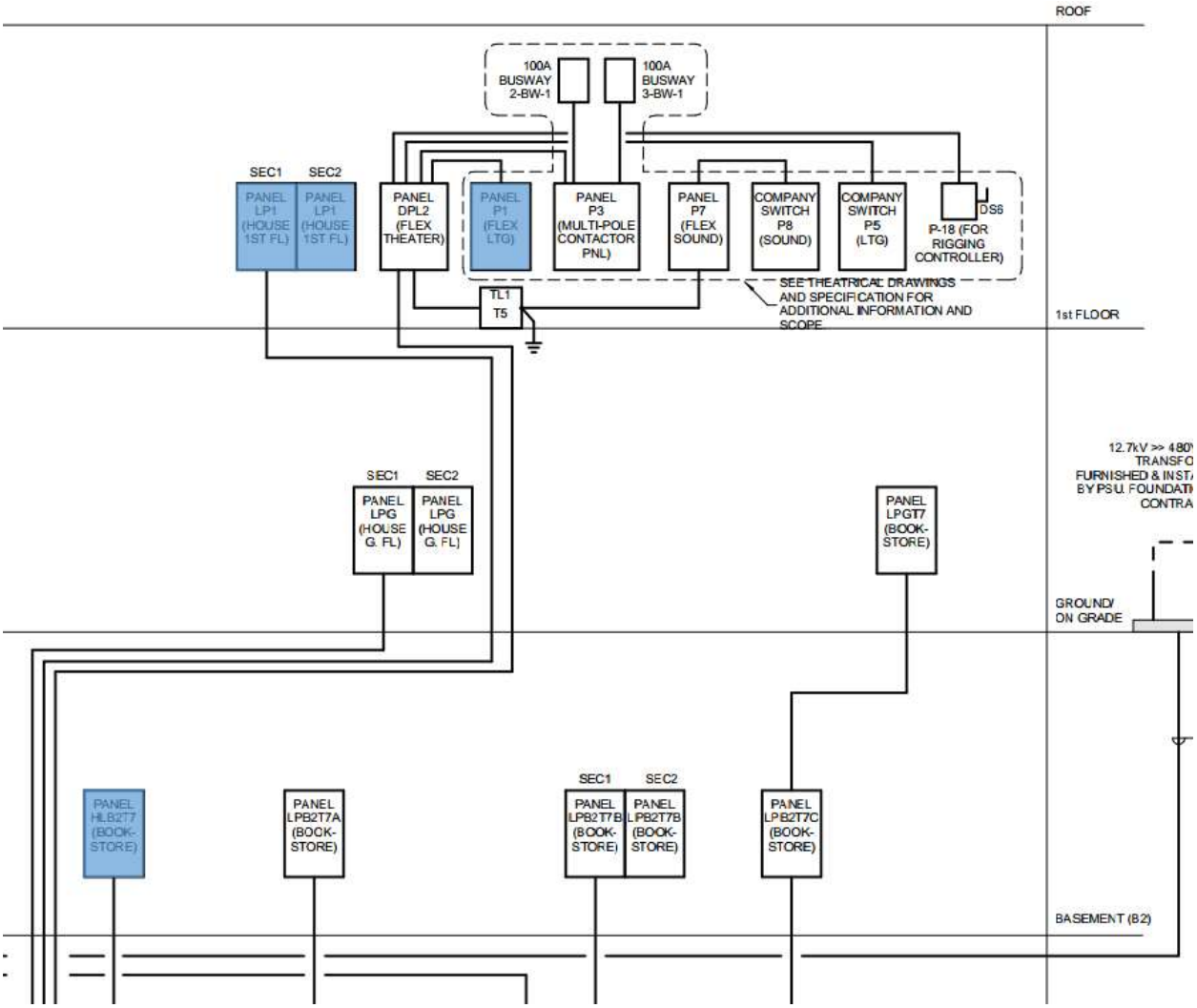
INTRODUCTION

BRANCH CIRCUIT REDESIGN

The new lighting design affects three panelboards in the HUB Addition: HLB2T7, LP1, and P3. Additionally, P3 was replaced with a new Echo relay panel to allow dimming of the house lights, power distribution to the theatrical fixtures, and power the two control systems within the flex theater space. These panels are all 208Y/120V, 3PH, 4 wire panelboards. Each of them are also MLO type panelboards.



HLB2T7 houses all of the bookstore lighting loads. LP1 is the main panelboard for the Atrium space lighting, receptacle, and telecom loads. P3 currently only services the flex theater lighting loads.



ELECTRICAL INFORMATION

FIXTURE LAYOUT

Refer to Appendix D for wiring diagrams.

EXISTING PANELBOARD LOADS

The panelboard schedules below show the existing lighting design loads. The highlighted circuits on panel LP1 are affected by the new lighting design and will be replaced to accurately

depict the new loads on the electrical system. HLB2T7 and P3 were completely redesigned and P3 was replaced with a dimming capable panel relay. For details see lighting depth.

PANEL: HLB2T7 **BUS AMPS: 225**

SUPPLY FROM: SDP-HB
MAIN: MLO
MOUNTING: Surface
ST MAIN:
SUB-FEED LUGS:
FEED-THRU LUS:
DISTRIBUTION: 480Y/277
A.I.C. RATING: 42 kAIC
IG GND:
NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	BKR TYPE	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	BKR TYPE	DESCRIPTION	TYPE	CKT
1	L	LTG BOOKSTORE RELAY#1		2w20	20	1	2.87	2.8					1	20	2w20		LTG BOOKSTORE RELAY#2	L	2
3	L	LTG BOOKSTORE RELAY#3		2w20	20	1			2.66	3.22			1	20	2w20		LTG BOOKSTORE RELAY#4	L	4
5	L	LTG BOOKSTORE RELAY#5		2w20	20	1					1.82	1.89	1	20	2w20		LTG BOOKSTORE RELAY#6	L	6
7	L	LTG BOOKSTORE RELAY#7		2w20	20	1	1.5	3.22					1	20	2w20		LTG BOOKSTORE RELAY#8	L	8
9	L	LTG BOOKSTORE RELAY#9		2w20	20	1			2.29	1.96			1	20	2w20		LTG BOOKSTORE RELAY#10	L	10
11	L	DISP CASE LTG RELAY #11		2w20	20	1					0.72	0.9	1	20	2w20		DISP CASE LTG RELAY #12	L	12
13	L	DISP CASE LTG RELAY #13		2w20	20	1	0.54	0.72					1	20	2w20		DISP CASE LTG RELAY #14	L	14
15	L	LTG BOOKSTORE RELAY#15		2w20	20	1			2.17	0.56			1	20	2w20		LTG BOOKSTORE RELAY#16	L	16
17	L	LTG BKSTORE CORRIDOR		2w20	20	1					0.63	0	1	20	--	--	SPARE	--	18
19	L	LTG BOOKSTORE OFFICES		2w20	20	1	2.18	0					1	20	--	--	SPARE	--	20
21	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	22
23	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	24
25	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	26
27	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	28
29	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	30
31	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	32
33	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	34
35	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	36
37	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	38
39	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	40
41	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	42
				PHASE LOAD:			13.83		12.86		5.96								
				PHASE AMPS:			53.77		50.27		21.52								

LOAD TYPE	CONNECTED	DEMAND/ADJUSTED	LOAD TYPE KEY	BREAKER TYPE KEY	PANEL TOTALS	
L	32.65	32.65	R = RECEPTACLE	BLANK = STANDARD		
			L = LIGHTING	G3 = GROUND FAULT 30 Ma (EQUIP)	CONNECTED LOAD:	32.65
			M = MECH/EQUIP	G = GROUND FAULT 5 Ma (PERSONNEL)	DEMAND LOAD:	32.65
			K = KITCHEN	A = ARC FAULT	CONNECTED AMPS:	39.27
			C = CONTINUOUS	ST = SHUNT TRIP	DEMAND AMPS:	39.27
			N = NONCONTINUOUS	HT = HANDLE TIE		

Notes:

PANEL: P3 **BUS AMPS: 225**

SUPPLY FROM: DPL2
MAIN: 225A MCB
MOUNTING: Surface
ST MAIN: No
SUB-FEED LUGS: No
FEED-THRU LUS: No
DISTRIBUTION: 208Y/120
A.I.C. RATING: 10 kAIC
IG GND: No
NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	BKR TYPE	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	BKR TYPE	DESCRIPTION	TYPE	CKT
1	R	TLB BOX #4 - DMX1		2W20	20	1	1.8	1.8					1	20	2W20		TLB BOX #5 - DMX2	R	2
3	R	TLB BOX #6 - DMX3		2W20	20	1			1.8	1.8			1	20	2W20		TLB BOX #7 - DMX4	R	4
5	R	TLB BOX #8 - CKT #1 - DMX5		2W20	20	1					1.8	1.8	1	20	2W20		TLB BOX #8 - CKT #2 - DMX6	R	6
7	R	TLB BOX #9 - CKT #1 - DMX7		2W20	20	1	1.8	1.8					1	20	2W20		TLB BOX #9 - CKT #2 - DMX8	R	8
9	R	TLB BOX #10 - CKT #1-DMX9		2W20	20	1			1.8	1.8			1	20	2W20		TLB BOX #10 - CKT...	R	10
11	R	TLB BOX #11 - CKT...		2W20	20	1					1.8	1.8	1	20	2W20		TLB BOX #11 - CKT...	R	12
13	--	SPARE - DMX13	--	--	20	1	0	0					1	20	--	--	SPARE - DMX14	--	14
15	--	SPARE - DMX15	--	--	20	1			0	0			1	20	--	--	SPARE - DMX16	--	16
17	L	LTG FLEX THEATER		2w20	20	1					0.24	0.24	1	20	2w20		LTG FLEX THEATER	L	18
19	L	LTG FLEX THEATER		2w20	20	1	0.24	0.24					1	20	2w20		LTG FLEX THEATER	L	20
21	L	LTG FLEX THEATER		2w20	20	1			0.24	0.24			1	20	2w20		LTG FLEX THEATER	L	22
23	L	LTG FLEX THEATER		2w20	20	1					0.24	0.16	1	20	2w20		LTG FLEX BALCONY	L	24
25	L	LTG FLEX BALCONY		2w20	20	1	0.11	0					1	20	--	--	SPARE	--	26
27	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	28
29	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	30
31	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	32
33	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	34
35	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	36
37	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	38
39	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	40
41	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	42
				PHASE LOAD:			7.79		7.68		8.06								
				PHASE AMPS:			65.06		64		67.47								

LOAD TYPE	CONNECTED	DEMAND/ADJUSTED	LOAD TYPE KEY	BREAKER TYPE KEY	PANEL TOTALS	
R	21.6	15.8	R = RECEPTACLE	BLANK = STANDARD		
L	1.95	1.95	L = LIGHTING	G3 = GROUND FAULT 30 Ma (EQUIP)	CONNECTED LOAD:	23.55
			M = MECH/EQUIP	G = GROUND FAULT 5 Ma (PERSONNEL)	DEMAND LOAD:	17.75
			K = KITCHEN	A = ARC FAULT	CONNECTED AMPS:	65.37
			C = CONTINUOUS	ST = SHUNT TRIP	DEMAND AMPS:	49.27
			N = NONCONTINUOUS	HT = HANDLE TIE		

Notes: MOTORIZED BREAKER PANEL FURNISHED BY PERFORMANCE LIGHTING CONTRACTOR, INSTALLED BY THE ELECTRICAL CONTRACTOR

PANEL: LP1 **BUS AMPS: 225**

SUPPLY FROM: SDP-LB

MAIN: MLO
MOUNTING: Surface
ST MAIN:
SUB-FEED LUGS: Yes
FEED-THRU LUS:

DISTRIBUTION: 208Y/120
A.I.C. RATING: 10 kAIC
IG GND:
NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	BKR TYPE	WIRE	TRIP	POLE	A		B		C		POLE	TRIP	WIRE	BKR TYPE	DESCRIPTION	TYPE	CKT
1	R	RECS CORRIDOR		2w20	20	1	0.72	0.72					1	20	2w20		FL BOXES MTG RM 131	R	2
3	R	RECS MTG RM 131		2w20	20	1			0.72	0.36			1	20	2w20		RECS SUPPORT 131A	R	4
5	R	RECS SUPPORT 131A		2w20	20	1					0.36	0.36	1	20	2w20		RECS SUPPORT 131A	R	6
7	R	RECS TEL/DATA T131		2w20	20	1	0.72	0.72					1	20	2w20		RECS TEL/DATA T131	R	8
9	R	FLOOR BOX MPR 132		2w20	20	1			0.36	0.54			1	20	2w20		RECS MPR 132	R	10
11	R	RECS MPR 132		2w20	20	1					0.72	0.72	1	20	2w20		RECS MPR 132	R	12
13	L	LTG ZONE 1a SEATING 133		2w20	20	1	0.66	1.2					1	20	2w20		LTG MAIN STAIR ZONE 1b	L	14
15	L	LTG ZONE 1j SEATING 133		2w20	20	1			1.34	1.2			1	20	2w20		LTG SEATING 134 ZONE 1c	L	16
17	M	SSAC-1 T131		2w25	25	2					1.35	0.5	1	20	2w20		AV RACK MTG RM 131	R	18
19							1.35	0.8					1	20	2w20		PROJ. & SCREEN 131	R	20
21	L	LTG MEZZ CORR ZONE 1f		2w20	20	1			1.48	0.36			1	20	2w20		FLOOR BOX MPR 132	R	22
23	L	LTG MEZZ CORR ZONE 1e		2w20	20	1					0.8	0	1	20	--	--	SPARE	--	24
25	L	LTG MTG/STUDIO SUPPORT		2w20	20	1	0.66	1.2					1	20	2w20		IT RACK T131	C	26
27	L	LTG MTG RM 131		2w20	20	1			1.44	1.2			1	20	2w20		IT RACK T131	C	28
29	R	ELEC LATCH DR GN ROOF		2w20	20	1					1.5	0.18	1	20	2w20		COUNTER REC MTG 131	R	30
31	R	ELEC LATCH DR GN ROOF		2w20	20	1	0.4	1.2					1	20	2w20		FS DAMPERS LEVEL 1	M	32
33	C	SEC PANELS TEL T131		2w20	20	1			0.8	1.2			1	20	2w20		LTG ZONE 1d SEATING 134	L	34
35	R	RECS MTG 131		2w20	20	1					0.18	0.18	1	20	2w20		RECS MTG 131	R	36
37	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	38
39	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	40
41	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	42
43	R	RECS MTG 131		2w20	20	1	0.18	0.18					1	20	2w20		RECS MTG 131	R	44
45	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	46
47	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	48
49	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	50
51	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	52
53	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	54
55	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	56
57	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	58
59	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	60
61	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	62
63	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	64
65	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	66
67	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	68
69	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	70
71	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	72
73	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	74
75	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	76
77	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	78
79	--	SPARE	--	--	20	1	0	0					1	20	--	--	SPARE	--	80
81	--	SPARE	--	--	20	1			0	0			1	20	--	--	SPARE	--	82
83	--	SPARE	--	--	20	1					0	0	1	20	--	--	SPARE	--	84
				PHASE LOAD:			10.71		11		6.85								
				PHASE AMPS:			94.2		96.65		57.08								

LOAD TYPE	CONNECTED	DEMAND/ADJUSTED
M	3.9	2.73
R	11.48	10.74
C	3.2	4
L	9.98	9.98

LOAD TYPE KEY
R = RECEPTACLE
L = LIGHTING
M = MECH/EQUIP
K = KITCHEN
C = CONTINUOUS
N = NONCONTINUOUS

BREAKER TYPE KEY
BLANK = STANDARD
G3 = GROUND FAULT 30 Ma (EQUIP)
G = GROUND FAULT 5 Ma (PERSONNEL)
A = ARC FAULT
ST = SHUNT TRIP
HT = HANDLE TIE

PANEL TOTALS	
CONNECTED LOAD:	28.56
DEMAND LOAD:	27.45
CONNECTED AMPS:	79.29
DEMAND AMPS:	76.21

Notes:

REVISED SCHEDULES

The panelboard schedules below depict the revised schedules for the new lighting designs. All circuits are 20A loaded to a 15A maximum and all lighting is 120V. A continuous load factor of 1.25 was applied to lighting kVA loads.

Allowable load per circuit: (120V x 15A) / 1000 = 1.8kVA

Circuit Calculations					
Space	Circuit	Type	Quant.	VA/fixture	Total VA
Atrium	PLL1	L1	12	99	1.79
		L2	9	66.5	
	PLL2	L1	5	99	0.86
		L2	5	66.5	
		L3	1	33.9	
	PLL3	L1	6	99	1.76
		L2	17	66.5	
		L3	1	33.9	
	PLL4	L4	5	14	1.28
		L5	4	48	
		L6	4	255	
	PLL5	L7	1572.5 in^2	0.016 W/in^2	0.36
Bookstore	HLB 1	L11	36	48	1.73
	HLB 2	L11	36	48	1.73
	HLB 3	L11	36	48	1.73
	HLB 4	L11	36	48	1.73
	HLB 5	L11	31	48	1.49
	HLB 6	L4	4	14	0.82
		L11	16	48	
	HLB 7	L11	36	48	1.73
	HLB 8	L11	36	48	1.73
	HLB 9	L1	1	99	1.57
		L8	6	132	
		L9	4	110	
		L10	16	15	
	HLB 10	L11	9	48	0.43
	HLB 11	L1	5	99	1.68
		L8	9	132	
Theater	LTGPIPE A	T2	4	90	0.36
	LTGPIPE B	T2	4	90	1.61
		T3	5	250	
	LTGPIPE C	T2	4	90	0.36
	LTGPIPE D	T1	2	148	0.30
	LTGPIPE E	T1	6	148	0.89
	LTGPIPE F	T1	6	148	0.89
	LTG HOUSE	L1	1	99	0.74
		L2	4	66.5	
		L3	11	33.9	
Outdoor	OD1	L7	5352 in^2	0.016 W/in^2	0.80
		L12	12	44	
		L13	4	39	
		L14	5	5	

The above table shows the calculations used to find the kVA contributions of each circuit. These were placed on their respective panelboards as shown below. Loads were placed to try and ensure that all phases were within 10% of each other.

Panel: LP1 | BUS AMPS: 225 | DISTR: 208Y/120
Supply From: SDP-LB | MAIN: MLO | NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRIPTION	TYPE	CKT
1	R	REC CORR	2#12	20	1	0.72	0.72					1	20	2#12	FL BOXES MTG RM 131	R	2
3	R	REC MGT RM 131	2#12	20	1			0.72	0.36			1	20	2#12	RECS SUPP 131A	R	4
5	R	RES SUPP 131A	2#12	20	1					0.36	0.36	1	20	2#12	RECS SUPP 131A	R	6
7	R	REC TEL/DATA 131	2#12	20	1	0.72	0.72					1	20	2#12	RECS TEL/DATA 131	R	8
9	R	FLOOR BOX MPR 132	2#12	20	1			0.36	0.54			1	20	2#12	RECS MPR 132	R	10
11	R	RECS MPR 132	2#12	20	1					0.72	0.72	1	20	2#12	RECS MPR 132	R	12
13	L	PLL1	2#12	20	1	1.79	0.86					1	20	2#12	PLL2	L	14
15	L	PLL3	2#12	20	1			1.75	1.29			1	20	2#12	PLL4	L	16
17	M	SSAC-1 T131	4#10	25	2					1.35	0.5	1	20	2#12	AV RACK MTG RM 131	R	18
19						1.35	0.8					1	20	2#12	PROJ. & SCREEN 131	R	20
21	L	LTG MTG/STUDIO SUPP	2#12	20	1			0.66	0.36			1	20	2#12	FLOOR BOX MPR 132	R	22
23	L	LTG MTG RM 131	2#12	20	1					1.44	0	1	20		Spare	--	24
25	R	ELEC LATCH DR GR	2#12	20	1	1.5	1.2					1	20	2#12	IT RACK T131	C	26
27	R	ELEC LATCH DR GR	2#12	20	1			0.4	1.2			1	20	2#12	IT RACK T131	C	28
29	C	SEC PANELS TEL T131	2#12	20	1					0.8	0.18	1	20	2#12	COUNTER REC MTG 131	R	30
31	R	RECS MTG 131	2#12	20	1	0.18	1.2					1	20	2#12	FS DAMPERS LEVEL 1	M	32
33	--	Spare		20	1			0	0.36			1	20	2#12	PLL5	L	34
35	--	Spare		20	1					0	0.18	1	20	2#12	RECS MTG 131	R	36
37	--	Spare		20	1	0	0					1	20		Spare	--	38
39	--	Spare		20	1			0	0			1	20		Spare	--	40
41	--	Spare		20	1					0	0	1	20		Spare	--	42
43	R	RECS MTG 131	2#12	20	1	0.18	0.18					1	20	2#12	RECS MTG 131	R	44
45	--	Spare		20	1			0	0			1	20		Spare	--	46
47	--	Spare		20	1					0	0	1	20		Spare	--	48
49	--	Spare		20	1	0	0					1	20		Spare	--	50
51	--	Spare		20	1			0	0			1	20		Spare	--	52
53	--	Spare		20	1					0	0	1	20		Spare	--	54
55	--	Spare		20	1	0	0					1	20		Spare	--	56
57	--	Spare		20	1			0	0			1	20		Spare	--	58
59	--	Spare		20	1					0	0	1	20		Spare	--	60
61	--	Spare		20	1	0	0					1	20		Spare	--	62
63	--	Spare		20	1			0	0			1	20		Spare	--	64
65	--	Spare		20	1					0	0	1	20		Spare	--	66
67	--	Spare		20	1	0	0					1	20		Spare	--	68
69	--	Spare		20	1			0	0			1	20		Spare	--	70
71	--	Spare		20	1					0	0	1	20		Spare	--	72
73	--	Spare		20	1	0	0					1	20		Spare	--	74
75	--	Spare		20	1			0	0			1	20		Spare	--	76
77	--	Spare		20	1					0	0	1	20		Spare	--	78
79	--	Spare		20	1	0	0					1	20		Spare	--	80
81	--	Spare		20	1			0	0			1	20		Spare	--	82
83	--	Spare		20	1					0	0	1	20		Spare	--	84
			Phase Load			12.12		8.00		6.61							
			Phase Amps			101.00		66.67		55.08							

Type	Connected Load	Demand/Adjusted	Panel Totals	
L	8.15	10.19	Connected Load	26.73
R	11.48	10.74	Demand Load	28.83
M	3.9	3.9	Connected Amps	74.20
C	3.2	4	Demand Amps	120.03

Panel: HLB2T7 BUS AMPS: 225 DISTR: 208Y/120
Supply From SDP-HB MAIN: MLO NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	L	HLB 1	2 #12	20	1	1.73	1.73					1	20	2 #12	HLB 2	L	2
3	L	HLB 3	2 #12	20	1			1.73	1.73			1	20	2 #12	HLB 4	L	4
5	L	HLB 5	2 #12	20	1					1.49	0.83	1	20	2 #12	HLB 6	L	6
7	L	HLB 7	2 #12	20	1	1.73	1.73					1	20	2 #12	HLB 8	L	8
9	L	HLB 9	2 #12	20	1			1.30	0.43			1	20	2 #12	HLB 10	L	10
11	L	HLB 11	2 #12	20	1					1.69	1.39	1	20	2 #12	Relay #8	L	12
13	L	Relay #5	2 #12	20	1	1.82	3.22					1	20	2 #12	Relay #10	L	14
15	L	Relay #9	2 #12	20	1			2.29	0.72			1	20	2 #12	Relay #14	L	16
17	L	LTG BKST OFFICES	2 #12	20	1					2.18	0	1	20		Spare	--	18
19	--	Spare		20	1	0	0					1	20		Spare	--	20
21	--	Spare		20	1			0	0			1	20		Spare	--	22
23	--	Spare		20	1					0	0	1	20		Spare	--	24
25	--	Spare		20	1	0	0					1	20		Spare	--	26
27	--	Spare		20	1			0	0			1	20		Spare	--	28
29	--	Spare		20	1					0	0	1	20		Spare	--	30
31	--	Spare		20	1	0	0					1	20		Spare	--	32
33	--	Spare		20	1			0	0			1	20		Spare	--	34
35	--	Spare		20	1					0	0	1	20		Spare	--	36
37	--	Spare		20	1	0	0					1	20		Spare	--	38
39	--	Spare		20	1			0	0			1	20		Spare	--	40
41	--	Spare		20	1					0	0	1	20		Spare	--	42
			Phase Load			11.95		8.19		7.58							
			Phase Amps			99.60		68.27		63.13							

Type	Connected Load	Demand/Adjusted	Panel Totals	
L	27.72	34.65	Connected Load	27.72
R			Demand Load	34.65
M			Connected Amps	76.94
C			Demand Amps	144.27

Panel: ECHO BUS AMPS: 100 DISTR: 208Y/120
Supply From DPL2 MAIN: MLO NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	L	LTG PIPE A	2 #12	20	1	0.36	0.36					1	20	2 #12	LTG PIPE C	L	2
3	L	LTG PIPE B	2 #12	20	1			1.61	0.16			1	20	2 #12	LTG BALC	L	4
5	L	LTG PIPE F	2 #12	20	1					0.88	0.88	1	20	2 #12	LTG PIPE E	L	6
7	L	LTG PIPE D	2 #12	20	1	0.29	0.73					1	20	2 #12	LTG HOUSE	L	8
9	--	Spare		19	1			0	0			1	20		Spare	--	10
11	--	Spare		20	1					0	0	1	20		Spare	--	12
13	--	Spare		20	1	0	0					1	20		Spare	--	14
15	--	Spare		20	1			0	0			1	20		Spare	--	16
17	--	Spare		20	1					0	0	1	20		Spare	--	18
19	--	Spare		20	1	0	0					1	20		Spare	--	20
21	--	Spare		20	1			0	0			1	20		Spare	--	22
23	--	Spare		20	1					0	0	1	20		Spare	--	24
			Phase Load			1.74		1.77		1.76							
			Phase Amps			14.50		14.75		14.67							

Type	Connected Load	Demand/Adjusted	Panel Totals	
L	5.27	6.5875	Connected Load	5.27
R			Demand Load	6.5875
M			Connected Amps	14.63
C			Demand Amps	27.43

PANELBOARD RESIZING

LOAD CALCULATIONS

Some panelboards were oversized beyond what code required and eight panels in particular were studied for resizing. Appropriate demand factors were applied to the loads to ensure an accurate amperage calculation for each panel. Growth varied from a factor of 1.5 to 3, based on the amount of space left on the panelboard for expansion. Other demand factors used include: 1.25 for continuous loads and lighting and 0.5 applied to receptacles after the first 10 kVA. The panelboards studied are P3, LPG, LPB2T7A, LPB2T7, LPB2T7C, DPHB2, LP2, and DPHB1. In the case of DPHB2 and DPHB1, spare loads were also added to overall load, due to the fact that they were likely to be added in the future since breaker sizes were already designated to some circuits. These were assumed to be at 100% circuit capacity to ensure the panel could handle the load after resizing. The load types included L for lighting, R for receptacles, M for mechanical, C for continuous, and S for spares. Below is a summary of the different loads on each panel, for detailed panel loads, see appendix E.

Panel Loads								
Panel	Size	New Size	Growth	Type	Connected	Demand (kVA)	Demand (A)	Resize?
P3	225	100	2	L	0.89	1.11	93.9	Yes
				R	21.6	15.8		
LPG	225	100	1.5	L	7.77	9.71	131.7	No
				R	24.55	17.28		
				M	4.4	4.4		
				C	0.2	0.25		
LPB2T7A	150	100	2	R	10.47	10.24	56.8	Yes
LPB2T7	150	100	2	L	0.54	0.68	35.9	Yes
				R	5.79	5.79		
LPB2T7C	400	225	3	L	0.54	0.68	117.7	Yes
				R	16.91	13.46		
DPHB2	600	400	1.5	M	95	95	570.2	No
				C	0.2	0.25		
				S	220.8	220.8		
LP2	225	100	2	L	8.31	10.39	162.9	No
				R	20.02	15.01		
				M	3.95	3.95		
DPHB1	400	225	1.5	M	79.93	79.63	213.0	Yes
				S	38.4	38.4		

COST ANALYSIS

Based on these load calculations, five of the eight panelboards studied were able to be resized and a cost analysis using RS Means was performed to determine any savings from the downsizing of the panels and their respective wiring. Wire takeoffs were estimations based on the shortest distance from the source to the panel plus an additional 10' of pull out length.

Panelboard Cost Analysis												
Cost Code	Item	Units	Quant.	Mat'l Unit Cost	Mat'l Cost	Labor Unit Cost	Labor Cost	Total	Wires	Sets	Summing	Totals
120-208V Panel Boards Old												
262416302800	4 wire, 120/208 V, 100 Amp, 32 ckt	Ea	0	$1,025.00	$ -	$ 805.00	$ -	$ -				
--	4 wire, 120/208 V, 150 Amp, 42 ckt	Ea	2	$1,795.00	$ 3,590.00	$1,010.00	$ 2,020.00	$ 5,610.00				
262416301000	4 wire, 120/208 V, 225 Amp, 42 ckt	Ea	3	$1,350.00	$ 4,050.00	$1,250.00	$ 3,750.00	$ 7,800.00				
262416302300	4 wire, 120/208 V, 400 Amp, 42 ckt	Ea	2	$3,225.00	$ 6,450.00	$1,775.00	$ 3,550.00	$ 10,000.00				Old Panel
262416302350	4 wire, 120/208 V, 600 Amp, 42 ckt	Ea	1	$4,775.00	$ 4,775.00	$2,125.00	$ 2,125.00	$ 6,900.00				$30,310.00
120-208V Electrical - 600 Volt Copper type THHN, standed, #6 Old												
260519901500	#2 Wire	CLF	0.0	$ 161.00	$ -	$ 95.00	$ -	$ -	4	1	$ -	
260519901650	2/0 Wire	CLF	3.5	$ 320.00	$ 1,120.00	$ 147.00	$ 514.50	$ 1,634.50	4	1	$ 6,538.00	
260519902200	250 kcmil wire Copper	CLF	0.1	$ 605.00	$ 60.50	$ 213.00	$ 21.30	$ 81.80	4	1	$ 327.20	Old Wire
260519902000	4/0 Wire	CLF	3.4	$ 500.00	$ 1,700.00	$ 194.00	$ 659.60	$ 2,359.60	4	2	$18,876.80	$25,742.00
120-208V Panel Boards New												
262416302800	4 wire, 120/208 V, 100 Amp, 32 ckt	Ea	3	$1,025.00	$ 3,075.00	$ 805.00	$ 2,415.00	$ 5,490.00				
--	4 wire, 120/208 V, 150 Amp, 42 ckt	Ea	0	$1,795.00	$ -	$1,105.00	$ -	$ -				
262416302250	4 wire, 120/208 V, 225 Amp, 42 ckt	Ea	4	$1,350.00	$ 5,400.00	$1,250.00	$ 5,000.00	$ 10,400.00				
262416302300	4 wire, 120/208 V, 400 Amp, 42 ckt	Ea	0	$3,225.00	$ -	$1,775.00	$ -	$ -				New Panel
262416302350	4 wire, 120/208 V, 600 Amp, 42 ckt	Ea	1	$4,775.00	$ 4,775.00	$2,125.00	$ 2,125.00	$ 6,900.00				$22,790.00
120-208V Electrical - 600 Volt Copper type THHN, standed, #6 New												
260519901500	#2 Wire	CLF	3.3	$ 161.00	$ 531.30	$ 95.00	$ 313.50	$ 844.80	4	1	$ 3,379.20	
260519901650	2/0 Wire	CLF	0.0	$ 320.00	$ -	$ 147.00	$ -	$ -	4	1	$ -	
260519902200	250 kcmil wire Copper	CLF	3.7	$ 605.00	$ 2,238.50	$ 213.00	$ 788.10	$ 3,026.60	4	1	$12,106.40	New Wire
260519902000	4/0 Wire	CLF	0.0	$ 500.00	$ -	$ 194.00	$ -	$ -	4	2	$ -	$15,485.60
											Old - New	$17,776.40

CONCLUSION

The cost analysis revealed that if the panelboards P3. LPB2T7A, LPB2T7, LPB2T7C, and DPHB1 were to be resized, the expected savings is around $18,000. The majority of the savings comes from the wire downsizing, which equates to a $10,000 savings. The remainder comes from the panelboards themselves. Although the system would lose some capacity with this downsizing, the growth factors still allow for significant additions to the system without the need for larger or more panelboards. Ultimately, the owner may chose the extra capacity over the cost savings, especially considering that the savings is minimal compared to the overall project cost.

Integrated Daylighting, Mechanical, Construction Management Depth & Breadths

DEPTH & BREADTHS INTEGRATION

INTRODUCTION

With sustainability and technology being more integrated into the design and construction process, it becomes not only beneficial, but necessary to look at a system from multiple disciples. The impact of an architectural system can be widespread and without looking at various aspects more problems may be created than solved. The upcoming sections will explain the process used for daylighting and the integrated energy and cost analysis. This informed method of designing will allow meaningful design decisions to be made to choose the best fit for the project and allow the design team to move forward with their eyes open.

PURPOSE & GOALS

1) Use parametric design to study various daylighting system options and combinations to allow informed choices to be made by the design team, balancing daylighting and energy performance, as well as overall cost.
2) Manage excessive daylighting in the atrium to comfortable levels.
3) Know the mechanical impacts that the various daylighting options have on the space and if possible improve on the current mechanical performance.
4) Weigh the various costs options of the systems against their performance.
5) Learn and apply the parametric design process.
6) Demonstrate the impact and potential of parametric analysis and informed design on this and other projects in the construction industry.

PARAMETRIC WORKFLOW

Parametric design is essentially changing different parameters within a design or model and then testing it to see the impact of that combination of variables. This can apply to many things from optimizations to daylighting and energy modelling. Within in the construction industry, parametric design is just now obtaining a foothold with a few companies leading the effort. The ultimate goal is to allow design teams to know what to expect when a design decision is made

and shape the design as early as possible. The earlier this style of designing is implemented on a project, the more informed decisions the team can make. With this the team can not only see potential issues with their design, but can address them when they have enough influence over the design to make a difference, rather than sticking a Band-Aid on something that could've been avoided. For the following analysis, Rhino was used due to its accessibility, user friendly interface, and plugin support.

Rhino is a 3D modelling software used by designers of all kinds. Unlike other modelling software, it is fairly constraint free and easy to create forms of various complexity. It accomplishes this by using mathematical representations of the curves that make up the geometry in addition to using point coordinates to define the vertexes of a plane or solid. Rhino also supports a number of plugins that make it an invaluable design tool and allow it to break into the realm of parametric design.

Grasshopper is a visual coding interface plugin for Rhino. It allows the instantaneous creation and manipulation of geometry and other variables within Rhino. This toolset allows for iterative analysis to be done as designated variables change to reflect the different options created by the designer.

Ladybug and Honeybee are plugins for Grasshopper that allow the connection of various platforms to Grasshopper and Rhino. Ladybug can apply .epw weather data and allows for radiation, solar, and comfort analyses to take place. It is also the primary visualizer for all results from both Ladybug and Honeybee. Honeybee connects Radiance, Daysim, Energy Plus, and Open Studio to Grasshopper and Rhino. It can load in models with fully defined material properties into any of these platforms for a variety of analyses. Radiance and Daysim are primarily used for lighting design and daylighting simulations, while Energy Plus and Open Studio are used for mechanical simulations.

With this collection of software any number of tests and simulations can be set and run while the designer works on other aspects of the project. The results can then be visualized in any number

of ways and analyzed to find only those solutions that meet all criteria. For this a web based app called Pollination was used along with visual analysis of each scenario.

MAE DEPTH DAYLIGHTING

INTRODUCTION

This section goes into detail on the daylighting design for the Atrium space. This includes the goals and criteria for the design, the variables studied, the methods and processed used, results of the analysis, and an evaluation of the various scenarios. Visualizations from Rhino and renders from Radiance are included to visually understand the results of the various studies.

GOALS

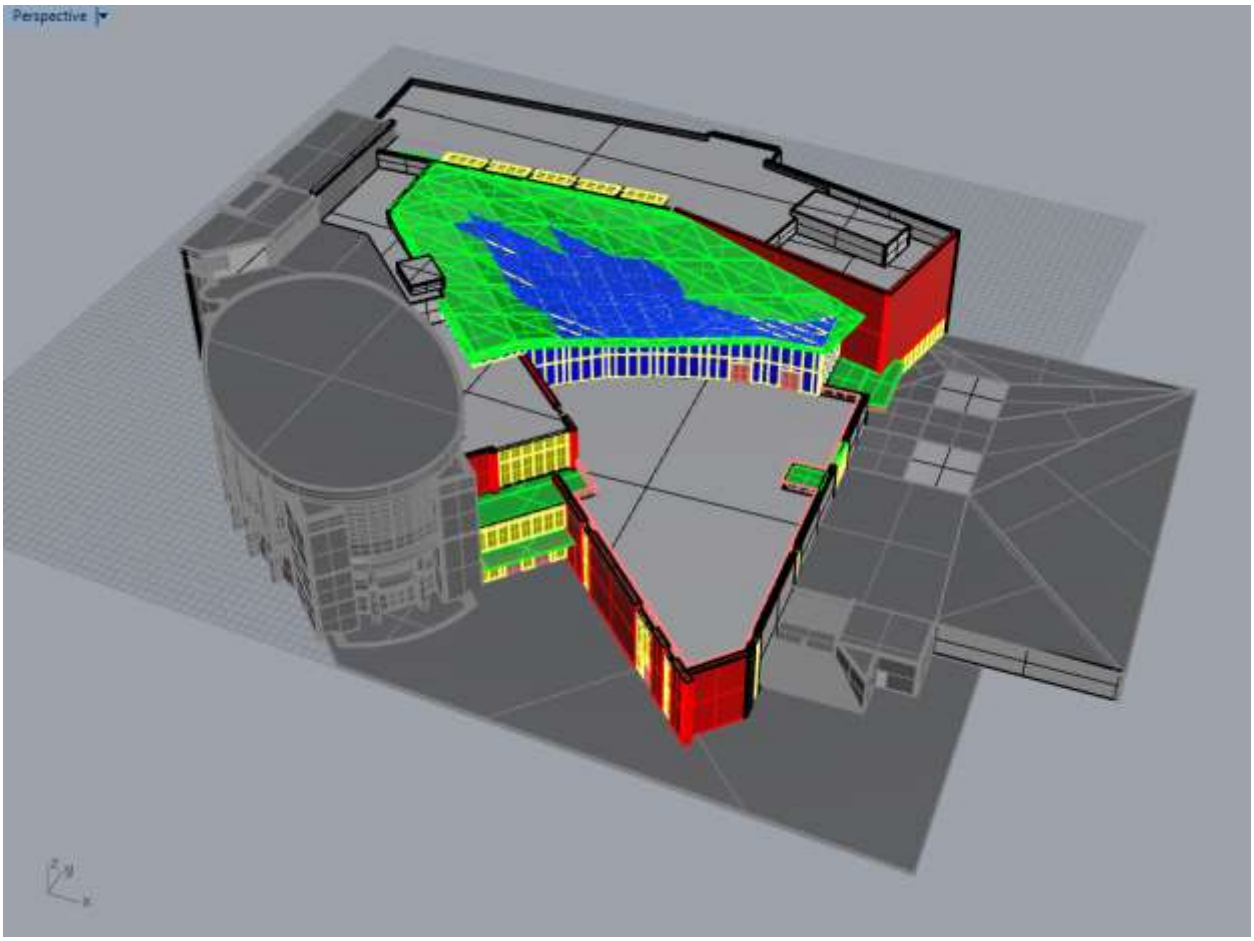
1) Manage excessive daylight within the Atrium space.
2) Create parametric model to simulate multiple scenarios.
3) Use visual result data and metrics to evaluate scenario performance.

METHODOLOGY

By using Ladybug and Honeybee, it is relatively easy to test and evaluate the performance of various models and scenarios. This extend beyond daylighting and into mechanical and architectural performance. The following is the general sequence used to import and test the base model, along with adding parametric variables that made up 16 initial scenarios that was narrowed down to four for more in-depth study.

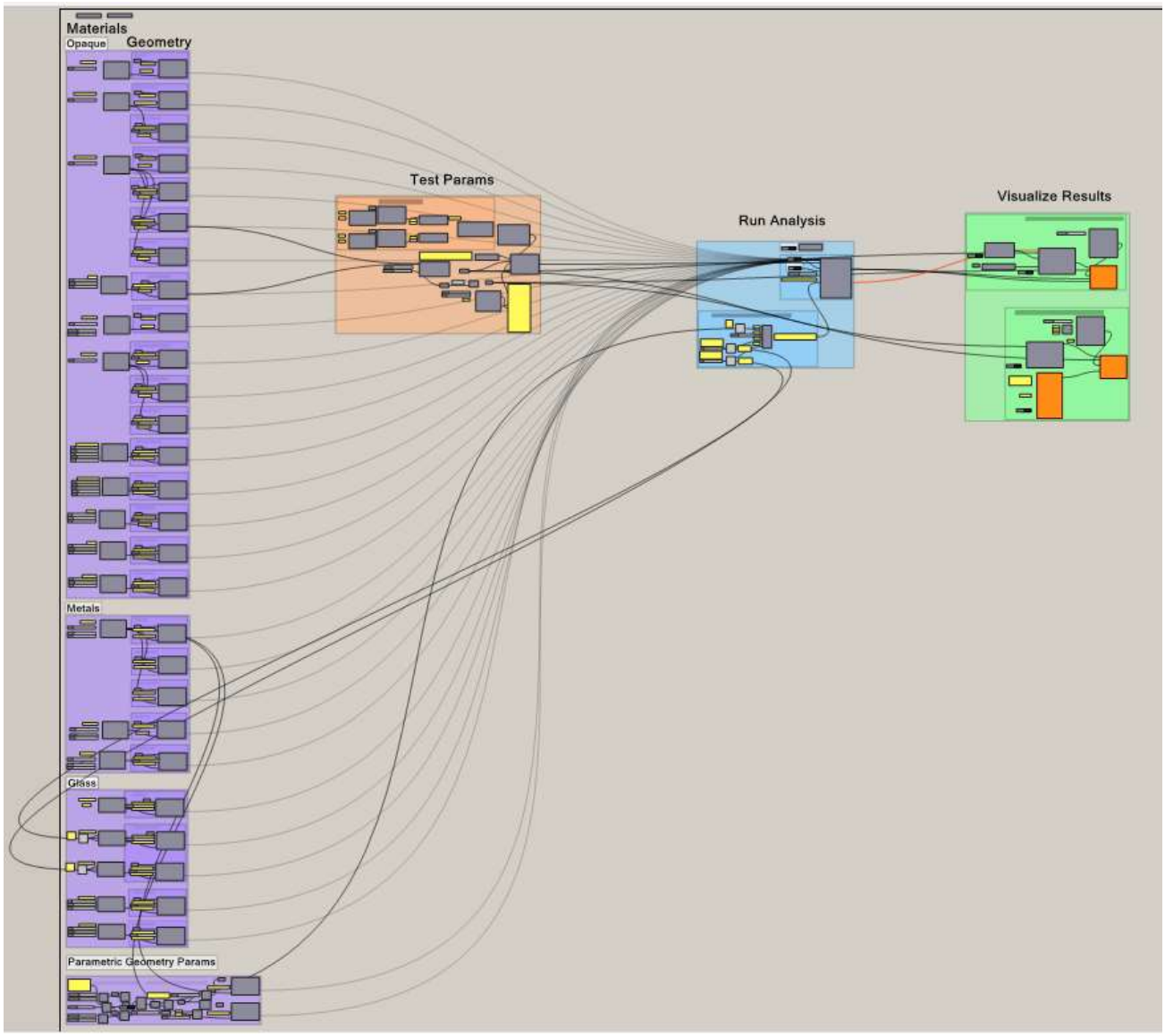
1: Import Geometry

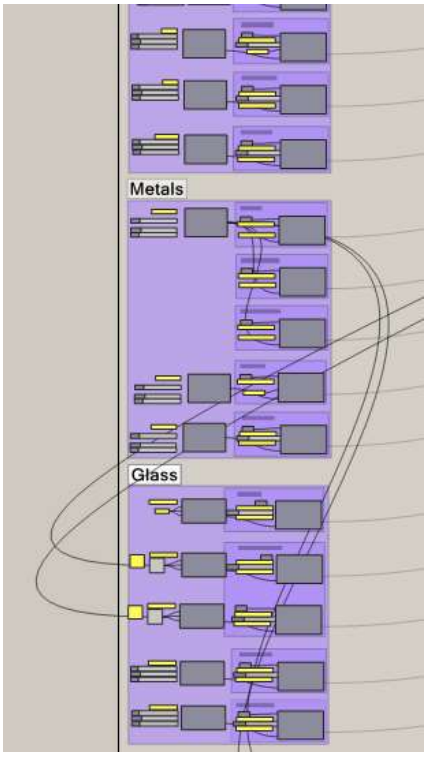
Import Revit geometry into Rhino. The area of study needed to be isolated from the context to avoid excessive simulation times in Radiance and Daysim. The Exterior walls of the immediate context were kept, while the interior of that context was excluded.

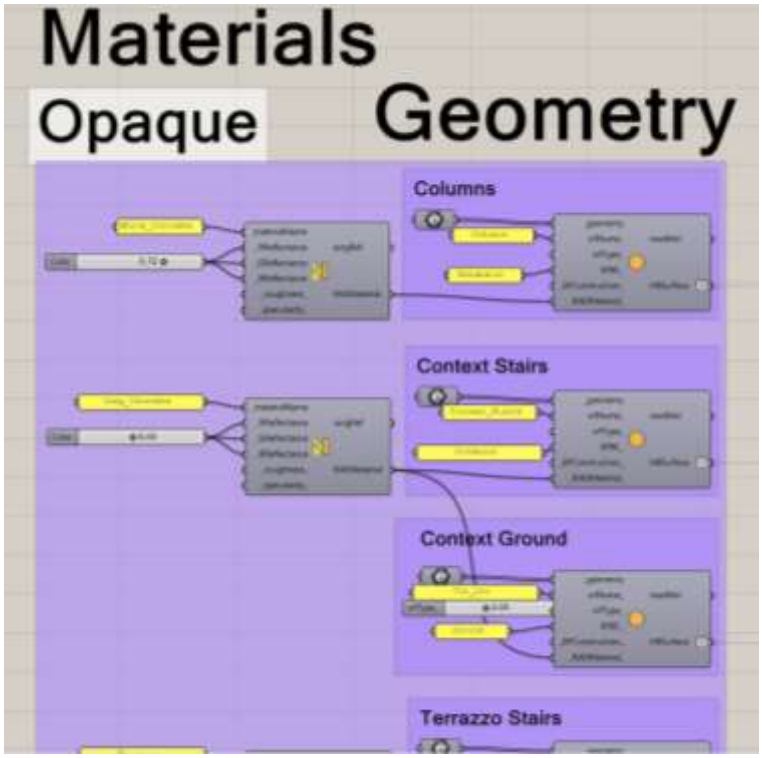


2: Define Workflow, Reference Geometry, and Set Materials

Create Grasshopper workflow and reference model geometry. This step lays the groundwork for the rest of the process, so it is imperative that the geometry be appropriately referenced. With the geometry referenced, materials can be assigned. Radiance materials are assigned to each referenced geometry for daylighting as .rad text files, while Energy Plus constructions were used for the mechanical studies.

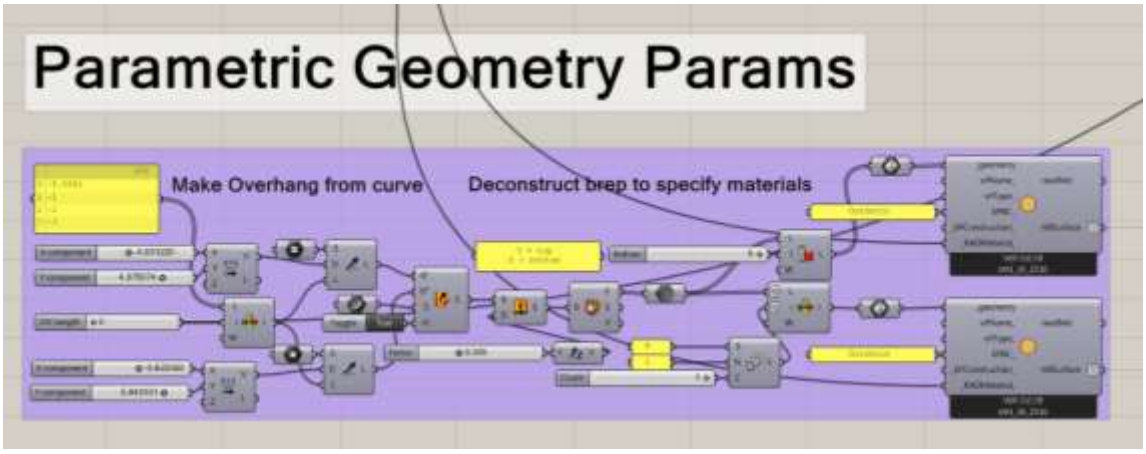

Materials
Opaque
Geometry
Test Params
Run Analysis
Visualize Results
Metals
Glass
Parametric Geometry Params



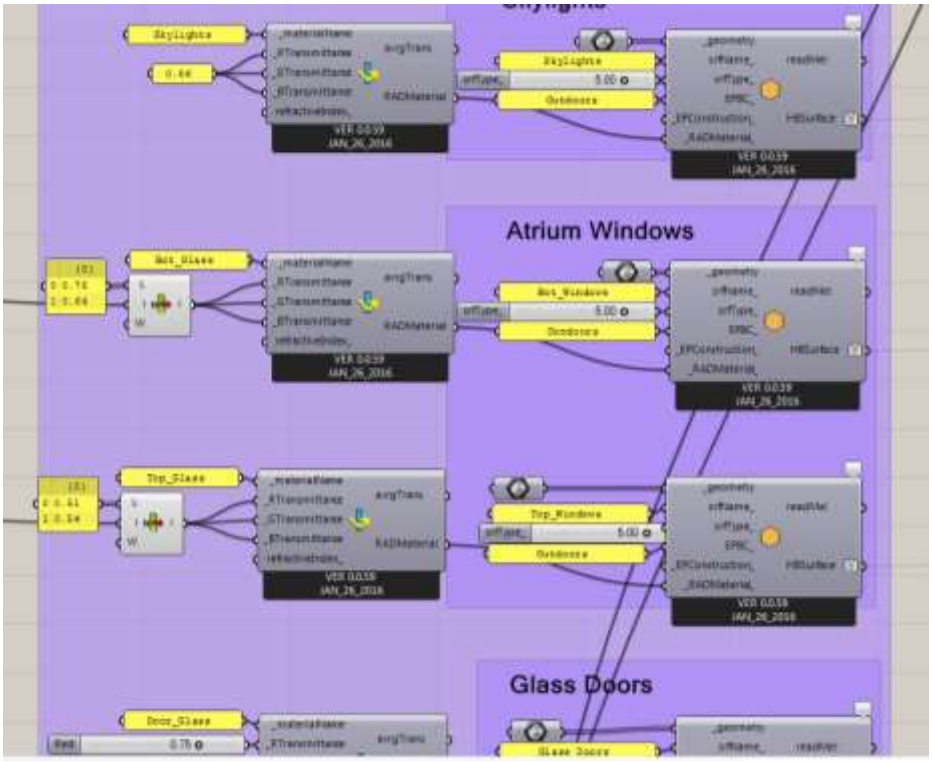


3: Incorporate Parametric Variables

With the geometry properly defined the parametric variables can be introduced. The parametric variables included both geometry and material variations. The first variable was the addition of an overhang with a depth of either one, two, or three meters. The other was one alternative glass material for both the top and bottom curtain wall sections. Additionally to address the large

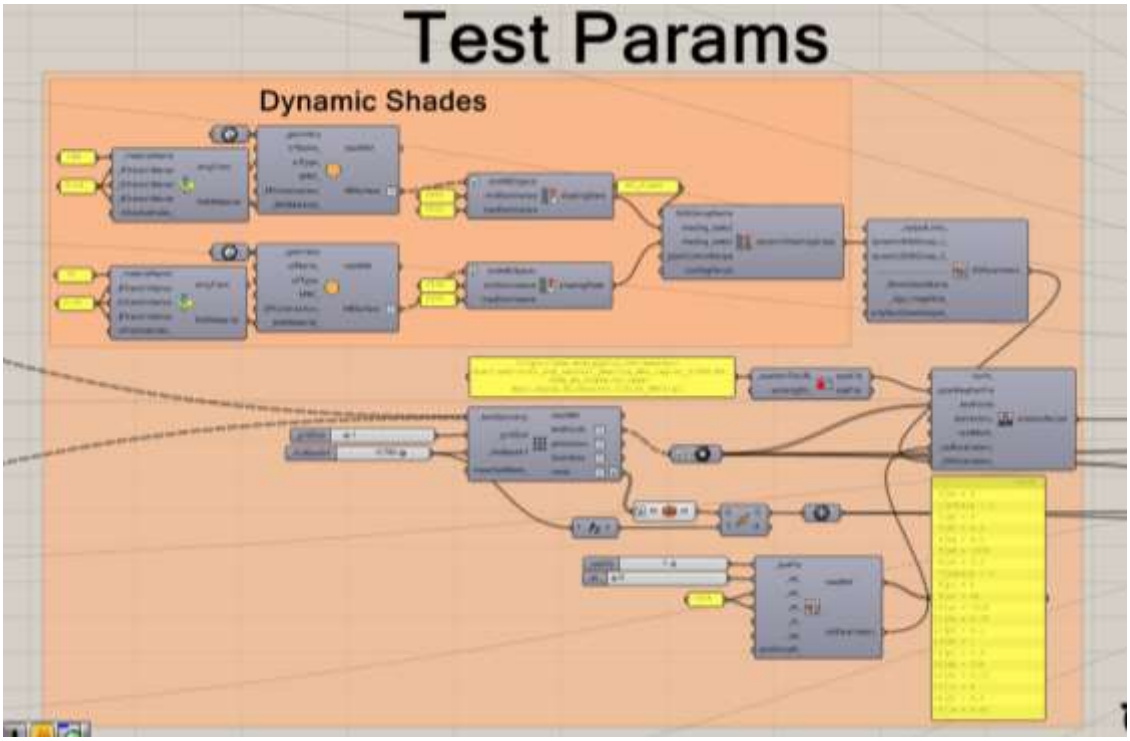


amount of skylights in the space, electrochromic glass was implemented as a shading component. Two cases for both the top and bottom curtain wall materials and four overhang configurations gave 16 separate scenarios to be tested.



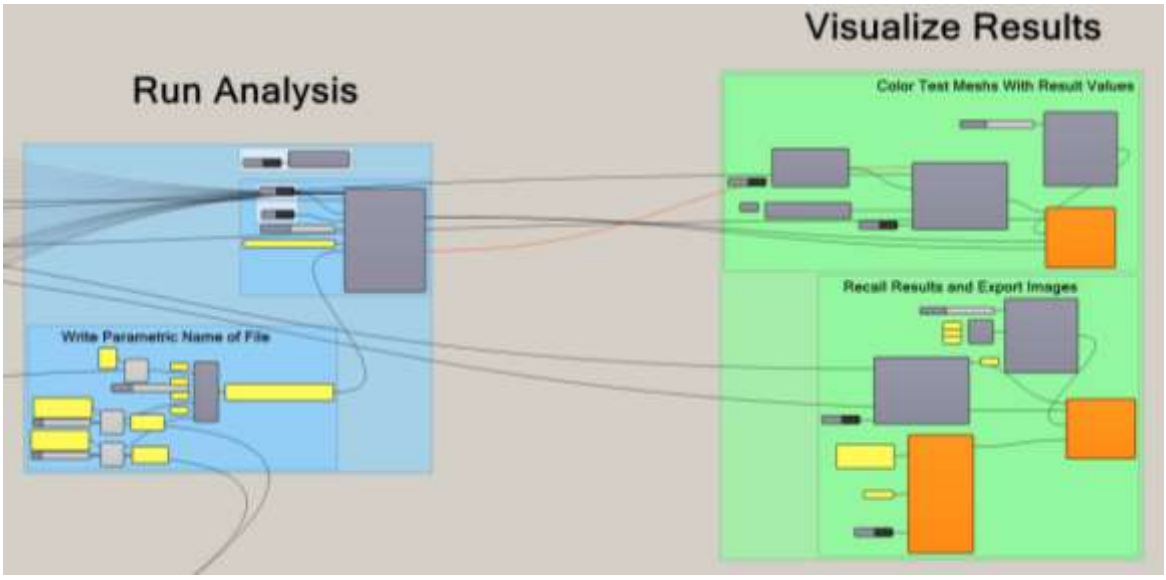
4: Select Analysis Type and Parameters

The next step is to set the analysis type and respective parameters. In the daylighting portion, two analysis types were used. The first being a grid based analysis that computes illuminance values at the specified times of the year. The second is an annual analysis that gives daylighting metrics for the test space. More specific Radiance and Daysim parameters can be set for both analysis types.



5: Run Simulation and Visualize Results

The final steps are to run the analysis and then set up the visualization of the results for final interpretation. These can range from looking at the average space metrics to coloring the test mesh based on a point's value.



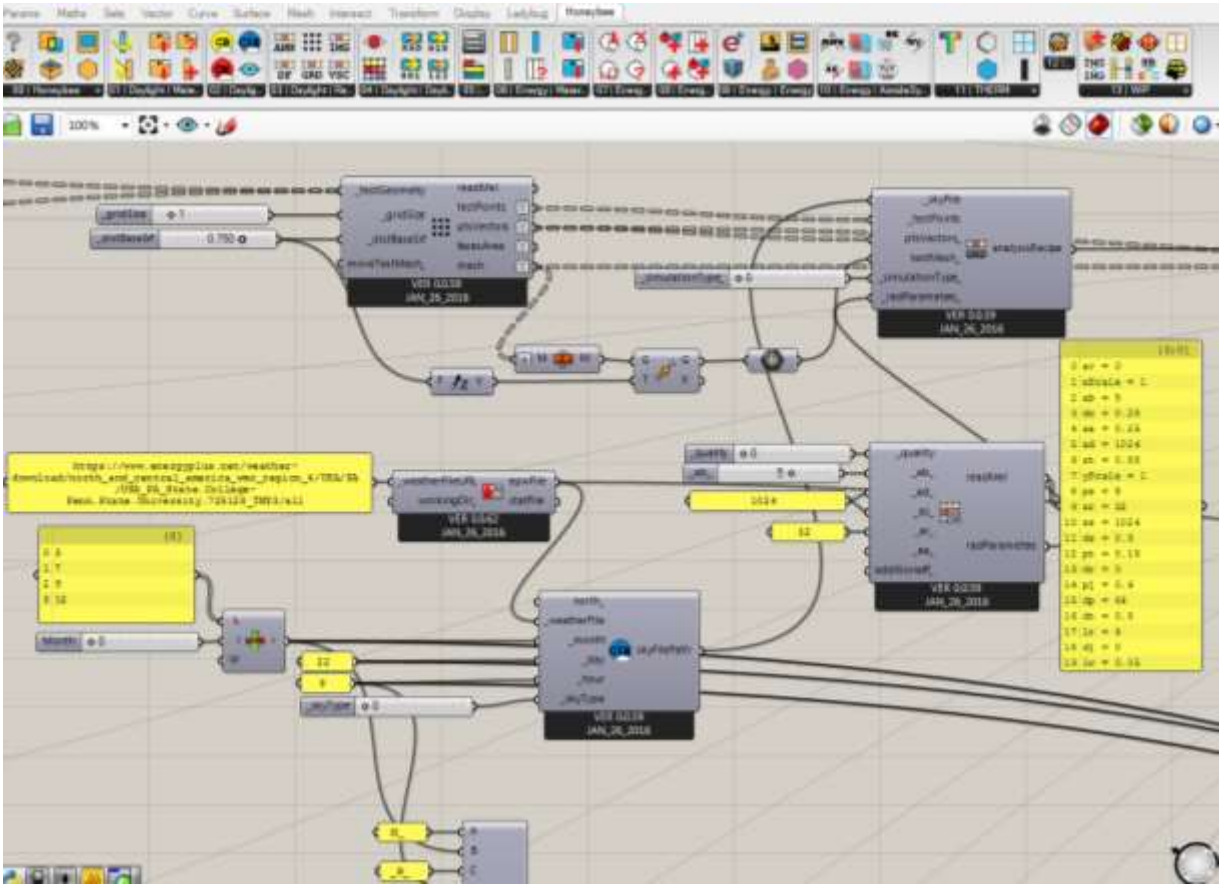
ILLUMINANCE STUDY

INTRODUCTION

To hone in on the most promising solutions before conducting more detailed analysis, an illuminance study was performed on all 17 scenarios. This study allows the use of visual results to determine a rough idea of daylighting performance. For each case, three hours, 9:00, 12:00, and 15:00, from both solstices and equinoxes were studied. These dates and times were chosen because they represent a wide variety of solar conditions. The effect of electric lighting was not considered.

PARAMETERS

To ensure an accurate simulations, the sky conditions and Radiance parameters needed to be set to reasonable settings. A CIE sky was set to sunny with sun and the time itself was variable based on the time that was being studied. The Radiance parameters can be seen in the picture below. To ensure a more accurate calculation, the ambient bounces were increased to 5, ambient divisions and super-samples were set to 1024, and ambient resolution is set to 32.



BASE CASE

The existing design for the Atrium utilizes a great deal of glass in the form of both curtain walls and skylights. Low-e IGUs of two different constructions were used. The first being the a 1" thick 2 lite glazing system with low-e coating on the #2 surface, an argon filled air space, and clear glazing for the interior lite. This type has a transmittance of 70%, U-value of 0.24, SHGC of 0.39, and is used for all glazing except the top of the curtain wall. The second type that is used for the top pane of the curtain wall is a similar construction, adding silk screen dots that cover 40% of the interior lite. This type has a transmittance of 51%, U-value of 0.24, and SHGC of 0.32.

MATERIALS

Below is a table of the Radiance materials and their properties that were used within the model. These were assigned to both room and context geometry to ensure an accurate representation of the space.

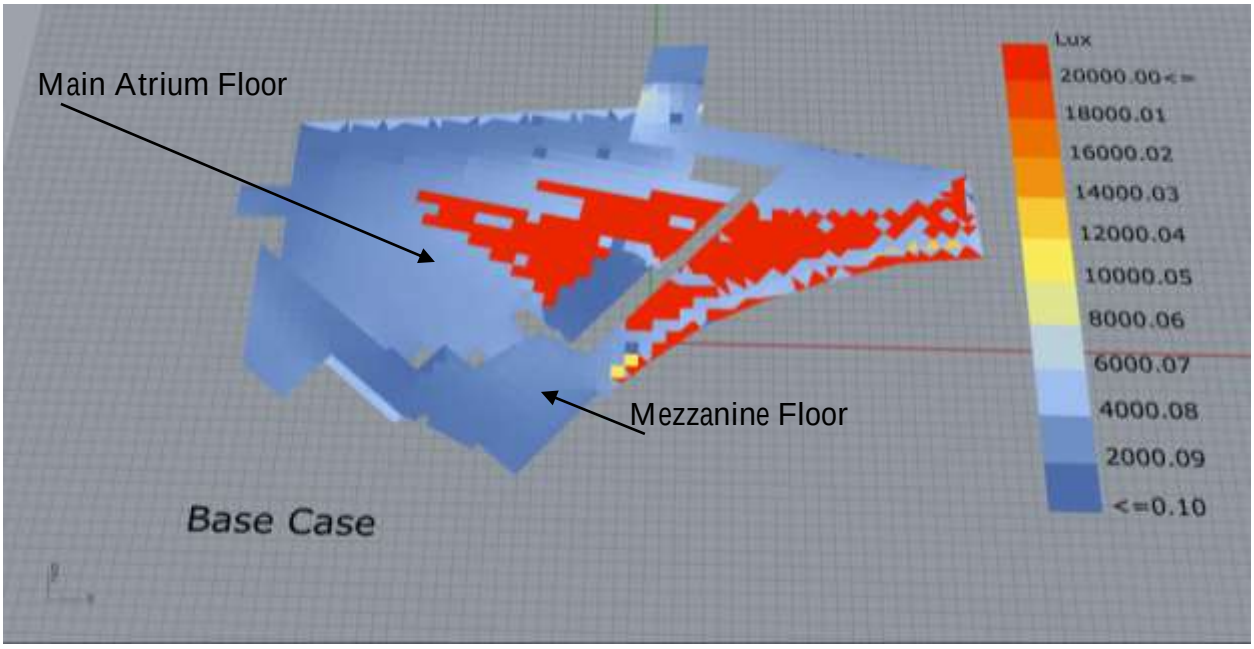
Radiance Materials						
		Reflectance				
Name	Type	Red	Green	Blue	Roughness	Specularity
White Concrete	Opaque	0.72	0.72	0.72	--	--
Grey Concrete	Opaque	0.43	0.43	0.43	--	--
Terrazzo	Opaque	0.85	0.85	0.85	--	--
Carpet	Opaque	0.07	0.28	0.76	--	--
Wood	Opaque	0.2	0.2	0.2	0.02	0.05
White Gypsum	Opaque	0.91	0.91	0.91	--	--
Terracotta	Opaque	0.94	0.39	0.05	0	0
Brick	Opaque	0.4	0.13	0.5	0	0.1
ACT	Opaque	0.8	0.8	0.8	--	--
Gen Roof	Opaque	0.2	0.2	0.2	--	--
Green Roof	Opaque	0.47	0.47	0.47	--	--
Aluminum	Metal	0.7	0.7	0.7	0.2	0.07
Handrail Metal	Metal	0.6	0.6	0.6	0.2	0
Roof Metal	Metal	0.82	0.82	0.82	0.1	0
Skylights	Glass	0.56	0.56	0.56	--	--
Bot Glass	Glass	0.75	0.75	0.75	--	--
Top Glass	Glass	0.51	0.51	0.51	--	--
Door Glass	Glass	0.75	0.75	0.75	--	--
Context Glass	Glass	0.56	0.56	0.56	--	--

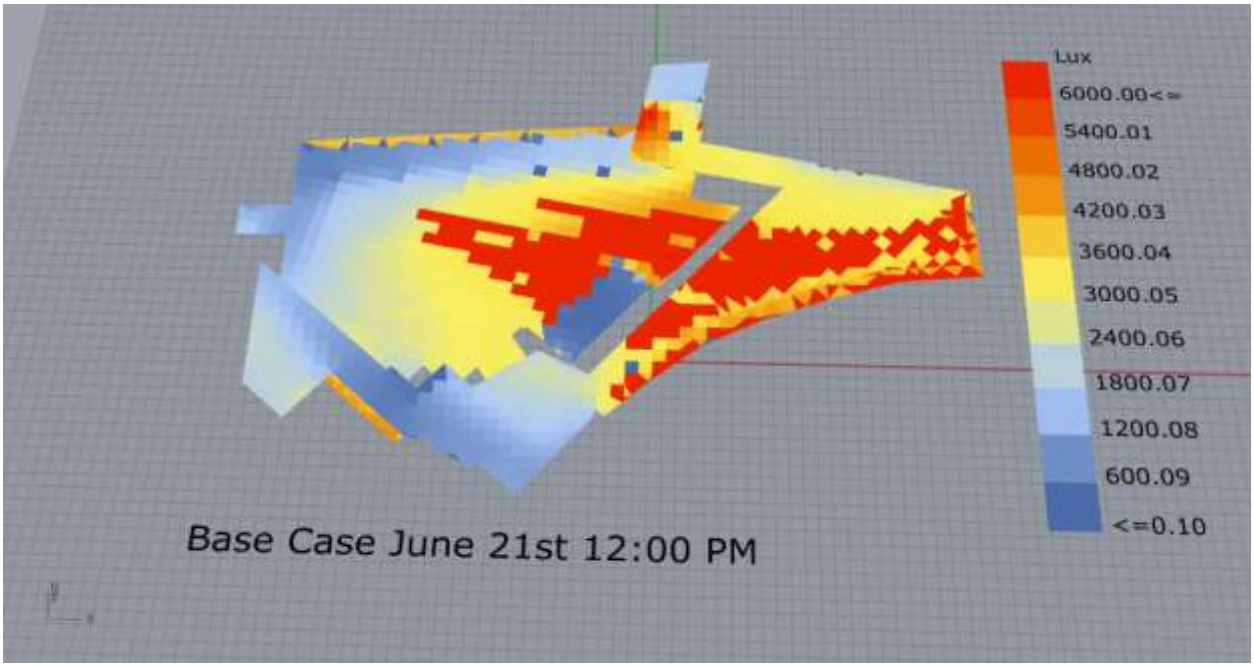
SETUP

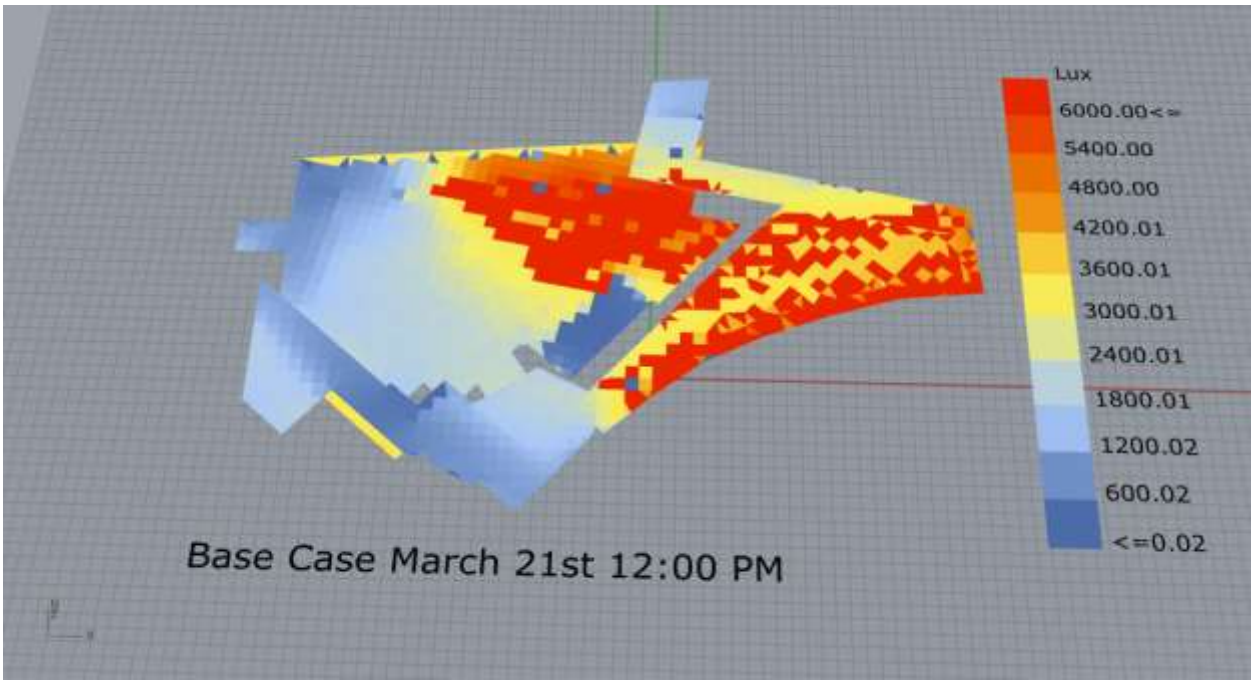
A testing grid with 1' spacing was set up on the testing surfaces, which include the mezzanine floor and main atrium. A standard occupancy profile from 9AM to 5PM was used to define the occupancy of the space.

RESULTS

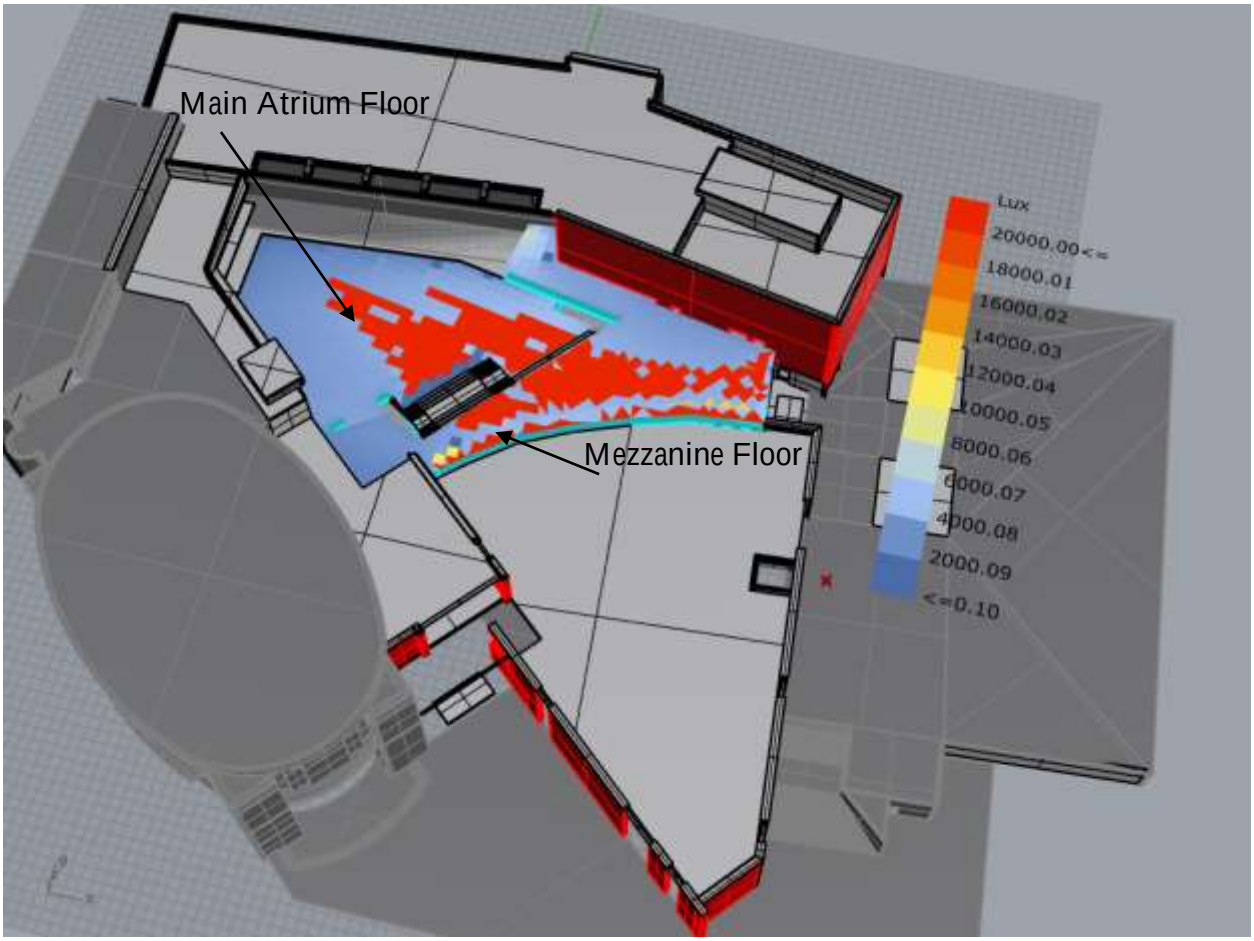
The results of the Base Case revealed that there is excessive daylight levels at various times of the year. The first two pictures below show the Base Case at 12:00 PM on the 21st of June. The first uses a scale with an upper limit of 20,000 lux and the second uses a scale with an upper limit 6000 lux. This was to show the overall upper limit of illuminance in the space, as well as show more detail of the illuminance spread.







Using figures like these to look at times throughout the year, it was determined that the mezzanine level and main seating area were two areas that needed some sort of daylighting solution. The excessive daylighting in these areas needs to be addressed to ensure a comfortable and usable space throughout the year.



The picture above shows the result mesh with surrounding context geometry. Note that there are two meshes, an upper mesh representing the mezzanine floor, and a lower mesh representing the main atrium floor.

PROPOSED DESIGNS

As stated above, there are a total of 16 scenarios that were tested in the illuminance study. From the results, no more than four cases would be chosen for further annual analysis. The variables being changed are the glass types for the both top and bottom panes in the curtain wall and the addition of an overhang ranging from 1m to 3m. All cases have replaced the skylight glazing with electrochromic glass. The electrochromic glass was had two states. The first state decreased the transmittance to 0.18 and triggered at 3000 lux. The second state decreased the transmittance further to 0.06 and triggered at 3500 lux. Both transmittances were taken from SageGlass ™ product information.

Scenarios			
#	Overhang Length (M)	Top Pane	Bottom Pane
1	0	Original	Original
2	0	Alternate	Original
3	0	Original	Alternate
4	0	Alternate	Alternate
5	1	Original	Original
6	1	Alternate	Original
7	1	Original	Alternate
8	1	Alternate	Alternate
9	2	Original	Original
10	2	Alternate	Original
11	2	Original	Alternate
12	2	Alternate	Alternate
13	3	Original	Original
14	3	Alternate	Original
15	3	Original	Alternate
16	3	Alternate	Alternate

MATERIALS

The materials used remained the same from the Base Case. The addition of two addition glass types for the alternative glazing were added and shown below. They were chosen based on their U-values, SHGC's, and LSG (Light to Solar gain Ratio). These factors were all higher compared to the Base Case. The other important factor is the transmittance, which was chosen to be similar to the Base Case.

Glass Types								
Type	Manu.	Composition	Size	Qty	VT	U	SHGC	LSG
1	JEB	1/4" Solarban 60 #2 1/2" Argon 1/4" Clear w/ 40% White Dots #3	6X4	47	51	0.29	0.32	1.59
1A	Trulite	1/4" Solarban 90 Starphire #2 1/2" Argon 1/4" Starphire	6X4	47	54	0.24	0.23	2.35
2	JEB	1/4" Solarban 60 #2 1/2" Argon 1/4" Clear	10X4	30	70	0.29	0.39	1.79
2A	Trulite	1/4" Solarban 70XL Starphire #2 1/2" Argon 1/4" Clear	10X4	30	64	0.26	0.27	2.37

SETUP

Setup is identical to the Base Case with the addition of the shading as noted above.

RESULTS

Using a mesh color component, the test grid was colored based on the corresponding test point's illuminance value. The overall performance of a scenario was based on the visual interpretation of the data. The main goal was to achieve more comfortable illuminance values than those of the Base Case. The main areas of interest are the floor area near the curtain wall and the main atrium floor.

EVALUATION

An overall trend emerged from the illuminance images that suggested that the key factors were an overhang of either 2m or 3m and the bottom curtain wall pane being replaced with the alternative glass material. These performed the best in terms of illuminance across the year. The mezzanine area by the curtain wall generally hovered around 2500 to 3500 lux. This was an improvement over the Base Case which had excesses of up to 20000 lux in that same area.

Based on their performance, the four cases chosen were 11, 12, 15, and 16. These four cases all have either 2m or 3m overhangs, as well as alternative bottom pane glazing material. That leaves the top pane glazing as an open variable.

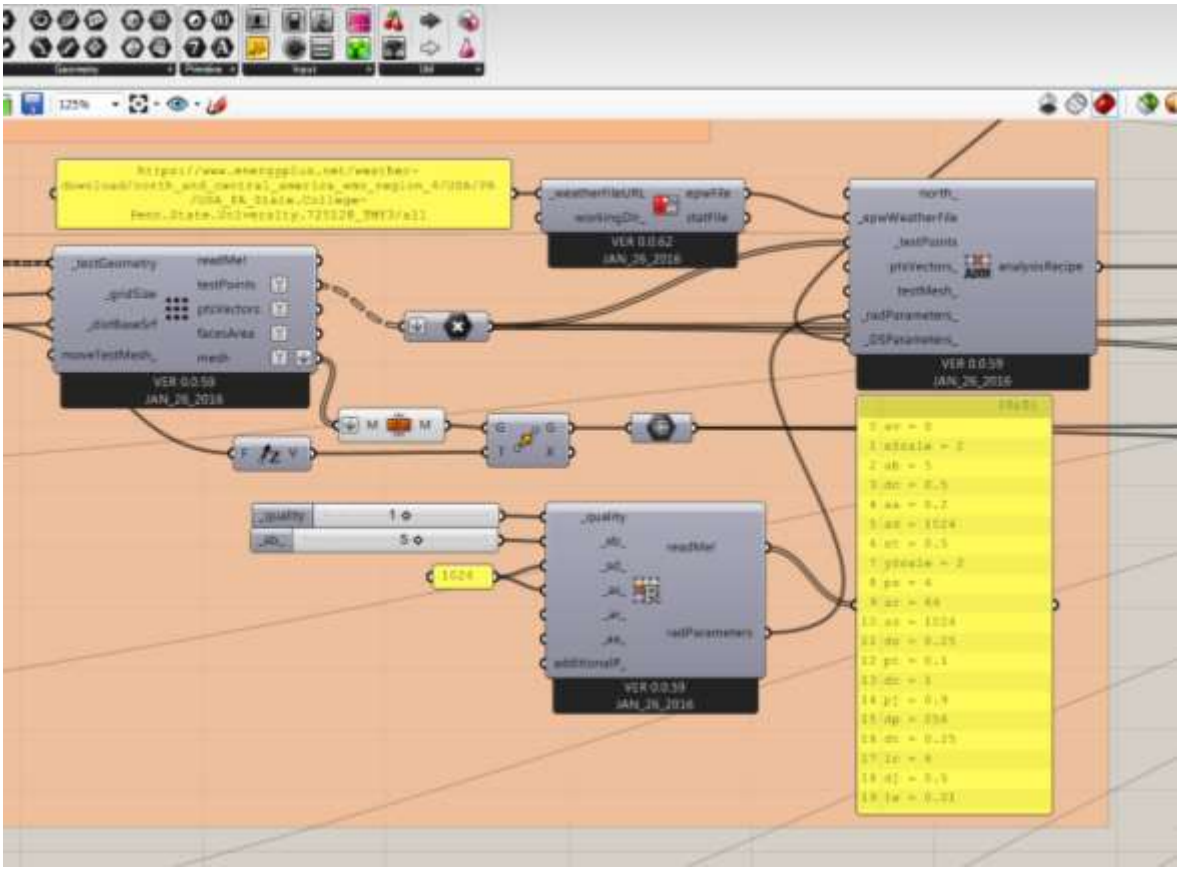
ANNUAL ANALYSIS

INTRODUCTION

With the four most promising scenarios selected through illuminance studies, an annual study is conducted to gather more thorough daylighting performance metrics for each case. These include cDA (Continuous Daylight Autonomy), DLA (Daylight Autonomy), and UDLI (Useful Daylight Illuminance). With these metrics a more concrete conclusion on the performance of each scenario can be reached. Materials and set up remained the same as the illuminance study unless otherwise noted.

PARAMETERS

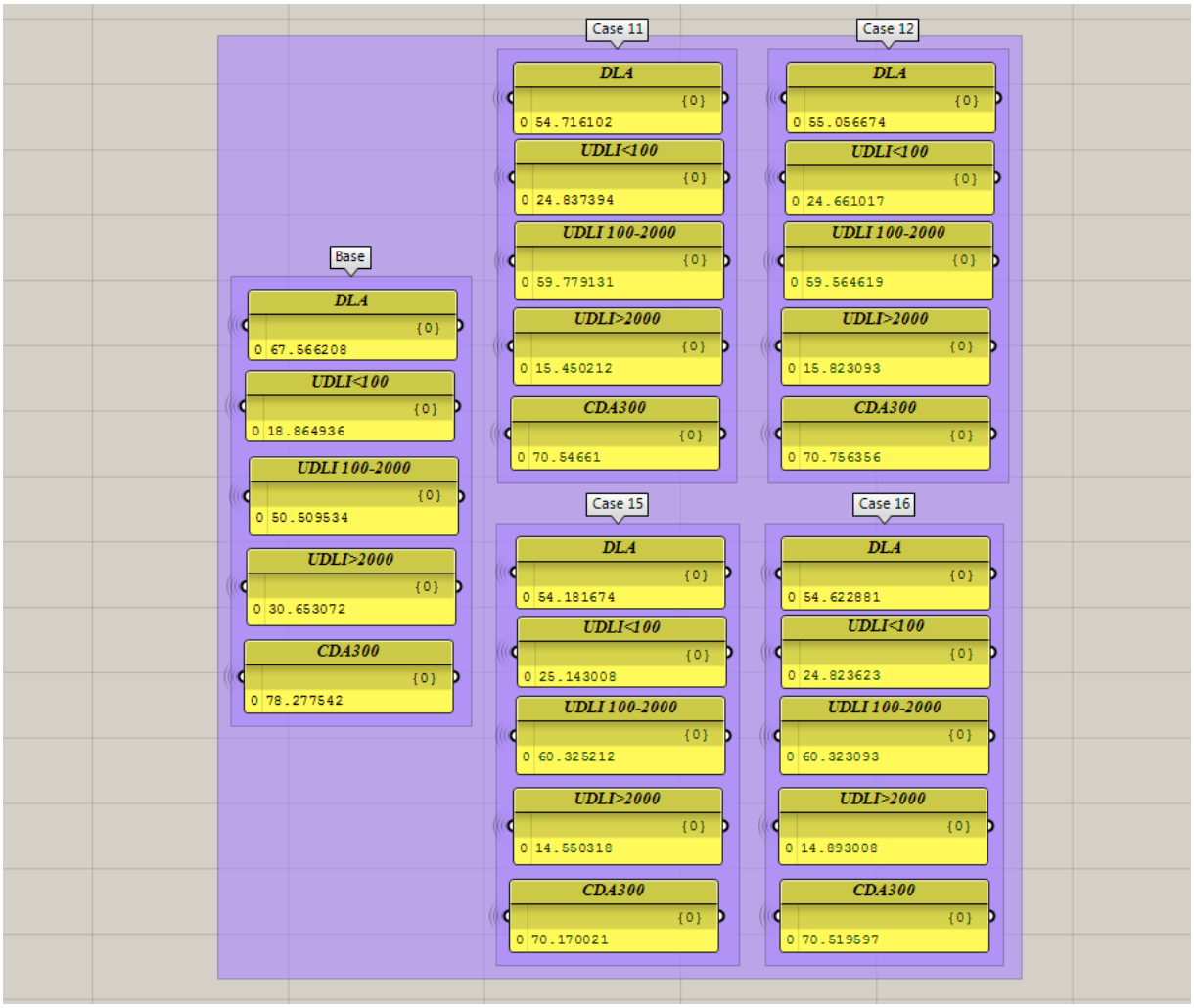
For this study the Radiance parameters were increased to ensure accurate results. They can be seen in the picture below. The State College .epw file was loaded into the analysis for the accurate weather data. The electrochromic glass parameters are the same as the illuminance study. The test surfaces and point grid also remained the same.



BASE CASE

The Base Case was studied to establish results to compare the four proposed scenarios. The daylighting metrics listed above were used to assess the performance for the space. The metric value for the entire space, as well as a colored mesh overlays were used.

RESULTS OF ALL CASES



The first thing that should be addressed is that all of the proposed cases performed similarly for all metrics tested. The most difference between them is a percentage point. Thus, it can be assumed that all solutions perform similarly. This is confirmed when the point data is overlaid on

a colored mesh, similar to the illuminance study. The four cases look nearly identical to each other, while the Base Case does differ slightly.

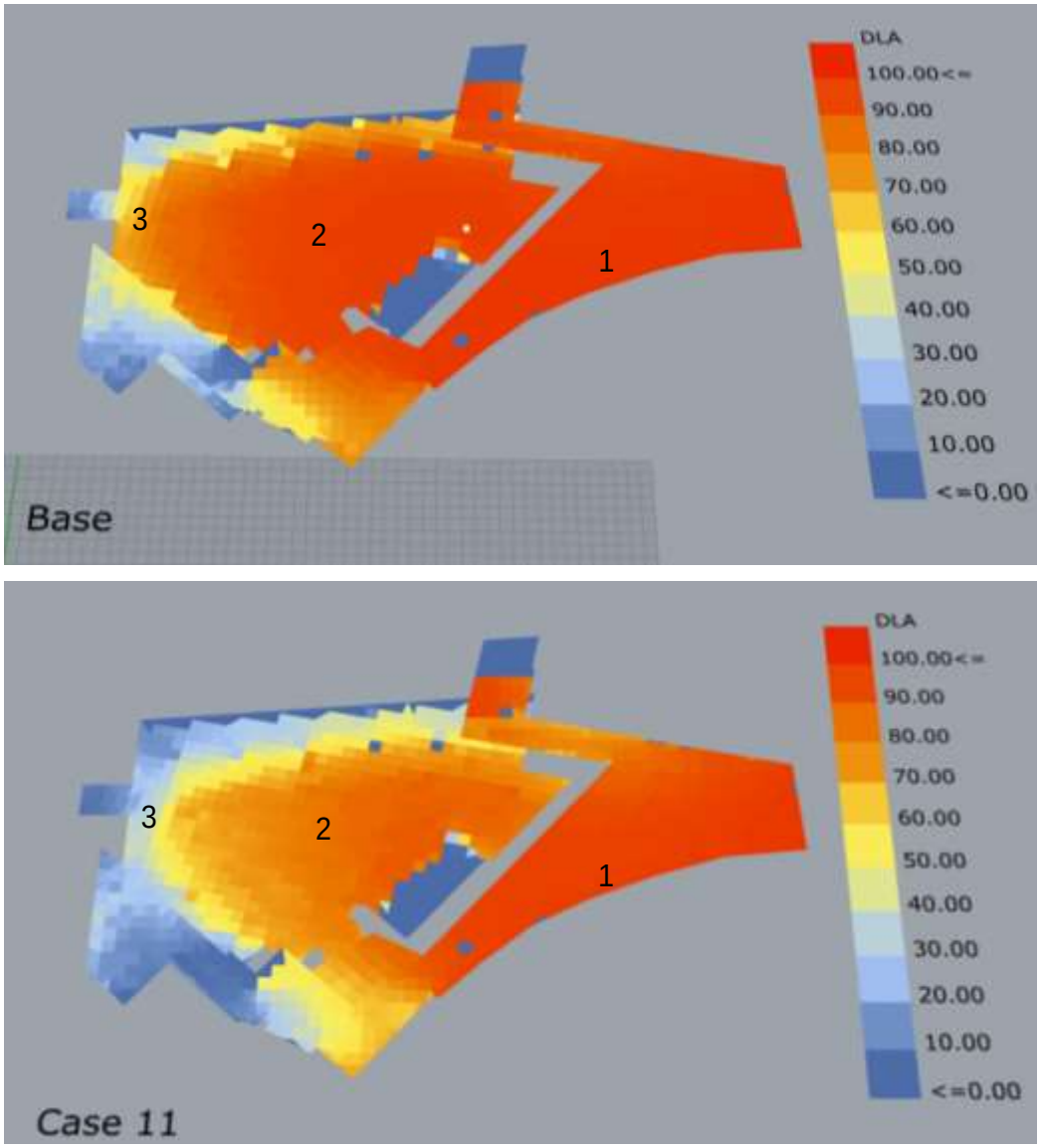
Daylighting Metrics						
Case	DLA300	CDA300	UDLI			DLA4000
			<100	100-2000	>2000	
Base	67.6	78.3	18.9	50.5	30.7	17.3
11	54.7	70.5	24.8	59.8	15.5	7.3
12	55.1	70.8	24.7	59.6	15.8	7.6
15	54.2	70.2	25.1	60.3	14.6	6.4
16	54.6	70.5	24.8	60.3	14.9	6.7

DLA_{300}

DLA shows the fraction of time that a given point meets or exceeds the target illuminance (300 lux). In this case, the DLA is averaged to give one value for the entire space. This is the case for all metrics tested.

Starting with the Base Case, the DLA is 67.6, which means that on average, 67.6% of the time, the space meets or exceeds 300 lux. The proposed designs have a slightly lower DLA of around 54.5%. This drop was expected, since the main goal of each of these designs was to manage excess daylight within the space. The two figures below show the colored mesh overlay for both the Base Case and case 11. Case 11 was chosen, as it was in closest to the average for all daylighting metrics. The scale is from 0% to 100%.

For the area nearest the curtain wall on the mezzanine level (labelled 1), there is a drop of 10% across all points from the Base Case to Case 11. The differences occur on the main atrium floor, (labelled 2). There is a noticeable drop in DLA from upper 90's for the Base Case to 70-80's range for the proposed solutions. The edges of the main floor facing toward the old HUB, (labelled 3), also see a drop-off in DLA from approximately 75% to 30%. These two results suggest that direct daylight that was previously hitting the main floor is now being blocked, most likely from the electrochromic glass that replaced the skylights.

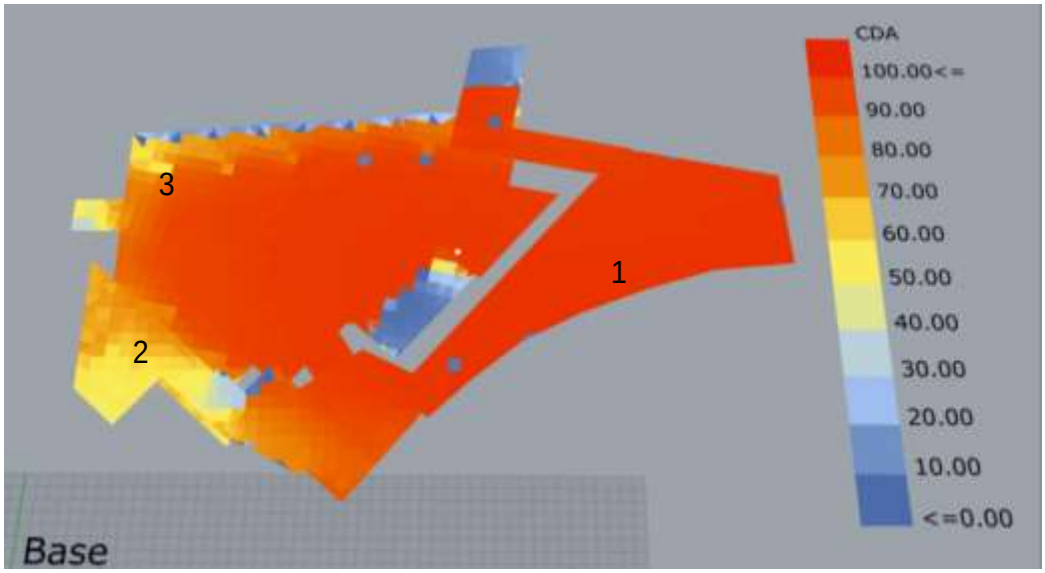


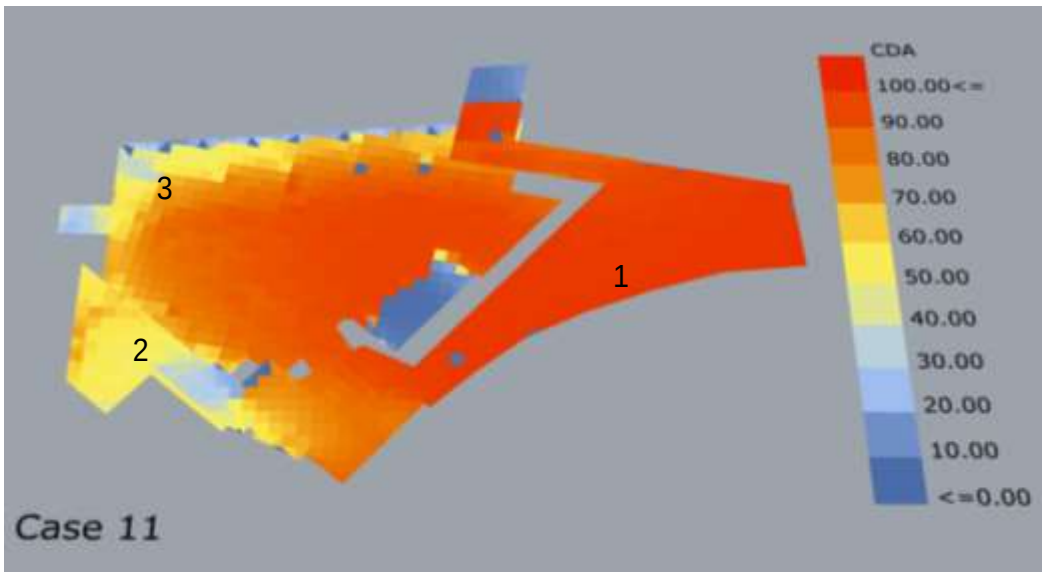
CDA_{300}

CDA is similar to DLA, with the difference being that CDA allows for partial credit to be given to points that don't meet the illuminance criteria, e.g. if the illuminance threshold is 300 lux and a point receives 150 lux, it would have a CDA of 50%.

The CDA between the base case and proposed cases saw an 8% drop, from 78% to 70%. Once again, a drop was expected due to the proposed designs blocking daylight coming into the space. There is some ambiguity with CDA, as there's no way to know if a point that has a CDA_{300} of 10% gets 30 lux 10% of the time or 3 lux 100% of the time.

The two figures below show the colored mesh overlay for CDA_{300}. The mezzanine floor near the curtain wall, labelled 1, is nearly identical for both cases, with CDA hovering around 100%. The two cases differ in CDA on the left side of the mezzanine, 2, and the edges of the atrium floor, 3.





UDLI

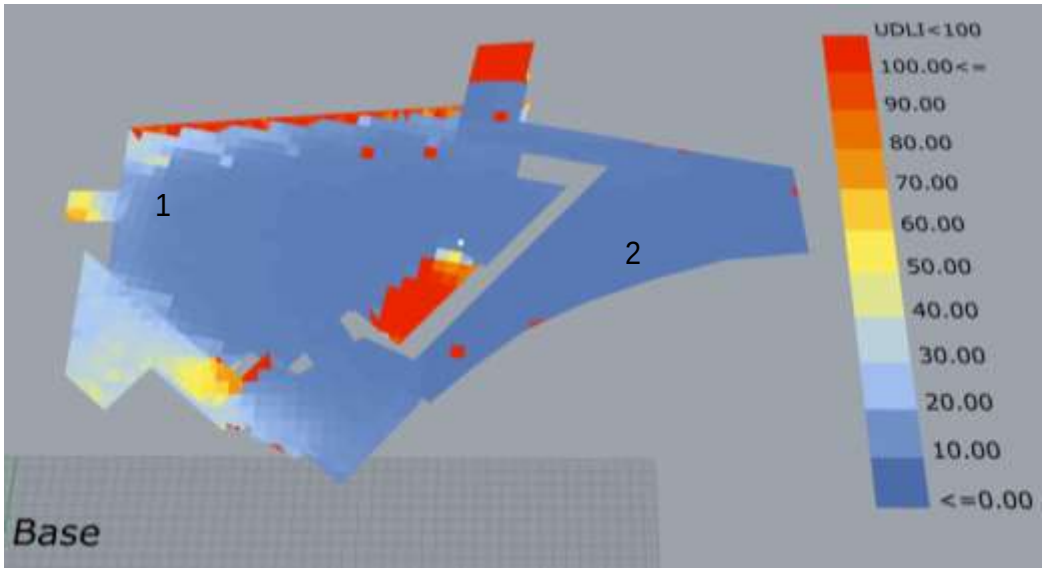
UDLI is broken into three parts, points below the minimum threshold, points within the thresholds, and points above the maximum threshold. Using these three values, a more complete picture of daylighting performance can be formed.

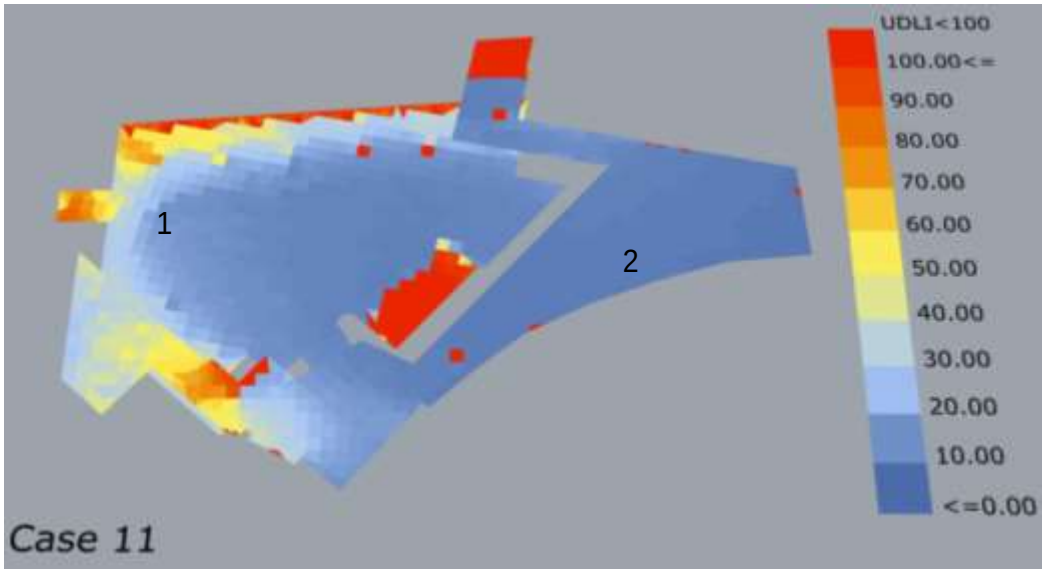
UDLI<100

UDLI<100 is the percentage of time that points within the space fall below the illuminance threshold, 100 lux.

From the Base Case to Case 11, there was a 6% increase for UDLA<100. This means that on average, each point within the space was below the threshold of 100 lux 6% than the Base Case. This isn't unexpected, since less daylight will be reaching deep into the space with the overhang and changed glass types.

Using the two colored mesh figures below, it can be seen that as predicted, UDLI<100 is higher deep in the space, (labelled 1), and remains practically unchanged near the curtain wall, (labelled 2).



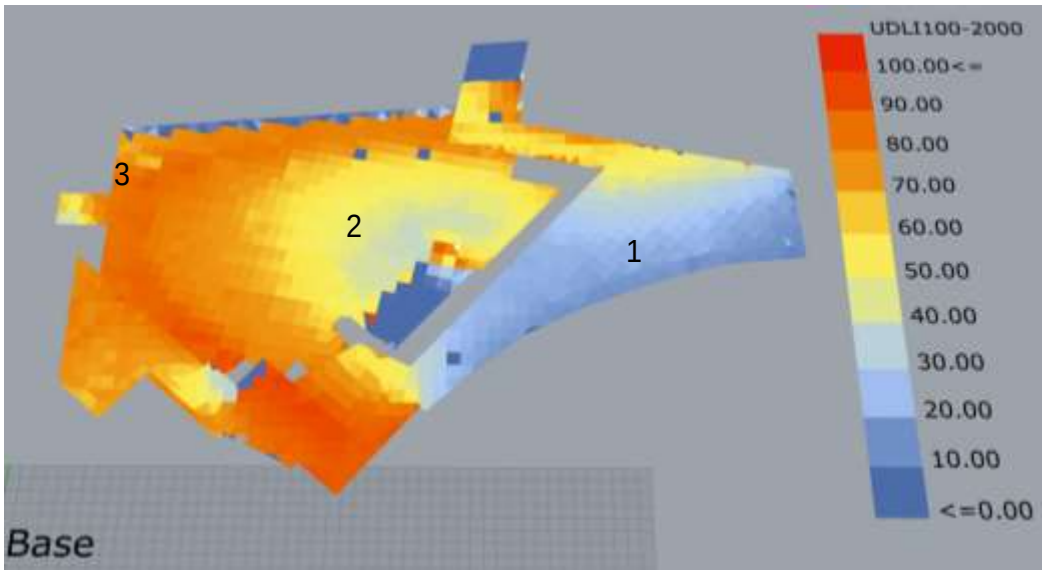


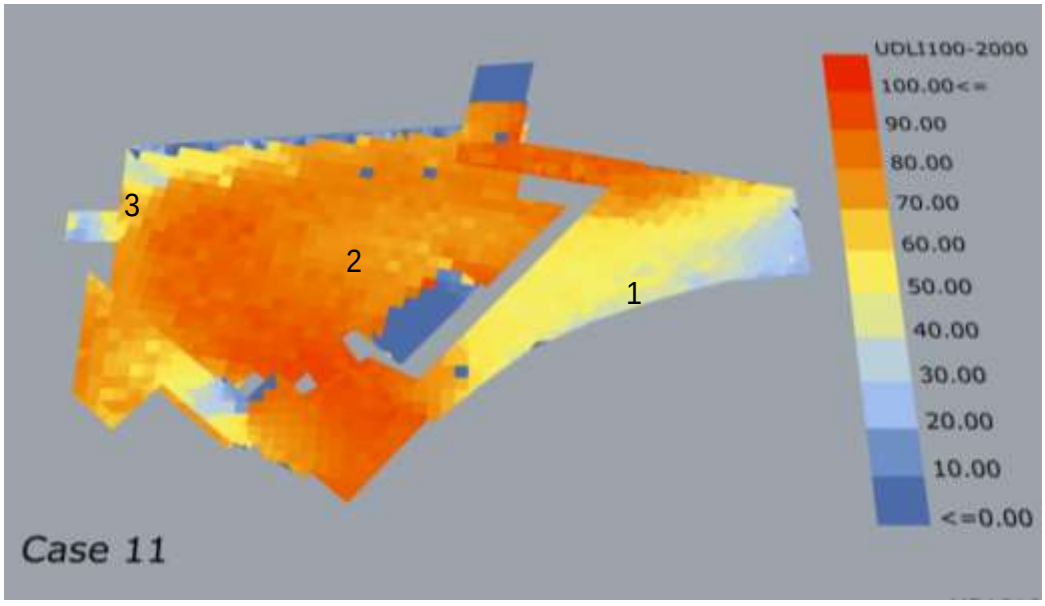
UDLI 100-2000

UDLI 100-2000 is the sweet spot, representing the amount of time a point receives between 100lux to 2000 lux.

From Base Case to Case 11, there was a 9% increase in UDLI 100-2000. This means that on average, the points within the space received between 100 lux and 2000 lux 9% more than the Base Case. This also means that the proposed solutions did perform better for this metric.

From the two figures below, it can be seen that the increase occurs near the curtain wall on the mezzanine, (labelled 1). The points in that area go from the 20-30 range to 40-50 range, around a 20% increase overall. The atrium floor, (Labelled 2), also sees an increase from around 50% to 70%. Some decreases in UDLI 100-2000 did occur near the edges of the atrium floor, (3). Since that area is deeper in the space, it isn't an unexpected result.



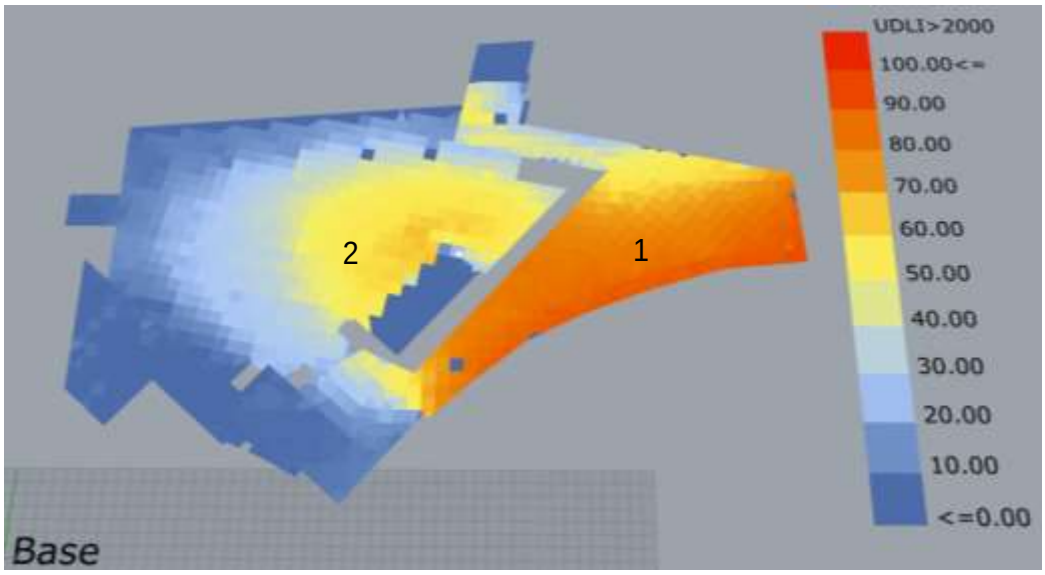


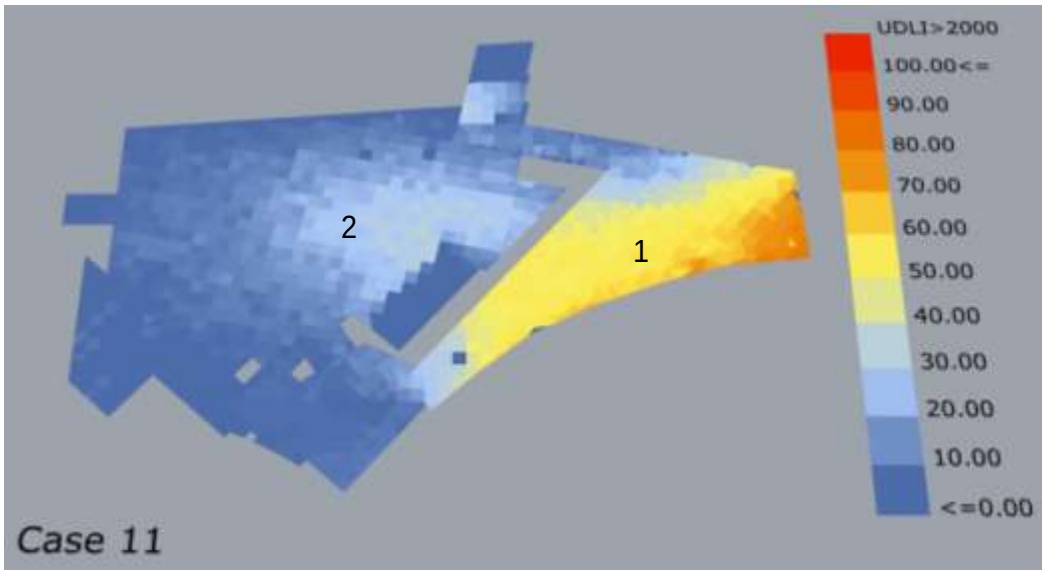
UDLI>2000

UDLI>2000 shows the percentage of time that a point is above the maximum threshold of 2000 lux, which is when glare may occur.

The Base Case had a UDLI>2000 of 31%, whereas Case 11 was only 15%. That means that the space for Case 11 was above 2000 lux 16% less of the time. This is 16% less of the time that glare would be an issue overall as well.

Mirroring UDLI 100-2000, the two figures below show that the main decreases occurred in the mezzanine level by the curtain wall, (1), and in the middle of the atrium floor, (2). Both of these decreases were around 20%. These were two areas that were likely to receive direct daylight and were probably prone to glare issues. With the decreases, those areas will be less likely to be glary and be more comfortable overall.





UDLI CONCLUSION

The proposed solutions perform better overall in terms of UDLI. Points deep within the space do get less daylight, as was shown with UDLI<100, however, both UDLI 100-2000 and UDLI>2000 were better. UDLI 100-2000 was higher throughout the space, especially near the curtain wall. UDLI>2000 was lower along the curtain wall and the main atrium floor – two locations where glare would likely occur. It can be concluded that the proposed designs may help alleviate glare and bring trouble areas down to an optimal illuminance range. Even though some

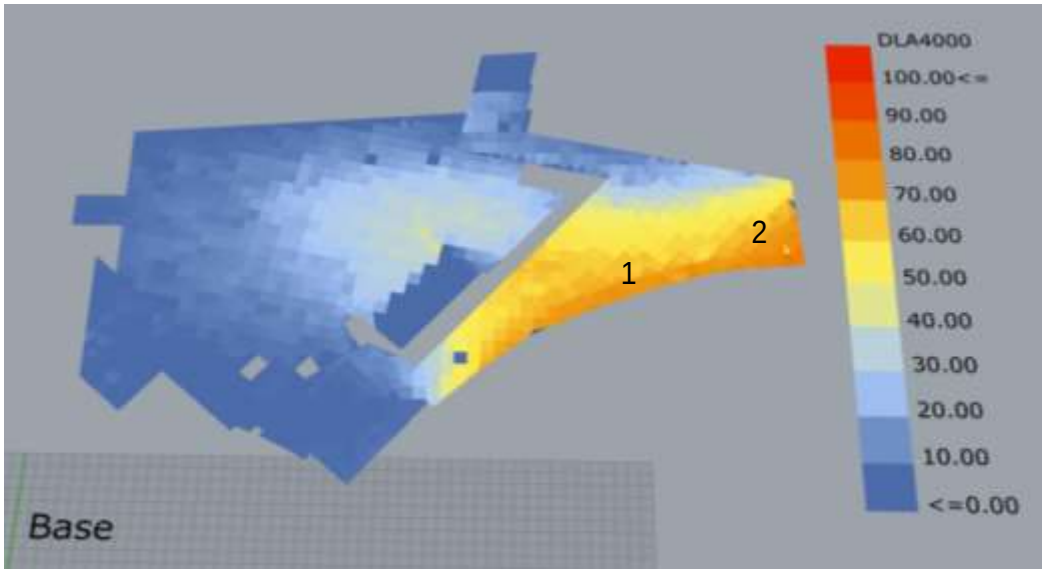
areas deep in the space receive less daylight, the areas receiving illumination from daylighting portals are in a more comfortable range.

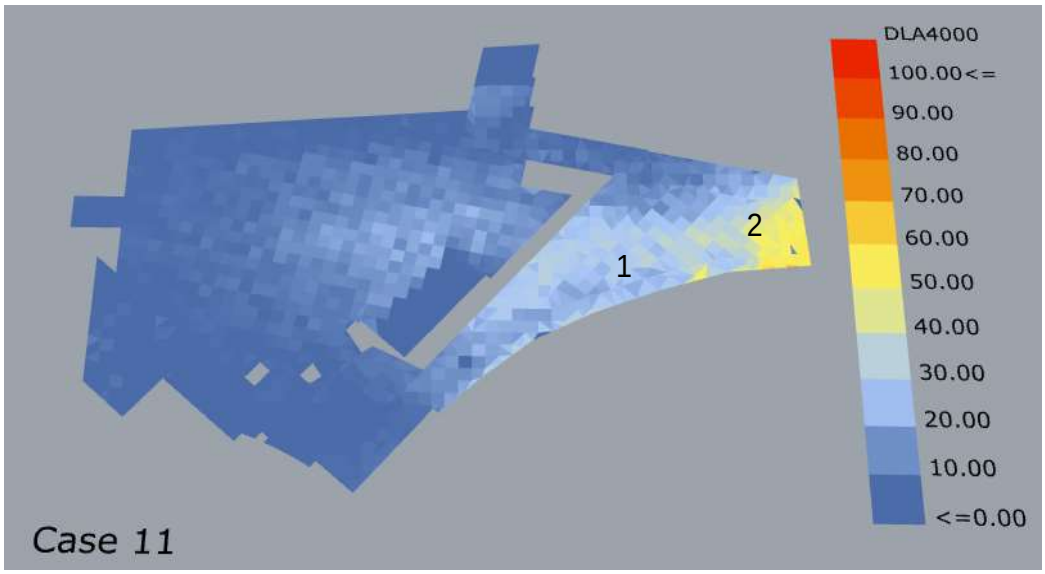
DLA_{4000}

DLA_{4000} is used further evaluate the potential for glare, suggested by UDLI>2000, within the atrium.

The Base case has a DLA_{4000} of 17.3%, meaning that 17.3% of the time, the space would have issues with glare. Compared to Case 11, the DLA_{4000} decreases to 7.3%. On average the space for Case 11 would experience glare 10% less of the time.

Referring to the two pictures below, the trouble area is near the curtain wall, (1). DLA_{4000} hovers between 50% and 70%, getting higher the closer a point is to the curtain wall. That same area drops down to 20% to 30%, with a few points getting up to 50% in the south eastern corner, (2).


DLA4000
100.00<=
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
<=0.00
1
2
Base


DLA4000
100.00<=
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
<=0.00
1
2
Case 11

CONCLUSION

SUMMARY

The initial illuminance studies were used to narrow down the 16 proposed cases to 4 of the most promising. The main criteria for considering a case as viable was the illuminance near the curtain wall on the mezzanine floor. The four cases that were chosen had reduced the illuminance in that area near the curtain wall from 20000 lux down to 2500 to 3500 lux. The other options didn't have as much of an impact, so they were not considered for the annual study.

The annual study tested five cases, the Base Case, and Cases 11, 12, 15, and 16. The daylighting performance was analyzed using both average metrics for the entire space and colored mesh overlays of the point values for each point. The metrics used were DLA_{300}, CDA_{300}, UDLI 100-2000, and DLA_{4000}. The proposed designs showed a decrease in DLA_{300} and CDA_{300}. This was to be expected since the solutions were meant to block incoming daylight. The main areas effected were deep in the space, whereas the area near the windows didn't see as sever a decrease.

UDLI revealed that the proposed designs may reduce glare potential, shown by the decrease in UDLI>2000 by the areas near the curtain wall and the middle of the atrium floor. These areas were reduced to a more comfortable range, as shown by UDLI 100-2000. Similarly to DLA and CDA, points deep in the space did see less daylight, hence the increase in UDLI<100. This isn't a major concern, seeing as such large areas that had a high potential for glare were brought into a more reasonable illuminance range. DLA_{4000} confirmed that the proposed designs reduced glare near the curtain wall significantly.

MECHANICAL BREADTH

INTRODUCTION

This section is devoted to explaining the mechanical portion of the integrated daylighting study. Much like the previous section, goals and criteria will be laid out to judge each case selected for the annual daylighting study.

GOALS

1) Analysis thermal performance of the atrium.
2) Evaluate thermal performance of the proposed designs against Base Case using parametric modelling techniques.
3) Improve thermal characteristics of the space if possible.

METHODOLOGY

Overall the methodology of the grasshopper model is very similar to the daylighting model. The sequence of steps stays the same, however, there are a few differences in referencing geometry, material types, analysis types, and the addition of building programs and zone loads.

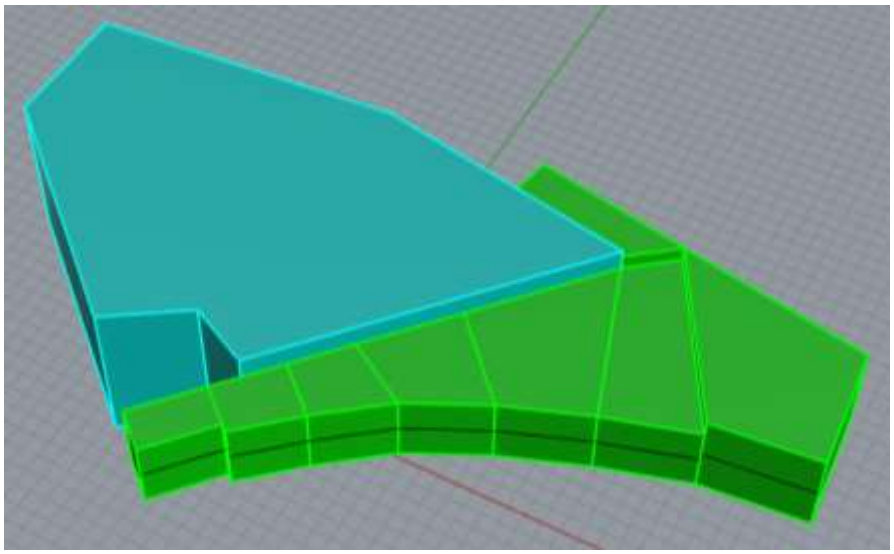
DIFFERENCES

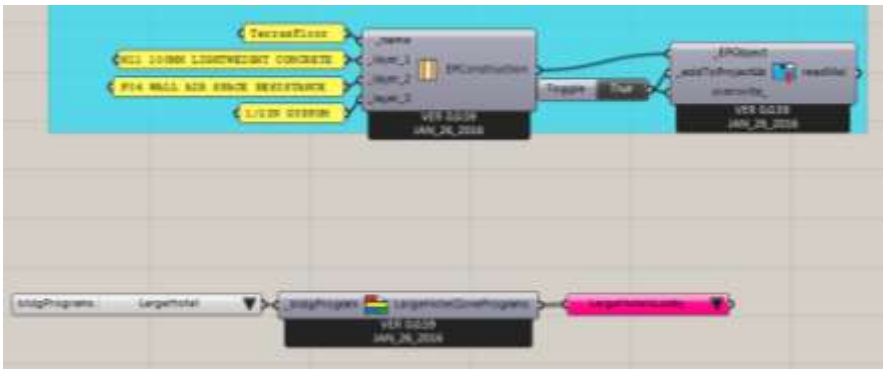
Geometry & Materials

Unlike in the daylighting model, Energy Plus needs geometry to be consolidated into zones. These are essentially boxes that are able to have different materials assigned to each surface, e.g. walls, ceiling, floor. For this study, nine zones were used to define the main atrium area. Eight of the nine zones break up the mezzanine floor. These zones act as buffer zones, green, to the main atrium floor zone, teal. The buffer zones ensure accurate convection and mixing of air between the different zones.

In place of Radiance materials, Energy Plus uses EP constructions to assign materials to zones. EP constructions define U-values and R-values based on thermal properties of the EP materials that make up an EP construction. Once defined, EP constructions are then assigned to the

surfaces of the zone based on type or surface by surface. Adjacent zones that are not separated by solid walls can have air walls separating them to ensure air mixing between those zones.





Analysis Types, Building Programs, & Zone Loads

For mechanical studies the type of loads that are output from the simulation are set before-hand. This is done in lieu of choosing an analysis type, as is done for daylighting studies.

Building programs are used to define the general schedules of the building. These include things like occupancy schedules of the space, which controls when 100% of the occupancy load is applied to the model.

Occupancy loads need to be defined to ensure that internal loads are accounted for within the energy model. These include equipment, infiltration, lighting density, number of people per area, ventilation, and recirculated air.

ANNUAL STUDY

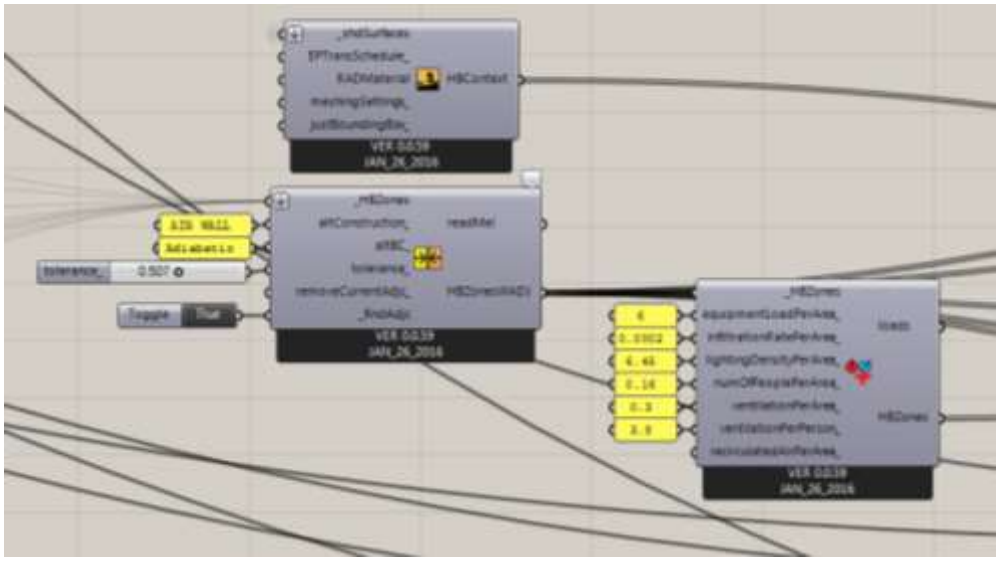
INTRODUCTION

An annual analysis was chosen to get the most complete picture of the thermal conditions in the space throughout the year. This was the best way to get total heating, cooling, and solar loads of the space. Total heating and cooling will be used to evaluate each space, whereas total solar gain will be used to determine the performance of the daylighting system implemented.

PARAMETERS

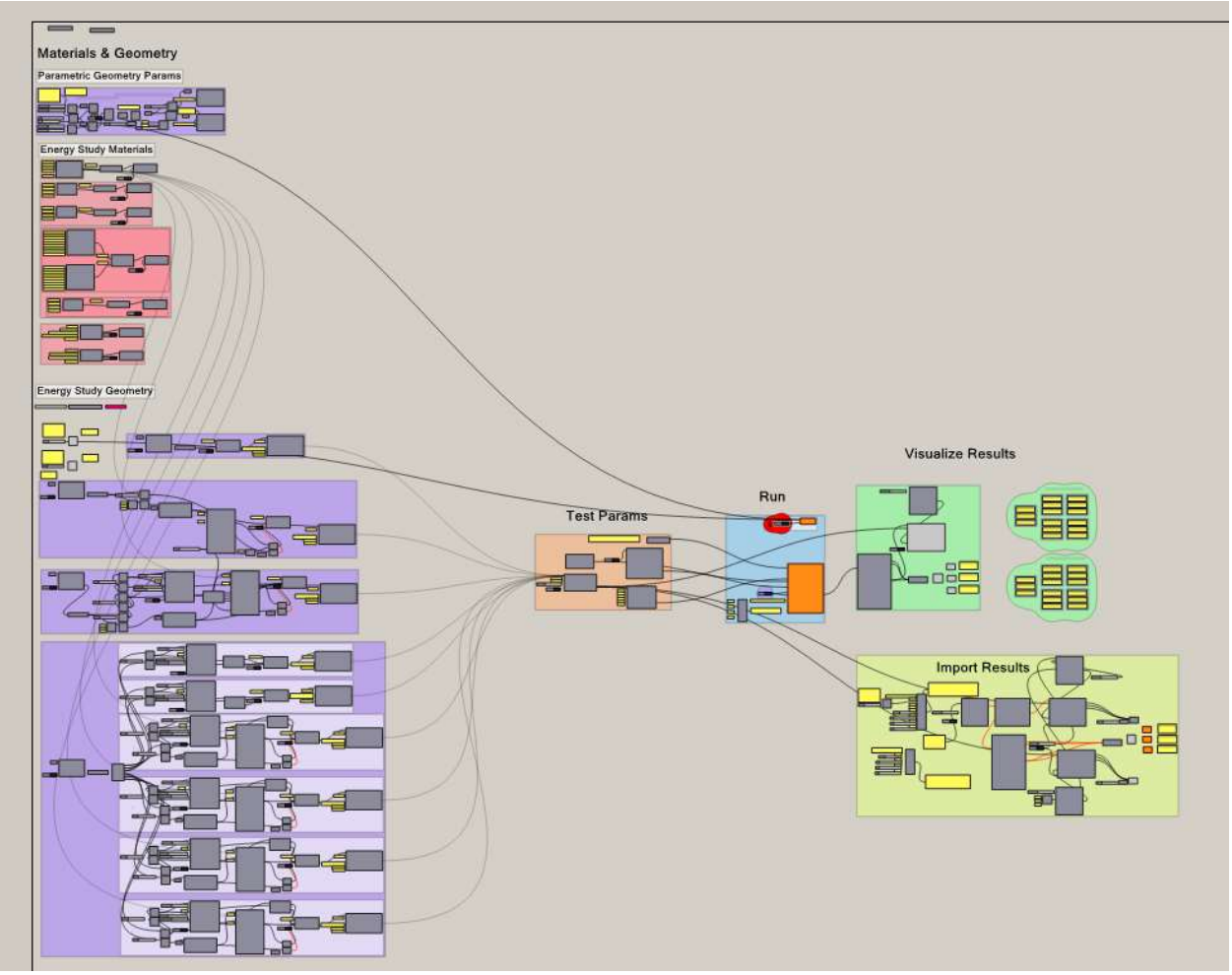
There are a number of parameters that can be changed based on the type of space and desired results of the study. The first is the building program, which in this study was set to a large hotel lobby. This was determined to be the closest program to what an atrium in a multi-purpose building would be.

Next all adjacencies need to be solved and appropriate materials be assigned to those surfaces. Because all adjacent surfaces were on the interior and there were no partitions between them, air wall materials were assigned to these surfaces.



The zone loads for the space also need to be set to ensure accurate load calculations. The equipment load is set to 6 W/m^2 due to the amount of laptops that students use within the space. The infiltration is 0.0002 m^3/s-m^2, which is typical of modern buildings. Lighting density is set to 6.45 W/m^2 to reflect the new lighting design. Number of people per area is set at 0.16 people/m^2, meaning that around 150 people would occupy the space during normal occupancy hours. Lastly, the ventilation per area and ventilation per person were set to 0.3 L/s m^2 and 3.8 L/s m^2 respectively. These values were found in the ASHRAE standards minimum ventilation rates in breathing zones and the space is classified as a multi-use assembly.

The load outputs for the study were the total heating and cooling loads, total thermal energy, and total solar gain. For evaluation, the total heating, cooling, and solar gain will be used.



CASE SETUP

The Base Case was set up similarly to the Base Case of the daylighting simulation. The original glass materials were used and no overhang or electrochromic glass.

MATERIALS

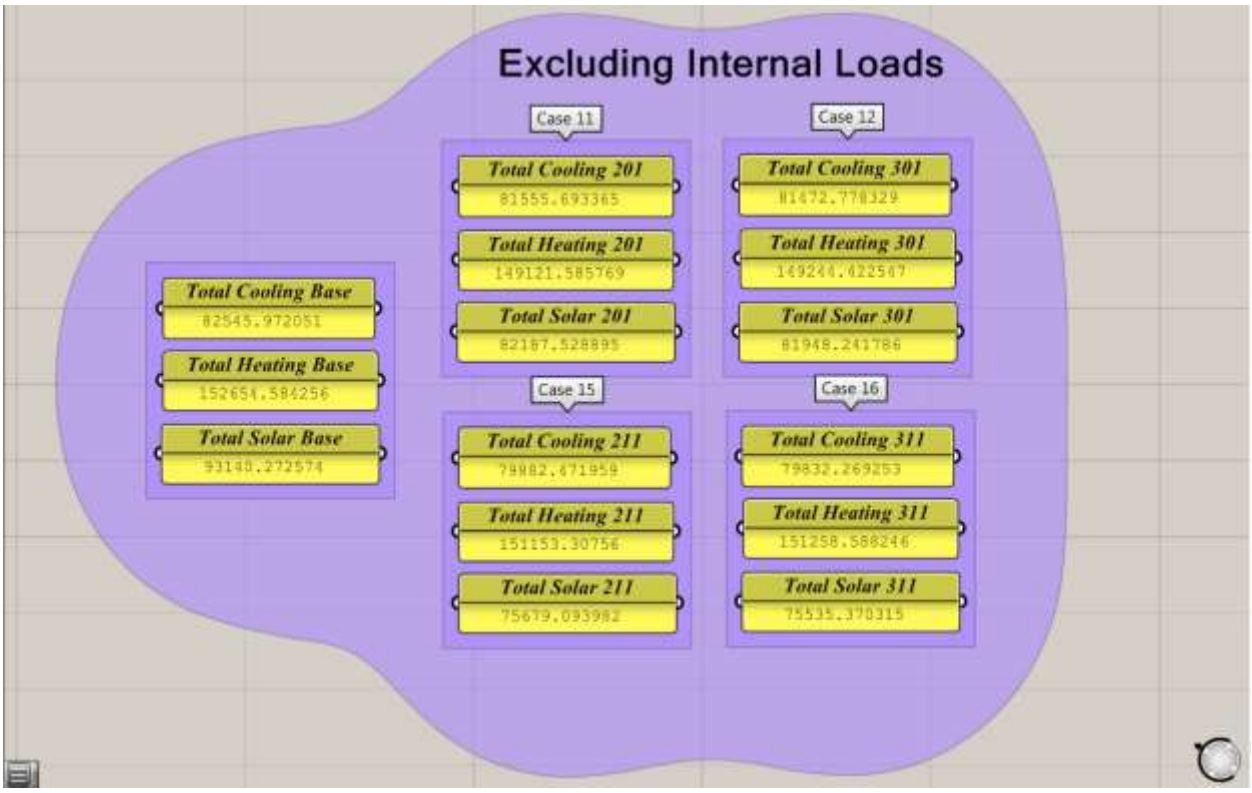
With the model being simplified to only include the nine zones making up the atrium, many of the materials included in the daylighting study were not needed in the mechanical study. For the solid materials, preexisting EP materials were used to create the custom EP constructions. The table below shows the materials used in the model.

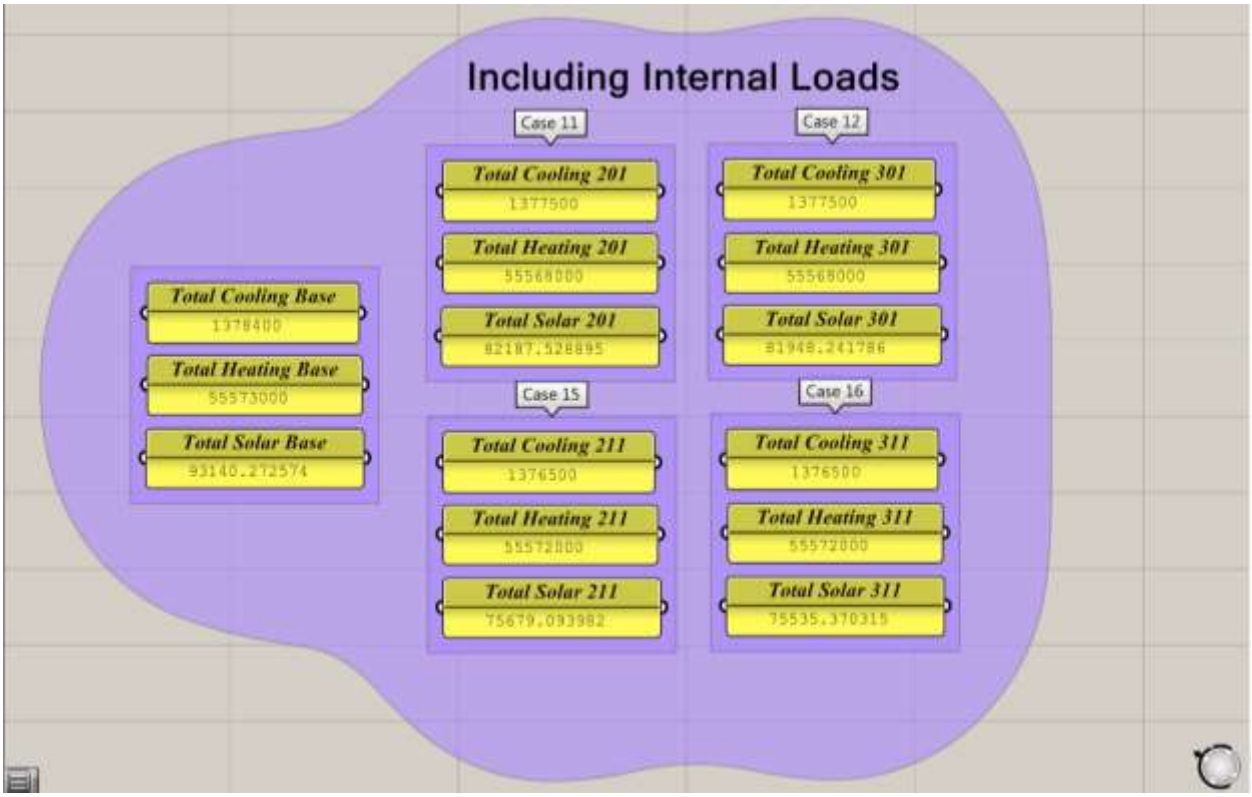
EP Construction					
Name	Type	U-value	R-value	Transmittance	SHGC
Terra Wall	Solid	0.47	2.12766	--	--
Terrazo Floor	Solid	2.37	0.421941	--	--
Air Wall	Fluid	60	0.016667	--	--
Top Glazing	Glass	0.29	3.448276	0.51	0.32
Bottom Glazing	Glass	0.29	3.448276	0.7	0.39
Alt Bot Glazing	Glass	0.26	3.846154	0.64	0.27
Alt Top Glazing	Glass	0.24	4.166667	0.54	0.23
Sage Glass	Shade	0.28	3.571429	0.06	0.1

SETUP

No additional setup was required for the Base Case beyond referencing the geometry and assigning material types. A total of 10 simulations were run, one set including internal loads another excluding them. This was to see the effects of just solar gain on the space, as well as the effect with typical loads.

RESULTS


Excluding Internal Loads
Case 11
Case 12
Total Cooling 201
81555.693365
Total Heating 201
149121.585769
Total Solar 201
82187.528895
Total Cooling 301
81472.778329
Total Heating 301
149244.622567
Total Solar 301
81948.241786
Case 15
Case 16
Total Cooling 211
79882.471959
Total Heating 211
151153.30756
Total Solar 211
75679.093982
Total Cooling 311
79832.269253
Total Heating 311
151258.588246
Total Solar 311
75535.370315
Total Cooling Base
82545.972051
Total Heating Base
152654.584256
Total Solar Base
93140.272574


Including Internal Loads
Case 11
Case 12
Total Cooling 201
1377500
Total Heating 201
55568000
Total Solar 201
82187.528895
Total Cooling 301
1377500
Total Heating 301
55568000
Total Solar 301
81948.241786
Case 15
Case 16
Total Cooling 211
1376500
Total Heating 211
55572000
Total Solar 211
75679.093982
Total Cooling 311
1376500
Total Heating 311
55572000
Total Solar 311
75535.370315
Total Cooling Base
1378400
Total Heating Base
55573000
Total Solar Base
93140.272574

The results shown above are in kWh. Starting off excluding internal loads, it can be seen that each of the scenarios saw a decrease in overall energy usage over the Base Case. Case 11 and 12 had similar results, with total heating, cooling, and solar gain being within 100 kWhs of each other. This is also the case with scenario 15 and 16. This leads to the conclusion that the 2m overhang performs just as well thermally as the 3m overhang. Case desriptions can be found in the daylighting section.

The major differences seemed to come from changing the top pane of glass to the alternative glazing. Comparing case 11 with case 15 and case 12 with case 16, around a 2000 kWh drop in cooling load occurs, however the heating load increases by an equal magnitude. The major difference comes from total solar gain when the top glazing is changed. The solar gain decreases 7000 kWh when the top glazing is changed.

These changes in overall loads can be explained by the change in U-value of the curtain wall when the alternative top glazing was used. The U-value and SHGC were better than the base glazing material. This should and did lead to a decrease in solar gain. This also explains the decrease in total cooling and increase in total heating. During summer months, the window would reject heat gain from the sun, leading to lower cooling loads. This rejection of heat would also happen in the winter when heat from the sun is generally benefitial, leading to higher heating loads.

Similar trends occurred with the inclusion of internal loads. From case 11 to 15 and case 12 to 16, a decrease in cooling and increase in heating is observed. As expected the overall cooling and heating loads are larger, in this case an entire magnitude for cooling and two magnitudes for heating. This reflects the heating dominated climate that the project is located in. Overall, solar loads on the spaces are only 8% for cooling and 2% for heating.

These loads were converted from kWh to ton hours for cooling and klbs for heating. The converstion factors used were 0.284 ton hours/kW and 0.003 klbs/hr kW. These converted

values were then multiplied by the utility rates provided by the owner of $0.22/ ton hour and $24.20/klb. The table below shows the operating cost excluding internal loads.

Energy cost				
Case	Type	Load	Convertion to Proper Units	Energy Cost
Base	Cooling	82546	23471.56	$16,246.50
	Heating	152655	457.97	
11	Cooling	81556	23190.05	$15,928.07
	Heating	149122	447.37	
12	Cooling	81473	23166.45	$15,931.73
	Heating	149244	447.73	
15	Cooling	79882	22714.06	$15,970.80
	Heating	151153	453.46	
16	Cooling	79832	22699.84	$15,975.37
	Heating	151259	453.78	

CONCLUSION

On average $300 per year in energy is saved over the Base Case. There is not much variation between the four proposed solutions, with a $40 difference existing between the best, case 11, and worst, case 16, case. This leads to the conclusion that although several thousand kWhs separate each case, the monetary impact is not that significant.

CONSTRUCTION BREADTH

INTRODUCTION

This section describes the third and final disciple that is part of the integrated daylighting study. A cost analysis of the Base Case and four proposed solutions serves as the final parameter for measuring each potential solutions success.

GOALS

1) Conduct a cost analysis for each of the annually tested cases.
2) Use RS means and manufacturer cost data to create an accurate cost summary.

METHODOLOGY

Quantity takeoffs were gathered from the construction documents provided by the owner. RS means and cost data provided by the manufacturers of the glazing materials were used to get an accurate cost estimate. Both the material and labor costs were included into the analysis. The schedule was also consulted to ensure that no changes to the critical path would take place with the additional construction and material changes. A detailed schedule can be found in appendix F.

COST ANALYSIS

As stated above, RS means 2016 supplemented by manufacturer cost data is used to determine an approximate cost for each of the four purposed options. These estimated costs were used to weigh each of the options against the Base Case and each other. Below is a table that includes the cost data gathered for each of the scenarios.

Panelboard Cost Analysis								
Cost Code	Item	Units	Quant.	Mat'l Unit Cost	Mat'l Cost	Labor Unit Cost	Labor Cost	Total
Base Case								
086113100130	High Perf TMP glazing, metallic frame 72" x 28"	SF	2150	$ 90.00	$193,500.00	$ 41.00	$ 88,150.00	$281,650.00
088130102500	Reduced Heat Transfer Glass Heat reflective, film inside, 1" thick, clear	SF	2300	$ 27.50	$ 63,250.00	$ 6.55	$ 15,065.00	$ 78,315.00
Scenario 11								
B10203100100	Canopies, wall hung, prefinished alumium	SF	689	$ 27.00	$ 18,603.00	$ 18.85	$ 12,987.65	$ 31,590.65
--	Sage Glass	SF	2,150	$ 115.00	$247,250.00	$ 45.00	$ 96,750.00	$344,000.00
088130102500	Reduced Heat Transfer Glass Heat reflective, film inside, 1" thick, clear	SF	1,100	$ 27.50	$ 30,250.00	$ 6.55	$ 7,205.00	$ 37,455.00
088130102000	Both lites, light and heat reflective	SF	1,200	$ 31.50	$ 37,800.00	$ 6.55	$ 7,860.00	$ 45,660.00
Scenario 12								
B10203100100	Canopies, wall hung, prefinished alumium	SF	689	$ 27.00	$ 18,603.00	$ 18.85	$ 12,987.65	$ 31,590.65
--	Sage Glass	SF	2,150	$ 115.00	$247,250.00	$ 45.00	$ 96,750.00	$344,000.00
088130102000	Both lites, light and heat reflective	SF	2,300	$ 31.50	$ 72,450.00	$ 6.55	$ 15,065.00	$ 87,515.00
Scenario 15								
B10203100100	Canopies, wall hung, prefinished alumium	SF	1,034	$ 27.00	$ 27,918.00	$ 18.85	$ 19,490.90	$ 47,408.90
--	Sage Glass	SF	2,150	$ 115.00	$247,250.00	$ 45.00	$ 96,750.00	$344,000.00
088130102500	Reduced Heat Transfer Glass Heat reflective, film inside, 1" thick, clear	SF	1,100	$ 27.50	$ 30,250.00	$ 6.55	$ 7,205.00	$ 37,455.00
088130102000	Both lites, light and heat reflective	SF	1,200	$ 31.50	$ 37,800.00	$ 6.55	$ 7,860.00	$ 45,660.00
Scenario 16								
B10203100100	Canopies, wall hung, prefinished alumium	SF	1,034	$ 27.00	$ 27,918.00	$ 18.85	$ 19,490.90	$ 47,408.90
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088130102000	Both lites, light and heat reflective	SF	2,300	$ 31.50	$ 72,450.00	$ 6.55	$ 15,065.00	$ 87,515.00

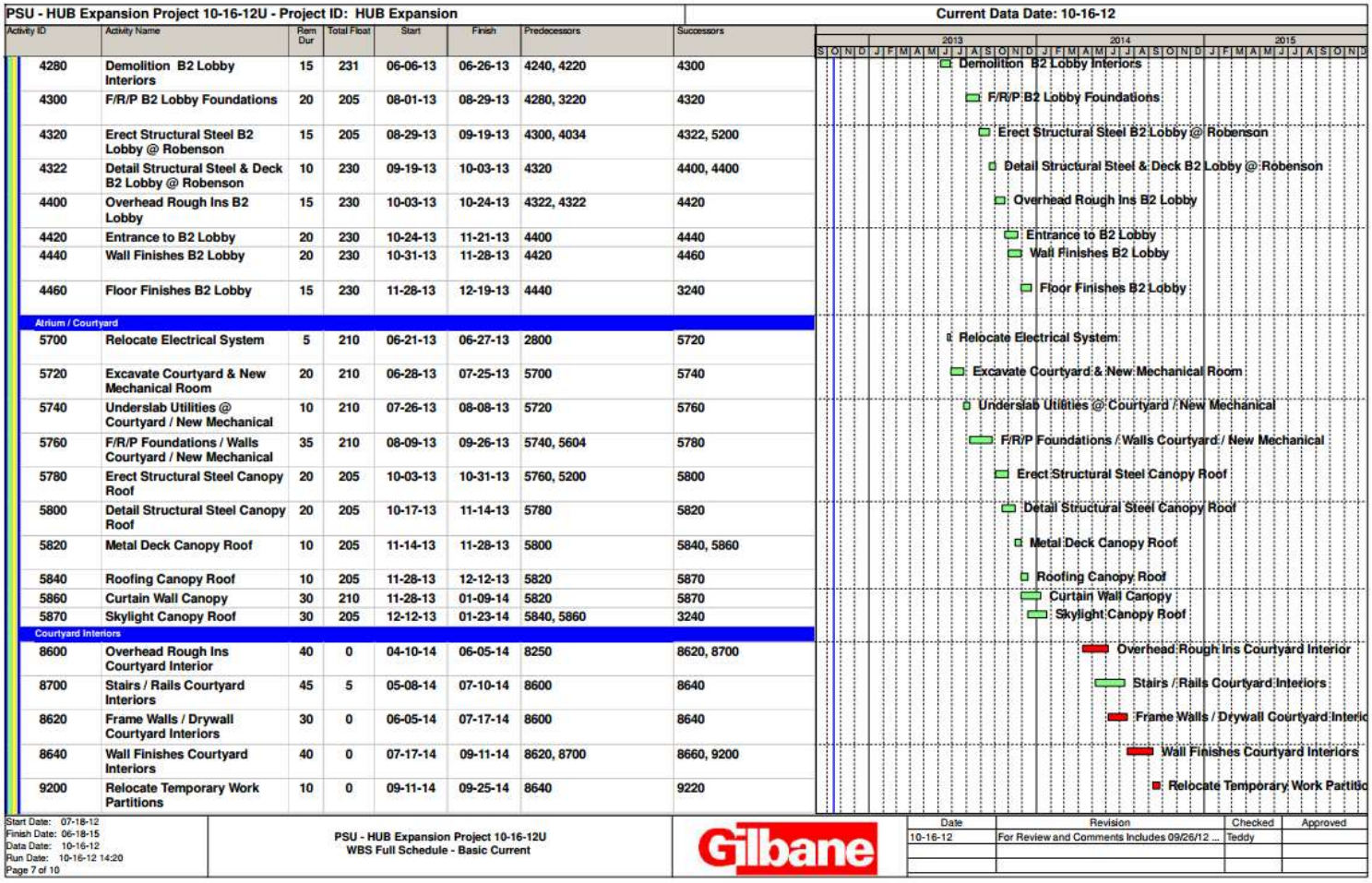
The glazing types were chosen based on the closest representation available in RS means. Sage Glass is the brand of electrochromic glass used in the proposed solutions. The material cost for Sage Glass represents the entire glazing system that the glazing units need to operate.

Cost Comparisons					
Case	Base	11	12	15	16
Cost	$ 359,965.00	$ 458,705.65	$ 463,105.65	$ 474,523.90	$ 478,923.90
Case - Base	$0.00	$ 98,740.65	$ 103,140.65	$ 114,558.90	$ 118,958.90

The skylight systems were by far the most expensive portion of each option, accounting for at least 70% of the total cost of each system. The glazing types were fairly similar in price as well, with the replacement windows being slightly more costly. The addition of the overhang is expected to cost around $31,000 for the 2m option up to $50,000 for the 3m option.

SCHEDULE

As stated above the schedule was consulted to ensure that no changes to the critical path would take place. Below is the atrium construction portion of the schedule.



PSU - HUB Expansion Project 10-16-12U - Project ID: HUB Expansion — Current Data Date: 10-16-12

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
4280	Demolition B2 Lobby Interiors	15	231	06-06-13	06-26-13	4240, 4220	4300
4300	F/R/P B2 Lobby Foundations	20	205	08-01-13	08-29-13	4280, 3220	4320
4320	Erect Structural Steel B2 Lobby @ Robenson	15	205	08-29-13	09-19-13	4300, 4034	4322, 5200
4322	Detail Structural Steel & Deck B2 Lobby @ Robenson	10	230	09-19-13	10-03-13	4320	4400, 4400
4400	Overhead Rough Ins B2 Lobby	15	230	10-03-13	10-24-13	4322, 4322	4420
4420	Entrance to B2 Lobby	20	230	10-24-13	11-21-13	4400	4440
4440	Wall Finishes B2 Lobby	20	230	10-31-13	11-28-13	4420	4460
4460	Floor Finishes B2 Lobby	15	230	11-28-13	12-19-13	4440	3240
Atrium / Courtyard							
5700	Relocate Electrical System	5	210	06-21-13	06-27-13	2800	5720
5720	Excavate Courtyard & New Mechanical Room	20	210	06-28-13	07-25-13	5700	5740
5740	Underslab Utilities @ Courtyard / New Mechanical	10	210	07-26-13	08-08-13	5720	5760
5760	F/R/P Foundations / Walls Courtyard / New Mechanical	35	210	08-09-13	09-26-13	5740, 5604	5780
5780	Erect Structural Steel Canopy Roof	20	205	10-03-13	10-31-13	5760, 5200	5800
5800	Detail Structural Steel Canopy Roof	20	205	10-17-13	11-14-13	5780	5820
5820	Metal Deck Canopy Roof	10	205	11-14-13	11-28-13	5800	5840, 5860
5840	Roofing Canopy Roof	10	205	11-28-13	12-12-13	5820	5870
5860	Curtain Wall Canopy	30	210	11-28-13	01-09-14	5820	5870
5870	Skylight Canopy Roof	30	205	12-12-13	01-23-14	5840, 5860	3240
Courtyard Interiors							
8600	Overhead Rough Ins Courtyard Interior	40	0	04-10-14	06-05-14	8250	8620, 8700
8700	Stairs / Rails Courtyard Interiors	45	5	05-08-14	07-10-14	8600	8640
8620	Frame Walls / Drywall Courtyard Interiors	30	0	06-05-14	07-17-14	8600	8640
8640	Wall Finishes Courtyard Interiors	40	0	07-17-14	09-11-14	8620, 8700	8660, 9200
9200	Relocate Temporary Work Partitions	10	0	09-11-14	09-25-14	8640	9220

Start Date: 07-18-12
Finish Date: 06-18-15
Data Date: 10-16-12
Run Date: 10-16-12 14:20
Page 7 of 10

PSU - HUB Expansion Project 10-16-12U
WBS Full Schedule - Basic Current

Gilbane

Date	Revision	Checked	Approved
10-16-12	For Review and Comments Includes 09/26/12 ...	Teddy	

With all of the items under the atrium/courtyard section having at least 200 days of float, there should be plenty of room for the addition of the overhang and increases install time for the electrochromic skylight glazing. The other item that was checked was the tower crane, since it is needed to install the both the overhang and skylights. The removal of the tower crane is set for the 10th of April 2014, whereas the items in the atrium needing the tower crane will be completed by the 23rd of January 2014. The float on the tower cranes removal is set at 150 days,

which should leave plenty of time for completion of the additional items without any shift in critical path.

CONCLUSION

After pricing out the four potential scenarios and Base Case, it was determined that all of the purposed designs will cost more than the Base Case. This extra cost to the project ranges from $100,000 to $120,000. Although it is costly to add the elements in the purposed solutions, overall it still only accounts for a 0.27% increase in cost for the $44.6million project. Now that the four options have been evaluated across three disciplines, a comprehensive analysis can take place to get a complete picture on the overall performance for each option.

INTEGRATED DESIGN ANALYSIS

INTRODUCTION

This section explains the integrated performance analysis of each of the studies in the sections above. With this data a complete evaluation of each option can take place. The main goal of this study is not to choose the option with the best performance, but to choose the one that best fits the project and the limitations that are inherent with any design. With this final step, the design team will be able to make an informed decision based on the data gathered from each of the studies. Moving forward, the team should have a good idea of what they're getting with whatever option is chosen.

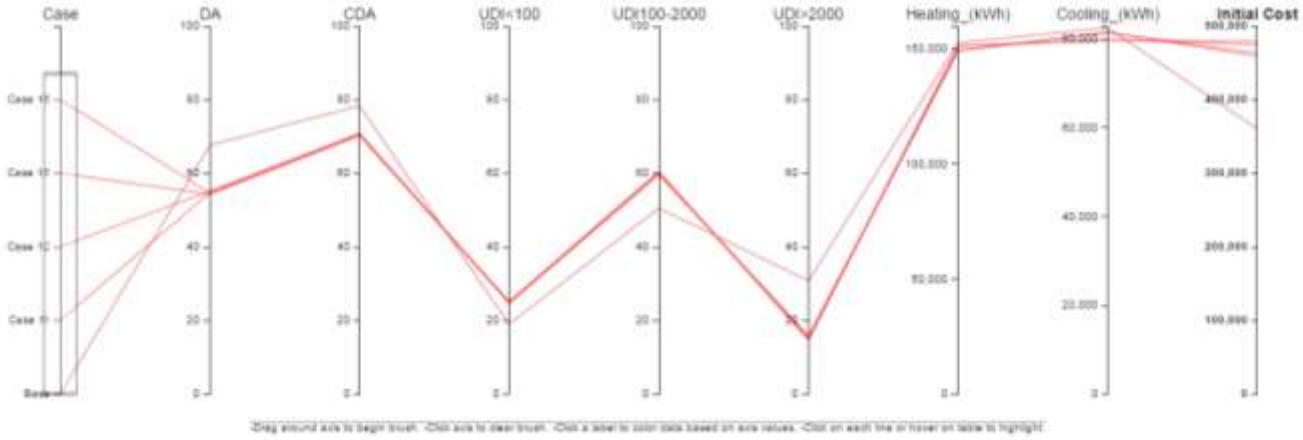
GOALS

1) Perform a comprehensive analysis of each option
2) With the data from this study, as well as the previous studies, make an informed decision as to which is the best option for the project

METHODOLOGY

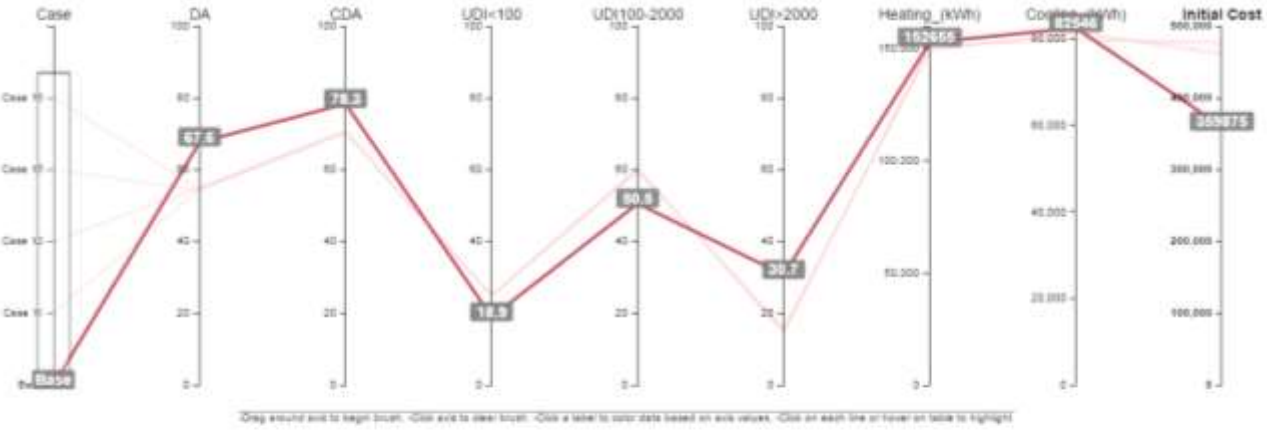
To assist with the visualization of the data, Pollination will be used to analysis the cases side by side. By using Pollination, each performance metric can be compared and the options that don't meet the criteria set can be easily excluded.

POLLINATION ANALYSIS



Case	DA	CDA	UDI<100	UDI100-2000	UDI>2000	Heating_(kWh)	Cooling_(kWh)	Initial Cost
Base	67.6	78.3	18.9	50.5	30.7	152655	82546	359675
Case 11	54.7	70.5	24.8	59.8	15.5	149122	81556	456705
Case 12	55.1	70.8	24.7	59.6	15.8	149244	81473	463105
Case 15	54.2	70.2	25.1	60.3	14.6	151153	79882	474523
Case 16	54.6	70.5	24.8	60.3	14.9	151259	79832	478923

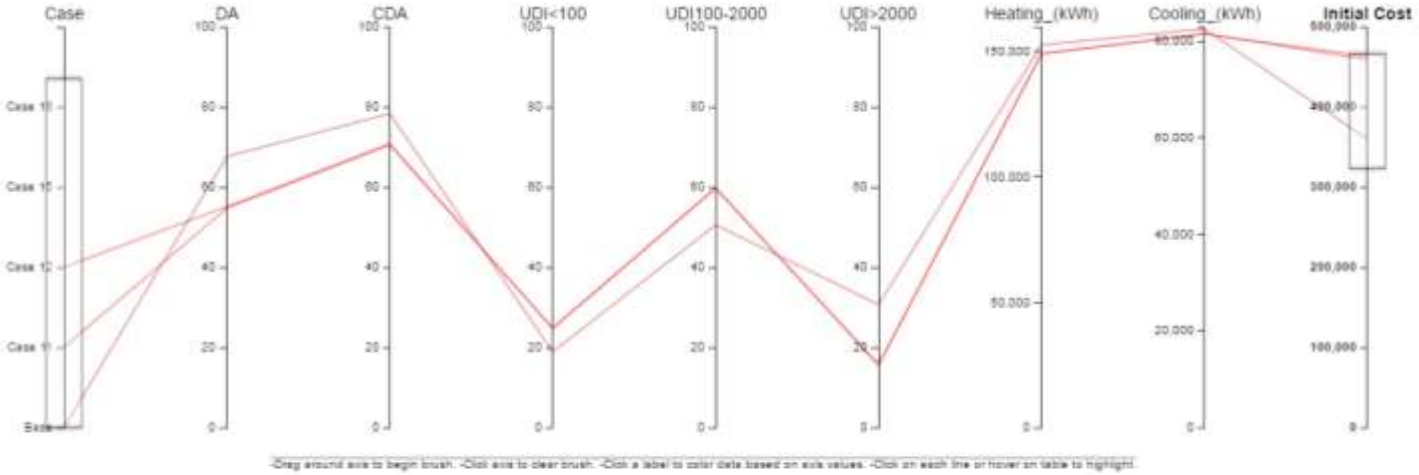
Above is the Pollination interface. Each case is listed on the left, which each line intersecting each axis at that cases respective value.



Case	DA	CDA	UDI<100	UDI100-2000	UDI>2000	Heating_(kWh)	Cooling_(kWh)	Initial Cost
Base	67.6	78.3	18.9	50.5	30.7	152655	82546	359675
Case 11	54.7	70.5	24.8	59.8	15.5	149122	81556	456705
Case 12	55.1	70.8	24.7	59.6	15.8	149244	81473	463105
Case 15	54.2	70.2	25.1	60.3	14.6	151153	79882	474523
Case 16	54.6	70.5	24.8	60.3	14.9	151259	79832	478923

Here the Base Case is highlighted, showing its' line, intersecting each axis based on the value inherent to that case. For instance, DA is 67.6, CDA is 78.3, etc.

Along each axis ranges of values can be selected to be shown as seen below.



Case	DA	CDA	UDI<100	UDI100-2000	UDI>2000	Heating_(kWh)	Cooling_(kWh)	Initial Cost
Base	67.6	78.3	18.9	50.5	30.7	152655	82546	359875
Case 11	54.7	70.5	24.8	59.8	15.5	149122	61556	458705
Case 12	55.1	70.8	24.7	59.6	15.8	149244	61473	463105

In this case the two more costly cases were excluded by selecting the range of costs that were of interest. Looking at the three cases remaining, Base Case, Case 11 and Case 12, the other performance metrics can be evaluated. The main factor that sets Case 11 and Case 12 apart are the cost, since all other metrics are nearly identical. This leads to the conclusion that Case 11 would be the optimal case to implement. It performs better than the base case in terms of daylighting and mechanical loads, as well as being the cheapest of the four proposed solutions.

To actually implement Case 11 would require an extra $100,000 added to the project with no practical payback, since the energy savings only amounts to $300 per year. In the grand scheme, $100,000 only equates to 0.22% of the total cost of $4.6 million. This cost could be offset by the fact that the space will have less potential for glare and be more comfortable overall.

CONCLUSION

The HUB addition was meant to better connect the building to campus. Building on this idea of connection, the lighting concept and later an entire integration study were based around this idea of connections.

Starting with the outdoor walkways, the lighting helps distinguish campus from the building, as well as guide people to the entryways, hence connecting people to the building. The change in general illumination marks the transition from campus to the building, while the highlighted entryways and Light Tape™ façade lighting create a beacon that adds a level of interest, as well as beckons passerby's to investigate.

The atrium lighting highlights areas which were most likely to foster conversation and interaction between people and events within the space, connecting people to people. A hierarchy is created by highlighting these landmarks within the space, helping to differentiate transition and conversation areas.

The bookstore lighting promotes a journey through the space, ultimately leading to the book section, and abstractly represents the learning process, thus connecting people to knowledge. Five stages of the learning process are represented by the lighting design, starting with the initial grasping of concepts and ending with synthesizing ideas into more complex and new information.

Finally, the flex theater connects people to emotions by providing a theatrical fixture layout with various levels of control for any experience level that the user might be. The three layers of control allow for different amounts of the lighting system to be controlled based on the needs of the user. This ranges from control of just the house lights to full control of the theatrical layout within the space.

To reflect the new lighting design, branch circuits were redone or eliminated. Additionally, several panelboards were resized based on more realistic demand factors than were originally used. This lead to a potential $18,000 initial cost savings over the current system.

Finally, an integrated daylighting, mechanical, and construction management study was conducted. Using parametric modelling tools and analysis, 16 potential daylighting solutions were narrowed down to 4. Through further analysis a final solution was reached base on the performance in each disciple's metrics. In all honesty, this analysis was something that took a great deal to learn how to do. The learning curve was steep, however it was beyond worth it. Looking past thesis and graduation, these tools and techniques allow for the integration of various disciples into one model. Parametric constraints and variables make this a very powerful design tool. Knowing how to do these types of analysis will allow engineers to design with architects, influencing designs from the beginning, rather than being called in to fix problems that could've been avoided. This truly is the epitome of what we as architectural engineers strive for, to make a real difference in design and work with designers and architects from the moment the first idea is jotted down to the moment the ribbon is cut.

ACKNOWLEDGEMENTS

First off I'd like to thank the faculty that have guided us through our journey from freshmen to super seniors. In particular, I'd like to thank:

Dr. Kevin Houser
Dr. Richard Mistrick
Professor Kevin Parfitt
Dr. Moses Ling

In particular, I'd like to thank Dr. Houser for pushing me to pursue Grasshopper and parametric design in general. He believed in me even when I was unsure and gave me the nudge I needed to just do it.

I'd also like to thank Sarith Subramaniam for all the Honeybee help and taking time to help troubleshoot my program. I couldn't have done it without you.

Penn State OPP was also a big help. Without them I wouldn't have had a building. All the help and quick responses from Chad Spackman were an invaluable resource.

All of my friends in AE that I'll miss dearly also deserve a big thank you. We all struggled through this together and without you I don't think I would've made it. Abraham Benguigui in particular was a huge help and always there to bounce ideas off of.

Finally, I'd like to thank my family for making me the person I am today. Without them, I just simply wouldn't be me. I'm eternally grateful for all of the guidance and support throughout the years, as well as putting up with my rants, looking at you dad.

REFERENCES

SOFTWARE

- Autodesk Revit 2016
- Elumtools
- Rhino 5
- Grasshopper
- Ladybug
- Honeybee
- Adobe Photoshop CS6
- LBL Window

REFERENCE MATERIALS

DiLaura, David L., Kevin W. Houser, Richard G. Mistrick, and Gary R. Steffy. The Lighting Handbook: Reference and Application. New York, NY: Illuminating Engineering Society of North America, 2011. Print.

ANSI/ASHRAE/IES Standard 90.1-2013: Energy Standard for Buildings except Lowrise Residential Buildings. Atlanta: ASHRAE, 2013. Print.

NFPA 70-2014: National Electrical Code, 2011. Quincy, MA: National Fire Protection Association, 2013. Print.

RS Means Electrical Cost Data 2016. S.l.: R S Means, 2014. Print.

RS Means Light Commercial Cost Data 2016. S.l.: R S Means, 2015. Print

Appendix A

10" High Lumen LED Cylinder

MC10LED

120 or 277V
0-10V Dimming

DATE: TYPE:

FIRM NAME:

PROJECT:

LiteForms®

Variable Intensity Technology

For conversion to millimeters, multiply inches by 25.4
Not to Scale

APPLICATIONS:
Designed for interior spaces, the MC10LED Series is a 10" specification grade high output LED cylinder capable of delivering over 16,500 lumens designed for ceiling heights from 20 to 60 feet. Combining energy savings, long life, low maintenance cost & controllability, it is an excellent alternative to metal halide (up to 250 watts) and quartz (up to 500 watts) fixtures. Rated for a minimum of 50,000 hours life (70% lumen maintenance) with ambient temperatures up to 30° C.

HOUSING:
Seamless .063" thick aluminum cylinder body with durable powder coat paint finish in a variety of architectural colors including Prescolite's exclusive Zet, metallic silver.

REFLECTOR:
High purity spun aluminum reflector with iridescence suppressed Alzak anodized finish. Available in specular and semi-specular finish in a variety of anodized colors as well as painted trim options. 25°, 35°, 45°, and 55° optical distributions with optional lens.

LED LIGHT ENGINE:
The MC10LED uses up to 480 individual Nichia LEDs specifically mixed to provide a minimum of 80 CRI with 3 SCDM color consistency. The LED light engine is available in multiple lumen packages and color temperatures to accommodate any design requirement. The use of individual LEDs to achieve these lumen packages enables optimal thermal management while creating a visually pleasing diffuse appearance in the ceiling. The LED light engine is coupled to a passive heat sink array utilizing innovative heat pipe technology, and is protected with a self resetting thermal protector.

LED DRIVER:
Each string of 120 LEDs is powered by a single 40 watt, constant current Osram LED driver (up for 4 drivers per fixture). The driver is UL8750 and Class 2 compliant. Lutron & Osram 1% dimming drivers also available.

DIMMING:
Standard 0-10v dimming provides flicker-free dimming to 10%. For sizing of the circuit control, the dimming circuit may require up to 1.2mA of sink current. See list of compatible dimmers on page 4.

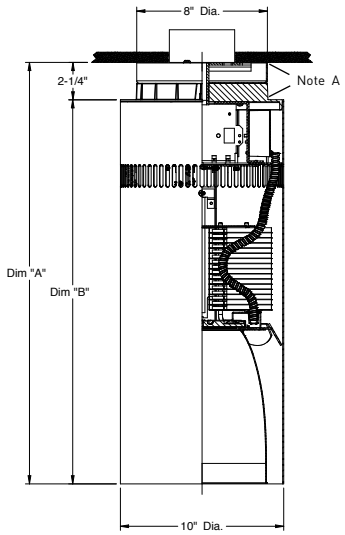
Lutron Series A dimming to 1% dimming is available as an option. EcoSystem Digital, or 2 wire (leading edge) available. Osram 0-10V dimming to 1% available. DMX to 0.1% available.

INSTALLATION:
Available as either a pendant, cord & cable, or ceiling mounted option. CCM option comes standard with 20ft length.

CERTIFICATIONS:
Certified to US and Canadian safety standards. Suitable for damp, interior locations.

WARRANTY:
5 Year Warranty. See www.prescolite.com for details.

CEILING/SURFACE MOUNT (S)



	26" HOUSING	30" HOUSING
DIM "A"	25-3/4"	29-1/8"
DIM "B"	23-1/2"	26-7/8"

Pendant and Wall Mount Line art on page 6

Note A: These areas will be painted black when Brushed Aluminum is chosen

CATALOG NUMBER: EXAMPLE: MC10LEDP12L35K8WFL45

CYLINDER	MOUNTING	OUTPUT	LED COLOR TEMP	CRI	VOLTAGE	OPTIONS	BEAM	FINISH	REFLECTOR COLOR	OPTIONS	LENGTH	CYLINDER COLOR
❑ **MC10LED** 10" High Output LED cylinder	❑ **P** Pendant (18" standard) ❑ **S** Surface ❑ **CCM**[6] Cord & Cable Mount ❑ **W** Wall Mount	❑ **3L** 3000 Delivered Lumens ❑ **6L** 6000 Delivered Lumens ❑ **9L** 9000 Delivered Lumens ❑ **12L** 12000 Delivered Lumens ❑ **15L**[3] 15000 Delivered Lumens	❑ **27K** 2700 Kelvin ❑ **30K** 3000 Kelvin ❑ **35K** 3500 Kelvin ❑ **40K** 4000 Kelvin ❑ **50K**[4] 5000 Kelvin	❑ **8** 80+ CRI ❑ **9**[4] 90+ CRI	❑ **Blank** 120-277 Volt ❑ **120V** 120V (for 2DM)	❑ **Blank** Standard 0-10V dimming to 10% ❑ **EDM** Lutron EcoSystem to 1% ❑ **2DM** Lutron 2 Wire Leading Edge Dimming to 1% (120V only) ❑ **DM1** Osram dimming to 1% 0-10V ❑ **DMX** DMX-512 enabled ❑ **LF**[5]____ Variable Intensity Lighting Lumen Factor	❑ **MD25**[1] 25 Degree Cutoff ❑ **FL35** 35 Degree Cutoff ❑ **WFL45** 45 Degree Cutoff ❑ **XFL55** 55 Degree Cutoff	❑ **Blank** Specular ❑ **SS** Semi-Specular	❑ **Blank** Clear ❑ **CG** Champagne Gold ❑ **BL** Black ❑ **WE** Wheat ❑ **LW** Light Wheat ❑ **PW** Pewter ❑ **BC** Painted Black Cone ❑ **WC** Painted White Cone	❑ **Blank** No Lens ❑ **CL** Clear Lens ❑ **SL** Solite Lens	❑ **26** 26" Housing ❑ **30** 30" Housing	❑ **BA**[2] Brushed Aluminum ❑ **BZ** Bronze ❑ **BL** Matte Black ❑ **WH** Matte White ❑ **Z** Zet

[1]Requires 30" housing option
[2]Standard with black accents
[3]Not available with EDM or 2DM
[4]50K not available in 90 CRI
[5]Lumen Factor available in 5% increments, from 55% (055) to 125% (125) on the 3L, 6L, 9L, or 12L housings. See spec sheet for more information. Not available greater than 100 for 2DM & EDM..
[6]CCM comes with 20ft clear cord & cable and white ceiling canopy standard.

prescolite
A Division of Hubbell Lighting, Inc.

PHOTOMETRIC DATA

LiteForms - 10" MC10LED Cylinder

DRIVER DATA	MC10LED3L	MC10LED6L	MC10LED9L	MC10LED12L	MC10LED15L
Input Voltage	120-277V	120-277V	120-277V	120-277V	120-277V
Input Frequency	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Input Current	0.28 (120v)	0.56 (120v) .	0.83 (120v)	1.10 (120v)	1.48 (120v)
	0.12 (277v)	0.24 (277v)	0.36 (277v)	0.48 (277v)	0.64 (277v)
Input Power	34W	67W	99W	132W	178W
Constant Current Output	800mA	800mA	800mA	800mA	1050mA
Power Factor	≥0.90	≥0.90	≥0.90	≥0.90	≥0.90
THD	<25%	<20%	<20%	<20%	<20%
EMI Filtering	FCC 47CFR	FCC 47CFR	FCC 47CFR	FCC 47CFR	FCC 47CFR
	Part 15, Class A	Part 15, Class A	Part 15, Class A	Part 15, Class A	Part 15, Class A
Operating Temperature	-30°C to +30°C	-30°C to +30°C	-30°C to +30°C	-30°C to +30°C	-30°C to +30°C
Dimming	0-10V	0-10V	0-10V	0-10V	0-10V

Over-voltage, over-current, short-circuit protected

Lumen output & input wattage may vary slightly with EDM/2DM/DM1/DMX Driver options

Lumen Multiplier Table

Photometrics for the MC10LED are published below at a nominal 3500 Kelvin temperature. This table may be used to approximate the lumen values at different Kelvin temperatures. Power consumption would stay the same.

5000 Kelvin	1.14
4000 Kelvin	1.03
3500 Kelvin	1.00
3000 Kelvin	1.00
2700 Kelvin	0.91
Solite Lens	0.87
90 CRI.....0.80	

Variable Intensity Technology

VARIABLE INSTENSITY LIGHTING
LUMEN FACTOR (LF)

The Megalum offers the ability to deliver precisely the amount of light you need for any downlighting application - from less than 2000 lumens to nearly 17000 lumens! The standard Megalum 3L, 6L, 9L and 12L fixtures can all be tuned from 55% to 125% of their published lumen outputs. Simply select your light engine, and in the housing options select a lumen factor (LF___). Note, this is not available on the '15L' lumen package.

In most lighting calculation software, the "LF" can be used in the ballast factor input to adjust the calculated light levels.

Lumen Factor	055	060	065	070	075	080	085	090	095	100	105	110	115	120	125
Watt Factor	0.52	0.57	0.62	0.67	0.72	0.78	0.83	0.89	0.94	1	1.06	1.13	1.20	1.27	1.35

It is also important to note that the input power also changes in the same direction, but not in proportion to the lumens. The 'watt factor' corresponding to the appropriate 'lumen factor' can be used to calculate the input power.

Example:
Desired: 7000 Lumens using a FL35 open reflector
MC10LED 6L FL35 Open fixture provides 5995 delivered lumens and requires 66.5 input watts (chart, page 3)
Choose: LF120. 5995 lumens x 1.2 = **7194 Delivered Lumens**
Calculated Watts: The corresponding Watt Factor to LF120 = 1.27
66.5 watts x 1.27 = **84.5 input watts**

PHOTOMETRIC DATA

Delivered Lumens

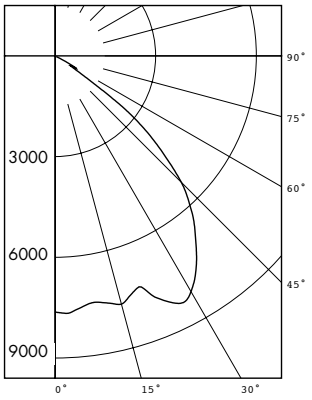
The table below shows the delivered lumens for the various lumen outputs and beam distributions. Use this chart in connection with the lumen factor (LF) capability to deliver any output required.

Output	Beam	Lens	Delivered Lumens	Input Watts	Lumens Per Watt	Test Number	Full Catalog String
15L	XFL55	Open	16826	178.2	94.4	IES	MC10LEDS15L35K8XFL5530WH
15L	WFL45	Open	15829	177.5	89.2	IES	MC10LEDS15L35K8WFL4530BL
15L	FL35	Open	15320	177.2	86.5	IES	MC10LEDS15L35K8FL3530BL
15L	MD25	Open	8498	176.6	48.1	IES	MC10LEDS15L35K8MD2530BL
15L	XFL55	SL	15091	177.9	84.8	IES	MC10LEDS15L35K8XFL55SL30WH
15L	WFL45	SL	14093	177.8	79.3	IES	MC10LEDS15L35K8WFL45SL30BL
15L	FL35	SL	13494	177.1	76.2	IES	MC10LEDS15L35K8FL35SL30BL
15L	MD25	SL	7359	176.6	41.7	IES	MC10LEDS15L35K8MD25SL30BL
12L	XFL55	Open	13350	132	101.1	IES	MC10LEDS12L35K8XFL5526BL
12L	WFL45	Open	12647	131.9	95.9	IES	MC10LEDS12L35K8WFL4526BL
12L	FL35	Open	12290	131.6	93.4	IES	MC10LEDS12L35K8FL3526BL
12L	MD25	Open	6259	131.2	47.7	IES	MC10LEDS12L35K8MD2530WH
12L	XFL55	SL	12072	131.8	91.6	IES	MC10LEDS12L35K8XFL55SL26BL
12L	WFL45	SL	11248	131.9	85.3	IES	MC10LEDS12L35K8WFL45SL26BL
12L	FL35	SL	10937	131.7	83.0	IES	MC10LEDS12L35K8FL35SL26BL
12L	MD25	SL	5915	131.1	45.1	IES	MC10LEDS12L35K8MD25SL30WH
9L	XFL55	Open	10099	99.2	101.8	IES	MC10LEDS9L35K8XFL5526BL
9L	WFL45	Open	9575	99.2	96.5	IES	MC10LEDS9L35K8WFL4526BL
9L	FL35	Open	9280	99.1	93.6	IES	MC10LEDS9L35K8FL3526BL
9L	MD25	Open	4867	99	49.2	IES	MC10LEDS9L35K8MD2530WH
9L	XFL55	SL	9146	99.1	92.3	IES	MC10LEDS9L35K8XFL55SL26BL
9L	WFL45	SL	8526	99.2	85.9	IES	MC10LEDS9L35K8WFL45SL26BL
9L	FL35	SL	8226	98.8	83.3	IES	MC10LEDS9L35K8FL35SL26BL
9L	MD25	SL	4600	99	46.5	IES	MC10LEDS9L35K8MD25SL30WH
6L	XFL55	Open	6822	66.5	102.6	IES	MC10LEDS6L35K8XFL5530WH
6L	WFL45	Open	6766	66.6	101.6	IES	MC10LEDS6L35K8WFL4530WH
6L	FL35	Open	5995	66.5	90.2	IES	MC10LEDS6L35K81FL3530WH
6L	MD25	Open	5210	66.4	78.5	IES	MC10LEDS6L35K8MD2530WH
6L	XFL55	SL	5813	66.5	87.4	IES	MC10LEDS6L35K8XFL55SL30WH
6L	WFL45	SL	6060	66.5	91.1	IES	MC10LEDS6L35K8WFL45SL30WH
6L	FL35	SL	5499	66.5	82.7	IES	MC10LEDS6L35K8FL35SL30WH
6L	MD25	SL	4792	66.5	72.1	IES	MC10LEDS6L35K8MD25SL30WH
3L	XFL55	Open	3473	33.9	102.4	IES	MC10LEDS3L35K8XFL5530WH
3L	WFL45	Open	3426	33.9	101.1	IES	MC10LEDS3L35K8WFL4530WH
3L	FL35	Open	3081	33.9	90.9	IES	MC10LEDS3L35K8FL3530WH
3L	MD25	Open	2752	33.9	81.2	IES	MC10LEDS3L35K8MD2530WH
3L	XFL55	SL	2998	33.8	88.7	IES	MC10LEDS3L35K8XFL55SL30WH
3L	WFL45	SL	3071	33.9	90.6	IES	MC10LEDS3L35K8WFL45SL30WH
3L	FL35	SL	2816	34	82.8	IES	MC10LEDS3L35K8FL35SL30WH
3L	MD25	SL	2519	33.9	74.3	IES	MC10LEDS3L35K8MD25SL30WH

PHOTOMETRIC DATA

LiteForms - 10" MC10LED Cylinder

MC10LEDP15L35K8XFL5526WH
LED Light Engine: 3500K, 80+ CRI
System Wattage: 178.2W
Fixture Delivered Lumens: 16825
Fixture Efficacy: 94.4
Spacing Criteria: 1.4



CANDELA DISTRIBUTION

DEG	CANDELA
0	7631
5	7577
15	7655
25	8091
35	7357
45	5326
55	1222
65	63
75	19
85	3
90	0

Test No. 9118
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%FIXT
0-40	11126	66.1
0-60	16612	98.7
0-90	16825	100.0
0-180	16825	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

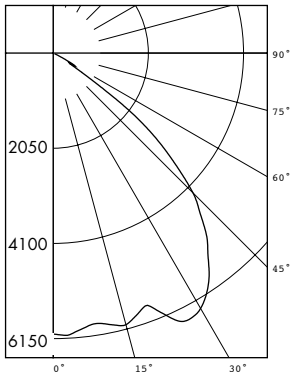
Angle in Vertical	Average - 0°
45°	232178
55°	65673
65°	4595
75°	2263
85°	1061

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	112	109	106	103	109	106	104	101	102	100	98	99	97	95	95	94	92
2	105	98	93	89	102	97	92	88	93	89	86	90	87	84	87	85	82
3	97	89	83	78	95	88	82	77	85	80	76	82	78	75	80	76	73
4	90	81	74	68	88	80	73	68	77	72	67	75	70	66	73	69	65
5	84	73	66	60	82	72	65	60	70	64	60	69	63	59	67	62	58
6	78	67	59	54	76	66	59	54	64	58	53	63	57	53	61	56	52
7	73	61	54	48	71	60	53	48	59	53	48	58	52	47	56	51	47
8	68	56	49	43	67	55	48	43	54	48	43	53	47	43	52	47	43
9	64	52	44	39	62	51	44	39	50	44	39	49	43	39	48	43	39
10	60	48	41	36	59	47	40	36	46	40	36	45	40	35	45	39	35

MC10LEDS15L35K8WIHXFL5530WH Test No. 9118

MC10LEDP12L35K8XFL5526
LED Light Engine: 3500K, 80+ CRI
System Wattage: 132.0W
Fixture Delivered Lumens: 13350
Fixture Efficacy: 101.1
Spacing Criteria: 1.4



CANDELA DISTRIBUTION

DEG	CANDELA
0	6050
5	6007
15	6056
25	6366
35	5857
45	4260
55	1091
65	48
75	15
85	2
90	0

Test No. 9060
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%FIXT
0-40	8782	65.8
0-60	13183	98.8
0-90	13350	100.0
0-180	13350	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average - 0°
45°	185708
55°	58633
65°	3501
75°	1786
85°	707

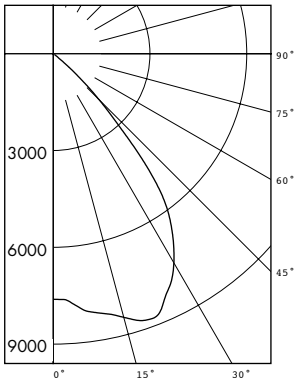
COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	112	109	106	103	109	106	104	101	102	100	98	99	97	95	95	94	92
2	105	98	93	89	102	97	92	88	93	89	86	90	87	84	87	85	82
3	97	89	83	78	95	88	82	77	85	80	76	82	78	74	80	76	73
4	90	81	74	68	88	79	73	68	77	71	67	75	70	66	73	69	65
5	84	73	66	60	82	72	65	60	70	64	59	68	63	59	67	62	58
6	78	67	59	54	76	66	59	54	64	58	53	63	57	53	61	56	52
7	73	61	53	48	71	60	53	48	59	52	48	58	52	47	56	51	47
8	68	56	48	43	67	55	48	43	54	48	43	53	47	43	52	47	43
9	64	52	44	39	62	51	44	39	50	43	39	49	43	39	48	43	39
10	60	48	40	36	58	47	40	36	46	40	35	45	39	35	45	39	35

MC10LEDP12L35K8XFL4526 Test No. 9060

PHOTOMETRIC DATA

MC10LEDP12L35K8WFL4526
LED Light Engine: 3500K, 80+ CRI
System Wattage: 131.9W
Fixture Delivered Lumens: 12647
Fixture Efficacy: 95.9
Spacing Criteria: 1.2



CANDELA DISTRIBUTION

DEG	CANDELA
0	7610
5	7816
15	8458
25	8262
35	6332
45	2019
55	120
65	26
75	10
85	2
90	0

Test No. 9056
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%FIXT
0-40	10821	85.6
0-60	12607	99.7
0-90	12647	100.0
0-180	12647	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

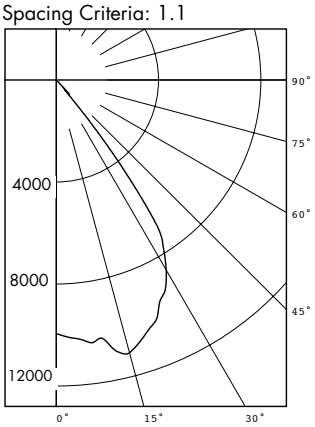
Angle in Vertical	Average - 0°
45°	88015
55°	6449
65°	1896
75°	1191
85°	707

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	113	110	107	105	110	108	105	103	104	102	100	100	98	97	97	95	94
2	107	101	97	93	104	100	95	92	96	93	90	93	90	88	90	88	86
3	100	93	88	83	98	92	87	83	89	85	81	87	83	80	84	81	79
4	94	86	80	75	93	85	79	75	83	78	74	81	76	73	79	75	72
5	89	80	73	68	87	79	72	68	77	71	67	75	70	67	73	69	66
6	84	74	67	62	82	73	67	62	71	66	62	70	65	61	68	64	61
7	79	68	62	57	77	68	61	57	66	61	56	65	60	56	64	59	56
8	74	64	57	52	73	63	57	52	62	56	52	61	55	52	60	55	51
9	70	59	53	48	69	59	52	48	58	52	48	57	51	48	56	51	48
10	66	55	49	45	65	55	49	44	54	48	44	53	48	44	52	48	44

MC10LEDP12L35K8WFL4526 Test No. 9056

MC10LEDP12L35K8FL3526
LED Light Engine: 3500K, 80+ CRI
System Wattage: 131.6W
Fixture Delivered Lumens: 12290
Fixture Efficacy: 93.4
Spacing Criteria: 1.1



CANDELA DISTRIBUTION

DEG	CANDELA
0	9942
5	10192
15	11073
25	9585
35	6580
45	163
55	33
65	13
75	5
85	1
90	0

Test No. 8954
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	
0-40	11965	97.4
0-60	12269	99.8
0-90	12290	100.0
0-180	12290	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average - 0°
45°	4548
55°	1135
65°	607
75°	381
85°	226

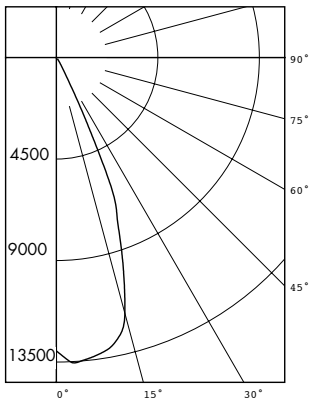
COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	113	111	108	106	111	109	106	104	105	103	101	101	99	98	97	96	95
2	108	103	99	96	106	101	98	94	98	95	92	95	93	90	92	90	89
3	102	96	91	87	100	94	90	86	92	88	85	89	86	83	87	85	82
4	97	89	84	80	95	88	83	79	86	82	78	84	80	77	82	79	76
5	92	84	78	73	90	83	77	73	81	76	72	79	75	72	78	74	71
6	87	78	72	68	86	77	72	68	76	71	67	74	70	67	73	69	66
7	83	73	67	63	81	73	67	63	71	66	62	70	65	62	69	65	62
8	78	69	63	58	77	68	62	58	67	62	58	66	61	58	65	61	58
9	74	65	59	55	73	64	58	54	63	58	54	62	58	54	61	57	54
10	71	61	55	51	70	60	55	51	60	54	51	59	54	51	58	54	50

MC10LEDP12L35K8FL3526 Test No. 8954

PHOTOMETRIC DATA

MC10LEDP12L35K8MD2530
LED Light Engine: 3500K, 80+ CRI
System Wattage: 131.2W
Fixture Delivered Lumens: 6259
Fixture Efficacy: 47.7
Spacing Criteria: 0.6



CANDELA DISTRIBUTION

DEG	CANDELA
0	13008
5	13478
15	11740
25	3299
35	191
45	42
55	15
65	6
75	3
85	1
90	0

Test No. 9064
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%FIXT
0-40	6200	99.1
0-60	6249	99.8
0-90	6259	100.0
0-180	6259	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average - 0°
45°	1831
55°	806
65°	438
75°	357
85°	354

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	112	109	106	103	109	106	104	101	102	100	98	99	97	95	95	94	92
2	105	98	93	89	102	97	92	88	93	89	86	90	87	84	87	85	82
3	97	89	83	78	95	88	82	77	85	80	76	82	78	75	80	76	73
4	90	81	74	68	88	80	73	68	77	72	67	75	70	66	73	69	65
5	84	73	66	60	82	72	65	60	70	64	60	69	63	59	67	62	58
6	78	67	59	54	76	66	59	54	64	58	53	63	57	53	61	56	52
7	73	61	54	48	71	60	53	48	59	53	48	58	52	47	56	51	47
8	68	56	49	43	67	55	48	43	54	48	43	53	47	43	52	47	43
9	64	52	44	39	62	51	44	39	50	44	39	49	43	39	48	43	39
10	60	48	41	36	59	47	40	36	46	40	36	45	40	35	45	39	35

MC10LEDP12L35K8MD2530 Test No. 9064

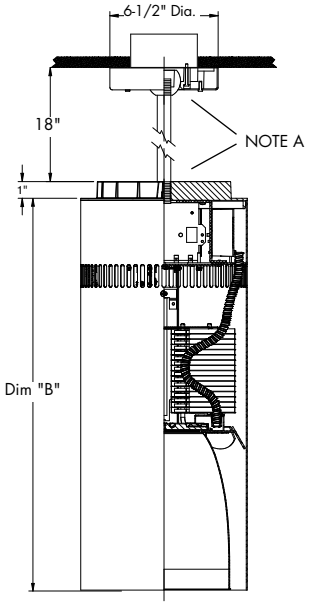
Dimming Compatibility Table

Dimming Ballast	Manufacturer	Web Link
DM/DM1	Lutron DVTV	http://bit.ly/11jSvZg
DM/DM1	Leviton AWRMG-7xx, AWSMG-7xx, AWSMT-7xx	http://bit.ly/1BJn2R9
EDM	Lutron	http://bit.ly/1vtjHAl
2DM	Lutron	http://bit.ly/1nF4Zp1

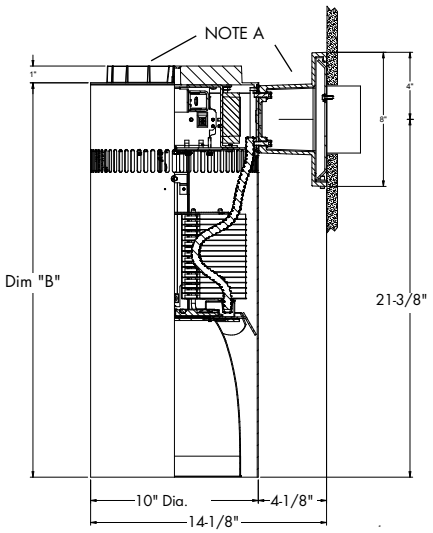
DMX

See instruction sheet on www.prescolite.com for connection & installation information.
Other useful links: http://www.eldoled.com/led-drivers/powerdrive/50-watt/ac-561s/

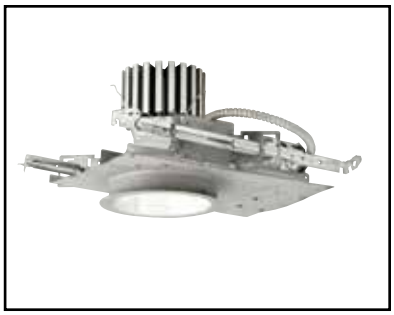
PENDANT MOUNT (P)



WALL MOUNT (W)



Note A: These areas will be painted black when Brushed Aluminum is chosen



6" LED Open Downlight
LF6LEDG4
120V–277V
0-10V Dimming

DATE: TYPE:

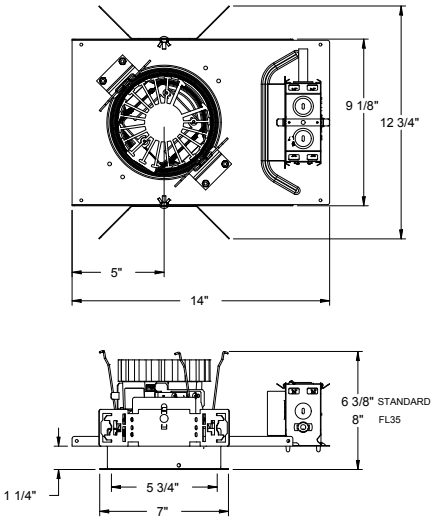
FIRM NAME:

PROJECT:

LiteFrame

ENERGY STAR

Ceiling Cutout: 6¼"
Maximum Ceiling Thickness 1¼"
For conversion to millimeters, multiply inches by 25.4
Not to Scale



*See page 5 for EM line art

*See page 6 for NCT line art

APPLICATIONS:
LiteFrame LF6LED is a 6" specification grade LED open downlight that utilizes remote phosphor technology to obtain color consistency, energy savings, and low maintenance costs. 50,000 hours minimum life up to 35°C (95°F) in open plenum applications.

HOUSING:
One-piece 22 gauge non-corrosive steel platform. Pre-wired j-box with snap-on cover for easy access. Snap-in-connection from driver compartment allows easy installation of light engine/trim assembly without tools above or below the ceiling and can be upgraded to accommodate technology improvements. Approve for 8 (4 in/4 out) No. 12 AWG conductors rated for 90°C through wiring.

REFLECTOR:
High purity aluminum, Alzak, iridescence suppressed, semi-diffuse upper reflector. Self-trim standard. Painted white self-trim (WT) available as option. Reflector is made from anodized Alanod Miro 4 aluminum.

LED LIGHT ENGINE:
The LF6LED uses the Philips Fortimo DLM Gen 4 LED Module with remote phosphor technology. This technology provides controlled color consistency (3 SCDM) from fixture to fixture. The system is designed for optional life and lumen maintenance (>50,000 hours at 70% lumen maintenance). Both reflector and light engine assembly are mechanically retained to housing. The light engine comes standard with 80 CRI in all Kelvin temperatures.

LED DRIVER:
The LF6LED utilizes the Philips Fortimo LED Driver specifically designed to optimize efficiency of the Fortimo DLM Module. Driver is designed to match the 50,000 hours minimum life expectancy of the system. Meets UL Class 2, inherent short circuit protection, self limited, overload protected. If critical temperatures are reached on driver or LED module, integrated thermal feedback loop will gradually reduce current to protect system life. Driver is universal 120V-277V. Optional Lutron Series A driver is also available.

DIMMING:
Comes standard with 0-10V dimming capability. Flicker-free dimming to 10%. 0-10V control may consume up to 1mA. 0-10V, Lutron 2 wire, 3 wire, and EcoSystem dimming available to 1% and DMX to 0.1%.

INSTALLATION:
Adjustable Bar hangers included. Universal adjustable mounting brackets also accept 1/2" EMT conduit or 1 1/2" or 3/4" lathing channel (by others) or Prescolite 24" bar hangers (B24 or B6).

CERTIFICATIONS:
CSA certified to US and Canadian safety standards. Suitable for wet locations. Approved for through wiring. Non-IC rated. EM and EMR is damp rated use only. ENERGY STAR qualified with open clear Alzak reflector. UL approved for NSF2 splash zone applications.

WARRANTY:
5 year warranty. See www.prescolite.com for details.

EXAMPLE: LF6LEDG4-6LFLED5G430K
EXAMPLE: LF6LED7G4120HDM-6LFLED7G435KWHWT

CATALOG NUMBER:

Order housing, reflector, and accessories separately

STANDARD 0-10V DIMMING

ALTERNATIVE DIMMING TO 1% & 0.1%

HOUSING/LED GENERATION
- ❑ **LF6LEDG4** 6" High Efficacy LED Housing

VOLTAGE
- ❑ **Blank** 120V–277V
- ❑ **347**[4]

OPTIONS
- ❑ **Blank** Standard 0-10V dimming to 10%
- ❑ **EM**[2,4,6] Emergency Battery Pack with integral test switch and indicator light
- ❑ **EMR**[4] Emergency Battery Pack with remote test switch and indicator light

TRIM
- ❑ **6LFLED5G4** 1100 Lumen Module
- ❑ **6LFLED6G4** 1500 Lumen Module
- ❑ **6LFLED7G4** 2000 Lumen Module

LED COLOR TEMP
- ❑ **30K**
- ❑ **35K**
- ❑ **40K**

BEAM ANGLE
- ❑ **Blank** Nominal 45 degree cutoff
- ❑ **FL35**[7] Nominal 35 degree cutoff

REF. FINISH
- ❑ **Blank** Semi-Diffuse

REFLECTOR COLORS
- ❑ **Blank** Clear
- ❑ **CG** Champagne Gold
- ❑ **BL** Black
- ❑ **WE** Wheat
- ❑ **LW** Light Wheat
- ❑ **PW** Pewter
- ❑ **WH**[1] White Paint

REF. OPTIONS
- ❑ **WT** White Trim
- ❑ **TRG**[6] Trim ring gasket
- ❑ **NCT**[1,3] Non-conductive trim
- ❑ **EM**[2,4,6] Pre-punched reflector for integral switch.
- ❑ **AM**[7,8] Antimicrobial coating on clear Alzak reflector only

Use with HDM/DM1/2DM/DMX dimming option: Match Housing to Trim Output
- ❑ **LF6LED5G4**
- ❑ **LF6LED6G4**
- ❑ **LF6LED7G4**

- ❑ **120**
- ❑ **277**

- ❑ **HDM**[5] Lutron 3-wire Eco System to 1%
- ❑ **2DM**[5] Lutron 2-wireLeading Edge to 1%(120V only)
- ❑ **DM1**[5] 0-10V dimming to 1%
- ❑ **DMX**[5] DMX-512 Enabled
- ❑ **EM**[2,4] Emergency Battery Pack with integral test switch and indicator light
- ❑ **EMR**[4] Emergency Battery Pack with remote test switch and indicator light

NOTES
1. Requires WT option also
2. EM options required on both housing and trim. Not compatible with FL35 reflector.
3. See page 5 for details
4. 347V not available with EM or EMR
5. For HDM, DM1, DMX & 2DM options, housing output must match trim output
6. Not available with NCT
7. Not available with EM option, NCT, TRG, or FL35. EMR is compatible.
8. Clear Alzak standard. Consult factory for other reflector colors

ACCESSORIES
- ❑ **B24** Set of two 24" bar hangers for T-bar ceilings
- ❑ **B6** Set of two (2) bar hangers for ceiling joist up to 24" centers
- ❑ **LFSC6** 6" reflector screw cover
- ❑ **LFSC6 EM** 6" reflector screw cover for EM
- ❑ **SCA6D** Sloped ceiling adapter (see note on spec sheet)
- ❑ **Signos6** Architectural glass elements. Refer to specification sheets ARCH-SIG-001 and -003
- ❑ **LiteGear** See page 4 for availability (not compatible with EM or EMR)

prescolite
A Division of Hubbell Lighting, Inc.

Web: **www.prescolite.com** • Tech Support: **(888) 777-4832**

PHOTOMETRIC DATA

LiteFrame - 6" LF6LEDG4 Downlight

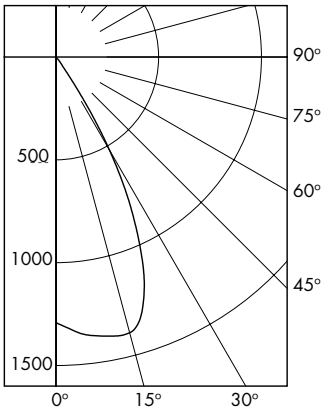
DRIVER DATA	LF6LED5G4 30K	LF6LED6G4 30K	LF6LED7G4 30K
Input Voltage	120-277V	120-277V	120-277V
Input Frequency	50/60 Hz	50/60 Hz	50/60 Hz
Input Current	0.12A (120v)	0.16A (120v)	0.22A (120v)
	0.052 (277v)	0.07A (277v)	0.10A (277v)
Input Power	14.5W	19.1W	26.5W
Constant Current Output	200–1000mA	200–1000mA	200–1000mA
Power Factor	≥0.90	≥0.90	≥0.90
THD	<20%	<20%	<20%
EMI Filtering	FCC 47CFR	FCC 47CFR	FCC 47CFR
	Part 15, Class A	Part 15, Class A	Part 15, Class A
Operating Temperature	-20°C to 35°C	-20°C to 35°C	-20°C to 35°C
Dimming	0-10V	0-10V	0-10V

Over-voltage, over-current, short-circuit protected

*Power consumption and photometric output may vary slightly with HDM or 2DM driver.

When operating in EM mode, the fixture will deliver approximately 30% of the published full lumen output.

LF6LEDG4 6LFLED5G4 30K FL35
LED Light Engine: 3000K, 80 CRI
System Wattage: 14.1W
Fixture Delivered Lumens: 1051
Fixture Efficacy: 74.5
Spacing Criteria: 0.8



CANDELA DISTRIBUTION

DEG	CANDELA	LUMENS
0	1291	
5	1348	129
15	1388	384
25	932	415
35	114	110
45	9	11
55	2	2
65	1	1
75	0	0
85	0	0
90	0	

Test No. 9373
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LUMINAIRE
0-30	928	88.3
0-40	1038	98.7
0-60	1050	99.9
0-90	1051	100.0
90-180	0	0.0
0-180	1051	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

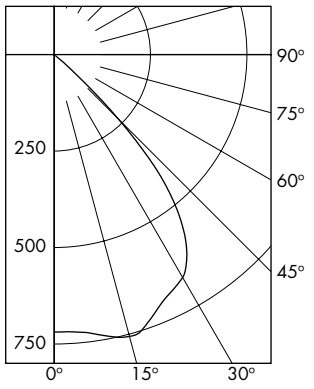
Angle in Vertical	Average
45°	759
55°	208
65°	141
75°	0
85°	0

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	114	112	109	107	112	109	107	106	105	104	102	102	100	99	98	97	96
2	109	105	101	98	107	103	100	97	100	97	95	97	95	93	94	93	91
3	104	99	94	91	103	97	93	90	95	91	89	92	90	87	90	88	86
4	100	93	88	84	98	92	88	84	90	86	83	88	85	82	86	83	81
5	96	88	83	79	94	87	82	79	86	81	78	84	80	77	82	79	77
6	91	84	78	74	90	83	78	74	81	77	74	80	76	73	79	75	73
7	88	79	74	70	86	79	74	70	77	73	70	76	72	69	75	72	69
8	84	75	70	66	83	75	70	66	74	69	66	73	69	66	72	68	65
9	80	72	66	63	79	71	66	63	70	66	63	70	65	62	69	65	62
10	77	68	63	60	76	68	63	60	67	63	59	66	62	59	66	62	59

LF6LEDG4 - 6LFLED5G430KFL35 Test No. 9373

LF6LEDG4 6LFLED5G4 30K
LED Light Engine: 3000K, 80 CRI
System Wattage: 14.5W
Fixture Delivered Lumens: 1157
Fixture Efficacy: 80.0
Spacing Criteria: 1.2



CANDELA DISTRIBUTION

DEG	CANDELA	LUMENS
0	719	
5	722	69
15	756	212
25	692	321
35	597	365
45	236	181
55	4	8
65	0	0
75	0	0
85	0	0
90	0	0

Test No. 8450 2673996-09
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LUMINAIRE
0-30	602	52.0
0-40	967	83.6
0-60	1157	100.0
0-90	1157	100.0
90-180	0	0.0
0-180	1157	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average
45°	18290
55°	382
65°	0
75°	0
85°	0

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

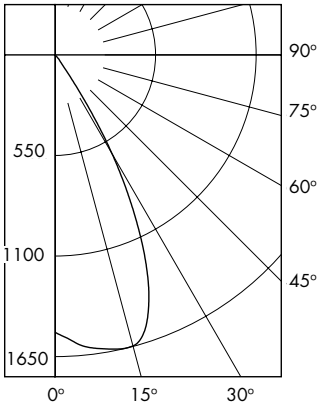
Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	113	110	107	105	110	108	105	103	104	102	100	100	98	97	96	95	94
2	107	101	97	93	104	99	95	92	96	93	90	93	90	88	90	88	86
3	100	93	87	83	98	92	87	82	89	85	81	86	83	80	84	81	79
4	94	86	80	75	92	85	79	74	82	77	73	80	76	73	78	75	72
5	88	79	73	68	87	78	72	67	76	71	67	74	70	66	73	69	65
6	83	73	66	61	82	72	66	61	71	65	61	69	64	60	68	63	60
7	78	68	61	56	77	67	61	56	66	60	56	64	59	55	63	59	55
8	74	63	56	51	72	62	56	51	61	55	51	60	55	51	59	54	51
9	69	58	52	47	68	58	52	47	57	51	47	56	51	47	55	50	47
10	65	55	48	44	64	54	48	44	53	47	43	52	47	43	52	47	43

LF6LEDG4 6LFLED5G4 30K Test No. 8450 2673996-09

HUBBELL® Lighting, Inc.

PHOTOMETRIC DATA

LF6LEDG4 6LFLED6G4 30K FL35
LED Light Engine: 3000K, 80 CRI
System Wattage: 18.7W
Fixture Delivered Lumens: 1251
Fixture Efficacy: 66.9
Spacing Criteria: 0.8



CANDELA DISTRIBUTION

DEG	CANDELA	LUMENS
0	1517	
5	1593	153
15	1648	456
25	1118	495
35	138	131
45	11	13
55	2	2
65	1	1
75	0	0
85	0	0
90	0	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LUMINAIRE
0-30	1105	88.3
0-40	1235	98.7
0-60	1250	99.9
0-90	1251	100.0
90-180	0	0.0
0-180	1251	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average
45°	928
55°	208
65°	141
75°	0
85°	0

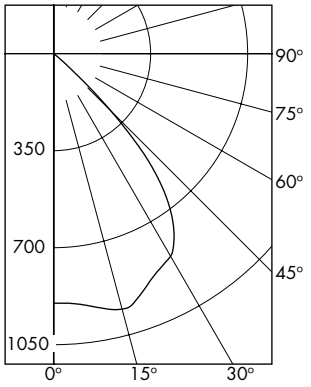
COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance: 70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	114	112	109	107	112	109	107	106	105	104	102	102	100	99	98	97	96
2	109	105	101	98	107	103	100	97	100	97	95	97	95	93	94	93	91
3	104	99	94	91	103	97	93	90	95	91	89	92	90	87	90	88	86
4	100	93	88	84	98	92	88	84	90	86	83	88	85	82	86	83	81
5	96	88	83	79	94	87	82	79	86	81	78	84	80	77	82	79	77
6	91	84	78	74	90	83	78	74	81	77	74	80	76	73	79	75	73
7	88	79	74	70	86	79	74	70	77	73	70	76	72	69	75	72	69
8	84	75	70	66	83	75	70	66	74	69	66	73	69	66	72	68	65
9	80	72	66	63	79	71	66	63	70	66	62	69	65	62	69	65	62
10	77	68	63	60	76	68	63	60	67	63	59	66	62	59	66	62	59

LF6LEDG4 - 6LFLED6G430K FL35 Test No. 9372

Test No. 9372
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

LF6LEDG4 6LFLED6G4 30K
LED Light Engine: 3000K, 80 CRI
System Wattage: 19.1W
Fixture Delivered Lumens: 1456
Fixture Efficacy: 76.2
Spacing Criteria: 1.2



CANDELA DISTRIBUTION

DEG	CANDELA	LUMENS
0	900	
5	906	87
15	954	267
25	874	405
35	753	461
45	293	224
55	5	9
65	1	1
75	0	0
85	0	0
90	0	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LUMINAIRE
0-30	760	52.2
0-40	1221	83.9
0-60	1454	99.9
0-90	1456	100.0
90-180	0	0.0
0-180	1456	100.0

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance: 70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	113	110	107	105	110	108	105	103	104	102	100	100	98	97	96	95	94
2	107	101	97	93	104	99	95	92	96	93	90	93	90	88	90	88	86
3	100	93	88	83	98	92	87	82	89	85	81	86	83	80	84	81	79
4	94	86	80	75	92	85	79	74	82	77	73	80	76	73	78	75	72
5	89	79	73	68	87	78	72	67	76	71	67	75	70	66	73	69	66
6	83	73	66	62	82	72	66	61	71	65	61	69	64	60	68	63	60
7	78	68	61	56	77	67	61	56	66	60	56	64	59	55	63	59	55
8	74	63	56	52	72	62	56	51	61	55	51	60	55	51	59	54	51
9	69	59	52	47	68	58	52	47	57	51	47	56	51	47	55	50	47
10	65	55	48	44	64	54	48	44	53	47	43	52	47	43	52	47	43

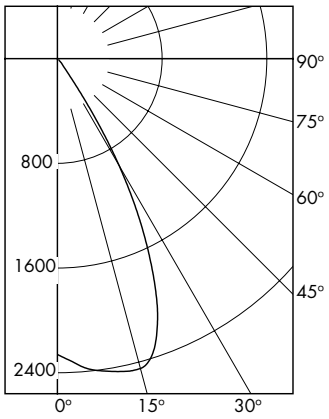
LF6LEDG4 6LFLED6G4 30K Test No.8683

Test No. 8683
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

HUBBELL® Lighting, Inc.

PHOTOMETRIC DATA

LF6LEDG4 6LFLED7G4 30K FL35
LED Light Engine: 3000K, 80 CRI
System Wattage: 26.0W
Fixture Delivered Lumens: 1870
Fixture Efficacy: 71.9
Spacing Criteria: 0.8



CANDELA DISTRIBUTION

DEG	CANDELA	LUMENS
0	2260	
5	2370	228
15	2451	679
25	1663	740
35	211	199
45	17	19
55	4	3
65	1	1
75	1	1
85	0	0
90	0	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LUMINAIRE
0-30	1646	88.0
0-40	1845	98.7
0-60	1868	99.9
0-90	1870	100.0
90-180	0	0.0
0-180	1870	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average
45°	1435
55°	416
65°	141
75°	231
85°	0

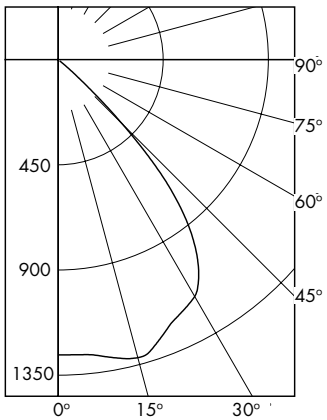
COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	114	112	109	107	112	109	107	106	105	104	102	102	100	99	98	97	96
2	109	105	101	98	107	103	100	97	100	97	95	97	95	93	94	92	91
3	104	99	94	91	103	97	93	90	95	91	89	92	90	87	90	88	86
4	100	93	88	84	98	92	87	84	90	86	83	88	85	82	86	83	81
5	96	88	83	79	94	87	82	79	85	81	78	84	80	77	82	79	77
6	91	83	78	74	90	83	78	74	81	77	74	80	76	73	79	75	73
7	87	79	74	70	86	79	73	70	77	73	69	76	72	69	75	71	69
8	84	75	70	66	83	75	70	66	74	69	66	73	69	65	72	68	65
9	80	72	66	63	79	71	66	63	70	66	62	69	65	62	69	65	62
10	77	68	63	59	76	68	63	59	67	62	59	66	62	59	66	62	59

LF6LEDG4 - 6LFLED7G430K FL35 Test No. 9314

Test No. 9314
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

LF6LEDG4 6LFLED7G4 30K
LED Light Engine: 3000K, 80 CRI
System Wattage: 26.4W
Fixture Delivered Lumens: 2013
Fixture Efficacy: 76.1
Spacing Criteria: 1.2



CANDELA DISTRIBUTION

DEG	CANDELA	LUMENS
0	1263	
5	1267	122
15	1320	370
25	1212	561
35	1041	637
45	391	306
55	9	15
65	2	2
75	0	0
85	0	0
90	0	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LUMINAIRE
0-30	1053	52.3
0-40	1690	83.9
0-60	2011	99.9
0-90	2013	100.0
90-180	0	0.0
0-180	2013	100.0

LUMINANCE DATA IN CANDELA/ SQ. METER

Angle in Vertical	Average
45°	30302
55°	860
65°	259
75°	0
85°	0

COEFFICIENTS OF UTILIZATION Zonal Cavity Method

Room Cavity Ratio	% Effective Ceiling Cavity Reflectance: 80%				70%				50%			30%			10%		
	20% Effective Floor Cavity Reflectance																
	% Wall Reflectance																
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
1	113	110	107	105	110	108	105	103	104	102	100	100	98	97	96	95	94
2	107	101	97	93	104	99	95	92	96	93	90	93	90	88	90	88	86
3	100	93	88	83	98	92	87	82	89	85	81	86	83	80	84	81	79
4	94	86	80	75	92	85	79	74	82	77	73	80	76	73	78	75	72
5	89	79	73	68	87	78	72	67	76	71	67	75	70	66	73	69	66
6	83	73	66	62	82	72	66	61	71	65	61	69	64	60	68	63	60
7	78	68	61	56	77	67	61	56	66	60	56	64	59	55	63	59	55
8	74	63	56	52	72	62	56	51	61	55	51	60	55	51	59	54	51
9	69	59	52	47	68	58	52	47	57	51	47	56	51	47	55	50	47
10	66	55	48	44	64	54	48	44	53	48	44	52	47	43	52	47	43

LF6LEDG4 6LFLED7G4 30K Test No. 8453 2673996-08

Test No. 8453 2673996-08
Tested at 25°C Ambient in accordance to IESNA LM-79-2008

PHOTOMETRIC DATA

LiteFrame - 6" LF6LEDG4 Downlight

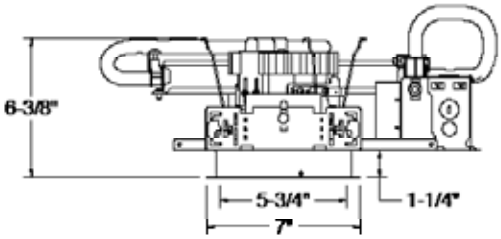
Dimming Compatibility Table

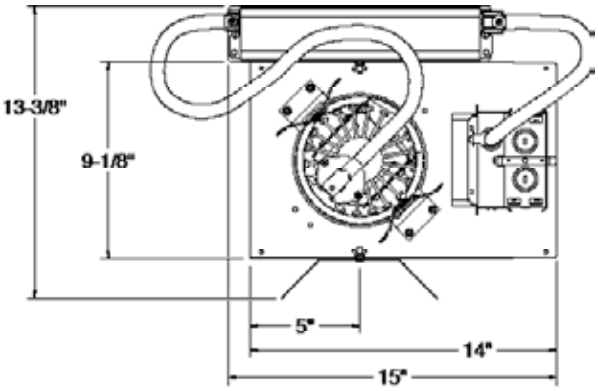
Dimming Ballast	Manufacturer	Web Link
DM/DM1	Lutron DVTV	http://bit.ly/11jSvZg
DM/DM1	Leviton AWRMG-7xx, AWSMG-7xx, AWSMT-7xx	http://bit.ly/1BJn2R9
HDM	Lutron	http://bit.ly/1vtjHAl
2DM	Lutron	http://bit.ly/1nF4Zp1

DMX

See instruction sheet on www.prescolite.com for connection & installation information.
Other useful links: http://www.eldoled.com/led-drivers/powerdrive/50-watt/ac-561s/

EM/EMR DIMENSIONS





Central Inverters

For fixture full light output in back-up mode, Prescolite and Dual-lite have jointly tested the LiteFrame LED with the 100 (LG1) and 250 (LG2) VA LiteGear inverters. (Note: Not for use with integral EM option). For more information on LiteGear go to www.dual-lite.com/resources/litegear_luminaire_loading_chart/

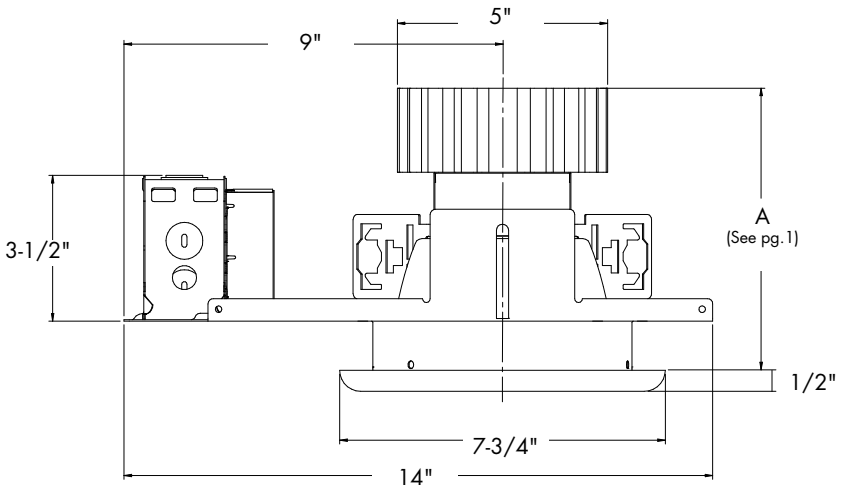
NOTES:
When ordering a sloped ceiling adapter, specify the degree of slope in 5° increments, max. of 35°. For a more precise degree or wet ceiling applications, please contact factory. Sloped ceiling adapter and housing must be installed at the same time.

prescolite
Web: **www.prescolite.com** • Tech Support: **(888) 777-4832**
701 Millennium Boulevard • Greenville, SC 29607 U.S.A. • Phone (864) 678-1000

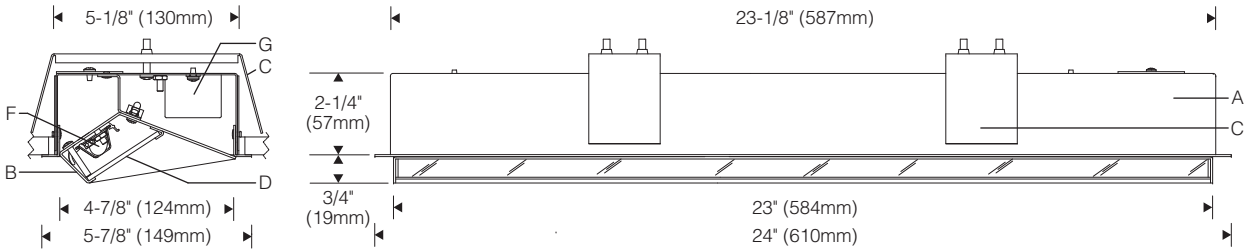
HUBBELL® Lighting, Inc.

PHOTOMETRIC DATA

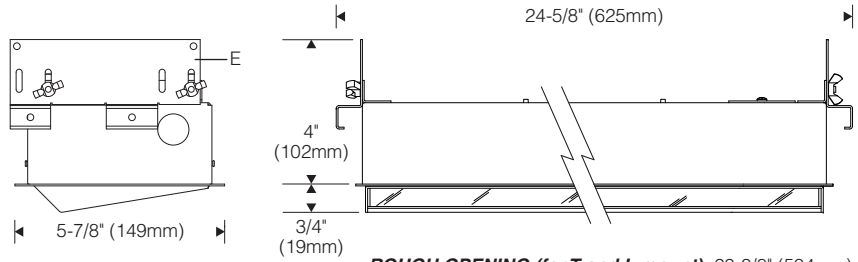
NCT
Non-Conductive Trim. Standard with Solite lens.



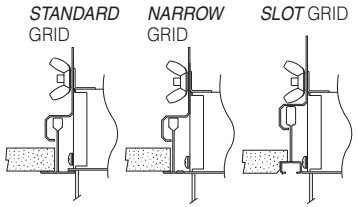
T Mount: Non-accessible Ceiling 1:8 Scale



L Mount: Accessible Grid Ceiling 1:8 Scale



Ceiling Compatibility



ROUGH OPENING (for T and L mount): 23-3/8" (594mm) x 5-3/8" (137mm)

Specifications

A Aluminum back box/ trim frame

B Removable aluminum heat sink/housing

C Wing mounting bracket (non-accessible ceiling)

D Acrylic lens with elliptical diffusion

E Adjustable hanger clamps, grid ceiling (**L** mount)

F Field serviceable light engine with **fraqtir™** asymmetric optic

G Integral constant current driver

Optical Assembly:

Formed aluminum housing, back box and trim frame; stainless steel hardware and spring mounting clips. Extruded aluminum heat sink, light engine with precision molded asymmetric light bar of high temperature, water-clear acrylic. Light engine may be removed for service or upgrade. Acrylic lens with elliptical diffusion maximizes lateral distribution without disturbing asymmetric forward throw.

Finish:

Housing, back box and trim frame finished in choice of matte or semigloss white. Painted surfaces – 6 stage pretreatment and electrostatically applied thermoset polyester powder coating for a durable abrasion, fade and corrosion resistant finish.

Electrical:

Use 90°C wire for supply connections. Integral electronic HPF constant current driver with quick connector. For complete driver specifications, see website, reference document MA-1303. Access plate on top of back box with two 1/2" knockouts for supply wiring. Internal splice compartment allows for access to splices below ceiling.

Mounting:

Luminaire installs from below finished ceiling – up to 1-1/2" (38mm) thick.

T mount provided with overlapping trim and spring clips for gypsum board/inaccessible ceilings.

L mount provided with overlapping trim and adjustable brackets for T-bar grid/accessible ceilings. Supplemental support wires, bar hangers, etc. (by others) required for accessible ceilings.

Standard:

UL listed or CSA certified for dry locations.
Suitable for insulated ceilings (Type IC).
5 year warranty, maximum ambient temperature 45°C (113°F).

DLC for interior wall washing only.

Features

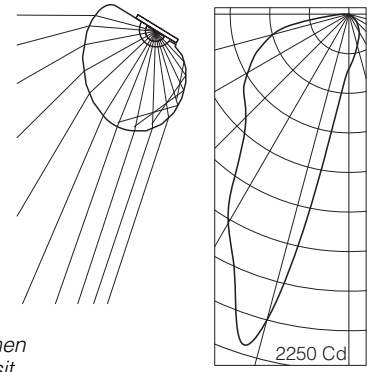
- *Low profile – minimal silhouette focuses attention on the luminous wall, not the luminaire*
- *Shallow recessed depth – fits under ducts at core walls*
- *48W input, output comparable to 80W CFL*
- *Compatible with lay-in or drywall ceilings*

SW 14.0

Performance

fraqtir *technology uses a combination of refraction and total internal reflection, creating a distribution of light ideal for illuminating surfaces uniformly. Glare is minimized while light delivered to the target is maximized, resulting in high application efficiency.*

For photometric and lumen maintenance reports, visit ***thelightingquotient.com***



L90(10k) > 60,000 hrs
@ 25°C per TM-21

 U.S. Patent 8,465,190; foreign patents pending

elliptipar® with fraqtir™ LED

To Order

Style S224

To form a Catalog Number

S 2 2 4 - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ]

1 2 3 4 5 6 7 8 9 10

Project: _____

Type: _____

1 Source

S = Solid state (LED)

2 Style

224 = Low profile semi-recessed 6" x 24", integral driver

3 Drive Current/Light Output

L021 = 21 LEDs @ 350mA (1488 lumens, 24W)

M021 = 21 LEDs @ 700mA (2711 lumens, 48W)

Based on 3000K/80+ CRI. **Click here** for scaled performance table.

Note: J and K codes are discontinued.

4 Mounting

T = Overlapping flange with spring clips for gypsum board ceiling

L = Overlapping flange with adjustable mounting brackets for accessible ceiling

5 Finish

SW 14.1

02 = Semigloss white

22 = Matte white

99 = Custom RAL or computer matched color to be specified; consult sales representative

6 Voltage/Driver

Electronic Driver	*Electronic Dimming Driver**
8 = 120-277V	**M** = 120-277V

*Dimming range refers to % power input, % light output will vary.

Refer to Driver Information document MA-1303

7 Option

00 = No options

0B = Vertical blade baffle, 25° shielding, matte gray finish, indoor use

0C = Modified to comply with Chicago plenum code

0M = For use in MRI medical facility (**L** mount only). MRI filters (by others) required on output of each remote driver. Consult factory prior to specification.

XX = For modification not listed, include detailed description. Consult factory prior to specification.

8 Destination Requirement

0 = UL listed or CSA certified for U.S.

J = UL listed or CSA certified for Canada

9 Color Temperature

27 = 2700K, 80+ CRI

30 = 3000K, 80+ CRI

35 = 3500K, 80+ CRI

40 = 4000K, 80+ CRI

2H = 2700K, 90+ CRI

3H = 3000K, 90+ CRI

4L = 4000K, 70+ CRI

Note: Additional CCT and CRI options are available; consult factory.

10 Dimming**

00 = Non-dimming

TE = LighTech 120-277V input, dimming range 100-10%, line voltage trailing edge/reverse phase/ELV dimming (controls by others)

ZX = 0-10V analog dimming 120-277V input, dimming range 100%-5%, 0-10V controls by others

EL = eldoLED SOLOdrive 120-277V input, dimming range 100%-0.1%, 0-10V controls by others
Note: EL is **not** suitable for MRI use (**0M** option).

REMOTE DRIVER Options:

L3 = Lutron A-Series 120-277V input, dimming range 100%-1%, Lutron EcoBus dimming (controls by others)

LH = Lutron A-Series 120-277V input, dimming range 100%-1%, Lutron 3-wire dimming (controls by others)

**Dimming range refers to % power input, % light output will vary.

Refer to Driver Information document MA-1303

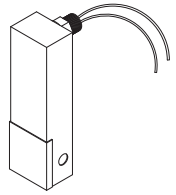
Example

S224-M021-T-02-M-00-0-27-ZX

Low profile indoor LED, wall wash luminaire with overlapping trim, formed aluminum housing and trim frame. Semigloss white. **fraqtir** light engine with (21) LEDs. Integral 120-277V, 700mA analog dimming driver compatible with 0-10V dimming controls by others, dims to 5% power (@120V), UL listed or CSA certified for U.S., Type IC, dry location. 2700K/80+ CRI.

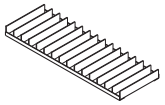
Accessories

Order separately. See Accessories Section for specifications.

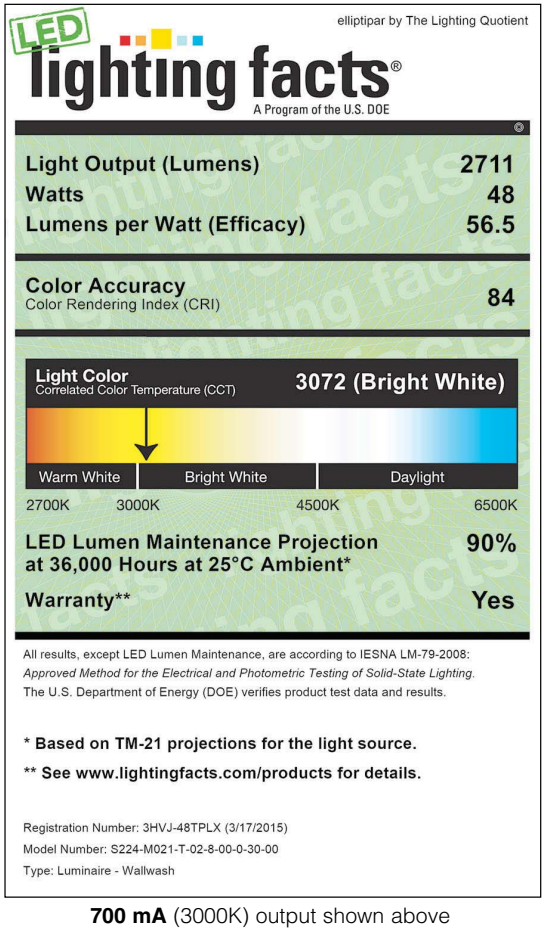


AMR02050 = Accessory Magnetic Resonance imaging filter. 2 conductor up to 5 amps, attenuation > 100dB (5MHz to 10GHz)

Note: one filter required per remote driver – consult factory for number of drivers required per luminaire.



AELV2000 = Vertical blade **baffle** for 24" S224, 25° shielding, matte gray finish, indoor use



700 mA (3000K) output shown above

elliptipar® with fraqtir™ LED

elliptipar *from* **The Lighting Quotient**
114 Boston Post Road, West Haven, Connecticut 06516, USA
Voice 203.931.4455 • Fax 203.931.4464 • **thelightingquotient.com**

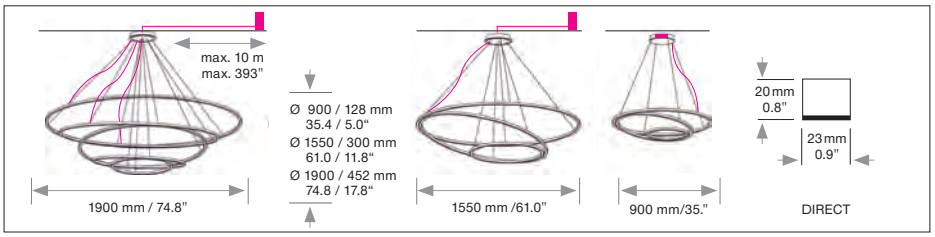
SATTLER

North-American Version

TOCCATA

Housing: Pendant light with direct light distribution, 3/ 5 parts aluminum profile, with integrated acrylic cover.

Design: MARKUS BISCHOF



	Size: L x W x H mm	inches	LED Watt	Lumen [1]	Weight kg [2] / lbs [2]	Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
Sizes	**Ø 900 mm**	**35.4"**	85	7.375	8.0 / 17.6	**777.**	x x.	x x.	x x.	x x.	x x x.	x
	Ø 1550 mm	**61.0"**	147	12.745	11.0 / 24.2	**771.**	x x.	x x.	x x.	x x.	x x x.	x
	Ø 1900 mm	**74.8"**	256	22.140	14.0 / 30.8	**773.**	x x.	x x.	x x.	x x.	x x x.	x
	LED	**Warm-white**	**3000 K**		**(Standard)**	x x x.	**63.**	x x.	x x.	x x.	x x x.	x
		Neutral-white	**4000 K**		(Optional)	x x x.	**69.**	x x.	x x.	x x.	x x x.	x
		Extra warm-white	**2700 K**		(Optional)	x x x.	**61.**	x x.	x x.	x x.	x x x.	x
Dimming		**Dimmable 0 - 10 V**			**(Standard)**	x x x.	x x.	**51. 00.**		x x.	x x x.	x
		DMX			(Optional)	x x x.	x x.	**31. 00.**		x x.	x x x.	x
		LUTRON (contact factory)			(Optional)	x x x.	x x.	**71. 00.**		x x.	x x x.	x
Finishes						x x x.	x x.	x x.	x x.	. .	x x x.	x
(Standard)	**11** white	(Optional)	**22** aluminum polished	**27** brush-finished aluminum	**30** anthracite	**32** crocodile black	**33** sand silver fine textured					
			35 gold	**36** brass	**37** bronze fine textured	**38** copper	**10** black fine textured					
						XX Custom finish						
Power Supply Cable (Standard)	**Z 70** Silver					x x x.	x x.	x x.	x x.	x x.	**Z70.**	x

1) The stated lumen output of the lights is without considering the acrylic covers or reflectors
2) Weight of lights without remote technical unit or canopy

IP 20

Light distribution direct

Conforms to UL-STD 1598
Certified to CSA-STD C22.2
No.250.0-08

www.sattler-lighting.com

- Custom sizes • Individual finishes
- Project-specific electrical adjustments

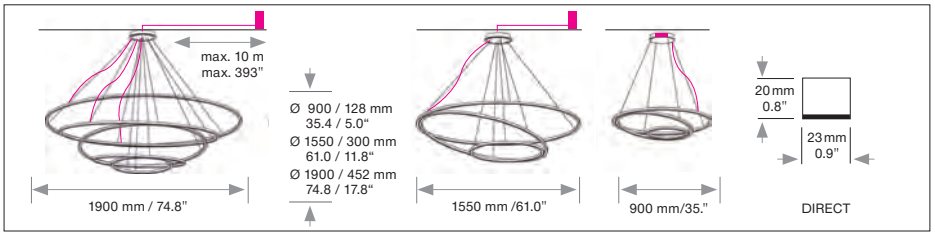
SATTLER

North-American Version

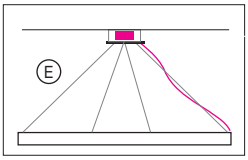
TOCCATA

Housing: Pendant light with direct light distribution, 3/ 5 parts aluminum profile, with integrated acrylic cover.

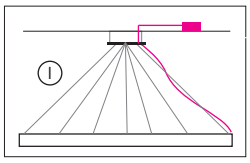
Design: MARKUS BISCHOF



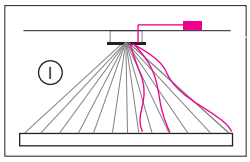
Mounting Version



Ø 900 mm / 35.4"
4 suspensions through canopy
with 1 external power supply unit
in canopy **(Standard)**



Ø 1550 mm / 61.0"
7 suspensions through canopy and
1 power supply cable
with external power supply unit in
suspended ceiling **(Standard)**



Ø 1900 mm / 61.0"
14 suspensions through canopy and
3 power supply cables
with external power supply unit in
suspended ceiling **(Standard)**

Item No.	LED	Dimming	Finishes	Power Supply cable	Mounting Version
x x x.	x x.	x x. x x.	x x.	x x x.	**E**
x x x.	x x.	x x. x x.	x x.	x x x.	**I**

I = Distance of external power supply unit to light fixture max. 10m / 394".

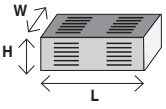
E = Power supply unit in canopy: Max. suspension height approx. 2.0 times diameter of light.
Min. suspension height approx. 0,5 times diameter of light.

Mounting versions with steel cable length 5 m / 197" and power supply cable transparent, length 10 m / 394"

x x x.	x x.	x x. x x.	x x.	**Z70.**	x

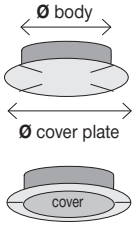
Complete order number

Dimensions of external power supply units



Typ	Size mm / inch L	W	H	For use with Mounting Version
DE 2F	360 x 300 x	85 mm / 14.7 x 11.8 x 3.3"		**Ø 1550** **I**
DE 3F	360 x 400 x	85 mm / 14.7 x 15.7 x 3.3"		**Ø 1900** **I**

Dimensions of canopies



Typ	Size mm / inch Ø cover plate / body	For use with Mounting Version
DB 350	Ø 350 / 320 mm / 13.7 x 12.5"	**Ø 900** **E**
DB 230S	Ø 230 / 210mm / 9.0 x 8.3"	**Ø 1550 / 1900** **I**

Canopy finish: white (11), Cover (22) aluminum polished

contact factory for other finishes

USA/Canada: Canopy mounts to 4" octagonal junction box.

Input voltage for all external power supply units and canopies is **120 / 277 VAC 50 / 60 Hz**

1) The stated lumen output of the lights is without considering the acrylic covers or reflectors
2) Weight of lights without remote technical unit or canopy

IP 20

Light distribution direct

Conforms to UL-STD 1598
Certified to CSA-STD C22.2
No.250.0-08

www.sattler-lighting.com

- Custom sizes • Individual finishes
- Project-specific electrical adjustments

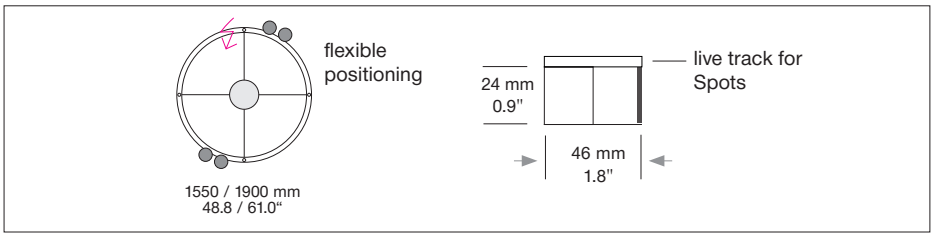
technical specifications

Light Tape® Physical Specifications	
Thickness (varies depending on color)	0.010 to 0.020 inches / 0.254 to 0.305 millimeters
Protective Encapsulation Seal	¼" on each side (+/-1/16" of an inch, +/- 0.159 cm)
Light Tape® Illuminated Width	0.25 to 33 inches / 0.625 to 90 cm
Illumination Coverage	Infinite, can be tiled without a break in light
Power System	
Light Tape® Load	Capacitive Load
Phase Angle	78° Leading Edge
Light Tape® Power Consumption by Area	0.016 watts per in^2 / 0.106 watts per cm^2
Light Tape® Amperage Consumption by Area**	0.19 milliamps per in^2 / 1.23 milliamps per cm^2
Light Tape® Watts per Linear Meter at 2.54 cm wide	0.4 to 1.1 watts based on low to full brightness dimming
Light Tape® Watts per Square Meter	0.21 to 0.53 watts based on low to full brightness dimming
Light Tape® Output Voltage (dimmable)	250 Volts AC, +/- 50 Volts AC
Light Tape® Operating Frequency	800 Hertz, +/- 300 Hertz (depending on tuning)
AC Driver Input Voltage Range	90 to 260 Volts AC
DC Driver Input Voltage Range	3 to 24 Volts DC (12 Volts DC standard)
Power Source	ELLC Smart Driver™ Power Supplies
Controllable	Dimming, 0 to 10 Volts DC and DMX 512 Capable
Light Tape® Performance	
Useful Life - Hours	20,000 hours to excess of 40,000 hours
Useful Life - Years	up to 20 years (dependent on drive parameters)
Average Brightness	125 cd/m^2
Brightness Range	0 to 200 cd/m^2
Brightness Differential - Completely Uniform	+/- 1 cd/m^2, independent of total surface area
Operating Temperature - Ambient	-40°C to +65°C
Heat Gain During Operation	Does not produce heat during operation
Compressive Strength - Ground Pressure	500 psi or more depending on mounting system
Impact Strength - Izod (73F)	6.5 ft-lbs/in^2
Flexural Strength	700 >15,000 cycles ASTM D2176
Flexibility - Wrap Angle	Contours around 6 millimeter diameter object
Punctureable	Yes, will illuminate after puncturing
Maximum Processing Temperature	350°F / 177°C (depending on residence time)
Health and Safety	
Safety Features	Overload and short circuit protection. UL listed.
UL Certifications	File number E319670, 2006/95/EC
CE Certification	EC-Attestation of conformity – No.0704 63147 001
Low Voltage Directive	Compliant
Environmental Compliance	ROHS and WEES Directive
EMC Emissions Compliant	EN55015 (CISPR15) Radiated and Conducted Emission

OCULI

Housing: Circular aluminum profile with integrated cover on the inside and live track on top for flexible positioning of spots

Design: SATTLER



	Size: Ø mm	inches	LED Watt	Lumen [1]	weight kg [2] / lbs [2]	Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
Sizes												
	Ø 1550 mm	**48,8“**	88	9.200	12.0 / 26.4	**955.**	x x.	x x.	x x.	x x.	x x x.	x
	Ø 1900 mm	**61.0“**	108	11.300	13.0 / 28.6	**956.**	x x.	x x.	x x.	x x.	x x x.	x

					Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
LED 24V CRI > 90	LED	**Warm-white**	**3000 K**	**(Standard)**	x x x.	**63.**	x x.	x x.	x x.	x x x.	x
		Neutral-white	**4000 K**	(Optional)	x x x.	**69.**	x x.	x x.	x x.	x x x.	x
		Extra warm-white	**2700 K**	(Optional)	x x x.	**61.**	x x.	x x.	x x.	x x x.	x

					Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
Dimming		**Without Dimmer**		**(Standard)**	x x x.	x x.	**01.**	**00.**	x x.	x x x.	x
		DMX		(Optional)	x x x.	x x.	**31.**	**00.**	x x.	x x x.	x
		Dimmable 1 - 10 V		(Optional)	x x x.	x x.	**41.**	**00.**	x x.	x x x.	x
		Dimmable 0 - 10 V		(Optional)	x x x.	x x.	**51.**	**00.**	x x.	x x x.	x
		Dimmable DALI		(Optional)	x x x.	x x.	**61.**	**00.**	x x.	x x x.	x

					Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
Finishes											
(Standard)	**11** white	(Optional)	**22** aluminum polished	**27** brush-finished aluminum	x x x.	x x.	x x.	x x.	. .	x x x.	x

					Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
Power Supply Cable											
(Standard)	**Z 70** Silver	(Optional)	**Z 71** white	**Z 72** grey	**Z 73** black						
			Z 74 orange	**Z 75** red	**Z 76** green	x x x.	x x.	x x.	x x.	x x.	. . .	x

Handcrafted in Germany, certified quality

IP 20 Protective rating

Light distribution direct /

III Protection class III: only suitable for very low voltag supply (<50V)

F Luminaires are suitable for mounting on ordinary flammable materials, which have an inflammation point of at least 200° C. / 392° F.

www.sattler-lighting.com

- Custom sizes • Individual finishes
- Project-specific electrical adjustments

Technical data is subject to change. Errors and omissions excepted

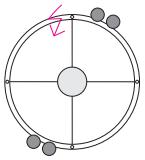
1) The stated lumen output of the lights is without considering the acrylic covers or reflectors

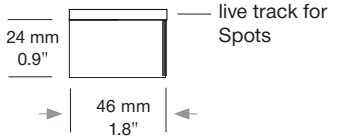
2) Weight of lights without remote technical unit or canopy 3) Not available in USA and Canada

OCULI

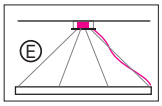
Housing: Circular aluminum profile with integrated cover on the inside and live track on top for flexible positioning of spots

Design: SATTLER

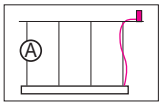




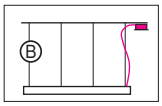
Mounting Version



suspension through canopy **(Standard)**



4 point suspension with external power supply unit in suspended ceiling (Optional)



4 point suspension with external power supply unit in separate canopy (Optional)

Item No.	LED	Dimming		Finishes	Power Supply cable	Mounting Version
x x x.	x x.	x x.	x x.	x x.	x x x.	E
x x x.	x x.	x x.	x x.	x x.	x x x.	A
x x x.	x x.	x x.	x x.	x x.	x x x.	B

A, B = Distance of external power supply unit to light fixture max. 10m / 394“.

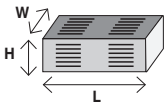
E = Power supply unit in canopy Max. suspension height approx. 2.0 times diameter of light.

Mounting versions with steel cable length 3000mm / 118“ and power supply cable, length 3000mm / 118“

x x x.	x x.	x x.	x x.	x x.	x x x.	x

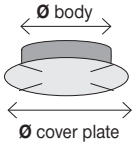
Complete order number

Dimensions of external power supply units



Typ	Size mm / inch L	W	H	For use with Mounting Version
DE 2F	360 x 300 x	85 mm / 14.7 x 11.8 x 3.3“		**A**

Dimensions of canopies



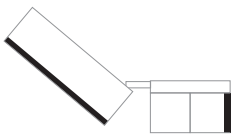
Typ	Size mm / inch Ø cover plate / body	For use with Mounting Version
DB 350	Ø 350 / 320 mm / 13.7 x 12.5“	**E, B**

Canopy finish: white (11) contact factory for other finishes

USA/Canada: Canopy mounts to 4“ octagonal junction box.

Input voltage for all external power supply units and canopies is **90-264 VAC 47-63 Hz**

Optional



LED SPOT CRI 95
12 V, 15 W, for live track, maximum wattage per light 110W.
Light color matches light fixture. Beam angle 9°, 25°, 36°, 60°.
Light fixture and spots separately switchable. If ordered with dimmer, spots dimmable too. (order separately)

960. 68. 01. 00. 11. (white)
960. 68. 01. 00. 22. (alumimium polished)

Bluetooth 4.0 CASAMBI remote control through app **997. 00. 00. 00. 00.**

ENOCEAN wireless push button
(single version - one control unit per light) **998. 00. 00. 00. 00.**

Handcrafted in Germany, certified quality

Conforms to UL-STD 1598 Certified to CSA-STD C22.2 No.250.0-08

IP 20 Protective rating

Light distribution direct / indirect

Protection class III: only suitable for very low voltag supply (<50V)

F Luminaires are suitable for mounting on ordinary flammable materials, which have an inflammation point of at least 200° C. / 392° F.

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2) Weight of lights without remote technical unit or canopy 3) Not available in USA and Canada

Specification Sheet

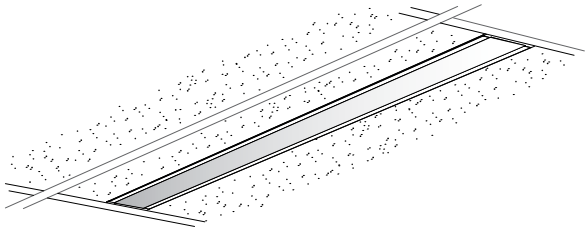
lumenline™ 2

RECESSED T-BAR

Client _____ **Project name** _____

Order# _____ **Type** _____ **Qty** _____

FEATURES AND BENEFITS



Physical :

- Aluminum extruded housing, 2" wide
- Available in 2', 4', 6' or 8' sections
- Durable polyester powder coat finish for flanges
- Standard and Tegular tile, centered or against tee mounting options available
- Easy installation
- Extruded acrylic lens
- Illuminated corners available for custom configurations, consult factory for availability and orders
- Tool-less system for reflector assembly and control gear access
- Suitable for use with grid and metal pan ceilings
- Compatible with motion sensors
- CCEA option available
- Dry location only

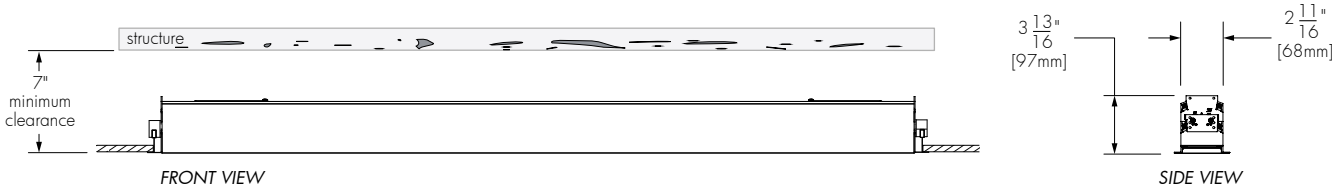
Performance :

- Available in 2700K, 3000K, 3500K, 4000K or RGB color mixing
- 87 lumens per watt (delivered, RO 4000K)
- CRI value: 80+
- Binning within a 3 step MacAdam ellipse
- Lumen maintenance: 100,000 hrs [L70 @ 25° C]
- Lumen measurements comply with LM - 79 - 08 standard
- Resolution per foot or per fixture (configured with LumenID V3 software & RDM)
- Operating temperatures: -25° C to 50° C [-13F to 122F]

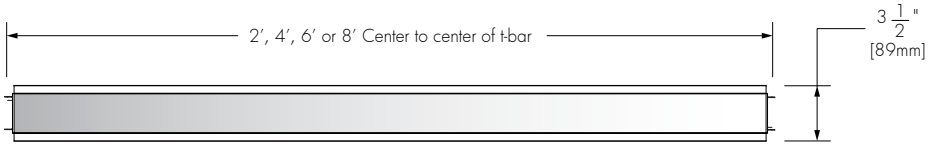
Lumens / 4ft	RO	HO
2700K	1831	3466
3000K	1871	3541
3500K	1910	3615
4000K	1969	3727
RGB	407	N/A

Electrical :

- Line voltage luminaire for 100 to 277V
- 6W/ft Regular Output version
- 12W/ft High Output version
- Dimming options for white light: 0-10 volt, DMX/RDM enabled, DALI, Lumentalk or Lutron® EcoSystem® enabled
- 6W/ft optional RGB source, DMX/RDM enabled



FRONT VIEW *SIDE VIEW*



BOTTOM VIEW

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www.lumenpulse.com

5-year limited warranty.

Consult www.lumenpulse.com for our complete Standard Terms and Conditions of Sales.

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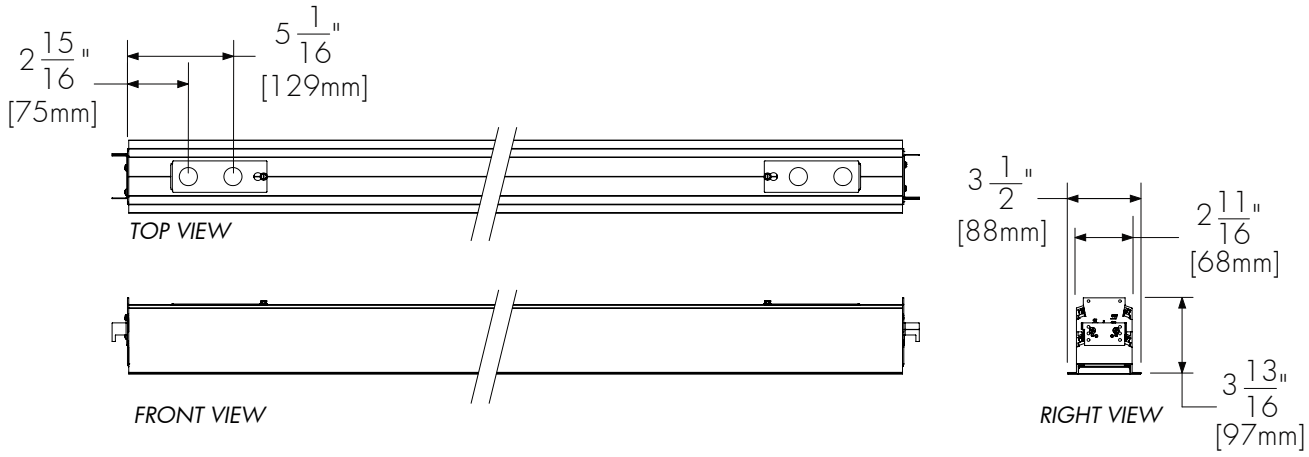
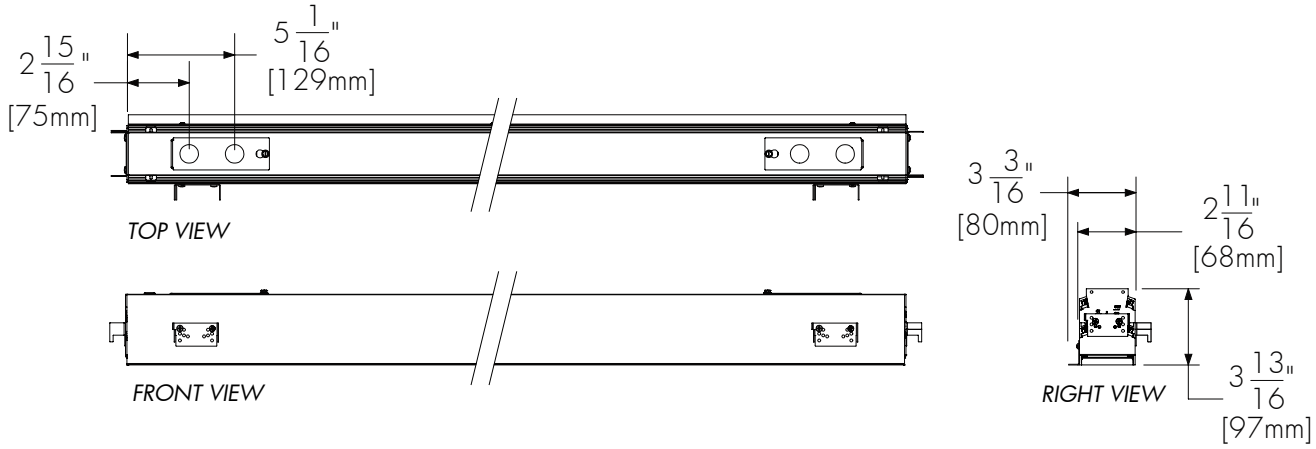
TYPICAL LUMENLINE RECESSED T-BAR DETAIL - CENTERED IN TILE



TYPICAL LUMENLINE RECESSED T-BAR DETAIL - AGAINST TEE



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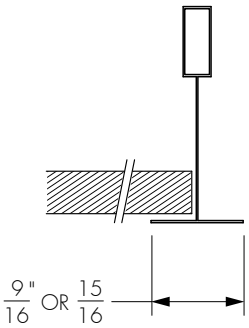
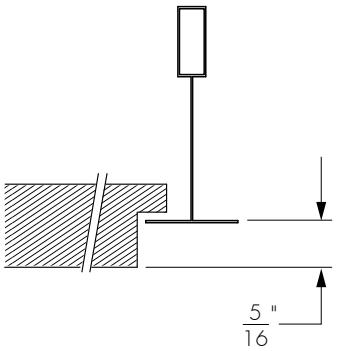
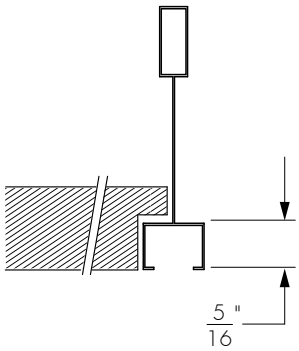
TILE TYPES



STANDARD TILE

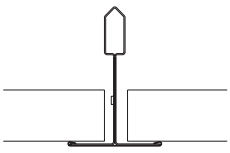


TEGULAR TILE

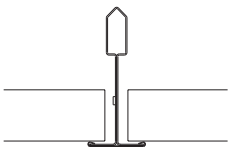


TEGULAR TILE SCREW SLOT TEE

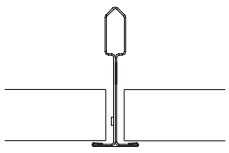
TYPICAL TEES FOR STANDARD TILES - BRAND NAMES



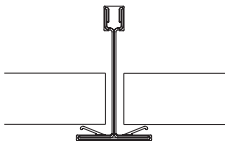
PRELUDE® 15/16"



PRELUDE® 9/16"

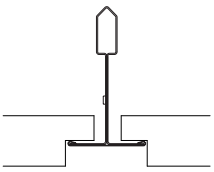


SUPRAFINE® 9/16"

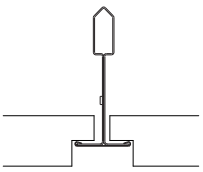


CLEAN ROOM® 15/16"

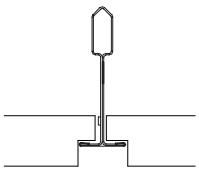
TYPICAL TEES FOR TEGULAR TILES - BRAND NAMES



PRELUDE® 15/16"



PRELUDE® 9/16"



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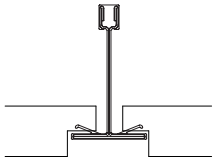
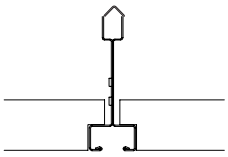
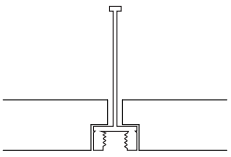


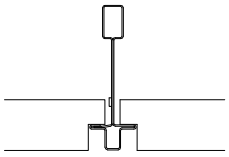
CLEAN ROOM® 15/16"



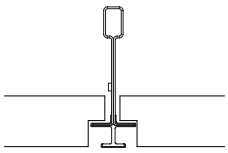
SILHOUETTE 1/4 REVEAL® & SILHOUETTE 1/8 REVEAL®



TRIMLOCK®



INTERLUDE®



SONATA®

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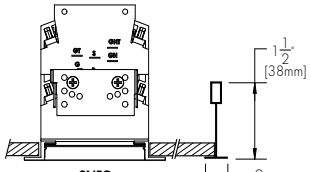
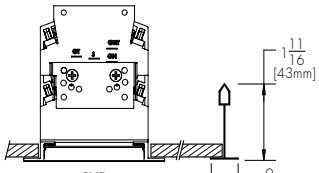
TEE TYPES - OVERVIEW TABLE

STANDARD TILE

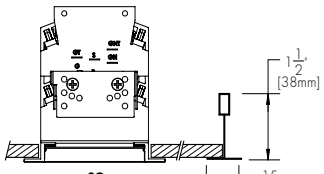
CENTERED IN TILE



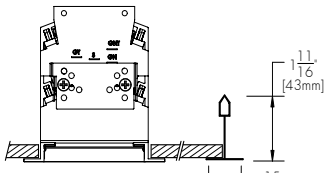
SNFG
NFG t-bar type
Standard tile
Centered



SNF
NF t-bar type
Standard tile
Centered

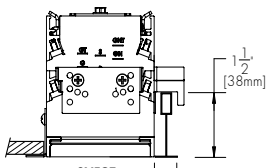


SG
G t-bar type
Standard tile
Centered

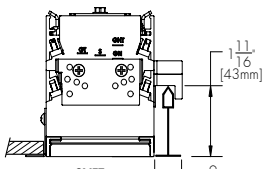


SGN
GN t-bar type
Standard tile
Centered

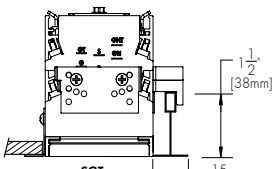
AGAINST TEE



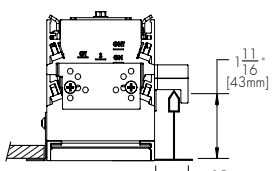
SNFGT
NFG t-bar type
Standard tile
Against tee



SNFT
NF t-bar type
Standard tile
Against tee



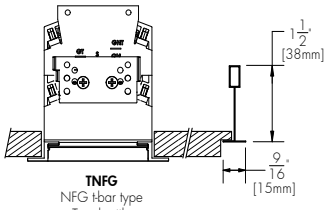
SGT
G t-bar type
Standard tile
Against tee



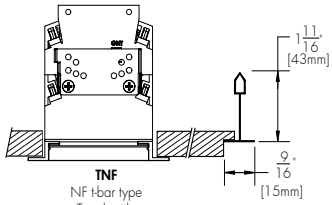
SGNT
GN t-bar type
Standard tile
Against tee

TEGULAR TILE

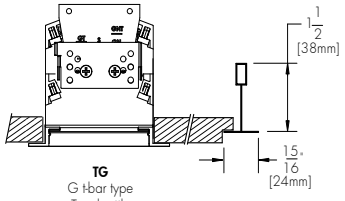
CENTERED IN TILE



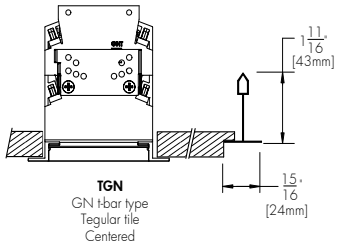
TNFG
NFG t-bar type
Tegular tile
Centered



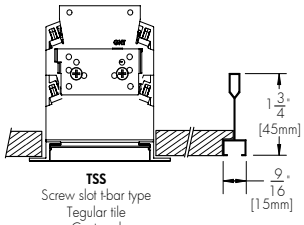
TNF
NF t-bar type
Tegular tile
Centered



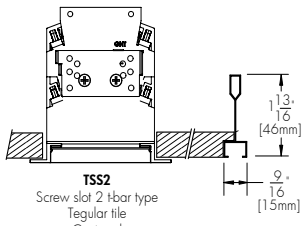
TG
G t-bar type
Tegular tile
Centered



TGN
GN t-bar type
Tegular tile
Centered

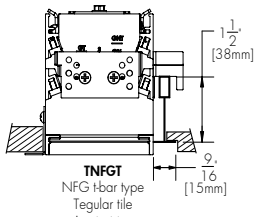


TSS
Screw slot t-bar type
Tegular tile
Centered

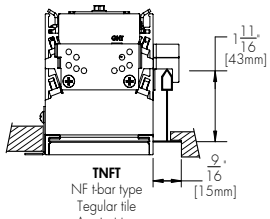


TSS2
Screw slot 2 t-bar type
Tegular tile
Centered

AGAINST TEE



TNFGT
NFG t-bar type
Tegular tile
Against tee



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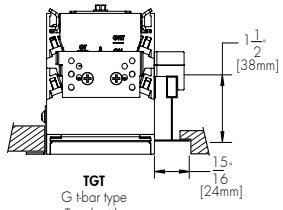
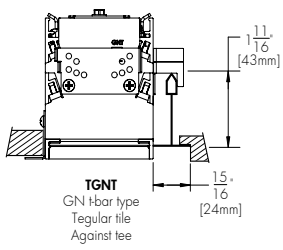
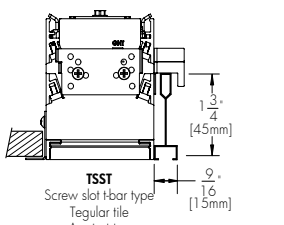
Tegular tile
Against tee



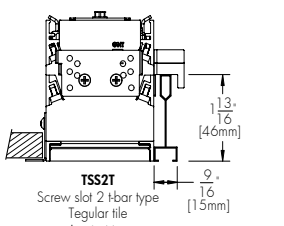
TGT
G t-bar type
Tegular tile
Against tee



TGNT
GN t-bar type
Tegular tile
Against tee



TSST
Screw slot t-bar type
Tegular tile
Against tee



TSS2T
Screw slot 2 t-bar type
Tegular tile
Against tee

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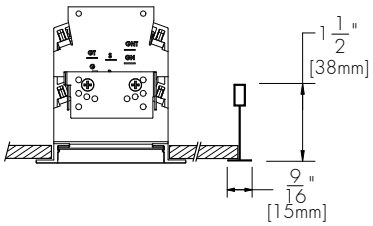
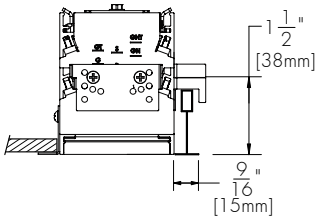
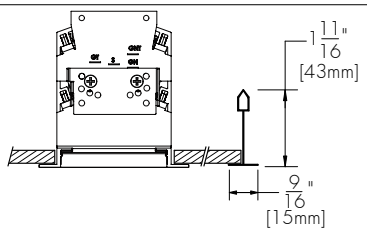
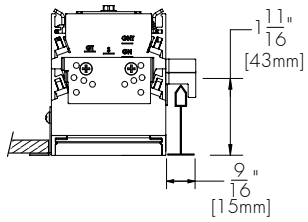
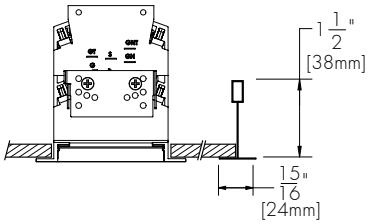
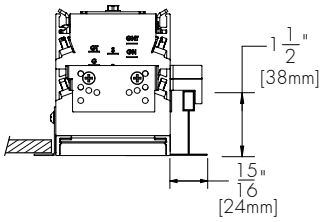
TEE TYPES ORDERING CODE - REFERENCE TABLE

TEE TYPE ORDERING CODE	SIDE VIEW TEE DIMENSIONS	TYLE TYPE	FIXTURE POSITION IN TILE	TYPICAL TBAR CEILING BRAND NAMES
SNFG		Standard	Centered	USG© Centricitee® DXT™ & USG© Centricitee® DXLT ™
SNFGT		Standard	Against tee	USG© Centricitee® DXT™ USG© Centricitee® DXLT ™
SNF		Standard	Centered	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Suprafine® XL & HRC Armstrong© Suprafine® ML Armstrong© 360 paint®
SNFT		Standard	Against tee	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Suprafine® XL & XL HRC Armstrong© Suprafine® ML Armstrong© 360 paint®
SG		Standard	Centered	Armstrong© AL Prelude® +XL Armstrong© SS Prelude® +XL Armstrong© Prelude® ML USG© AX™ & AXCE™ USG© DXSS™ USG© Drywall flat ceiling DGL
SGT		Standard	Against tee	Armstrong© AL Prelude® +XL Armstrong© SS Prelude® +XL Armstrong© Prelude® ML USG© AX™ & AXCE™ USG© DXSS™ USG© Drywall flat ceiling DGL

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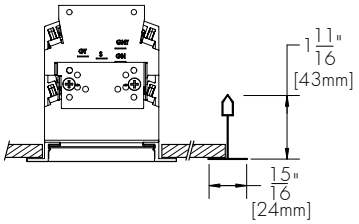
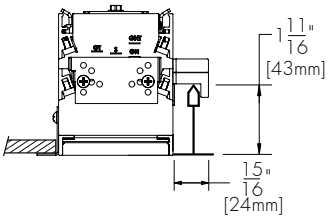
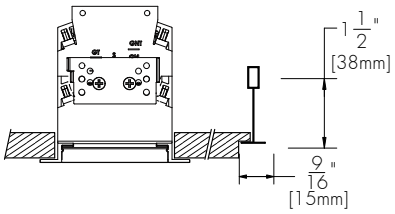
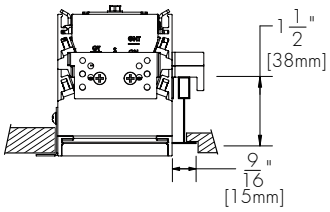
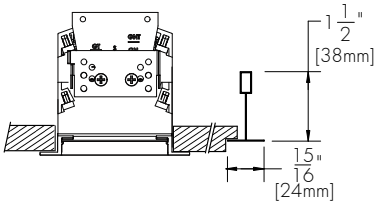
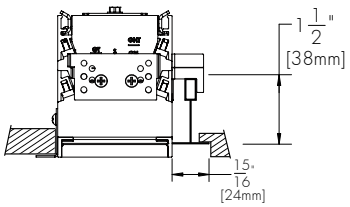
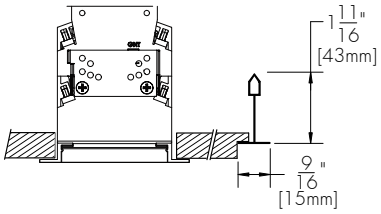
SGN		Standard	Centered	Armstrong© Prelude® XL, XL HRC, Armstrong© Prelude® XL exterior, +XL fire Armstrong© Cleanroom® Armstrong© 360 paint® USG© CE™, DX™ , DXL™ USG© DXLA™, DXACE™, ZXLA™
SGNT		Standard	Against tee	Armstrong© Prelude® XL, XL HRC, Armstrong© Prelude® XL exterior, +XL fire Armstrong© Cleanroom® Armstrong© 360 paint® USG© CE™, DX™ , DXL™ USG© DXLA™, DXACE™, ZXLA™
TNFG		Tegular	Centered	USG© Centricitee® DXT™ USG© Centricitee® DXLT ™
TNFGT		Tegular	Against tee	USG© Centricitee® DXT™ USG© Centricitee® DXLT ™
TG		Tegular	Centered	Armstrong© AL Prelude® +XL Armstrong© SS Prelude® +XL Armstrong© Prelude® ML USG© AX™ USG© AXCE™ USG© DXSS™ USG© Drywall flat ceiling DGL
TGT		Tegular	Against tee	Armstrong© AL Prelude® +XL Armstrong© SS Prelude® +XL Armstrong© Prelude® ML USG© AX™ USG© AXCE™ USG© DXSS™ USG© Drywall flat ceiling DGL
TNG		Tegular	Centered	Armstrong© Prelude® XL, Armstrong© Prelude® XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Suprafine® XL & Armstrong© Suprafine® XL HRC Armstrong© Suprafine® ML Armstrong© 360 paint®

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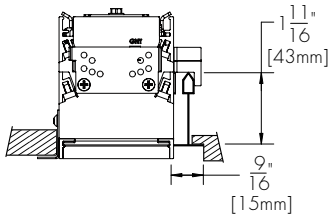
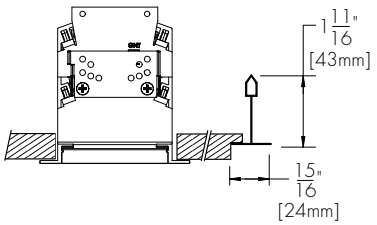
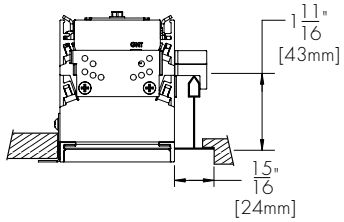
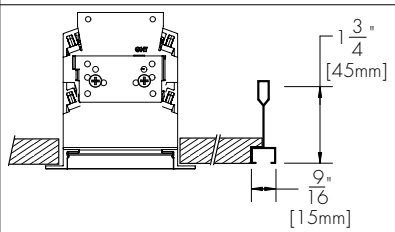
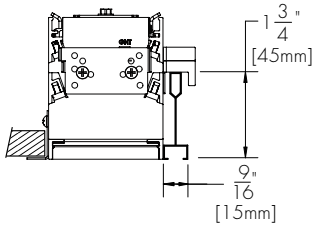
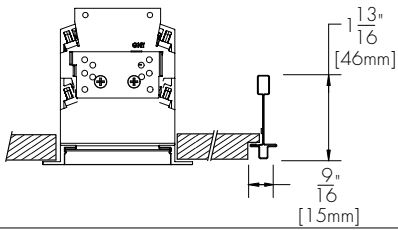
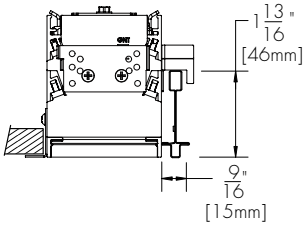
TNFT		Tegular	Against tee	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Suprafine® XL, XL HRC Armstrong© Suprafine® ML Armstrong© 360 paint®
TGN		Tegular	Centered	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Cleanroom® Armstrong© 360 paint®
TGNT		Tegular	Against tee	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Cleanroom® Armstrong© 360 paint®
TSS		Tegular	Centered	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Cleanroom® Armstrong© 360 paint® Armstrong© Silhouette® XL
TSST		Tegular	Against tee	Armstrong© Prelude® XL, XL HRC Armstrong© Prelude® +XL fire Armstrong© Prelude® XL exterior Armstrong© Cleanroom® Armstrong© 360 paint® Armstrong© Silhouette® XL
TSS2		Tegular	Centered	Armstrong© Sonata® XL USG© Indentitee™ DXI
TSS2T		Tegular	Against tee	Armstrong© Sonata® XL USG© Indentitee™ DXI

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ACCESSORIES

Order separately

Control Systems:

LTO2 Lumentouch is a wall mount DMX 512 controller keypad.

LCU Lumencue is a USB / mini SD DMX 512 controller.

LID LumenID is a diagnostic and addressing DMX 512 controller.
It must be specified on all DMX applications.
Refer to LID specification sheet for details.

LTN Lumentone is a simple pre-programmed DMX 512 controller with a push button rotary dial and live feedback.

Control Boxes:

CBX DMX/RDM control box.
Up to six power and data outputs to fixtures or fixture runs.
Ethernet enabled option.
Refer to CBX specification sheet for details.

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RESOLUTION DETAILS

Applicable for DMX/RDM control option only.
Fixture resolution can be configured on-site within the LumenID V3 software.
A DMX/RDM enabled CBX is required.

Resolution per foot: each foot is addressed independently

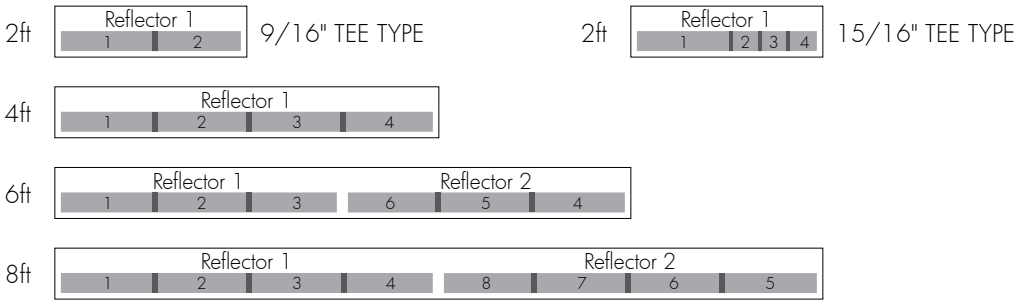
	Single units				
Total number of DMX addresses required per fixture	2ft (9/16" TEE TYPE)	2ft (15/16" TEE TYPE)	4ft	6ft	8ft
WH	2	4	4	6	8
RGB	6	12	12	18	24

Resolution per fixture: each reflector is addressed independently

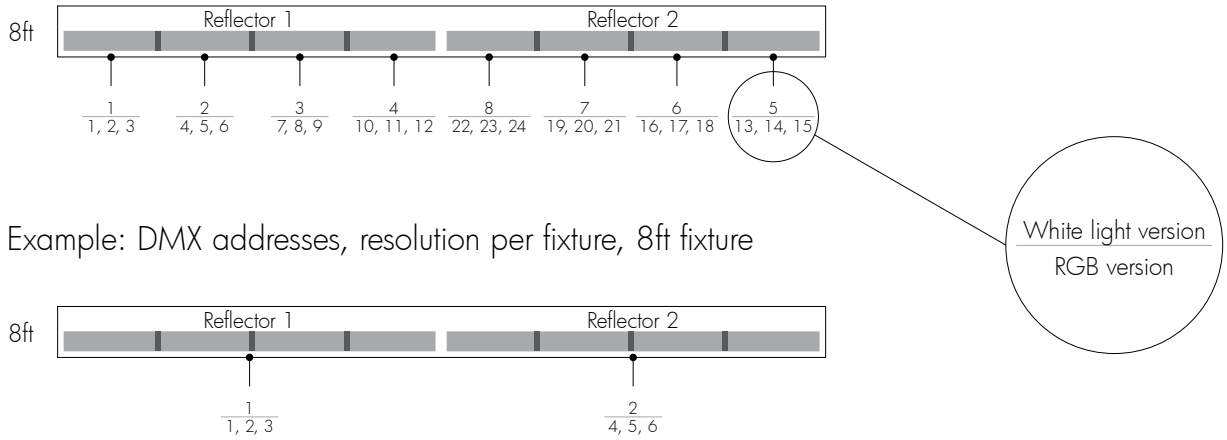
	Single units	
Total number of DMX addresses required per fixture	2ft and 4ft	6ft and 8ft
WH	1	2
RGB	3	6

Board and reflector layout per fixture length

SINGLE UNITS



Example: DMX addresses, resolution per foot, 8ft fixture



Example: DMX addresses, resolution per fixture, 8ft fixture

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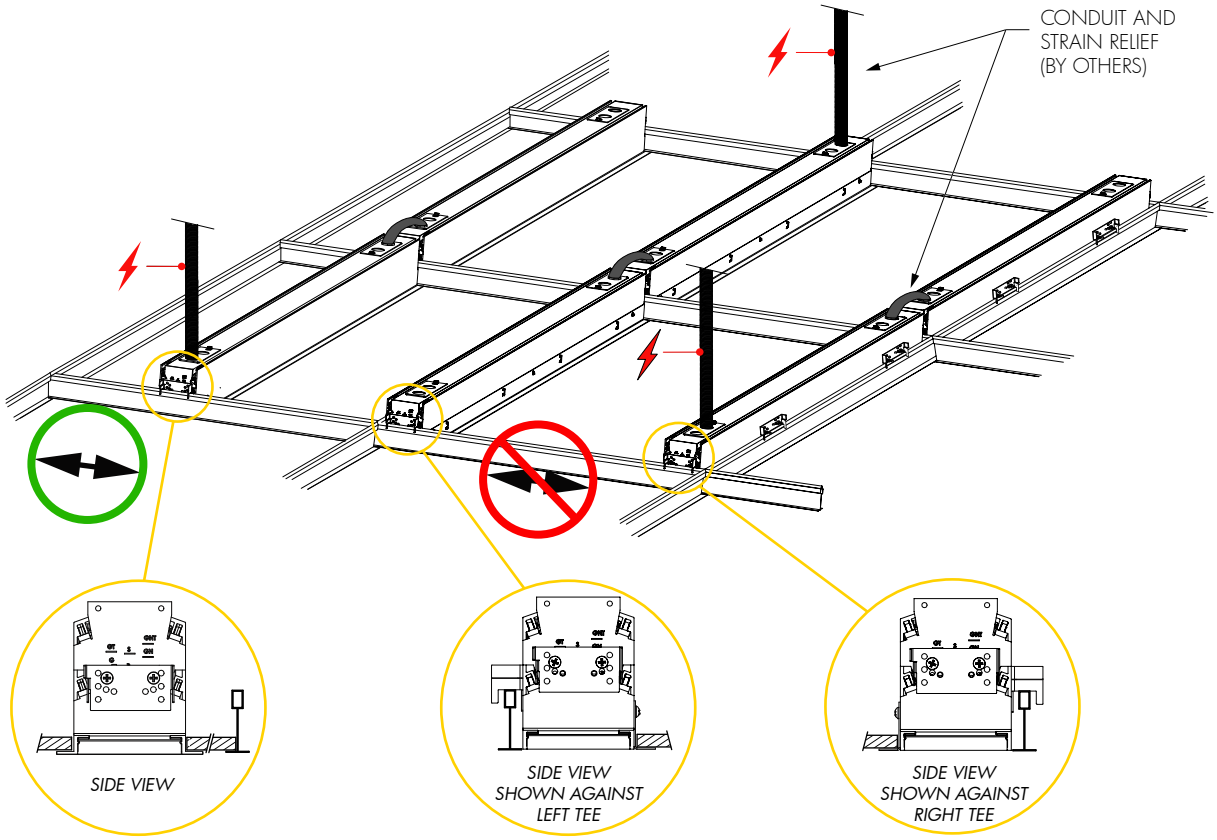
Specification Sheet

lumenline™ 2

RECESSED T-BAR

TYPICAL POSITION DETAIL



CENTERED TILE POSITION

Fixture can be moved onto tee grid
Without extra tee along fixture's length.

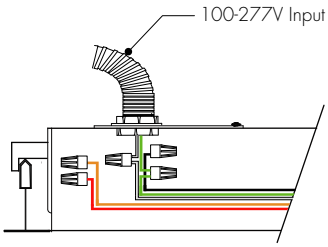
AGAINST TEE POSITION

Fixture position is fixed against tee grid.
Requires only one tee along fixture's length.

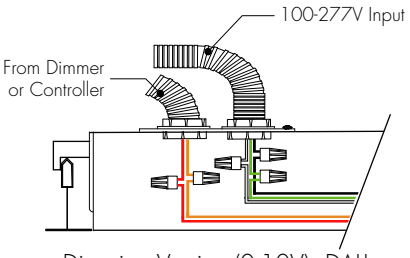
AGAINST TEE POSITION

WIRING DETAIL

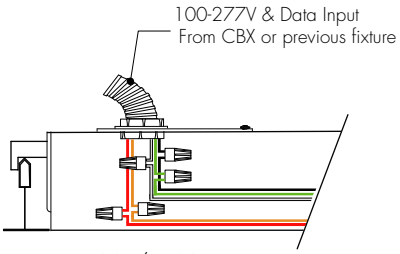
SECTION VIEW



Non-Dimming or
Lumentalk Dimming Version



Dimming Version (0-10V), DALI
or EcoSystem®



DMX/RDM Dimming

Maximum run lengths 7A maximum with 10ft fixture cord						
Configuration/Voltage	**100V**	**120V**	**208V**	**220V**	**240V**	**277V**
RO: Regular Output	93ft	116ft	126ft	126ft	126ft	126ft
HO: High Output	46ft	56ft	98ft	104ft	116ft	126ft

*Maximum run length calculations are typically based on 4ft fixtures.
Consult factory for specific applications.

Wiring detail

WIRE COLOR	*/ USE*
GREEN	*GROUND*
WHITE	*NEUTRAL*
BLACK	*LINE 100-277V*
RED/ PURPLE	*DATA +*
ORANGE	*DATA -*

10/12

02/DE/2015
N.Kassabian - Rev.20

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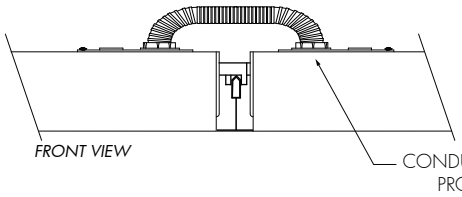
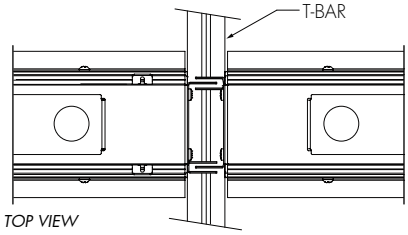
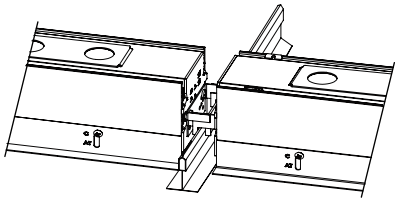
TYPICAL LUMENLINE END-TO-END INSTALLATION DETAIL

FEEDING DETAIL FOR END TO END INSTALLATION



INTERLOCK ENDCAP BRACKETS FOR END TO END INSTALLATION





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HOW TO ORDER

LLI2R TBAR	Select:	Select:	Select:	Select:	Select:	Select:	Select:	Select:
1	2	3	4	5	6	7	8	9

1 | Housing:

LLI2R TBAR - Lumenline™ Recessed T-BAR mounting, 2" wide

2 | Voltage:

100 - 100 volts
120 - 120 volts
208 - 208 volts
220 - 220 volts
240 - 240 volts
277 - 277 volts

3 | Length (nominal):

2 - 2 foot length
4 - 4 foot length
6 - 6 foot length
8 - 8 foot length

4 | Output & Color temperature:

dRO 27K - 2700K regular output 6W/ft
dRO 30K - 3000K regular output 6W/ft
dRO 35K - 3500K regular output 6W/ft
dRO 40K - 4000K regular output 6W/ft
dHO 27K - 2700K high output 12W/ft
dHO 30K - 3000K high output 12W/ft
dHO 35K - 3500K high output 12W/ft
dHO 40K - 4000K high output 12W/ft
dRO RGB - Tri-color red, green and blue direct lighting 6W/ft[1]

5 | Control:

NO - On/Off control
LT - Lumentalk[2]
DIM - 0-10V Dimming option[3]
DMX/RDM - DMX/RDM enabled[4]
DALI - DALI Dimming option[5]
ES - Lutron® EcoSystem® Enabled Dimming[6]

6 | Tile Type:

S - Standard tile
T - Tegular tile

7 | Tee Type:

NFG - NFG t-bar 9/16" x 1-1/2", centered in tile
NFGT - NFG t-bar 9/16" x 1-1/2", against tee

G - G t-bar 15/16" x 1-1/2", centered in tile
GT - G t-bar 15/16" x 1-1/2", against tee

NF - NF t-bar 9/16" x 1-11/16", centered in tile
NFT - NF t-bar 9/16" x 1-11/16", against tee

GN - GN t-bar 15/16" x 1-11/16", centered in tile
GNT - GN t-bar 15/16" x 1-11/16", against tee

SS - Srew Slot t-bar 9/16" x 1-3/4", centered in tile
SST - Screw Slot t-bar 9/16" x 1-3/4", against tee

SS2 - SS2 t-bar 9/16" x 1-13/16", centered in tile*
SS2T - SS2 t-bar 9/16" x 1-13/16", against tee*
*For Tegular tiles only.

8 | Trim Finish:

WH - White
SI - Silver
CC - Custom (please specify RAL color)

9 | Option:

CCEA - Chicago plenum rated option

Notes:

[1] RGB option requires DMX/RDM control to be specified in Control section.
[2] Available with white light only. 1% minimum dimming value.
[3] 10% minimum dimming value.
[4] 1% minimum dimming value. Fixtures come pre-addressed by fixture (consult the Resolution Details page for the number of DMX addresses per fixture length and type).
[5] 1% minimum dimming value.
[6] Available with white light only. One EcoSystem® address per fixture length. 1% minimum dimming value.

1751 Richardson, Suite 1505
Montreal (Quebec) Canada
H3K 1G6

1.877.937.3003
P.514.937.3003
F. 514.937.6289
info@lumenpulse.com
www.lumenpulse.com

5-year limited warranty.

Consult www.lumenpulse.com for our complete Standard Terms and Conditions of Sales.

lumenpulse

KIP-PT / 44W LED/3000K / 120-277V / BLK / DIM 0-10V / 10000130218

DESIGN:
Alfred Homann

PRODUCT DESCRIPTION:
•Cone-shaped post fixture carried on a console with three arms
•Opal diffuser inside a clear enclosure.
•Terse design suitable for both modern and classic design.
•Different colour variants.
•The console serves as heat sink.
•A special system makes it easy to tilt the light head for access to the lamp.
•Part of a family.

LIGHT DESCRIPTION:
•The fixture emits symmetrical glare-free light directed downwards and outwards.
•The angle of the internal diffuser, together with

INSTALLATION DESCRIPTION:
•LED variant with electronic constant current, class II driver for 120-277V operation and 0-10V dimming control.
•Mounting tenon of die-cast aluminum, 4mm (0.18") thickness for T-DRA-5"-3" (MH only) or T-RSA-4.5" (MH or LED) poles.
•Surge protector with 10,000 Amp current rating available upon request.

WEIGHT:
Min: 23 lbs. Max: 29 lbs.

VOLTAGE:
120-277V

ALTERNATIVES:
FINISH:

the slightly curved and white painted top shade, ensures a wide band of glare-free, uniform lighting.
•Provides a high level of vertical light for people to feel safe and comfortable.
•Functional and pleasant lighting comfort.
•The fixture design is identifiable when the light is on.
•LED technology with more options of standard CCTs.
•Electronic dimmable driver, night time dimming and control by additional phase

MATERIAL AND FINISH DESCRIPTION:
•EU: Aluminium coloured with textured surface or graphite with textured surface powder coated.
•US: Aluminium coloured or black powder coated.
•Top shade: Injection moulded U.V. and weather resistant ASA, 3mm (0.12") thick.
•LED enclosure of sandblasted glass, 3mm (.12") thick, for improving uniformity of the light on the internal diffuser, sealed with silicone gasket.
•Internal conical diffuser: Injected moulded opal acrylic, 2mm (0.08") thick.
•Enclosure: Injection moulded U.V. stabilized clear polycarbonate, 4mm (0.16") thick.
•Console and supporting arms: Die-cast aluminium. LED variants use unibody frame that transfers heat from LED to atmosphere.

Black or natural painted aluminum, powder coated.

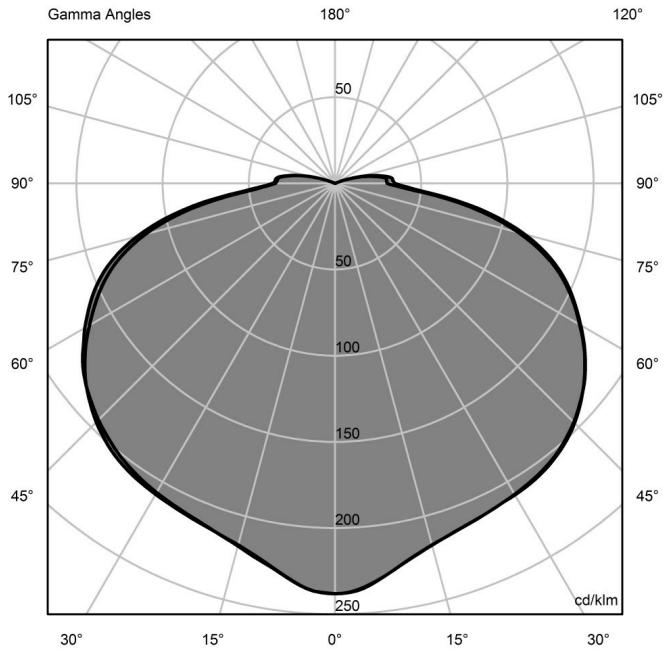
DATA SPECIFICATIONS

INSULATION CLASS	I/II
KELVIN	3000k
POWER FACTOR	0.92
WIDTH	30.4"
LENGTH	30.4"
HEIGHT	18.1"
NET WEIGHT	28 lbs
COLOR RENDERING INDEX (>)	80
LIGHT SOURCE	44W LED/3000K
LUMEN	2822
WATT	44.0
EFFICACY	64 lm/W
BUG RATING	B1 U3 G1
IP	66
IK	10

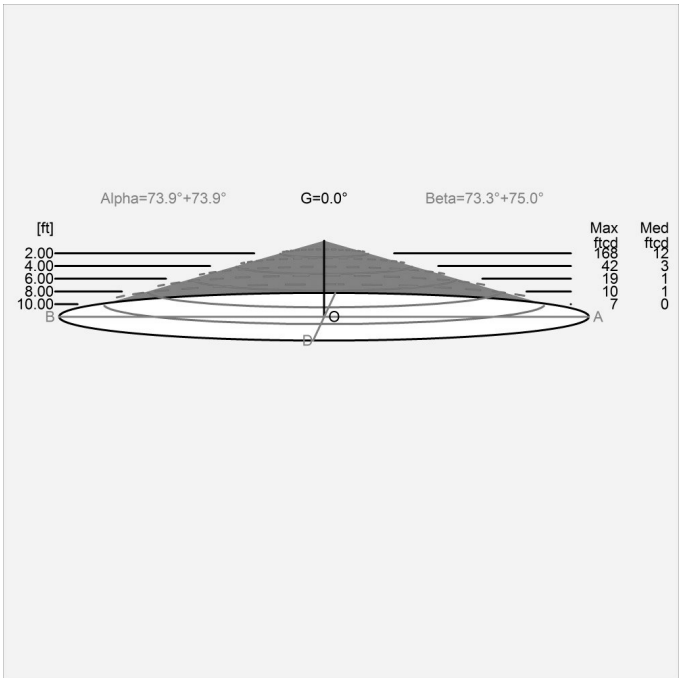
MIN. DIM. VALUE (%)	10
SDCM	03
INRUSH CURRENT	55A/265µs
WIND LOAD	1.7
SURGES	4.0 KV

LIGHT MEASUREMENTS

LIGHT DISTRIBUTION
POLAR DIAGRAM

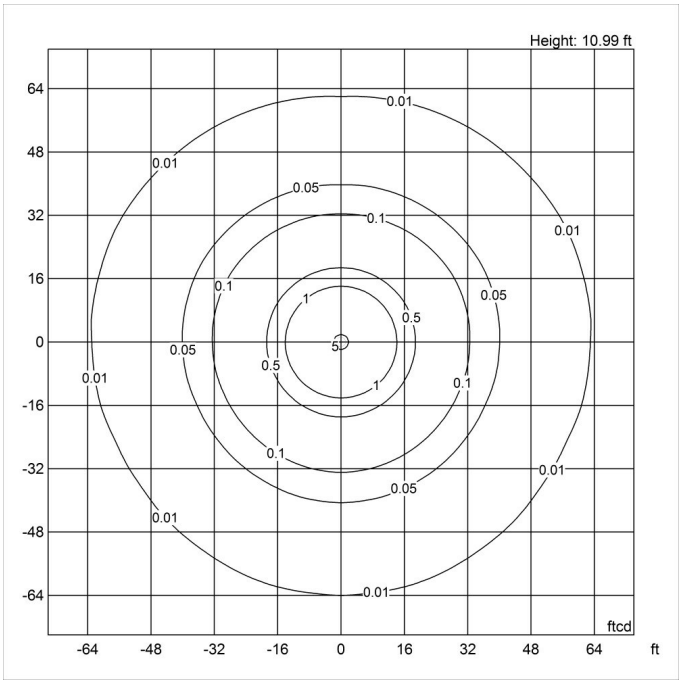


LIGHT DISTRIBUTION
CARTESIAN



ISOLUX DIAGRAM

BUG RATING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48
32
16
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-64
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ftcd
-64
-48
-32
-16
0
16
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64
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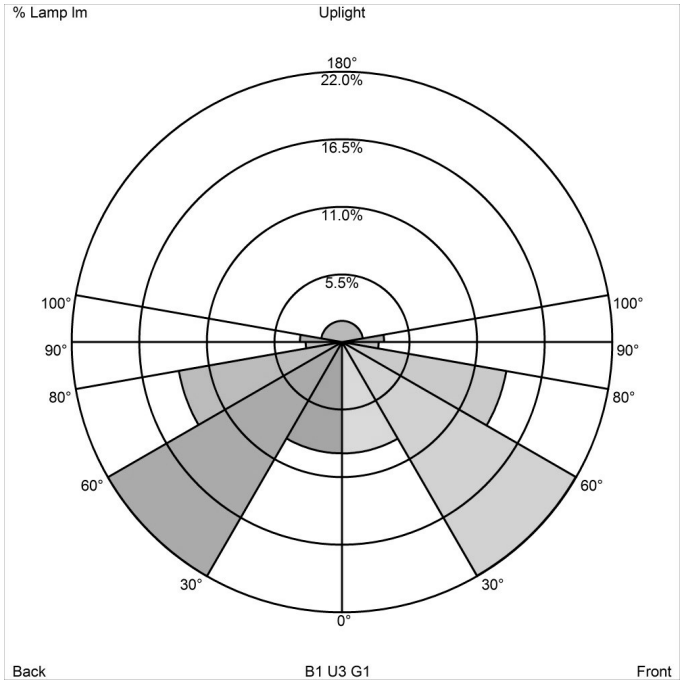

% Lamp lm
Uplight
180°
22.0%
16.5%
11.0%
5.5%
100°
90°
80°
60°
30°
0°
Back
B1 U3 G1
Front

FFLED39SFYB44

Rectangular shaped LED floodlight designed to replace 150W Metal Halide. Patent Pending airflow technology ensures long LED and driver lifespan. Use for building facade lighting, sign lighting, LED landscape lighting and instant-on security lighting.

Color: Bronze

Weight: 14.2 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	39W
120V:	0.35A	Color Temp:	3000K (Warm)
208V:	0.20A	Color Accuracy:	82 CRI
240V:	0.18A	L70 Lifespan:	100000
277V:	0.15A	Lumens:	3,405
Input Watts:	41W	Efficacy:	84 LPW
Efficiency:	96%		

Technical Specifications

Listings

UL Listing:

Suitable For Wet Locations. Suitable for mounting within 1.2M(4FT) of the ground.

IESNA LM-79 & LM-80 Testing:

RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have received the Department of Energy "Lighting Facts" label.

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code: PVR3KPC2

LED Characteristics

Lifespan:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

LEDs:

Two multi-chip, 26Watt high performance LEDs.

Color Consistency:

3-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:

RAB's range of CCT (Correlated Color Temperature) follows the guidelines of the American National Standard for (SSL) Products, ANSI C78.377-2015.

Construction

IP Rating:

Ingress Protection rating of IP65 for dust and water.

Ambient Temperature:

Suitable for use in 40°C ambient temperatures.

Cold Weather Starting:

The minimum starting temperature is -40°F/-40°C.

Thermal Management Housing:

Superior heat sinking with external Air-Flow fins.

Housing:

Die-cast aluminum housing, lens frame and mounting arm.

Threaded Size:

1/2" threaded arm.

Mounting:

Heavy-duty Slip Fitter for 2 3/8" OD pipe.

Effective Projected Area:

EPA = 0.75

Reflector:

Specular polycarbonate

Gaskets:

High-temperature silicone gaskets.

Finish:

Our environmentally friendly polyester powder coatings are formulated for high-durability and long-lasting color, and contains no VOC or toxic heavy metals.

Green Technology:

Mercury and UV free.

Electrical

Driver:

Constant Current, Class 2, 100-277V, 50/60 Hz, 6 kV surge protection, 120V: 0.35A, 208V: 0.20A, 240V: 0.18A, 277V: 0.15A

Power Factor:

99.5% at 120V, 96.1% at 277V

THD:

5.1% at 120V, 7.8% at 277V

Surge Protection:

4kV

Other

Equivalency:

The FFLED39SFYB44 is equivalent in delivered lumens to a 150W Metal Halide.

California Title 24:

Select an FFLED39SFYB44 model equipped with a 0-10V driver (look for /D10 in the catalog #) for a 2013 California Title 24 compliant model.

Technical Specifications (continued)

Other

Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

Patents:

The FFLED design is protected by U.S. Pat. D643,147, Canada Pat. 140798, China Pat. ZL201130171304.1, Mexico Pat. 36757 and pending patent in Taiwan.

Country of Origin:

Designed by RAB in New Jersey and assembled in the USA by RAB's IBEW Local 3 workers.

Buy American Act Compliant:

This product is a COTS item manufactured in the United States, and is compliant with the Buy American Act.

Recovery Act (ARRA) Compliant:

This product complies with the 52.225-21 "Required Use of American Iron, Steel, and Manufactured Goods-- Buy American Act-- Construction Materials (October 2010).

Trade Agreements Act Compliant:

This product is a COTS item manufactured in the United States, and is compliant with the Trade Agreements Act.

GSA Schedule:

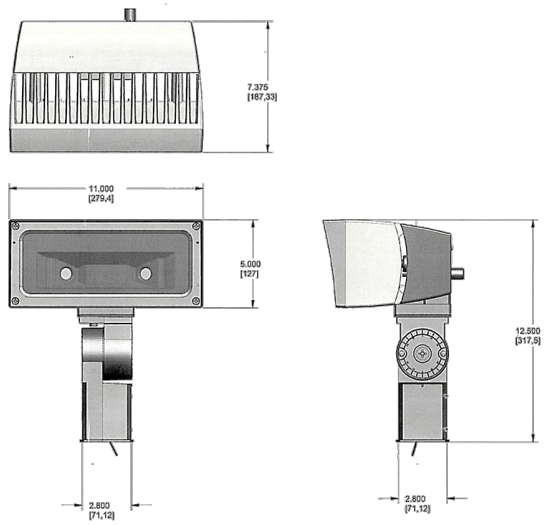
Suitable in accordance with FAR Subpart 25.4.

Optical

NEMA Type:

NEMA Beam Spread of 4H x 4V

Dimensions



Features

- Ultra efficient LED and optical design
- Replaces 150W MH floodlights
- 100,000 hour life based on LM-80 tests
- Air-flow technology heatsink
- 5-year warranty

Ordering Matrix

Family	Watts	Mount	Color Temp	Beam Spread	Finish	Dimming	Voltage	Photocell
FFLED								
	39 = 39W	= Arm **T** = Trunnion **SF** = Slipfitter	= 5000K (Cool) **Y** = 3000K (Warm) **N** = 4000K (Neutral)	= 7H x 6V **B44** = 4H x 4V **B55** = 5H x 5V	= Bronze **W** = White	= No Dimming **/D10** = Dimmable	= 120-277V **/480** = 480 Volt	= No Photocell **/PC** = 120V Button **/PC2** = 277V Button **/PCS** = 120V Swivel **/PCS2** = 277V Swivel

JUNO

MINI LED DOWNLIGHT

Project:

Fixture Type:

Location:

Contact/Phone:

OUTDOOR/WET LOCATION
MD1LWG2 RECESSED HOUSING AND TRIM
LOW VOLTAGE

PRODUCT DESCRIPTION

The MD1LW mini LED recessed downlight is for use in wet locations and is IC rated for insulated or non-insulated applications • Sleek, compact form factor provides direct accent lighting with low glare optic system that approximates the light output and distribution of 20W halogen lamps • Ideal for both residential and commercial wet location applications including bathrooms and eave lighting • Remote mount Class 2 120V to 12V AC electronic or magnetic transformer required • Designed to provide 50,000 hours of life • 5 year limited warranty on LED components.

ENVIRONMENTALLY FRIENDLY, ENERGY EFFICIENT

- No harmful ultraviolet or infrared wavelengths
- No lead or mercury
- Comparable light output to 20W MR11 halogen lamps while consuming 5W

PRODUCT SPECIFICATIONS

LED Light Engine High performance, low power LEDs provide outstanding reliability, performance and color quality/consistency • 2700K, 3000K, 3500K or 4100K color temperatures available • 80 CRI minimum.

Optical System Fixtures are offered with a choice of spot, narrow flood or flood beam patterns • LED source concealed with lensed optic is deeply regressed into an internal reflector to produce a low glare system • Reflectors finished to match trim ring color for uniform appearance • Field replacement of optical lenses is NOT recommended.

Transformer Requires remote mount Class 2, 120V to 12V AC electronic or magnetic transformer for operation • Juno TL602E electronic transformer and TL576 magnetic transformer are designed specifically for use with these fixtures.

Dimming May be dimmed with dimmers tested and qualified by Juno for use with TL602E and TL576 – see transformer specifications for compatible dimmers • Color temperature remains constant over dimming range • Consult factory for additional information.

Life Rated for 50,000 hours at 70% lumen maintenance.

Labels UL Listed for wet locations and daisy chaining • Union made • UL and cUL listed • RoHS compliant.

Testing All reports are based on published industry procedures; field performance may differ from laboratory performance.

Product specifications subject to change without notice.

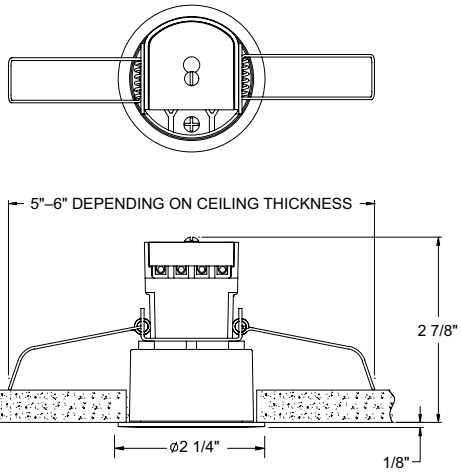
HOUSING FEATURES

Housing Designed for use in IC (insulated ceiling) or non-IC construction • Die cast aluminum housing • Finished with either corrosion resistant painted finishes or E-coat for decorative plated finishes.

Wiring Compartment Provided with removable access plate • Four pole terminal block allows for quick, secure connection • UL /cUL listed for daisy chaining • Easy to wire with commonly available low voltage cable (Type CL2 or NEC equivalent, 18-12 AWG). Consult local codes for compliant wiring methods.

Mounting Zinc plated torsion clips are provided fully assembled to housing • Springs allow for fast, secure installation or removal in mounting surfaces from 1/8" to 1" thick material • 2" Cutout dimension corresponds to common hole saw size.

DIMENSIONS



2" CUTOUT

ELECTRICAL DATA

Input Voltage	**12VAC**
Input Power	4.8W
Input Current	0.42A
Frequency	Varies with Transformer

ORDERING INFORMATION:

Example: **MD1LWG2-27K-FL-WH**

Fixture

Catalog No.	Color Temp.	Optic	Finish
MD1LWG2	**27K** 2700K **3K** 3000K **35K** 3500K **41K** 4100K	**SP** Spot **NFL** Narrow Flood **FL** Flood	**WH** White **BL** Black **SN** Satin Nickel **BZ** Bronze

Transformer

Catalog Number	Finish	Description
TL602E-10-WH	White	10W 12V AC Electronic Driver/Transformer
TL602E-25-WH	White	25W 12V AC Electronic Driver/Transformer
TL602E-60-WH	White	60W 12V AC Electronic Driver/Transformer
TL576-10-BL	Black	10W 12V AC Magnetic Driver/Transformer
TL576-25-BL	Black	25W 12V AC Magnetic Driver/Transformer
TL576-60-BL	Black	60W 12V AC Magnetic Driver/Transformer

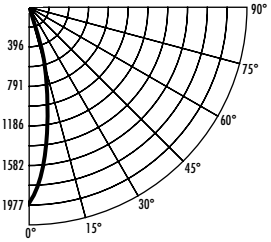
MINI LED DOWNLIGHT

MD1LWG2 OUTDOOR/WET LOCATION RECESSED HOUSING AND TRIM

LOW VOLTAGE

PHOTOMETRIC REPORT

Test Report #: PT10130702R
Catalog No: MD1LWG2-35K-SP-WH
Luminaire Spacing Criterion: 0.34
Luminaire LPW: 64



CANDLEPOWER DISTRIBUTION (Candelas)

Degrees Vertical	0°
0	1977
5	1648
15	421
25	80
35	17
45	6
55	3
65	1
75	1
85	0
90	0

Multiplier: 27K - 0.92
3K - 0.96
41K - 1.06

AVERAGE INITIAL FOOTCANDLES

Multiple Units (Square Array, 60′ x 60′ room)
Ceiling 80%, Wall 50%, Floor 20%

Spacing	RCR1	RCR4	RCR8
4′	23	21	19
5′	14	13	12
6′	10	9	9
7′	8	7	7
8′	6	6	5
9′	5	4	4
10′	4	3	3

ZONAL LUMEN SUMMARY

Zone	Lumens	%Lamp	%Fixture
0-30°	297	N/A	93.3
0-40°	309	N/A	96.9
0-60°	316	N/A	99.2
0-90°	319	N/A	100.0

INITIAL FOOTCANDLES

One Unit, 5W, 19.4° Beam

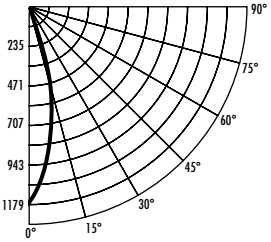
Distance to Illuminated Plane (Feet)	Footcandles Beam Center	Beam Diameter
4	123.6	1.4′
6	54.9	2.1′
8	30.9	2.7′
10	19.8	3.4′

LUMINANCE (Average cd/m²)

Degrees	Average 0° Luminance
45	12095
55	6710
65	4720
75	4407
85	1634

PHOTOMETRIC REPORT

Test Report #: PT10130703R
Catalog No: MD1LWG2-35K-NFL-WH
Luminaire Spacing Criterion: 0.42
Luminaire LPW: 61



CANDLEPOWER DISTRIBUTION (Candelas)

Degrees Vertical	0°
0	1179
5	1044
15	436
25	122
35	30
45	9
55	3
65	2
75	1
85	0
90	0

Multiplier: 27K - 0.92
3K - 0.96
41K - 1.06

AVERAGE INITIAL FOOTCANDLES

Multiple Units (Square Array, 60′ x 60′ room)
Ceiling 80%, Wall 50%, Floor 20%

Spacing	RCR1	RCR4	RCR8
4′	21	19	17
5′	14	12	11
6′	9	9	8
7′	8	7	6
8′	6	5	5
9′	5	4	4
10′	3	3	3

ZONAL LUMEN SUMMARY

Zone	Lumens	%Lamp	%Fixture
0-30°	270	N/A	88.9
0-40°	290	N/A	95.5
0-60°	300	N/A	98.9
0-90°	304	N/A	100.0

INITIAL FOOTCANDLES

One Unit, 5W, 24.6° Beam

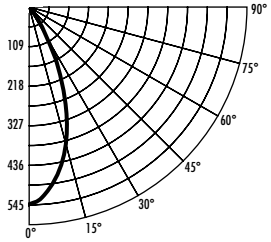
Distance to Illuminated Plane (Feet)	Footcandles Beam Center	Beam Diameter
4	73.7	1.7′
6	32.8	2.6′
8	18.4	3.5′
10	11.8	4.4′

LUMINANCE (Average cd/m²)

Degrees	Average 0° Luminance
45	17336
55	7952
65	6071
75	5507
85	3268

PHOTOMETRIC REPORT

Test Report #: PT10130704R
Catalog No: MD1LWG2-35K-FL-WH
Luminaire Spacing Criterion: 0.64
Luminaire LPW: 55



CANDLEPOWER DISTRIBUTION (Candelas)

Degrees Vertical	0°
0	545
5	527
15	366
25	158
35	44
45	14
55	6
65	3
75	2
85	0
90	0

Multiplier: 27K - 0.92
3K - 0.96
41K - 1.06

AVERAGE INITIAL FOOTCANDLES

Multiple Units (Square Array, 60′ x 60′ room)
Ceiling 80%, Wall 50%, Floor 20%

Spacing	RCR1	RCR4	RCR8
4′	19	17	15
5′	12	11	10
6′	8	7	7
7′	7	6	5
8′	5	5	4
9′	4	4	3
10′	3	3	2

ZONAL LUMEN SUMMARY

Zone	Lumens	%Lamp	%Fixture
0-30°	221	N/A	81.2
0-40°	251	N/A	91.9
0-60°	267	N/A	98.0
0-90°	273	N/A	100.0

INITIAL FOOTCANDLES

One Unit, 5W, 38.3° Beam

Distance to Illuminated Plane (Feet)	Footcandles Beam Center	Beam Diameter
4	34.1	2.8′
6	15.1	4.2′
8	8.5	5.6′
10	5.5	6.9′

LUMINANCE (Average cd/m²)

Degrees	Average 0° Luminance
45	26205
55	13917
65	10455
75	9364
85	4902

Fixtures tested to IES recommended standard for solid state lighting per LM-79-08. Photometric performance on a single unit at 12VAC in a 25°C ambient represents a baseline of performance for the fixture. Results may vary in the field and when multiple fixtures are used in a system.

JUNO LIGHTING GROUP
an AcuityBrands company

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220 Chrysler Drive • Brampton, Ontario • Canada L6S 6B6 • Phone (905) 792-7335 • Fax (905) 792-0064
Visit us at www.junolightinggroup.com

ETC®

ColorSource™ Spot

ColorSource Series

100V 115/120V 230/240V

GENERAL INFORMATION

The ETC ColorSource Spot brings together the affordability of a four-color light engine with the build-quality and support of an ETC product. Using a unique mix of red, green, blue and lime LED emitters, the ColorSource spot allows for an amazing range of color and depth, unlike other low-cost LED fixtures. Because it utilizes standard ETC optics, adapters and accessories, it is a versatile solution for any lighting need.

APPLICATIONS

- Houses of worship
- Universities and schools
- Hospitality
- Retail
- Exhibition centers
- Meeting rooms
- Clubs
- Cafetoriums

PRODUCT FEATURES

- ETC's new RGB-L array (Red, Green, Blue and Lime)
- Simple user interface with seven-segment display
- PowerCon in and thru
- DMX/RDM in and thru (5-pin XLR or RJ45)
- LED droop compensation
- Optically calibrated
- Tour-ready, aluminum housing

ORDERING INFORMATION

ColorSource Spot Light Engine with Shutter Barrel

(For use with fixed-field lens tubes only)

MODEL	DESCRIPTION
CSSPOTS-0	ColorSource Spot with shutter barrel, black
CSSPOT45S-0	ColorSource Spot RJ45 with shutter barrel, black

ColorSource Spot Light Engine Body

(For use with zoom lens tubes and adapters and for retrofit of existing fixtures)

MODEL	DESCRIPTION
CSSPOT-0	ColorSource Spot, body only, black
CSSPOT45-0	ColorSource Spot RJ45, body only, black

Color options: -1 = white, -5 = silver gray/custom colors
Fixture ships with a soft-focus diffuser in a gobo holder and a 1.5m PowerCON™ power-input cable with a connector of choice. See page 2 for connector options.

Please note: Lens tubes to be ordered separately.

SPECIFICATIONS

GENERAL

- ETL Listed to UL1573: the standard for stage and studio lighting units
- IP20-rated for indoor use
- Power and DMX in/thru connections for easy setup
- Simple seven-segment, three-button interface with easy access to 12 customizable presets and five sequences

PHYSICAL

- Rugged, die-cast, all-metal housing
- Available in black (standard), white, silver or custom colors (contact factory)
- C-clamp included
- Positive-locking double-clutch fixture body
- Slot for glass or stainless steel patterns and soft-focus diffuser
- Wide accessory slot with sliding cover for motorized pattern devices or optional iris
- Hanging yoke standard. Optional yoke/floor-stand available

ELECTRICAL

- 100VAC to 240VAC 50/60Hz universal power input
- PowerCon power in and thru connections
- Up to nine ColorSource Spot fixtures (15A max) may be linked via power thru connector (10 ColorSource Spot luminaires total per circuit) when used with R20 Relay Module or Unison Echo™ Relay Panel
  - Consult breaker-trip curves when used with other equipment. Requires power from a non-dim source
- Inrush
  - 120V: 28A (First half-cycle)
  - 240V: 46A (First half-cycle)

LED*

- 20,000-hour LED life (20,000 hours to 70% intensity)
- 60 Luxeon® Rebel LED emitters

*See additional LED notes on page four

COLOR

- Exclusive RGB-L color array
- Brightness and color range unlike any other four-color system.
- Optical calibration for consistency from fixture to fixture
- Droop compensation for consistent output and color accuracy

OPTICAL

- Use the included soft-focus diffuser for creating washes or soft light
- Best performance using ETC's EDLT lens tubes
- Can use all ETC Source Four® interchangeable lens barrels: 5°, 10°, 14°, 19°, 26°, 36°, 50°, 70°, and 90° field angles, as well as 19°, 26°, 36°, and 50° EDLT lenses
- For better performance, use the LED 50° barrel
- Can be used with Source Four LED CYC and Fresnel adapters

CONTROL

- Available with DMX512 in and thru via five-pin XLR or RJ45 connectors
- Simple RGB control (IRGBS profile)
- See DMX Control Table for additional information
- 15-bit virtual dimming engine provides smooth, high-quality theatrical fades and minimizes color shift during dimming
- RDM functionality for address and setting change
- Local control of presets (12) and sequences (5)

SPECIFICATIONS

THERMAL

- Ambient operating temperature of 32° to 104°F (0° to 40°C)
- Active electronic thermal management for droop-free operation
- Quiet fan cooling
- Fixture is designed for continuous operation up to 104°F (40°C) ambient temperature and requires free flow of air around fixture housing

ADDITIONAL ORDERING INFORMATION

Power Input Cables

Use information below to order 5' power input leads with factory-fitted connectors

MODEL	DESCRIPTION
DPA-A	5ft PowerCon to parallel blade U-ground (Edison) connector
DPA-B	5ft PowerCon to 20A two-pin and ground (stage pin) connector
DPA-C	5ft PowerCon to grounded 20A twistlock connector
DPA-X	5ft PowerCon to bare-end power input lead

Power Thru Jumpers

Note: Power thru jumpers connect to fixture's output (thru) connector to provide link to successive fixtures

MODEL	DESCRIPTION
DPJ-5	5ft PowerCon-to-PowerCon fixture-to-fixture jumper
DPJ-10	10ft PowerCon-to-PowerCon fixture-to-fixture jumper

Diffusers

MODEL	DESCRIPTION
S4LED-SFD	Source Four LED - Soft Focus Diffuser (included)
S4LED-SWD6	Source Four LED - Smooth Wash Diffuser for 6.25in gel frame slots
S4LED-SWD7	Source Four LED - Smooth Wash Diffuser for 7.5in gel frame slots
S4LED-SWD12	Source Four LED - Smooth Wash Diffuser for 10° lens tubes
S4LED-SWD14	Source Four LED - Smooth Wash Diffuser for 5° lens tubes

The Soft Focus Diffuser fits into a standard A-size pattern holder and delivers beautiful, homogenized light when not in sharp focus. Also, use with patterns for dappled and soft-edge projections.

The Smooth Wash Diffuser is used when extra-smooth blending of multiple ColorSource Spot luminaires is required. The smooth wash diffuser is placed into the gel-frame slot of the lens tube.

RJ45 to XLR Adapter Cables

MODEL	DESCRIPTION
W6538	RJ45 to female five-pin XLR adapter (6ft)
W6539	RJ45 to male five-pin XLR adapter (6ft)

PREFERRED LENSING OPTIONS

(Lenses sold separately)

Fixed Beam Lenses

MODEL	DESCRIPTION
LED50LT	LED-specific 50° EDLT with lenses installed
LED50LT-1	LED-specific 50° EDLT (white) with lenses installed
436EDLT	36° EDLT w/lens installed
436EDLT-1	36° EDLT (white) w/lens installed
426EDLT	26° EDLT w/lens installed
426EDLT-1	26° EDLT (white) w/lens installed
419EDLT	19° EDLT w/lens installed
419EDLT-1	19° EDLT (white) w/lens installed
490LT	90° w/lens installed
490LT-1	90° (white) w/lens installed
470LT	70° w/lens installed
470LT-1	70° (white) w/lens installed
414LT	14° w/lens installed
414LT-1	14° (white) w/lens installed
410LT	10° w/lens installed
410LT-1	10° (white) w/lens installed
405LT	5° w/lens installed
405LT-1	5° (white) w/lens installed

Zoom Lens Assemblies

Use with light-engine body models.

MODEL	DESCRIPTION
41530LT	Source Four 15-30° Zoom lens assembly
42550LT	Source Four 25-50° Zoom lens assembly

LED Adapters

MODEL	DESCRIPTION
S4LEDCYC	Source Four LED CYC
S4LEDFRES	Source Four LED Fresnel

Power Consumption With RGB at full

MODEL	VOLTAGE (V)	CURRENT (A)	MAX POWER (W)
ColorSource Spot	100	1.48	148
	120	1.24	147
	230	0.65	141

ADDITIONAL ORDERING INFORMATION

Fixture Accessories

MODEL	DESCRIPTION
400CC	C-Clamp (included)
400SC	Safety Cable
400PH-A	Pattern holder (A size)
400PH-B	Pattern holder (B size)
400PH-G	Glass pattern holder
400RS	Drop-In Iris
400CF	Color frame (6.25")
407CF	7.5in square color frame
400DN	Donut
400TH	Top Hat
400HH	Half Hat
DPSJ-X	25ft PowerCon to Edison input power cable with inline switch

NOTES ABOUT LED LUMINAIRES

All LED sources experience some lessening of light output and some color shift over time. LED output will vary with thermal conditions. Based on the LED manufacturer's B50 L70 specification, a ColorSource Spot luminaire will achieve ~70% of its initial output after 20,000 hours of typical usage. In individual situations, LEDs will be used for different durations and at different levels. This can eventually lead to minor alterations in color performance, necessitating slight adjustments to presets, cues or programs.

PHOTOMETRY

See ColorSource Spot Photometry Guide available at www.etcconnect.com

PHYSICAL

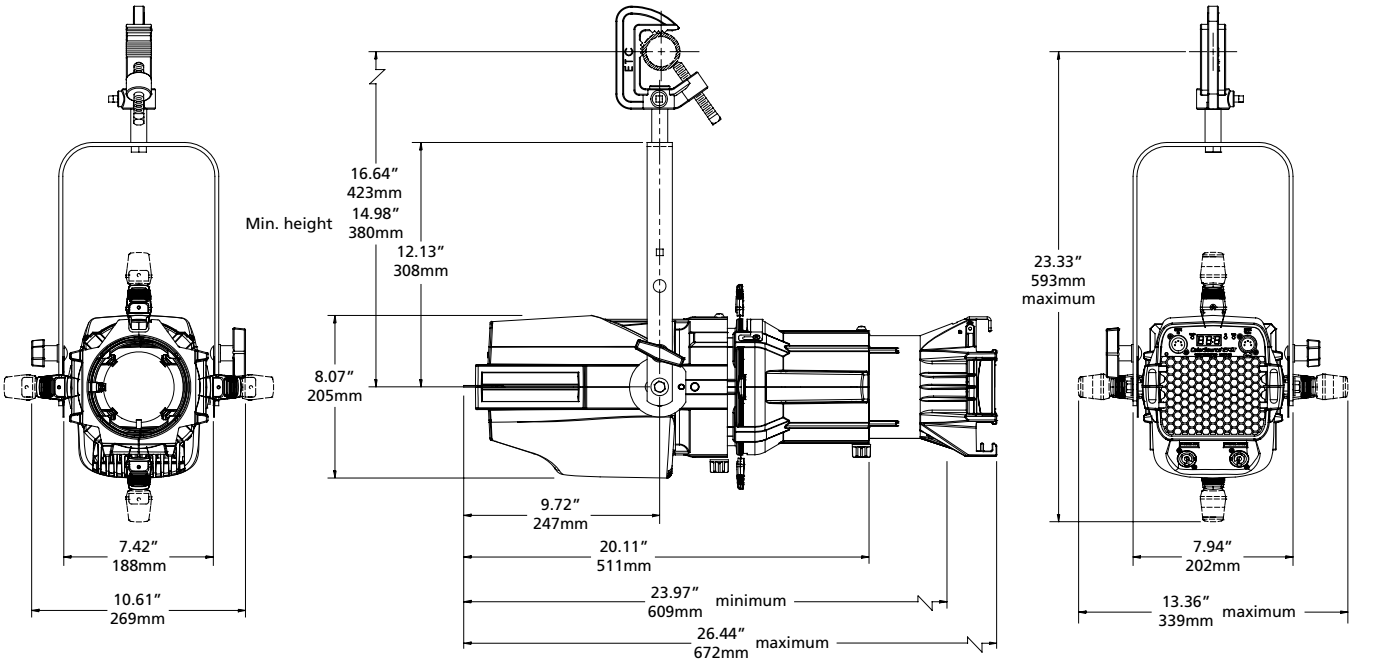
ColorSource Spot Weights

	WEIGHT*		SHIPPING WEIGHT	
	lbs	kgs	lbs	kgs
With Barrel	17	7.7	22	10
Without Barrel	13	5.9	16.3	7.4

* Does not include mounting hardware or lens tube

ColorSource Spot Dimensions

	HEIGHT		WIDTH		DEPTH	
	in	mm	in	mm	in	mm
ColorSource Spot	23.33	593	13.36	339	26.44	672



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ETC®

ColorSource™ PAR

ColorSource Series

100V 115/120V 230/240V

GENERAL INFORMATION

The ETC ColorSource PAR offers a quality of build and light that has never been seen in an affordable wash fixture. Using ETC's unique RGB-L color system, the ColorSource PAR provides a rich, bright light unlike any other LED washlight in its class. And it was design and manufactured by ETC.

APPLICATIONS

- Houses of worship
- Universities and schools
- Hospitality
- Retail
- Exhibition centers
- Meeting rooms
- Clubs
- Cafetoriums

PRODUCT FEATURES

- ETC's new RGB-L chipset (Red, Green, Blue and Lime)
- Homogenized optics
- Simple user interface with 7-segment display
- PowerCon in and thru
- DMX/RDM in and thru (5-pin)
- LED droop compensation
- Optically calibrated
- Tour-ready, aluminum housing

ORDERING INFORMATION

ColorSource PAR

MODEL	DESCRIPTION
CSPAR	ColorSource PAR

Note: ColorSource PAR luminaires ship with a hanging yoke and a power cable with connector of choice. See page 2 for connector options. C-clamps are not included. For addtional color options, please add the following: -1 for white, -5 for silver or -8 for custom color.

SPECIFICATIONS

GENERAL

- 8 RGB-L chipset color-mixing wash luminaire
- ETL Listed to UL1573, the standard for stage and studio lighting units
- IP20-rated for indoor use
- Power- and DMX-in/thru connections for easy setup
- Simple 7-segment, three-button interface with easy access to 12 customizable presets and five sequences

PHYSICAL

- Rugged, die-cast, all-metal housing
- Easy-access slots for secondary lenses and standard 7.5" PAR accessories
- Available in black (standard), white or silver (optional) or custom colors (contact factory)
- Hanging yoke included

ELECTRICAL

- 100VAC to 240VAC 50/60Hz universal power input
- PowerCon in and thru connections
- Up to nine luminaires (15A max) may be linked via power thru connector (10 luminaires total per circuit) when used with R20 relay module or Unison® Echo Relay Panel. Consult breaker trip curves when used with other equipment. Requires power from a non-dimmable source
- Inrush
  - 120V: 35A (First half-cycle)
  - 240V: 49A (First half-cycle)

LED*

- 20,000-hour LED life (20,000 hours at 70% intensity)
- 40 Luxeon® Z LED emitters (five per optic)

*See additional LED notes on page 3

COLOR

- Exclusive RGB-L Color array
- Brightness and color range unlike any other 4-color system
- Droop compensation maintains color accuracy during use
- Optically calibrated to ensure consistency across fixture

OPTICAL

- Primary field angle of 24.9° and beam angle of 14.5°
- Secondary lenses available for multiple beam-spread options
- Homoginized optics for a consistent, smooth beam
- Refer to accessories charts for lenses available

CONTROL

- DMX512 in and thru via five-pin XLR (termination required)
- RGB control (See DMX control table for additional information)
- 15-bit virtual dimming engine provides smooth, high-quality theatrical fades
- RDM functionality for address and setting changes
- Local control of presets (12) and sequences (5)

THERMAL

- Ambient operating temperature of 32° to 104°F (0° to 40°C)
- Active electronic thermal management for thermal droop-free operation
- Variable-speed fan
- Fixture is designed for continuous operation up to 104°F (40°C) ambient temperature and requires free flow of air around fixture housing

ADDITIONAL ORDERING INFORMATION

Power Input Cables

Use information below to order 5' power input leads with factory-fitted connectors.

MODEL	DESCRIPTION
DPA-A	5' PowerCon to parallel blade U-ground (Edison) connector
DPA-B	5' PowerCon to 20A two-pin and ground (stage-pin) connector
DPA-C	5' PowerCon to grounded 20A twistlock connector
DPA-X	5' PowerCon to bare-end power input lead

Power-Thru Jumpers

Note: Power thru jumpers connect to luminaire's output (thru) connector to provide link to successive luminaires

MODEL	DESCRIPTION
DPJ-5	5' PowerCon to PowerCon fixture to fixture jumper
DPJ-10	10' PowerCon to PowerCon fixture to fixture jumper

Luminaire Accessories

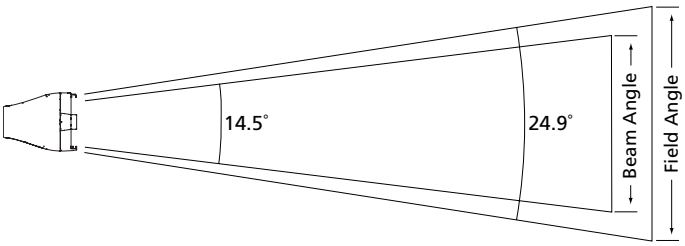
MODEL	DESCRIPTION
CSPARFSY	Yoke with floor-stand attachment
400BD	Barn door (Use only as a flexible top hat to diminish aperture glare. Not for beam shaping)
407CF	Color Frame (use for round and oblong lenses)
400L	Egg Crate Louver
400PTH3	Top Hat 3" Tube
400PTH6	Top Hat 6" Tube
400PHH	Half Hat 6" Tube
400CC	C-Clamp (does not ship with fixture)
400SC	Safety Cable (32")
DPSJ-25	25' PowerCon to Edison input power cable with inline switch

PHOTOMETRICS

ColorSource PAR

Mode	Degree	Candela	Field Lumens	Beam Lumens	Lumens Per Watt
Regulated - RGB	24.9	47,900	2,749	1,537	32

Metric conversions: For meters, multiply feet by 0.3048
For lux, multiply footcandles by 10.76



Throw Distance (d)	10′ 3.0m	15′ 4.6m	20′ 6.1m	25′ 7.6m	217.7′ 66.4m
Field Diameter	4.4′ 1.3m	6.6′ 2.0m	8.8′ 2.7m	11′ 3.4m	–
Illuminance (fc)	474	211	119	76	1
Illuminance (lux)	5,102	2,268	1,276	816	10.76

To determine center beam illumination in footcandles at any throw distance, divide candela by the throw distance squared

For field diameter at any distance, multiply distance by 0.442
For beam diameter at any distance, multiply by 0.254

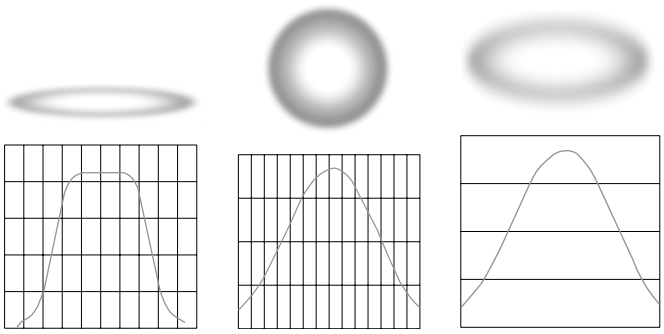
ADDITIONAL ORDERING INFORMATION

Secondary Lens Options

MODEL	DESCRIPTION: The following lenses are cut for ColorSource luminaires and create round, linear or oblong field patterns as described below. These lenses are not sized for use in Selador® Classic fixtures.	
Narrow Linear Field	Note: This is the same material as Selador Classic lenses	
SELLVN-7.5	7.5" Very Narrow lens	Linear lenses may be combined to create desired field size
SELLN-7.5	7.5" Narrow lens	
SELLM-7.5	7.5" Medium lens	
SELLW-7.5	7.5" Wide lens	
SELLEW-7.5	7.5" Extra Wide lens	
Round Field		
SELRVN-7.5	7.5" Very Narrow lens (round field)	
SELRN-7.5	7.5" Narrow lens (round field)	
SELRM-7.5	7.5" Medium lens (round field)	
SELRW-7.5	7.5" Wide lens (round field)	
Oblong Field		
SELON-7.5	7.5" Narrow lens (oblong field)	
SELOM-7.5	7.5" Medium lens (oblong field)	
SELOW-7.5	7.5" Wide lens (oblong field)	

[Desire lenses compared to Source Four PAR EA]

Typical Lens Field Profiles



Narrow Linear | Round | Oblong

Power Consumption at Full Intensity

MODEL	VOLTAGE (V)	CURRENT (A)	WATTS
ColorSource PAR	120 / 240	0.75 / 0.4	90/89

NOTES ABOUT LED LUMINAIRES

All LED sources experience some lessening of light output and some color shift over time. LED output will vary with thermal conditions. Thermal conditions can be affected by ambient temperatures and orientation. Based on the LED manufacturer's B50 L70 specification, a ColorSource luminaire will achieve ~70% of its initial output after 20,000 hours of typical usage. In individual situations, LEDs will be used for different durations and at different levels. This can eventually lead to minor alterations in color performance, necessitating slight adjustments to presets, cues or programs.

CONTROL

DMX Input Channel Profiles

DMX Profile	DMX Channels	Channel Assignments	Notes
RGB	5	1-INT 2-Red 3-Green 4-Blue 5-Strobe	

PHYSICAL

ColorSource PAR Dimensions

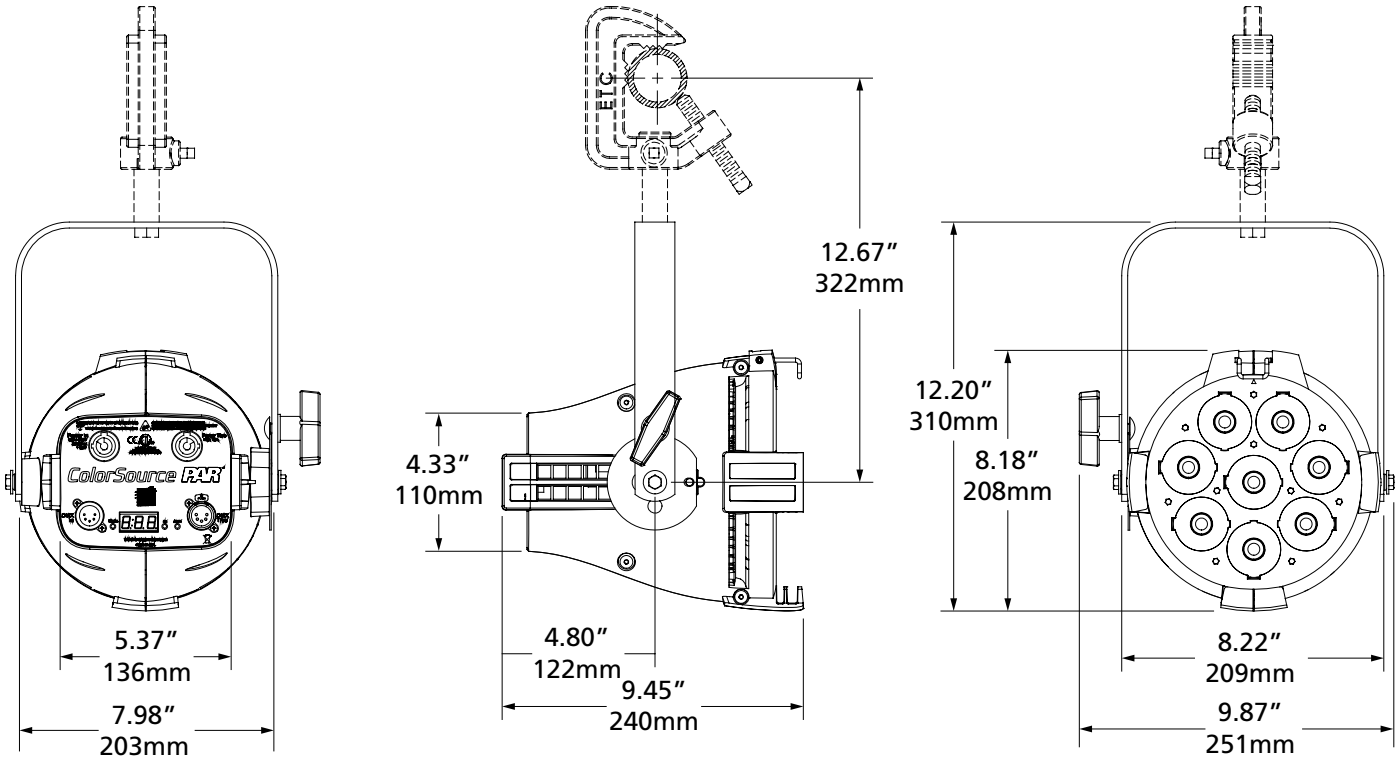
HEIGHT		WIDTH		DEPTH	
inches	mm	inches	mm	inches	mm
12.20	310	7.98	203	9.45	240

* Does not include mounting hardware

ColorSource PAR Weights

WEIGHT*		SHIPPING WEIGHT	
lbs	kgs	lbs	kgs
8.3	3.77	10.1	4.59

* Does not include mounting hardware



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ETC®

VIVID-R

selador series by ETC

100V 115/120V 230/240V

GENERAL INFORMATION

The Selador Series Vivid-R fixture replaces Vivid as ETC's strong color, long-throw LED fixture. Highly efficient primary lenses and careful color choices make Vivid-R brighter than the original Vivid while using less power. Vivid-R is ideal for stage, studio and anywhere strong color and high intensity lighting is required. It uses the *x7 Color System*™ to produce the widest range of spectrally balanced saturated and tinted colors available. Lighting designers will love the deep, pure colors teamed with high-power color punch. While maximized for high-brightness and deep color output, Vivid-R does not give up Selador Series' unique ability to match warm, tungsten white light, vibrant daylight white, and soft, tinted gel colors.

Note: Vivid-R uses the 2.5W Rebel LED in place of the 3.5W K2 LED. The K2 LED is being discontinued in 2010. Color differences between Vivid and Vivid-R are slight, but will be noticeable if the fixtures are used side-by-side.

APPLICATIONS

- Theaters
- Themed entertainment
- TV/Film studios
- Houses of worship
- Hotels
- Convention centers
- Schools

SUGGESTED APPLICATIONS

VIVID MODEL	11	21	42	63
Truss warmer	•			
Front light	•	•		
Side light	•	•		
Key light	•	•		
Fill light	•	•	•	
Specials	•	•		
Downlight	•	•	•	
Backlight	•	•	•	•
Stagewash	•	•	•	•
Cyc light	•	•	•	•

ORDERING INFORMATION

Selador Vivid-R

MODEL	DESCRIPTION
SELVR11	Selador Vivid 11" (one cell)
SELVR21	Selador Vivid 21" (two cell)
SELVR42	Selador Vivid 42" (four cell)
SELVR63	Selador Vivid 63" (six cell)

Note: Units ship with mounting bolts, parallel-blade, U-ground (Edison) pigtail (SPA-A) only. Power leads with alternate connectors and luminaire mounting hardware must be ordered separately. All secondary lenses must be ordered separately.

Connector Designation

Use information below to order 5ft leads with factory-fitted connectors:

MODEL	DESCRIPTION
SPA-X	PowerCon™ to bare-end pigtail
SPA-A	PowerCon™ to parallel-blade U-ground pigtail
SPA-B	PowerCon™ to 20 amp two-pin and ground (stage pin) pigtail
SPA-C	PowerCon™ to grounded 20 amp twistlock pigtail

See page 2 for Selador Vivid-R Accessories.

SPECIFICATIONS

GENERAL
- 2.5W color-mixing LED fixture
- Available in 11in, 21in, 42in, and 63in lengths
- ETL rated for indoor dry location use

PHYSICAL
- Rugged all-metal extruded housing
- Easy-access slots for secondary lenses
- Combine secondary lenses for desired horizontal and vertical beam spread
- Available in black (standard)
- Yoke (11in and 21in only), trunnion (floor stand), and hanging bracket mounting options

ELECTRICAL
- 100VAC to 240VAC 50/60 Hz universal power input
- Neutrik® PowerCon™ input connector
- 5ft power lead (parallel-blade, U-ground) supplied (see page 1 for input connector options)
- Requires power from non-dim source

LED*
- 50,000 hr. LED life
- 40 Luxeon® Rebel 2.5W LED emitters per cell

* See additional LED notes on page 3

COLOR
- Exclusive *x7 Color System*™ 7-color LED array
- Vivid-R – optimized for strong saturated colors at maximum brightness
- Interacts seamlessly with conventional sources
- Beautifully illuminates skin tones and other objects, for a natural appearance with high color rendering
- Strong saturated colors with maximum punch

OPTICAL
- Native tight beam spread of approximately 19°
- Secondary lenses install in fixture front to change distribution of light
- Use a combination of vertical and horizontal lenses to spread light both directions
- Lenses must be ordered separately
- Refer to accessories for lenses available

CONTROL
- DMX512 in and thru via 5-pin XLR connectors
- Eight channel control (seven color plus intensity)
- Intensity channel minimizes color shift during dimming
- 15-bit internal control control for smooth low-end dimming
- 21in fixture provides two independently controlled cells
- 42in fixture provides four independently controlled cells
- 63in fixture provides six independently controlled cells

THERMAL
- Ambient operating temperature of 32°-104°F (0°- 40°C)
- Fixture case can become extremely hot (approx. 85°C) under long-term, high-output, continuous usage
- Fixture is designed for continuous usage at 40°C ambient temperature. Requires free air flow around fixture
- Fan speed thermostatically controlled for no-noise operation execpt as required for high heat or low air flow situations

POWER CONSUMPTION AT FULL INTENSITY

MODEL	VOLTAGE (V)	CURRENT (A)	WATTS
Vivid-R 11 (SELVR11)	120 / 240	1.05 / 0.60	125W / 144W
Vivid-R 21 (SELVR21)	120 / 240	2.10 / 1.20	250W / 288W
Vivid-R 42 (SELVR42)	120 / 240	3.60 / 2.00	430W / 480W
Vivid-R 63 (SELVR63)	120 / 240	6.30 / 3.60	750W / 864W

ADDITIONAL ORDERING INFORMATION

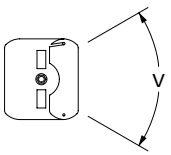
Continued from front page...

Selador Vivid-R Accessories

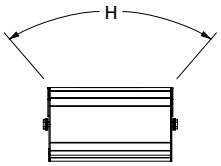
MODEL	DESCRIPTION
SELLH(degree)	20°, 30°, 40°, 50°, 60°, 70° or 80° Secondary Lens – Horizontal dispersion
SELLV(degree)	20°, 30°, 40°, 50°, 60°, 70°, or 80° Secondary Lens – Vertical dispersion
SELYOKE11	Yoke Kit for 11in unit with C-clamp and hardware
SELYOKE21	Yoke Kit for 21in unit with C-clamp and hardware
SELDYOKE11	Double Yoke Kit for 11in unit with C-clamp and hardware
SELDYOKE21	Double Yoke Kit for 21in unit with C-clamp and hardware
SELTRU	Trunnion / Floor Stand Kit (set of 2 with hardware)
MPARHBK	Hanger Bracket Kit (set of 2 with C-clamps and hardware)
400SC	Safety cable (32-inch)

Secondary Lenses

Vertical Spread



Horizontal Spread



DMX CONTROL CHANNELS

DATA CHANNEL		COLOR	VALUE	FUNCTION
1	Luminaire Address	Red	0-255	Intensity 0-100%
2	Luminaire Address + 1	Red-Orange	0-255	Intensity 0-100%
3	Luminaire Address + 2	Amber	0-255	Intensity 0-100%
4	Luminaire Address + 3	Green	0-255	Intensity 0-100%
5	Luminaire Address + 4	Cyan	0-255	Intensity 0-100%
6	Luminaire Address + 5	Blue	0-255	Intensity 0-100%
7	Luminaire Address + 6	Indigo	0-255	Intensity 0-100%
8	Luminaire Address + 7	Master Intensity Control	0-255	Overall Intensity 0-100%

Note: Use individual color channels to create color mix. Use Master Intensity Control to set luminaire intensity. Master Intensity Control (Channel 8) must be above 0% for luminaire to output.

NOTES ABOUT LED LUMINAIRES

All LED sources experience some lessening of light output and some color shift over time. LED output will vary with thermal conditions. With typical usage, a Selador luminaire will still achieve 70% of its initial output after 50,000 hours. In individual situations, LEDs will be used for different durations and at different levels. This can eventually lead to minor alterations in color performance, necessitating slight adjustment to presets, cues or programs.

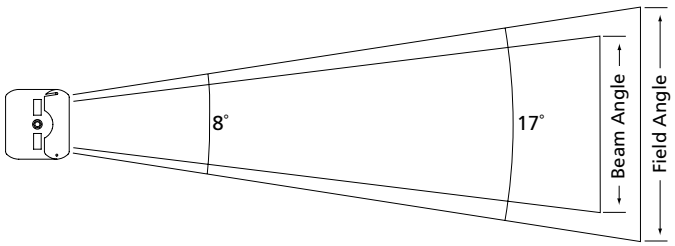
OUTPUT AND EFFICACY DATA FOR VARIOUS GEL COLORS

Output information for a Source Four PAR EA with 575W/115X HPL lamp is provided for each line of the listed gel colors for comparison.

Gel	Field Lumens	Watts	Efficacy	Par Field Lumens	Par Efficacy
L116	730	44.7	16.3	700	1.22
G945	240	39	6.2	62	.11
G250	460	45.3	10.2	437	.76
G245	535	47.2	11.3	767	1.33
AP7570	1230	73.3	16.8	2027	3.53
AP6300	990	50.9	19.4	4592	8.00
AP5300	780	42.91	18.5	151	.26
R382	110	28.8	3.8	31	.05
R80	560	49.8	11.2	258	.45
R343	890	64.3	13.8	1568	2.73
L345	1460	95.8	15.2	801	1.40
L344	1480	90.8	16.3	1002	1.74
3200K	1450	77.4	18.7	5320	9.25
Full (all channels at 100%)	1750	108	16.2	5322	9.25

PHOTOMETRICS

Photometric data taken with all channels at full. Data reflects the output of one 11in unit. See chart on page 2 for lumen and efficiency information in sample gel colors. Information for PAR fixtures with the same gel colors is presented for comparison. Due to the variability of all LEDs, output data and color matched should be viewed as approximate. Photometric data for individual lenses and lens combinations may be found at www.etcconnect.com/docs/docs_downloads/techdocs/Selador-Lens-Photometrics.xls



Throw Distance (d)	10′ 3.0m	15′ 4.6m	20′ 6.1m	25′ 7.6m
Field Diameter	2.9′ 0.9m	4.4′ 1.3m	5.9′ 1.8m	7.3′ 2.2m
Illuminance (fc)	790	351	198	126
Illuminance (lux)	8,503	3,779	2,126	1,361

For illumination with any lamp, multiply the candlepower of a beam spread by the multiplying factor (mf) shown for that lamp.

To determine illumination in footcandles or lux at any throw distance, divide candlepower by distance squared.

For Field diameter at any distance, multiply distance by .294

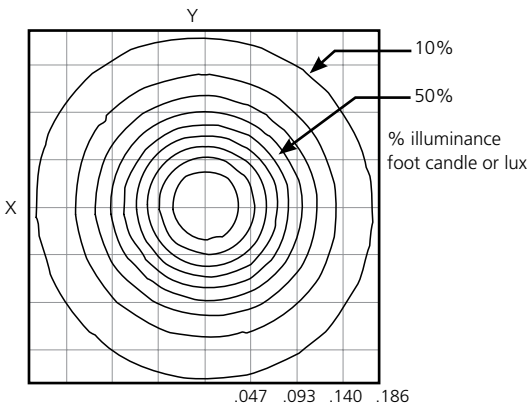
For Beam diameter at any distance, multiply distance by .136

Selador Vivid-R

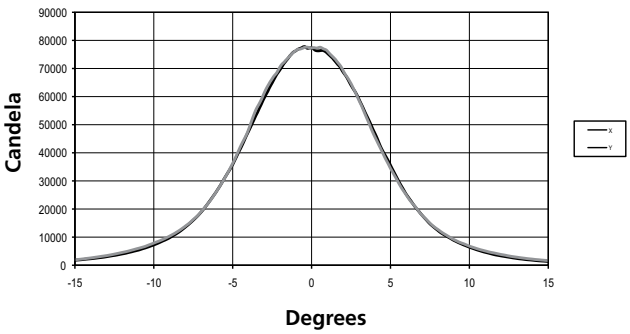
Degree	Candela	Field Lumens	Beam Lumens	Lumens per Watt
17°	79,000	1,750	820	16.2

Metric Conversions: For Meters multiply feet by .3048
For Lux multiply footcandles by 10.76

Iso-Illuminance Diagram
(Flat Surface Distribution)



Cosine Candela Plot



*** Throw Distance Multiplier (TDM)

To determine the distance from the center of the beam (Origin) to a certain illuminance level at a particular distance, multiply the desired throw distance by the TDM desired on the Iso-Illuminance diagram.

Throw Distance (TD) x Throw Distance Multiplier (TDM) = Distance from the Origin (DfO) (distance from the center of the beam)

Example: 25 feet (TD) x 0.047 (TDM) = 1.175 feet from center of beam (DfO)

PHYSICAL

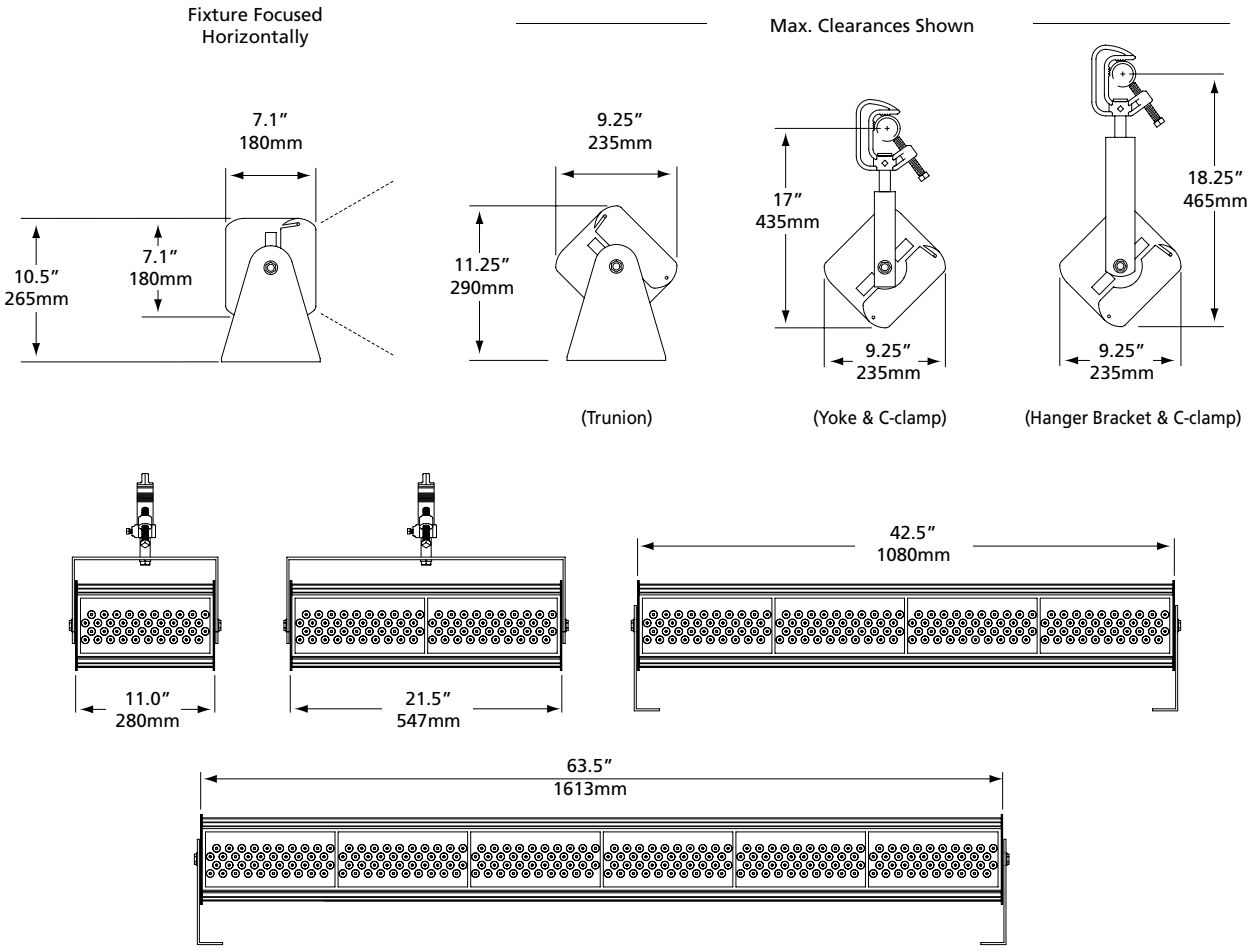
Selador Vivid-R Dimensions & Weights

MODEL	# OF LEDS	LENGTH		HEIGHT		DEPTH	
		in	mm	in	mm	in	mm
SELVR11	40	11.0	280	7.1	180	7.1	180
SELVR21	80	21.5	547	7.1	180	7.1	180
SELVR42	160	42.5	1080	7.1	180	7.1	180
SELVR63	240	63.5	1613	7.1	180	7.1	180

WEIGHT*		SHIPPING WEIGHT	
lbs	kgs	lbs	kgs
11.5	5.2	15	6.9
20	9.1	25	11.4
35	15.9	42	19.1
53	24.1	62	28.2

40 Luxeon® Rebel 2.5W LEDs in each 11-inch (280-mm) length of fixture.

* Does not include mounting hardware



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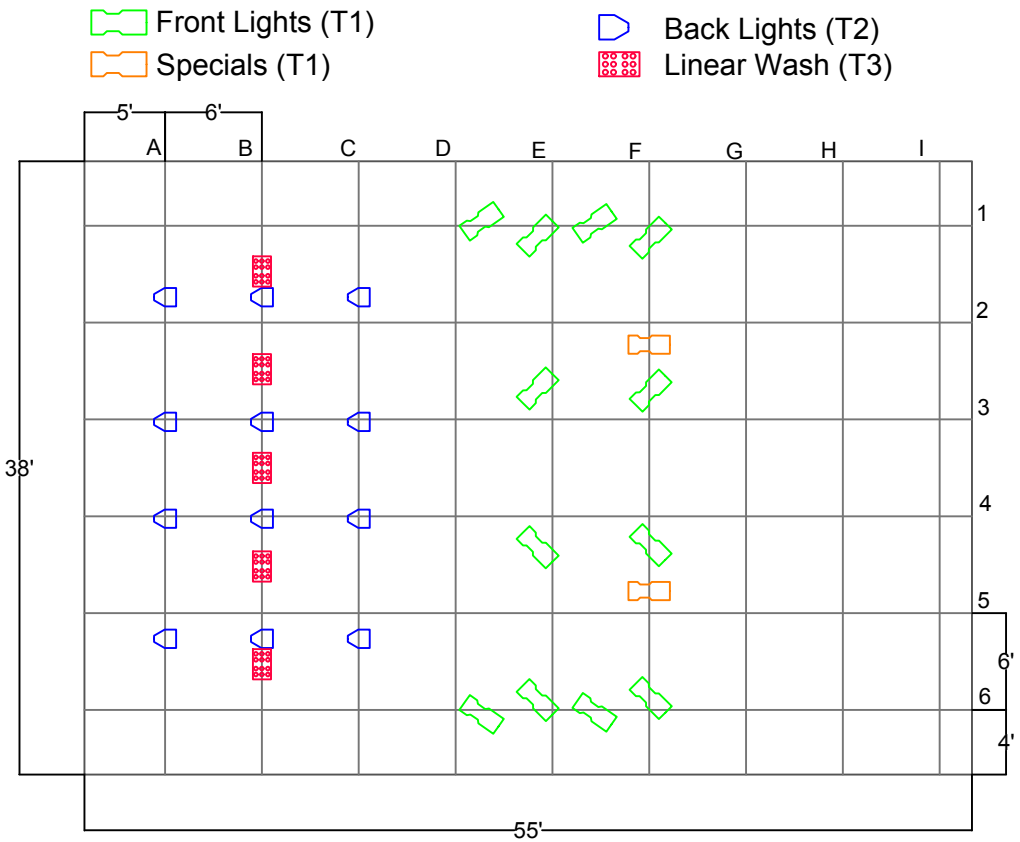
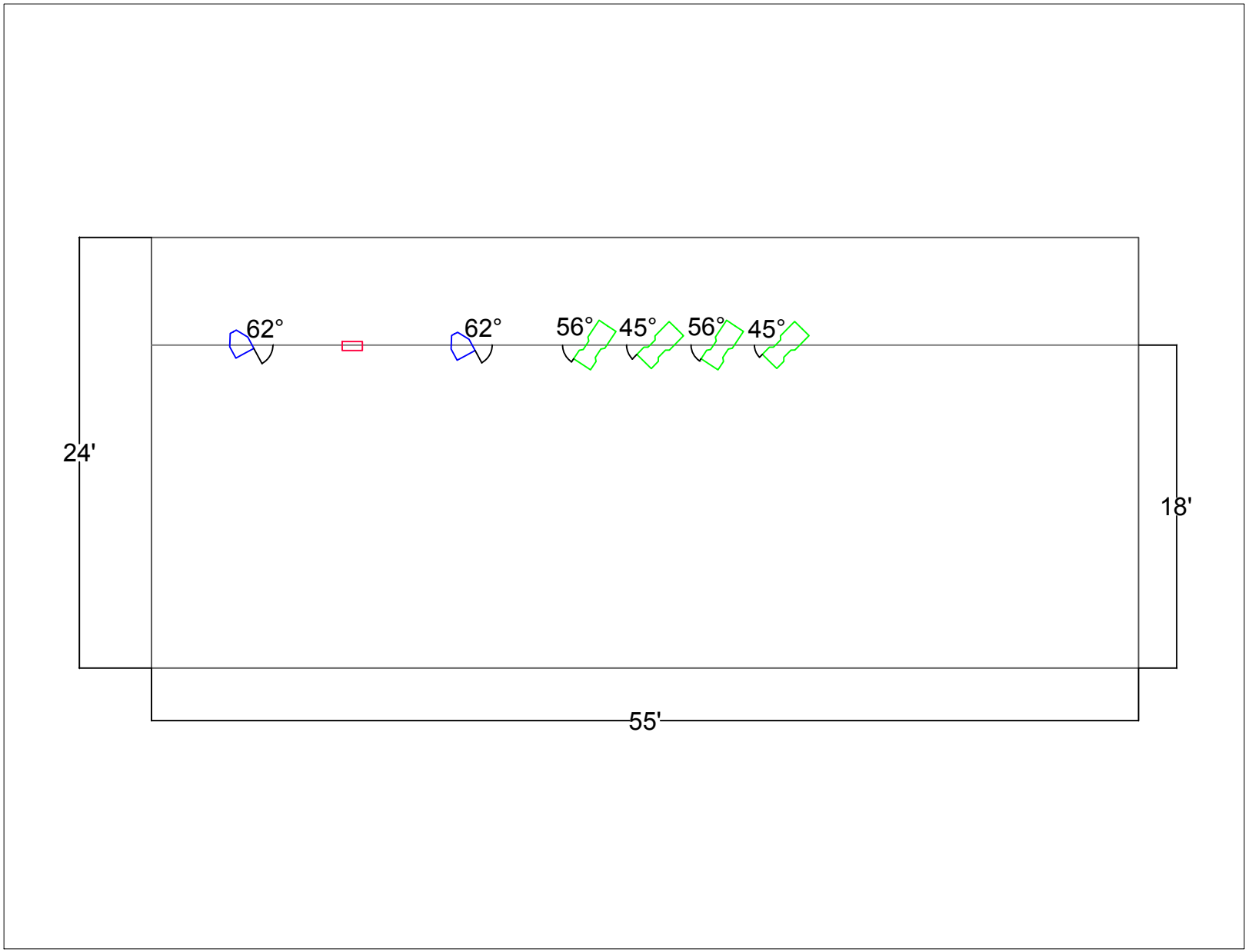
Appendix B

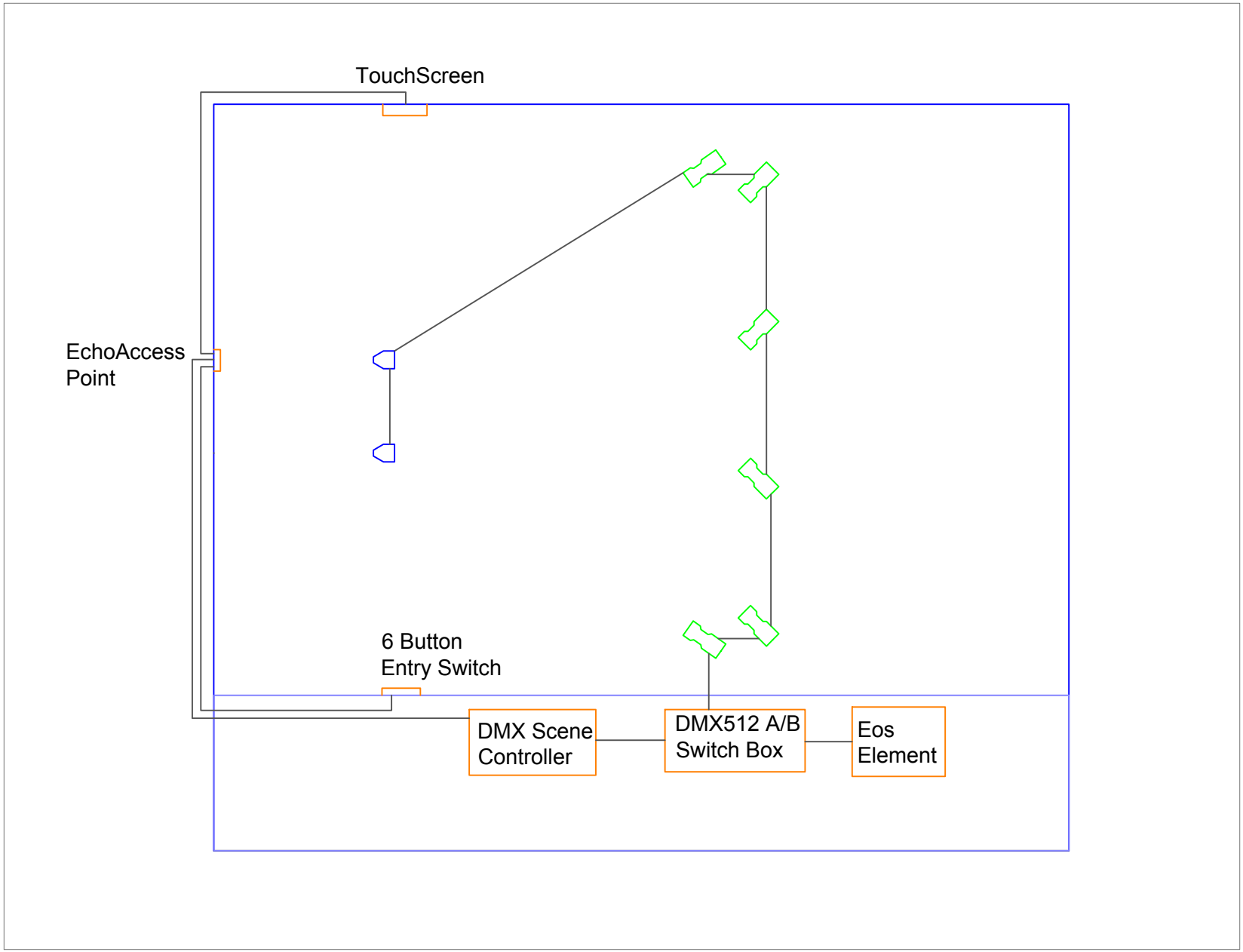
Fixture Schedule

Type	Description	Manufacturer	Catalog Number	Lamp Type	Volt.	Input Watts	Color Temp
L1	10" HO 9000 lumen LED cylinder pendant. 45° beam spread. 0-10V dimming to 1%. Semi-specular clear reflector. 26" Housing with Matte White finish and Solite Lens	Prescotlite	MC10LED-P-9L-35K-9-DM1-WFL45-SS-SL-26-WH	LED	MVOLT	99	3500
L2	10" HO 6000 lumen LED cylinder pendant. 45° beam spread. 0-10V dimming to 1%. Semi-specular clear reflector. 26" Housing with Matte White finish and Solite Lens	Prescotlite	MC10LED-P-6L-35K-9-DM1-WFL45-SS-SL-26-WH	LED	MVOLT	66.5	3500
L3	10" HO 3000 lumen LED cylinder pendant. 45° beam spread. 0-10V dimming to 1%. Semi-specular clear reflector. 26" Housing with Matte White finish and Solite Lens	Prescotlite	MC10LED-P-3L-35K-9-DM1-WFL45-SS-SL-26-WH	LED	MVOLT	33.9	3500
L4	6" High Efficacy LED. 0-10V dimming to 10%. 1100 lumen module with 45° cutoff. Semi-diffuse reflector finish with white trim	Prescotlite	LF6LEDG4-6LFLED5G435KWT	LED	MVOLT	14	3500
L5	Low profile semi-recessed 6"x24" 700mA LED wall washer. Overlapping flange with adjustable mounting brackets. Matte white finish with dimming driver 0-10V to 5%	Lighting Quotient	S244-M021-L-22-M-00-0-35-ZX	LED	MVOLT	48	3500
L6	1900 mm LED pendant. 0-10V dimming. White finish with silver power cable and standard mounting	Sattler	773.63.51.00.11.Z70.I	LED	MVOLT	255	3000
L7	0.5" Illuminated width orange light tape exterior rated. 4' sections with 120V AC power	Light Tape	lt-050-EXT-4'-ORA-AC120	LED	MVOLT	0.016/ft^2	NA
L8	10" HO 12000 lumen LED cylinder pendant. 45° beam spread. 0-10V dimming to 1%. Semi-specular clear reflector. 26" Housing with Matte White finish and Solite Lens	Prescotlite	MC10LED-P-12L-35K-9-DM1-WFL45-SS-SL-26-WH	LED	MVOLT	132	3500
L9	1900 mm LED pendant. 0-10V dimming. White finish with silver power cable and 4 point suspension mounting	Sattler	956.63.51.00.11.Z70.A	LED	MVOLT	110	3000
L10	15W 95CRI LED spot light. Attachs to live track on Oculi fixture	Sattler	960.68.01.00.11	LED	MVOLT	15	3500
L11	Lumenline recessed T-BAR mounting, 2" wide. 4' length, HO 12W/ft. 0-10V dimming. Standard tile NFG t-bar 9/16", 1-1/2", centered in tile with white trim	Lumenpulse	LL12R TBAR 120 4 DHO 35K DIM S NFG WH CCEA	LED	120	48	3500
L12	Kipp post LED with black finish, surge protection and 0-10V dimming	Louis Poulson	KIP-PT-44W LED 3000K 120-277V BLK DIM 0-10V 10000130218	LED	MVOLT	44	3000
L13	FF LED flood. Trunnion mount. 4H x 4V beam spread. Bronze finish and dimmable	RAB	FFLED39TYB44/D12	LED	MVOLT	39	3000
L14	2" dia. recessed LED downlight. Flood optic with satin nickel finish.	Juno	MD1LWG2-3K-FL-SN	LED	MVOLT	5	3000
T1	ColorSource Spot with 5' PowerCon to 20A two-pin and ground connector. 26° EDLT w/lens installed and C clamp	ETC	CSSSPOTS-0-DPA-B-S4LED-SFD-426EDLT-C-CLAMP	LED	120	148	NA
T2	ColorSource Par with 5' PowerCon to 20A two-pin and ground connector. Yoke with floor-stand attachment	ETC	CSPAR-DPA-B-CSPARFSY	LED	120	90	NA
T3	Selador Vivid 21" with PowerCon to 20A two-pin and ground pig tail. Secondary vertical lens and yoke kit	ETC	SELVR21-SPA-B-SELV-SELYOKE21	LED	120	250	NA

Appendix C


Front Lights (T1)
Specials (T1)
Back Lights (T2)
Linear Wash (T3)
5'
6'
A
B
C
D
E
F
G
H
I
1
2
3
4
5
6
38'
6'
4'
55'


62°
62°
56°
45°
56°
45°
24'
18'
55'


TouchScreen
EchoAccess
Point
6 Button
Entry Switch
DMX Scene
Controller
DMX512 A/B
Switch Box
Eos
Element

ETC®

Element™ Control Console

Eos® Series

100V 115/120V 230/240V

GENERAL INFORMATION

Designed for venues using primarily conventional lighting, the Element control console provides the powerful features of the Eos system in an economical and simplified package. In addition to keypad commands, True LTP Channel Faders provide hands-on control of intensity and can be used to set manual levels and edit recorded cues and submasters. Moving Light Controls are available to facilitate the use of conventional accessories like moving mirror heads, color scrollers or gobo rotators, or to make controlling small numbers of moving lights simple and direct. Element can be backed up by another Element, ETCnomad™ 1024 dongle or ETCnomad Puck™ 1024 mini-computer.

FEATURES

- 1,024 Outputs
- 250 or 500 Channels
- 40 or 60 Fader versions, pageable as channel or submaster control
- User Definable Direct Selects
- User Configurable, interactive Magic Sheets
- Master Playback pair with 60mm faders, Go, Stop/Back
- Intensity, Focus, Color and Beam Palettes
- Stepped, Relative and Absolute Effects
- Six Color Pickers and Gel Picker for LED, CMY color mixing
- ETCNet2™, Net3™/ACN, ArtNet and Avab UDP output protocols
- Show import from Obsession®, Express™, Expression®, Emphasis®, Congo®, Cobalt®, Safari, Strand 500/300 Series, Grand MA1 and Grand MA2
- Distributed DMX, MIDI, SMPTE and contact closure via Net3 Gateways
- OSC Transmit/Receive
- UDP Transmit/Receive
- Support for multiple languages, including English, German, Spanish, French, Italian, Japanese, Korean, Russian and Chinese (Simplified and Traditional)

ORDERING INFORMATION

Element

MODEL	DESCRIPTION
LMNT-40-250	Element Console, 40 Faders, 250 Channels
LMNT-40-500	Element Console, 40 Faders, 500 Channels
LMNT-60-250	Element Console, 60 Faders, 250 Channels
LMNT-60-500	Element Console, 60 Faders, 500 Channels
LMNT-UPGD	Element 250 - Channel Upgrade

ETCNet2 or Net3 is distributed using Net3 Gateways, which provide DMX, MIDI/SMPTE Time Code and switch-closure functionality. MIDI In/Out and switch-closure are also available locally at the console.

Two universes of DMX512A output are available at the console via 5-pin XLR. These also support RDM.

Element Accessories

MODEL	DESCRIPTION
Net3 RFR	Net3 Radio Focus Remote
Net3 RFR-RX	Net3 Radio Focus Remote, Receiver Only
Net3 RFR-TX	Net3 Radio Focus Remote, Transmitter Only
Net3 RVI	Net3 Remote Video Interface (Element supports Mirror Mode* operation only)

*Mirror Mode provides remote display and paging of the same screens that are displayed on the console itself. Synchronized backup is provided by another Element console or a Nomad™.

Element supports two external monitors compatible with Windows 7, 1280x1024 minimum resolution, standard, touch or multi-touch. These may be two DVI or one DVI and one Display port

SHIPS WITH:

- Dust cover
- Mouse and mousepad

SPECIFICATIONS

SYSTEM CAPACITY

- 1,024 Outputs/Parameters
- 250 or 500 Channels
- 10,000 Cues
- One Cue List
- 4 x 1000 Palettes (Intensity, Focus, Color, Beam)
- 1,000 Groups
- 1,000 Effects (relative, absolute or step)
- 1,000 Macros
- 1,000 Snapshots
- 1,000 Color Paths
- Supports two external DVI monitors or one Display Port monitor with a minumum of 1280x1024 resolution, which may also be touch- or multi-touchscreens
- Solid-state hard drive
- USB ports for flashdrives, pointing devices, keyboards

DISPLAY FUNCTIONS

- All show data may be viewed on one or two external monitors. Views may be expanded across both from easily-accessed front-panel controls. Three user-configurable workspaces per display, with split screen/sizing controls
- The Central Information Area accesses:
  - Browser
  - File Management
  - System Setup
  - Network Configuration
  - Show Data Utilities
  - Printing
  - Record Target Lists
  - Patch functions
  - Help
  - Six Color Pickers and Gel Picker
  - On-Demand Moving Light Controls
  - Electronic alpha keyboard
  - Command Line
  - Selected Cue
  - Error messages and advisories
- Channel Displays
  - Live channel summary or table view
  - Blind cue, palette and submaster views in list, channel, table and spreadsheet formats
  - Flexi-channel to determine which channels to display
  - Zoom allows user to define how many channels are viewed
  - Color-coded intensity levels indicate direction of move
  - Color-coded non-intensity levels indicate change from previous state
  - Graphic differentiation of moving lights, single-parameter devices, unpatched channels and deleted channels
- Magic Sheets
  - User-definable interactive display layouts
  - Images and symbols may be imported

SPECIFICATIONS

- Patch Views
  - Patch by channel
  - Patch by address
  - Patch by Device List (RDM)
  - Assign proportional patch value, curve, preheat value for intensity
  - Swap pan and tilt
  - Invert pan and tilt
  - Custom fixture editor
- Playback Status Display
  - Graphic representation of cue list status and past and future cues
- Cue List Index
- Effects Editor
- Group Editor
- Park Display
- Dimmer Monitoring

PLAYBACK CONTROLS

- Master Playback crossfade pair with two 60mm potentiometers, Go, Stop/Back and Load buttons
- Grand Master with Blackout
- Playback fader controls include:
  - Timing Disable
  - Off
  - Release
  - Manual Override
  - Rate
- A maximum of 300 submasters (additive or inhibitive) via integral faders

MOVING LIGHT CONTROLS

- On-Demand Moving Light controls include labeling and current parameter value on connected display monitor
- Flip and Home functions
- Parameters selectable on screen for mouse-based or touchscreen control or command-line actions

MACROS

- May be set to play background or foreground
- Startup and shutdown Macros

SPECIFICATIONS

MANUAL CONTROL

- Channel selection from keypad
- Lists constructed with +, -, thru
- Intensity set with level wheel, keypad, "full" and "out"
- True LTP channel faders for direct hands-on intensity control
- Ordered groups
- Offset, including even, odd, random, reverse
- Sneak
- Remainder Dim and restore
- Home by parameter, parameter category or all non-intensity parameters
- Park at level
- Scaled park for temporary percentage adjustment
- 'Recall' from and 'Copy' to commands
- 'About' provides detailed view of selected channels or record targets
- Undo manual control, record, update and delete operations
- Lamp controls to strike, douse, calibrate fixtures

PROGRAMMING FEATURES

- Channel Functions
  - Non-Intensity parameters set via numeric entry or On-Demand Moving Light Controls
  - Color matching to gel selector
  - Color Path, color tinting and color spectrum tools.
- Palette Functions
  - Record and Update functions
  - Toggle display to absolute data
  - Up to 99 decimal values may be inserted between any two whole numbers
  - Selective store to refine contents of record targets
- Effects
  - Create live or blind
  - Pattern-based relative dynamic effects
  - Absolute effects
  - Step effects
  - Cycle time, trail and grouping determine channel distribution and behavior when moving through effect
  - Duration of infinite, a specific amount of time or number of passes through pattern
  - Effect attributes to modify basic behavior
  - Channel Level overrides
  - Cue Level overrides
  - Entry mode determines how parameters enter effects
  - Exit mode determines how parameters depart effects
- Cue Recording
  - Record tracking or cue-only
  - Auto-playback recorded cues

SPECIFICATIONS

  - Auto-mark
  - Block at cue, intensity or parameter level
  - Follow times
  - Out of sequence link
  - Loop functions
  - Preheat enable
  - Twenty-part multi-part cues with default part assignment
  - Cue level rate override
  - Up to 99 decimal cues between every two complete numbered cues
  - Execute List
    - Triggers macros with delay
    - Show-control triggers
    - Analog triggers
  - Update and Update Trace functions
  - Undo record and delete
- Submasters
  - Additive, inhibitive or effect submasters
  - Bump button timing to fade up, dwell and fade out
  - Exclusive and Shielded modes
  - Faders as progress controller or intensity master
  - Bump button to mark NPs
  - Priority status
- Curves
  - Assignable in patch to modify dimmer output ramp
  - Assignable at cue or cue part-level to modify intensity crossfade profile or non-intensity parameter ramping

INTERFACES

- Two DMX/RDM Ports
- Two Ethernet ports (ETCNet2™, Net3™, Artnet and Avab UDP output protocols)
- Contact Closure triggers via D-Sub connector
- Two DVI video connectors support two external DVI displays (1280x1024) with optional touch or multi-touch control
- One Display Port connector
- Seven multipurpose USB ports
- OSC Transmit/Receive
- UDP Transmit/Receive
- Net3 Radio Focus Remote
- MIDI In/Out (Timecode, Show Control)
- Additional MIDI/SMPTE Time Code and Show Control through Net3 Gateway
- Additional contact closure (12 analog inputs, 12 SPDT contact outputs, RS-232) through Net3 Gateway
- One eSATA port

ELECTRICAL

- AC input (100-240V at 50/60 Hz)
- 2A at 120V or 1A at 240V maximum power consumption

PHYSICAL

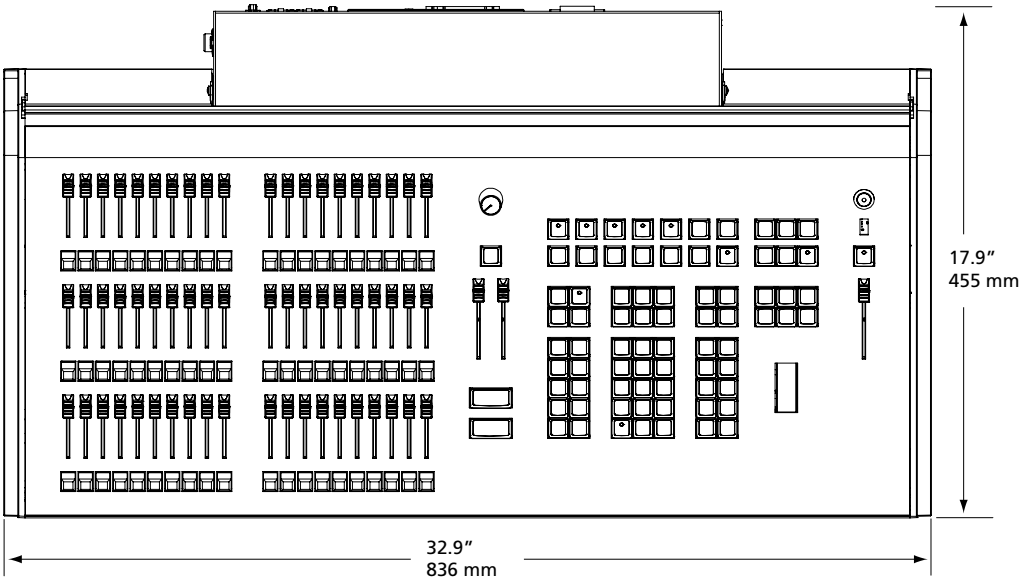
Element Console Dimensions*

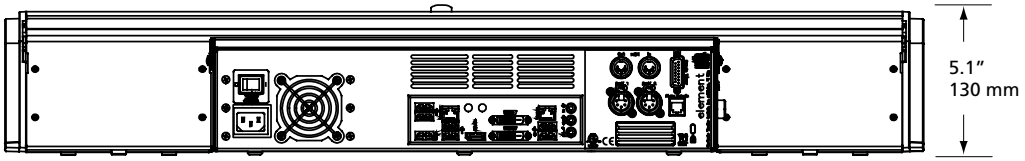
MODEL	HEIGHT		WIDTH		DEPTH	
	inches	mm	inches	mm	inches	mm
Element Console	5.1	130	32.9	836	17.9	455

Element Console Weights*

MODEL	WEIGHT		SHIPPING WEIGHT	
	lbs	kgs	lbs	kgs
Element Console	30	13.6	37.5	17

*Weights and dimensions typical





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Web • www.etcconnect.com 4330L1003 Rev L USA 07/15

ETC® Unison Echo® EchoConnect™ Station Power Supply

100V 120V 230/240V 277V

Echo Control Series

GENERAL INFORMATION

A member of ETC's Unison Echo family of lighting-control and power-control products, the Echo Station Power Supply provides EchoConnect power for stations, Responsive Controls and Power Controllers. The Echo Station Power Supplies are designed for use with distributed Echo Control Systems, Unison® DRd Power Enclosures with Echo control, Echo Relay Panels and Sensor3 Power Control Systems.

APPLICATIONS

- Houses of worship
- Education
- Hospitality
- Healthcare facilities
- Office buildings
- Conference rooms
- Meeting rooms
- Retail

FEATURES

- Designed for use with any EchoConnect-enabled station, Responsive Controls or Echo Power Controllers
- EchoConnect: Two-wire, topology-free system gives you the freedom to put stations where you need them
- Multiple form factors and mounting options available
- Plug and play: ready to go out of the box with no software or programming required

SYSTEM LIMITATIONS

- Up to 500 meters (1640 feet) of control wiring
- DRd, Wall- and Rack-Mount:
  - Up to 16 stations and Responsive Controls
  - Up to 16 power controllers or panels
- Echo Station Power Supply
  - Up to six stations and Responsive Controls
  - Up to six power controllers or panels

GENERAL

- UL and cUL LISTED
- CE marked

ORDERING INFORMATION

EchoConnect Power Supplies

MODEL	DESCRIPTION
E-SPS	Echo Station Power Supply, Knockout Mount
E-SPM-WM	Wall-Mount Station Power Module
E-SPM-RM	Rack-Mount Station Power Module
E-SPM	DRd Station Power Module
E-SPM-WM-A	Wall-Mount Station Power Module with 24V Aux
E-SPM-RM-A	Rack-Mount Station Power Module with 24V Aux
E-SPM-A	DRd Station Power Module with 24V Aux
E-APS	24V Aux Power Supply, Knockout Mount

EchoConnect Power Supply Accessories

MODEL	DESCRIPTION
E-C5T-ST	Category-5 Station Wiring Kit
E-C5T-WM	Category-5 Wiring Termination Box
E-C5T-RM	Category-5 Wiring Termination Tray

Compatible Stations and Sensors

MODEL	DESCRIPTION
E100X	Inspire® Button Stations
E1104	Inspire Fader Station
ELS	Light Sensor
EOCC	Occupancy/Vacancy Sensor
EPS05/ EPS10	Preset Stations
E-ATC	Echo TimeClock

ORDERING INFORMATION

Compatible Interfaces

MODEL	DESCRIPTION
EACC	EchoAccess™ Interface
EDMXC	Echo DMX Scene Controller

Compatible Power Controls

MODEL	DESCRIPTION
ERC	One-Zone Relay Controller
EDRC	Two-Zone Relay Controller
ELD	One-Zone 0-10V Dimming Controller
EDLD	Two-Zone 0-10V Dimming Controller
ESSC	One-Zone SmartSpace Controller
EDSSC	Two-Zone SmartSpace Controller
ELVD	600-Watt Phase Adaptive Dimmer
ERP/ERP-FT	Echo Relay Panel/Echo Relay Panel Feedthrough
DRd	Unison DRd with Echo Control
SR3	Sensor3 Power Control System

SPECIFICATIONS

FUNCTIONAL

- Provides EchoConnect power for up to 6 or16 stations or Responsive Controls and 6 or 16 power controllers or panels
- Supports 500 meters (1640 feet) of control wiring from the DRd enclosure

MECHANICAL

- Echo Station Power Supply
  - Mounts using half-inch conduit knockout
  - Constructed of injection-molded ABS plastic
- DRd, Wall- and Rack-Mount:
  - 18-gauge formed steel construction
  - Fine-texture, scratch-resistant, epoxy paint
  - Convection cooled
  - Fully-contained plug-in module with no discrete wire connections (DRd only)
  - Front panel status indicators
  - Wall-mount and 19-inch rack-mount variants available

ELECTRICAL

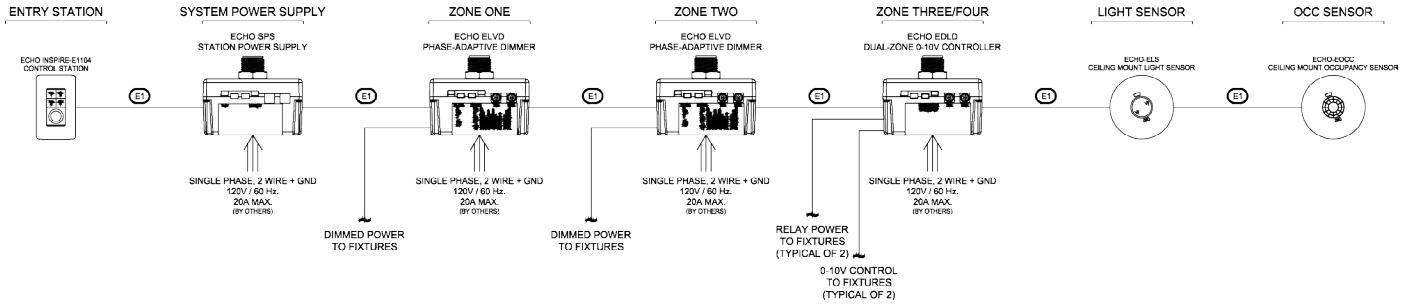
- 100V-277V, 50/60Hz, two-wire+GND power input
- Optional 24V Aux power options for connected devices
- EchoConnect two-wire control network utilizing low-voltage Class 2 wiring
- Topology-free and polarity-independent wiring over Belden 8471 or equivalent and one #14 ESD drain wire
- Wiring may be bus, loop, homerun or any combination of these
- Up to 500 meters (1,640 feet) of control wiring per system
- Supports optional Cat5 or better wiring using Belden 1583A or equivalent
  - Requires optional Cat5 termination accessories
- UL and cUL LISTED
- CE marked

THERMAL

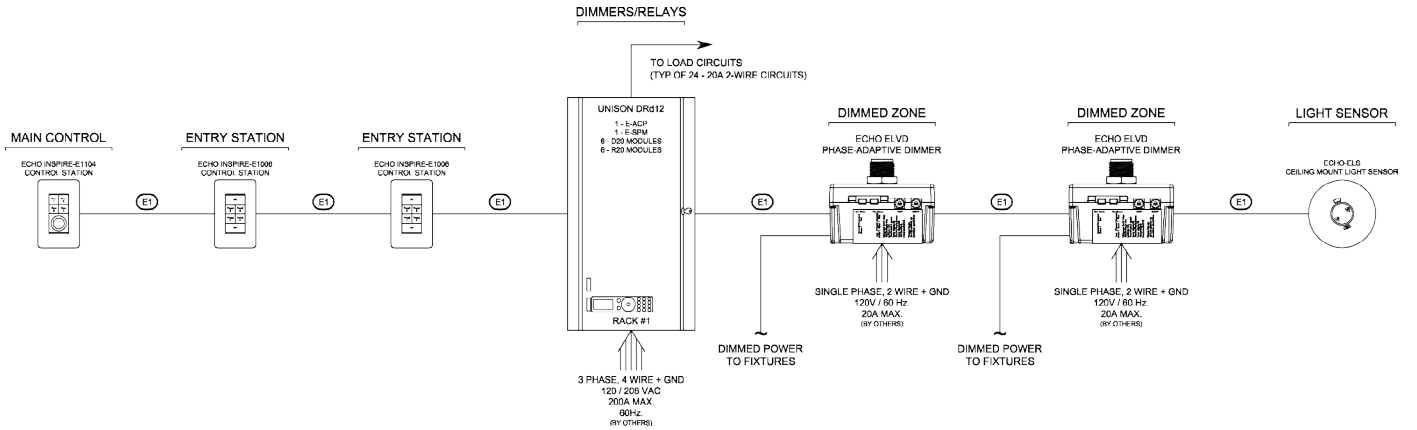
- Echo Station Power Supply:
  - Ambient room temperature: 0-50°C / 32-122°F
  - Ambient humidity: 5-95% non-condensing
- DRd, Wall- and Rack-Mount
  - Ambient room temperature: 0-40°C / 32-104°F
  - Ambient humidity: 10-90% non-condensing

SAMPLE ECHO SYSTEMS

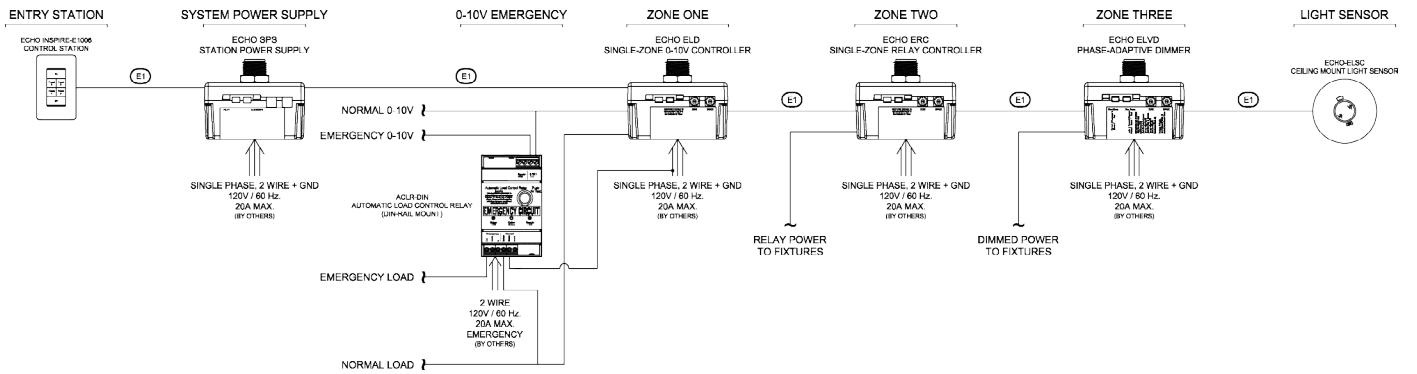
SMALL SYSTEM



MEDIUM SYSTEM

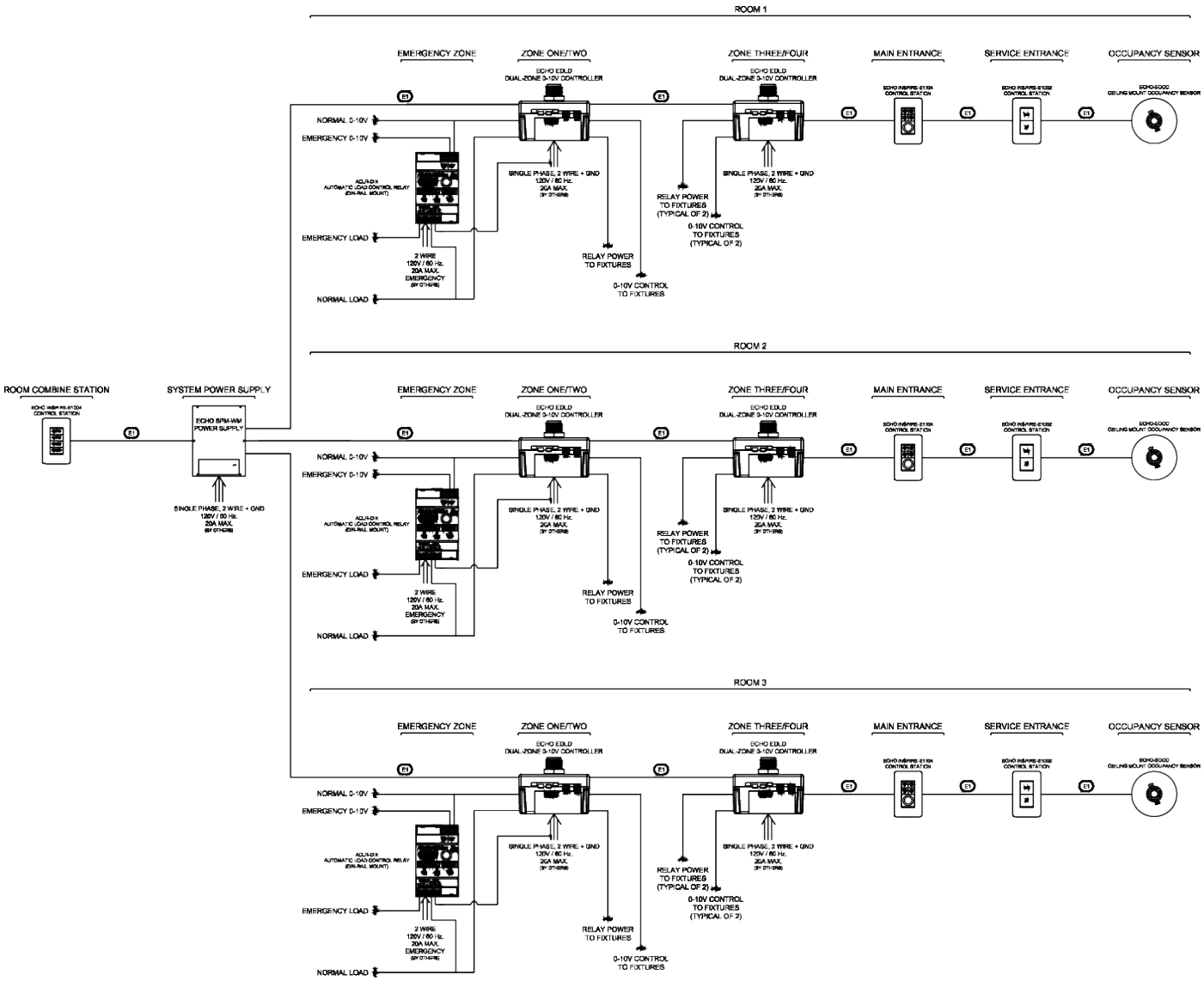


CONFERENCE ROOM



SAMPLE ECHO SYSTEMS

MEDIUM BALLROOM



PHYSICAL

Module Dimensions*

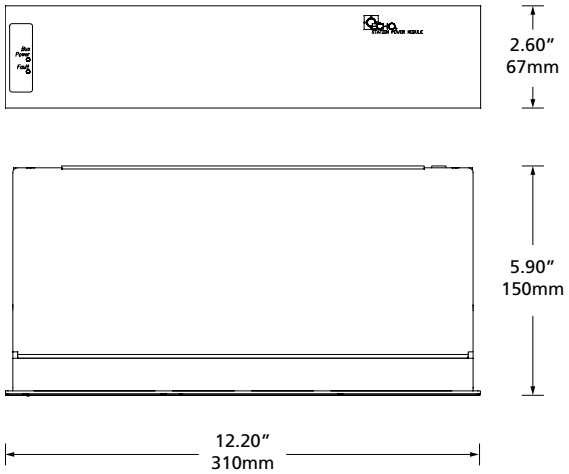
MODEL	HEIGHT		WIDTH		DEPTH	
	inches	mm	inches	mm	inches	mm
E-SPM(-A)	2.6	67	12.2	310	5.9	150
E-SPM-WM(-A)	14	356	10.5	267	3.06	79
E-SPM-RM(-A)	3.46	88	19	483	10.04	255
E-SPS(-A)	1.97	51	35	89	2.19	56

Module Weights*

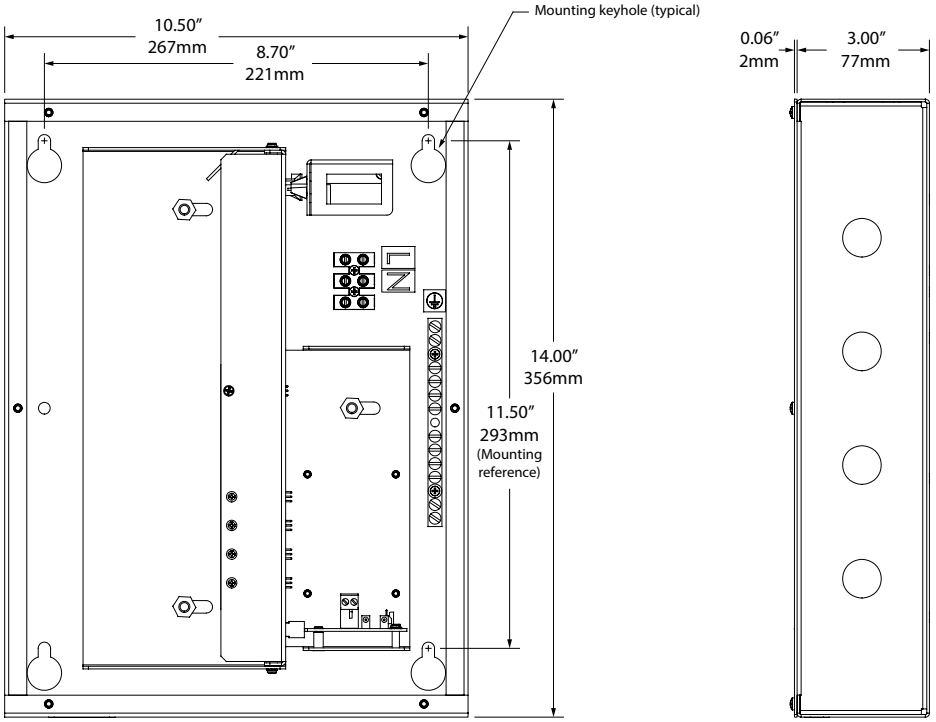
MODEL	WEIGHT		SHIPPING WEIGHT	
	lbs	kgs	lbs	kgs
E-SPM(-A)	4.8	2.18	5.8	2.63
E-SPM-WM(-A)	14.7	6.67	15.7	7.12
E-SPM-RM(-A)	15	6.80	16	7.26
E-SPS(-A)	1	0.45	1.5	0.68

*Weights and dimensions typical

E-SPM(-A)

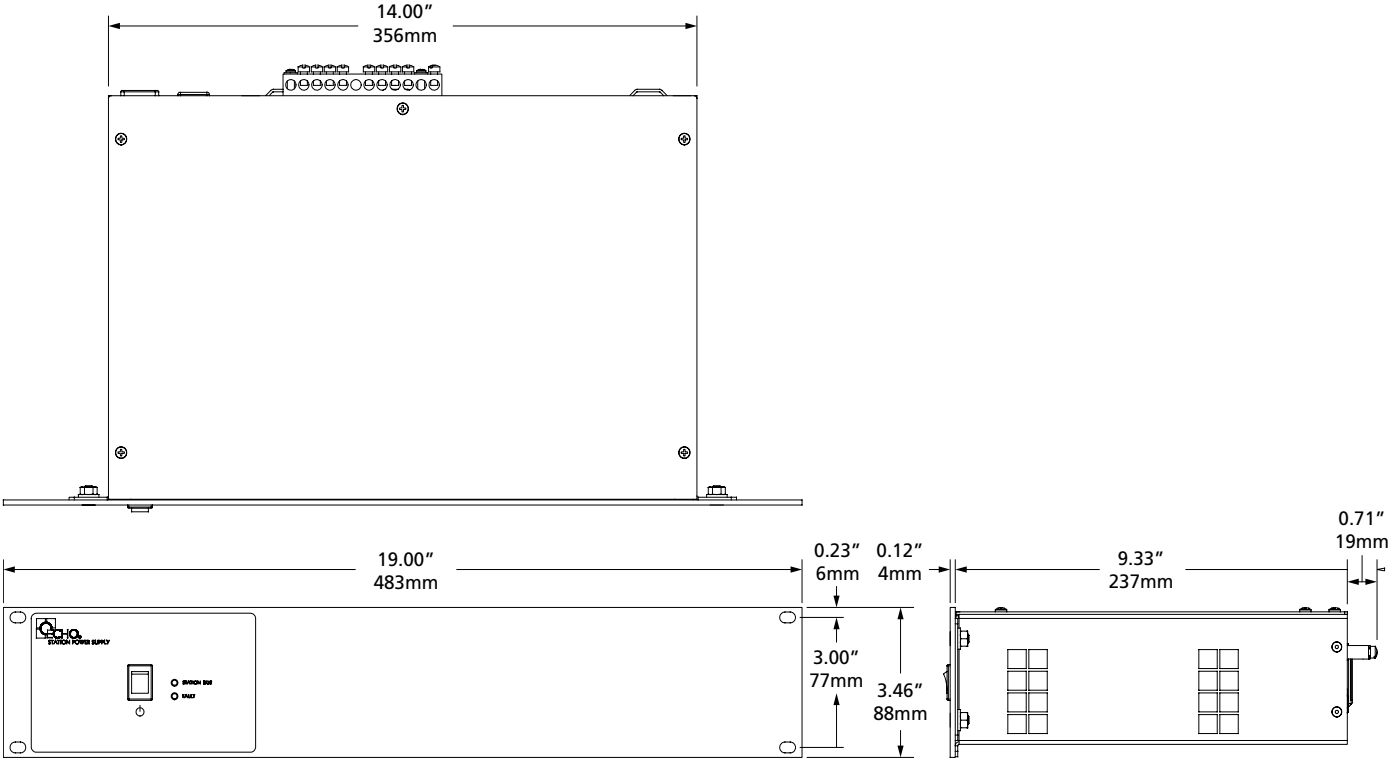


E-SPM-WM(-A)

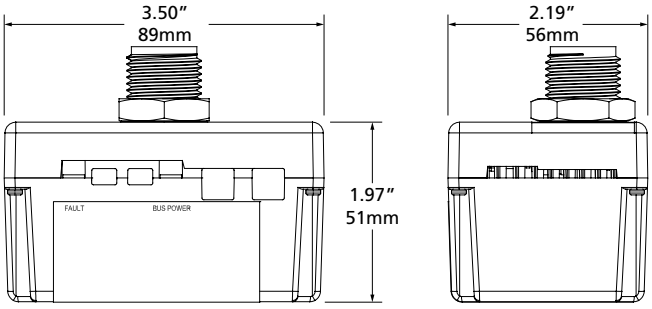


PHYSICAL

E-SPM-RM



E-SPS / E-APS



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ETC® Unison Echo® Inspire® Control Stations

115/120V

Echo Control Series

GENERAL INFORMATION

The control you need – right at your fingertips. These EchoConnect™-powered stations are designed to initiate preset, zone, and space controls for your entire system. They communicate efficiently with dimmers, relays and power control panels to provide necessary control for any installation. You can choose your level of control with a variety of button and fader stations created with your solutions in mind.

APPLICATIONS

- Education
- Hospitality
- Healthcare facilities
- Office buildings
- Conference rooms
- Meeting rooms
- Retail

FEATURES

- EchoConnect: two-wire topology-free system gives you the freedom to easily place stations wherever they are needed
- Fastener-Free Faceplate System: no visible means of attachment
- Decorator style face places available in one-, two-, three- and four-gang options
- Color condition: rear-illuminated buttons that indicate system status using blue for active and amber or off for inactive
- Simple user-legend system supports use of a variety of standard nomenclature, or user-supplied inserts

GENERAL

- UL and cUL LISTED
- CE marked

ORDERING INFORMATION

Product

MODEL	DESCRIPTION
E1001-_	Inspire 1-Button Control Station
E1002-_	Inspire 2-Button Control Station
E1004-_	Inspire 4-Button Control Station
E1006-_	Inspire 6-Button Control Station
E1008-_	Inspire 8-Button Control Station
E1104-_	Inspire 4-Button with Fader Control Station

Enter station color code in __ space provided:

1 = Cream (RAL 9001), 4 = Black (RAL 9004), 5 = Signal White (RAL 9003)

Stations flush-mount (F) in industry-standard gang boxes. (By others)

Related EchoConnect Power Supplies

MODEL	DESCRIPTION
E-SPM(-A)	DRd Station Power Module (24V Aux)
E-SPM-WM(-A)	Wall-Mount Station Power Module (24V Aux)
E-SPM-RM(-A)	Rack-Mount Station Power Module (24V Aux)
E-SPS	Room Station Power Supply
E-APS	24V Aux Power Supply, Knockout Mount

Compatible Stations, Sensors and Interfaces

MODEL	DESCRIPTION
ELS	Light Sensor
EOCC	Occupancy/ Vacancy Sensor
EPS05/ EPS10	Preset Stations
EACC	EchoAccess™ Interface
EDMXC	Echo DMX Scene Controller
E-ATC	Echo TimeClock

Compatible Output Products

MODEL	DESCRIPTION
ERC/EDRC	One/Two Zone Relay Controllers
ELD/EDLD	One/Two Zone 0-10V Dimming Controllers
ESSC/EDSSC	One/Two Zone SmartSpace Controllers
ELVD	600-Watt Phase Adaptive Dimmer
ERMCX	Echo Room Controllers
ERP/ERP-FT	Echo Relay Panel/Echo Relay Panel Feedthrough
DRd	Unison® DRd with Echo Control
SR3	Sensor3 Power Control System

SPECIFICATIONS

FUNCTIONAL

- Button and fader functions include: preset activation/ deactivation, record, raise, lower, zone on/off control and room combine
- Blue button illumination for active status
- Amber or no button illumination for inactive status
- Fader halo-illumination displays actual output level
- Zone or preset control from any station with real-time user toggle

MECHANICAL

- Standard configurations with 1, 2, 4, 6 and 8 buttons or 4 buttons and rotary fader
- Gangable for custom applications
- Enclosed electronics assembly and faceplate included
- Cantilevered switch arrays with removable button caps
- No visible means of attachment
- Flush-mount in industry standard backbox, RACO 690 or equivalent
- Surface-mount backboxes available from ETC upon request
- Constructed of injection-molded, ABS plastic in three RAL standard colors Cream (RAL 9001), Black (RAL 9004), and White (RAL 9003)
- User configurable legends on each button, or use standard legends that come with each station. Field configurable without the use of tools
- Integral LED response indicator for each button with indication of active(blue) and inactive(amber or off) state

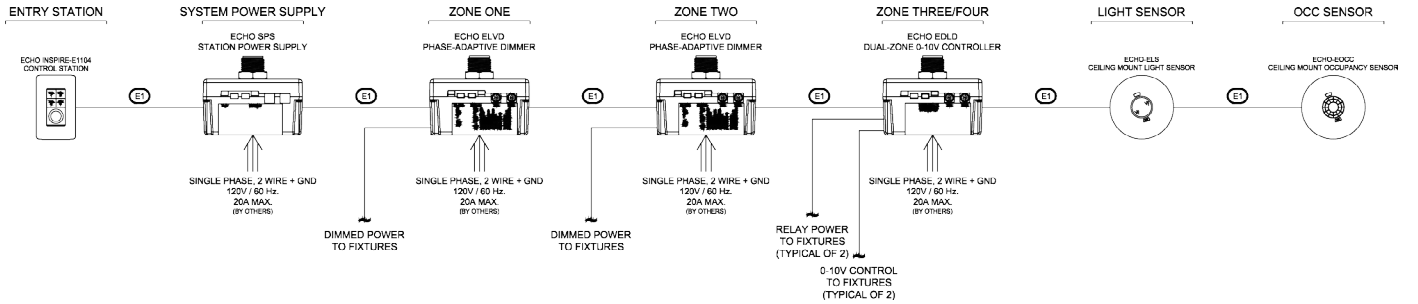
ELECTRICAL

- Connect via the EchoConnect control network via low-voltage Class 2 wiring
- Topology-free wiring over Belden 8471 or equivalent and one #14 ESD drain wire
- Supports optional use of Belden 1583A or equivalent Ethernet control wire when used with Cat5 termination accessories
- Wiring may be bus, loop, homerun or any combination of these
- Supports up to 500 meters (1640 feet) of control wiring
  - Up to 1000' using CAT5
- All station terminations utilize removable connectors
- UL and cUL LISTED, CE marked

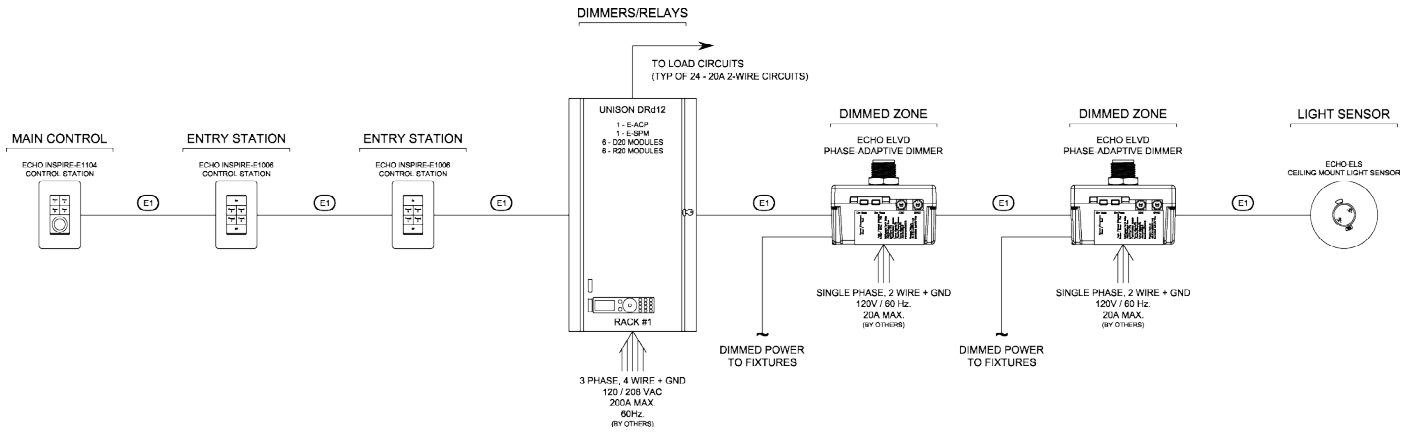
THERMAL

- Ambient room temperature: 0-50°C / 32-122°F
- Ambient humidity: 5-95% non-condensing

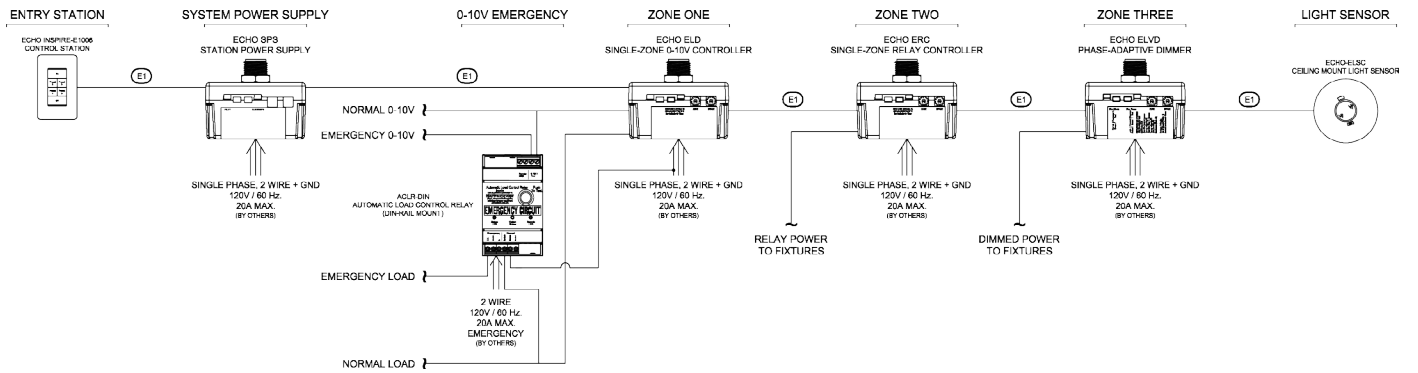
SMALL SYSTEM



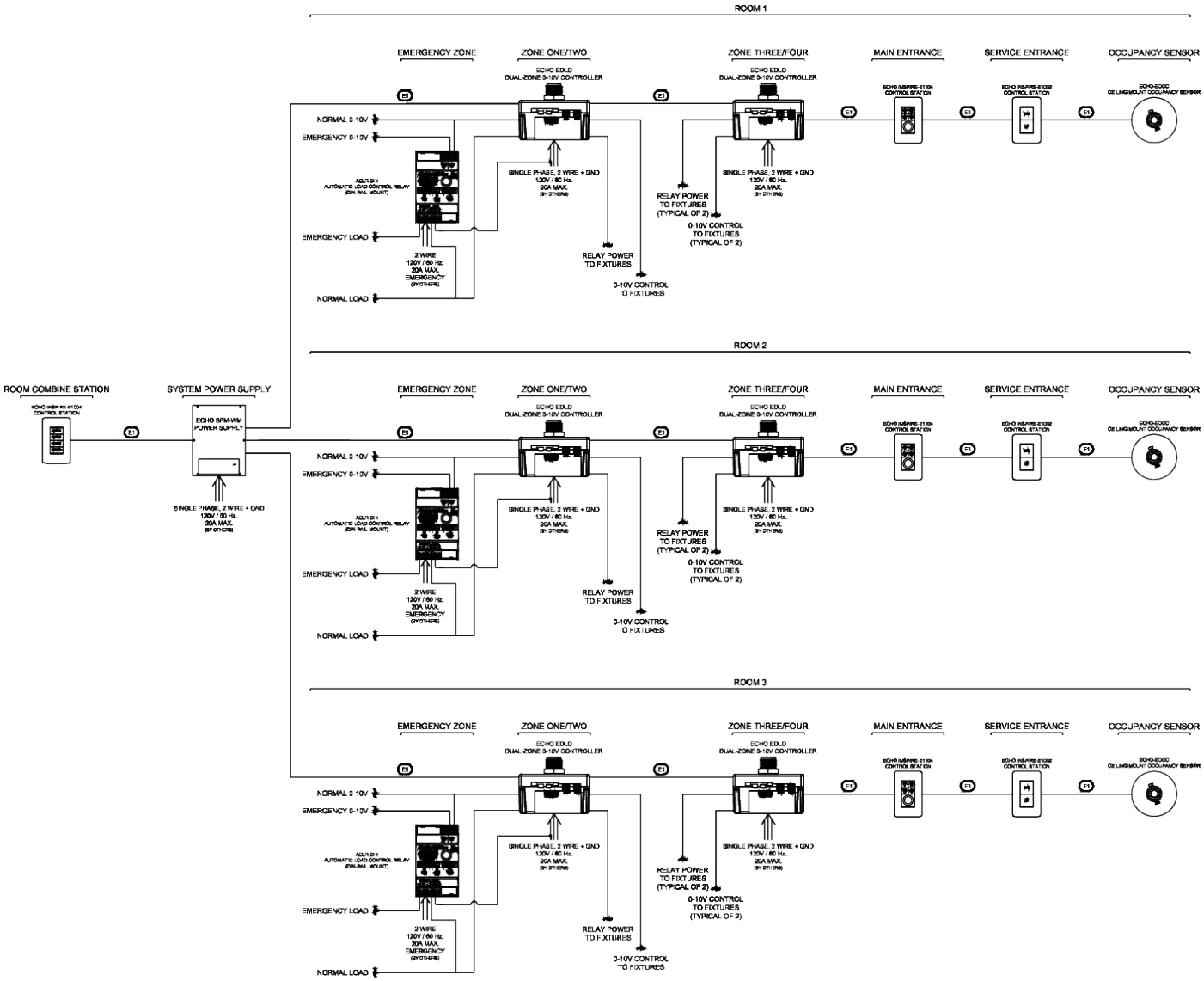
MEDIUM SYSTEM



CONFERENCE ROOM



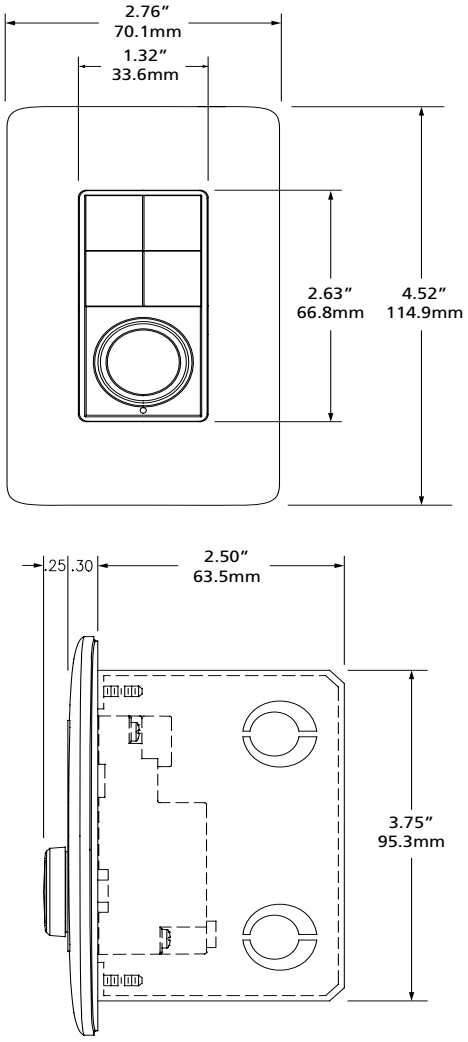
MEDIUM BALLROOM



PHYSICAL

Product Dimensions

MODEL	HEIGHT		WIDTH		DEPTH	
	inches	mm	inches	mm	inches	mm
E100X	4.52	115	2.76	71	0.30	8
E1104	4.52	115	2.76	71	0.55	14



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ETC® Unison Echo® DMX Scene Controller

115/120V

Echo Interface Series

GENERAL INFORMATION

A powerful addition to the Echo family, the DMX Scene Controller uses snapshot technology to capture lighting looks and save them to connected Inspire® control stations, simplifying customization and control of individualized zones and fixtures. Combined with EchoAccess or the Inspire Four-Button with Fader Station, the DMX Scene Controller allows for lighting hue, saturation and color to be modified locally or remotely.

APPLICATIONS

- Small theaters
- Hospitality
- Healthcare facilities
- Conference and meeting rooms
- Lobby spaces
- Retail
- Houses of worship

FEATURES

- DMX input for snapshot capture of lighting scenes
- Works with EchoAccess™ and Inspire Four-Button with Fader Station for live control of intensity, hue and saturation of Echo zones
- Supports 32 presets of 512 DMX addresses
- Support for control of 16 patched Echo zones
- Basic and custom-use modes
- EchoConnect™: two-wire topology-free system gives you the freedom to easily place stations wherever they are needed

GENERAL

- UL and cUL Listed
- CE Marked

ORDERING INFORMATION

Product

MODEL	DESCRIPTION
EDMXC	Echo DMX Scene Controller

Mounting Accessories:

MODEL	DESCRIPTION
ECHO-DIN	Echo Low-Voltage DIN-Rail Cover Kit

Related EchoConnect Power Supplies

MODEL	DESCRIPTION
E-SPM-A	DRd Station Power Module with 24V Aux
E-SPM-WM-A	Wall-Mount Station Power Module with 24V Aux
E-SPM-RM-A	Rack-Mount Station Power Module with 24V Aux
E-SPS	Echo Station Power Supply, Knockout Mount
E-APS	24V Aux Power Supply, Knockout Mount

Compatible Stations and Sensors

MODEL	DESCRIPTION
ELS	Light Sensor
EOCC	Occupancy/Vacancy Sensor
E100X	Inspire Button Stations
E1104	Inspire Fader Stations
EPS05/ EPS10	Preset Stations
EPSLO	Echo Keyswitch Lockout Station
E-ATC	Echo TimeClock

Compatible Interfaces

MODEL	DESCRIPTION
EACC	EchoAccess™ Interface

SPECIFICATIONS

FUNCTIONAL

- Recall prerecorded scenes for playback using DMX
- DMX input for snapshot recording up to 32 presets
- DMX output for up to 512 addresses
- Use any Unison Echo station for preset playback
- Supports DMX pass-through for real-time output of incoming level when recording snapshots
- Meets USITT DMX-512A specifications
- Supports live control and recording for the following fixture profiles:
  - Intensity
  - RGB
  - RGBA
  - RGBW
  - RGB_S (Selador Desire® D22, D40, Source Four® LED Series 1, Source Four LED Series 2)
  - RGB_SF (Desire D60)
  - IRGBS (ColorSource® PAR, Spot)

MECHANICAL

- One integrated DMX-input and one integrated DMX-output port
- Din-rail mounting complies with DIN43880 (35/7.5 rail)
- Constructed of injection-molded black ABS plastic
- Toggle switches for DMX-Termination and Config Mode
- DMX-In, DMX-Out and power indicators
  - Blue power indicator
  - Bi-color DMX activity indicator

ELECTRICAL

- Connects via two-wire EchoConnect control network through low-voltage Class 2 wiring + 24Vdc auxiliary power
  - Topology-free wiring over Belden 8471 or equivalent and one #14 ESD drain wire
  - Two #16 AWG wires for 24VDC auxiliary power
- Supports optional use of Belden 1583A or equivalent Ethernet control wire when used with Cat5 termination accessories
- Wiring may be bus, loop, homerun or any combination of these
- Supports up to 500 meters (1,640 feet) of control wiring
  - Up to 1,000 feet using Cat5
- MicroSD card slot for firmware maintenance
- UL and cUL Listed, CE Marked

DMX PORTS

- Eight-position removable pluggable connectors for in and out ports
  - Connectors designed for use with Belden 9729 (or equivalent)
  - Optional headers available for use with Belden 1583A (or equivalent)
- Input is fully optically isolated from controller electronics
- Withstands fault voltages up to 250VAC
- Integrated DMX termination

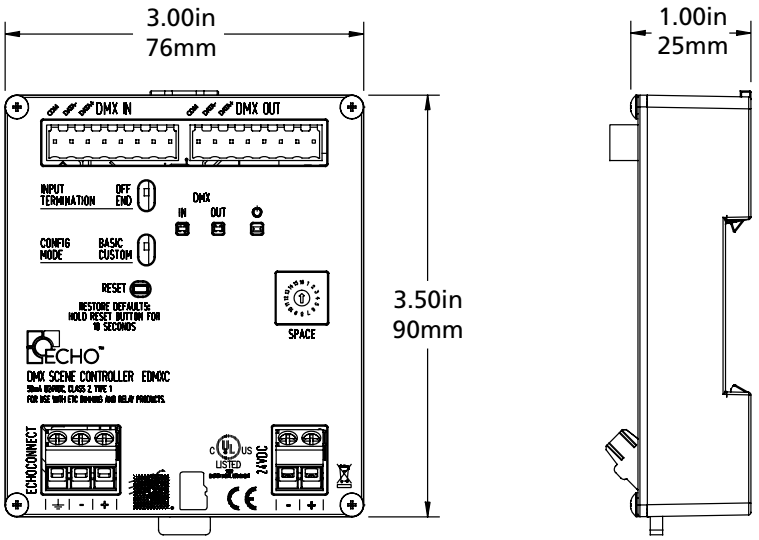
THERMAL

- Ambient room temperature: 0-50°C / 32-122°F
- Ambient humidity: 5-95% non-condensing

PHYSICAL

Product Dimensions

MODEL	HEIGHT		WIDTH		DEPTH		WEIGHT	
	inches	mm	inches	mm	inches	mm	lbs	kgs
EMDXC	3.5	90	3.0	76	1.0	25	.22	.10



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ETC® Unison Echo® EchoAccess™ Interface

115/120V

Echo Interface Series

GENERAL INFORMATION

EchoAccess provides remote control and configuration of ETC Unison Echo lighting-control systems from any iOS or Android mobile device. When connected you are able to set lighting levels, combine spaces, and control zones directly, as well as record, activate and deactivate presets for connected Echo stations and sensors. EchoAccess communicates to other Echo devices allowing for remote configuration of various settings such and preset timing, button functionality and sensor configuration. For added security you can assign varying levels of system access and functionality with multiple system passwords.

APPLICATIONS

- Education
- Hospitality
- Healthcare facilities
- Office buildings
- Conference rooms
- Meeting rooms
- Retail

FEATURES

- Provides communication from the EchoAccess mobile app to devices on the EchoConnect™ system bus via Bluetooth® Smart
- Mobile app available for Android and iOS
- Preset, zone and color control for Echo products
- Advanced feature configuration of Echo products
- EchoConnect: two-wire topology-free system gives you the freedom to easily place stations wherever they are needed

GENERAL

- UL and cUL Listed
- CE Marked

ORDERING INFORMATION

Product

MODEL	DESCRIPTION
EACC-_	EchoAccess Interface

Enter station color code in __ space provided:
1 = Cream (RAL 9001), 4 = Black (RAL 9004), 5 = Signal White (RAL 9003)
Stations flush-mount (F) in industry-standard gang boxes. (By others)

EchoAccess Mobile App

MODEL	DESCRIPTION
EACC-A	EchoAccess Mobile App (Android)
EACC-I	EchoAccess Mobile App (iOS)

Related EchoConnect Power Supplies

MODEL	DESCRIPTION
E-SPM-A	DRd Station Power Module with 24V Aux
E-SPM-WM-A	Wall-Mount Station Power Module with 24V Aux
E-SPM-RM-A	Rack-Mount Station Power Module with 24V Aux
E-SPS	Echo Station Power Supply, Knockout Mount
E-APS	24V Aux Power Supply, Knockout Mount

Compatible Stations and Sensors

MODEL	DESCRIPTION
ELS	Light Sensor
EOCC	Occupancy/Vacancy Sensor
E100X	Inspire® Button Stations
E1104	Inspire Fader Station
EPS05/ EPS10	Preset Stations

Compatible Output Products

MODEL	DESCRIPTION
ERC/EDRC	One/Two Zone Relay Controllers
ELD/EDLD	One/Two Zone 0-10V Dimming Controllers
ESSC/EDSSC	One/Two Zone SmartSpace Controllers
ELVD	600-Watt Phase-Adaptive Dimmer
ERMCX	Echo Room Controllers
ERP	Echo Relay Panel
ERP-FT	Echo Relay Panel Feedthrough
DRd	Unison® DRd with Echo Control
SR3	Sensor3 Power Control System
EDMXC	Echo DMX Scene Controller

SPECIFICATIONS

FUNCTIONAL

- Remote control of preset activation/deactivation, record, raise, lower, zone on/off control and room combine
- Configuration of Echo Zone Controllers, Room Controllers, Responsive Controls, Inspire and Preset Stations
- Configurable security levels for both connection and configuration

MECHANICAL

- Gangable for custom applications
- Enclosed electronics assembly and faceplate included
- No visible means of attachment
- Flush-mount in industry standard backbox, RACO 690 or equivalent
- Surface-mount backboxes available from manufacture upon request
- Constructed of injection-molded, ABS plastic in three RAL standard colors Cream (RAL 9001), Black (RAL 9004), and White (RAL 9003)
- Power and Bluetooth activity indicators
  - Blue power status indicatior
  - Amber Bluetooth activity indicator

ELECTRICAL

- Connects via EchoConnect control network through low-voltage Class 2 wiring + 24Vdc auxiliary power
  - Topology-free wiring over Belden 8471 or equivalent and one #14 ESD drain wire
  - Two #16 AWG wires for 24VDC auxiliary power
- Supports optional use of Belden 1583A or equivalent Ethernet control wire when used with Cat5 termination accessories
- Wiring may be bus, loop, homerun or any combination of these
- Supports up to 500 meters (1640 feet) of control wiring
  - Up to 1000 feet using Cat5
- MicroSD card slot for firmware maintenance
- UL and cUL Listed, CE Marked

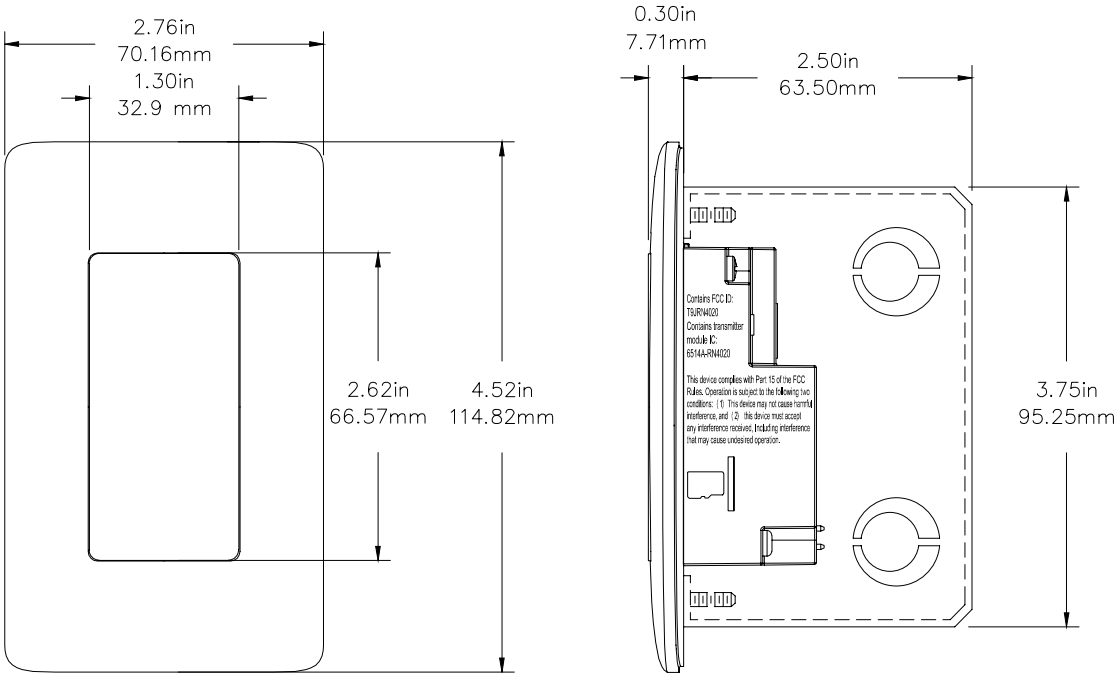
THERMAL

- Ambient room temperature: 0-40°C / 32-104°F
- Ambient humidity: 5-95% non-condensing

PHYSICAL

Product Dimensions

MODEL	HEIGHT		WIDTH		DEPTH	
	inches	mm	inches	mm	inches	mm
EACC	4.52	115	2.76	71	0.30	8



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ETC® Unison Echo® 0-10V Dimming Controller

115/120V 277V

Echo Distributed Power Series

GENERAL INFORMATION

Unison Echo 0-10V Dimming Controllers offer fully-rated 20-amp relays coupled with 0-10V dimming for direct control of compatible LED drivers and fluorescent dimming ballasts. The Controller mounts to fixtures and electrical junction boxes.

APPLICATIONS

- Houses of worship
- Education
- Hospitality
- Healthcare facilities
- Office buildings
- Conference rooms
- Meeting rooms
- Retail

FEATURES

- Single- and dual-zone options
- 20A fully-rated relay for use with general purpose, tungsten, fluorescent and LED loads
- 0-10V dimming for direct connection to dimming ballasts and LED drivers
- 120/277VAC power input
- Plug and Play: ready to go out of the box, no software or external programming required
- Supports Unison Echo control stations and responsive controls
- EchoConnect™: Two-wire topology-free system gives you the freedom to put stations where you need them
  - Up to 16 stations and sensors
  - Up to 16 power controllers or panels
  - Up to 500 meters (1640 feet) of control wire per system

GENERAL

- UL and cUL LISTED
- Rated for plenum use

ORDERING INFORMATION

Echo 0-10V Dimming Controller

MODEL	DESCRIPTION
ELD	Echo Single-Channel 0-10V Dimmer
EDLD	Echo Dual-Channel 0-10V Dimmer

Related EchoConnect Power Supplies

MODEL	DESCRIPTION
E-SPM(-A)	DRd Station Power Module (24V Aux)
E-SPM-WM(-A)	Wall-Mount Station Power Module (24V Aux)
E-SPM-RM(-A)	Rack-Mount Station Power Module (24V Aux)
E-SPS	Room Station Power Supply
E-APS	24V Aux Power Supply, Knockout Mount

Compatible Stations and Sensors

MODEL	DESCRIPTION
E100X	Inspire® Button Stations
E1104	Inspire Fader Station
ELS	Light Sensor
EOCC	Occupancy/Vacancy Sensor
EPS05/ EPS10	Preset Stations

Compatible Interfaces

MODEL	DESCRIPTION
EACC	EchoAccess™ Interface
EDMXC	Echo DMX Scene Controller

Compatible Output Products

MODEL	DESCRIPTION
ERC/EDRC	One/Two Zone Relay Controllers
ELD/EDLD	One/Two Zone 0-10V Dimming Controllers
ESSC/EDSSC	One/Two Zone SmartSpace Controllers
ELVD	600-Watt Phase Adaptive Dimmer
ERMCX	Echo Room Controllers
ERP/ERP-FT	Echo Relay Panel/ Echo Relay Panel Feed Through
DRd	Unison® DRd with Echo Control
SR3	Sensor3 Power Control System

SPECIFICATIONS

FUNCTIONAL

- Control for individual fixtures, zone power and 0-10V dimming for fluorescent ballasts and LED drivers
- Occupancy sensor status may be shared to the entire Echo Control System

MECHANICAL

- Constructed of injection-molded ABS plastic
- Button interface and LED indicator per zone for configuration
- Rotary dials for selection of space and device number
- Half-inch conduit knockout mounted
- Mains-voltage wiring exits through knockout mount
- Low-voltage wiring exits through side of controller
- Optional mounting plate available for applications that require low-voltage wiring to be in conduit
- Mains power input:
  - 12 AWG Hot - Black
  - 14 AWG Neutral - White
- Relay output:
  - Zone 1, 12 AWG - Red
  - Zone 2, 12 AWG - Red/White
- 0-10V dimming output:
  - Zone 1, 22 AWG - Violet and Gray
  - Zone 2, 22 AWG - Violet/White and Gray/White
- EchoConnect control connection:
  - Control, 18 AWG - Black and White
  - Ground, 18 AWG - Green/Yellow

ELECTRICAL

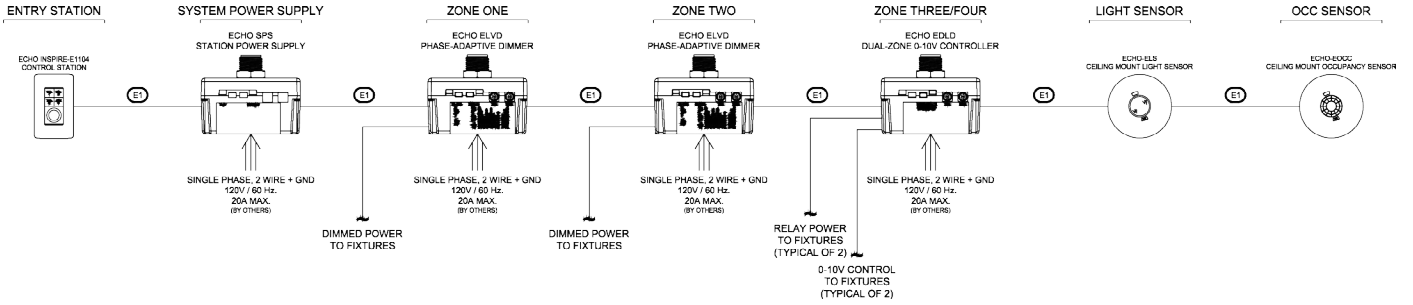
- 120V-277V, 60Hz power input
- Normally Open (NO) 20-amp fully-rated relay
- 0-10vDC ballast control (sink) rated for 100mA maximum
- EchoConnect Class 2 control network
  - Topology-free wiring using Belden 8471 or equivalent and one #18 ESD drain wire
  - Wiring may be bus, loop, homerun or any combination of these
- Up to 500 meters (1640 feet) of control wiring per system
- Optional Cat5/5e wiring using Belden 1583A or equivalent
  - Requires optional Cat5 termination accessories
- UL and cUL LISTED
- Conforms to UL 508 and UL 2043

THERMAL

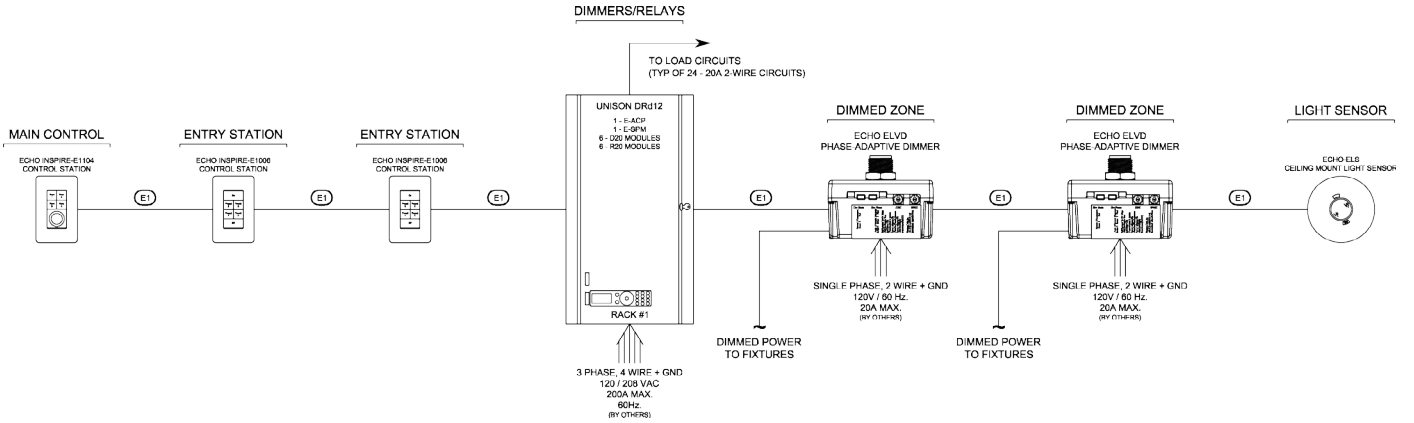
- Ambient room temperature: -10 to 45°C / 14 to 113°F
- Ambient humidity: 5 to 95% non-condensing

SAMPLE ECHO SYSTEMS

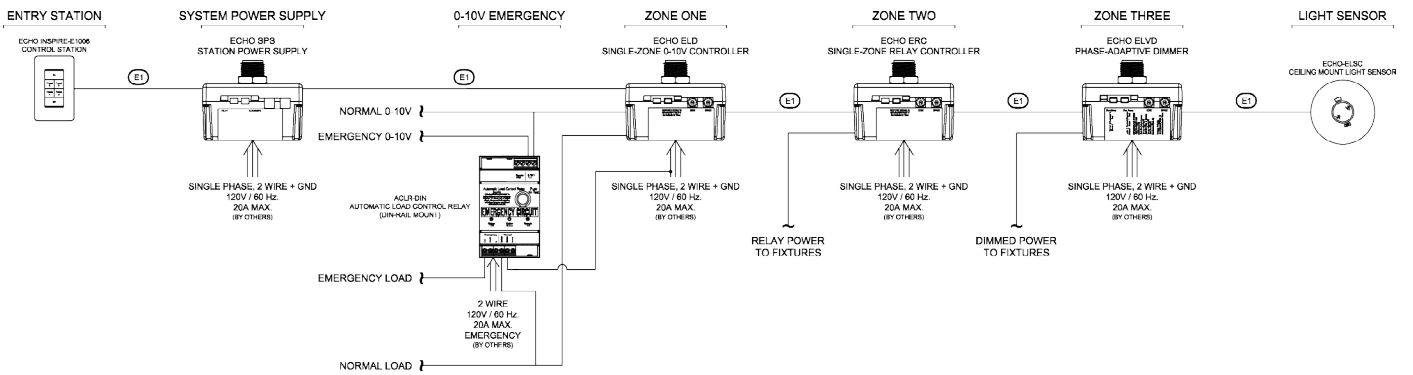
SMALL SYSTEM



MEDIUM SYSTEM

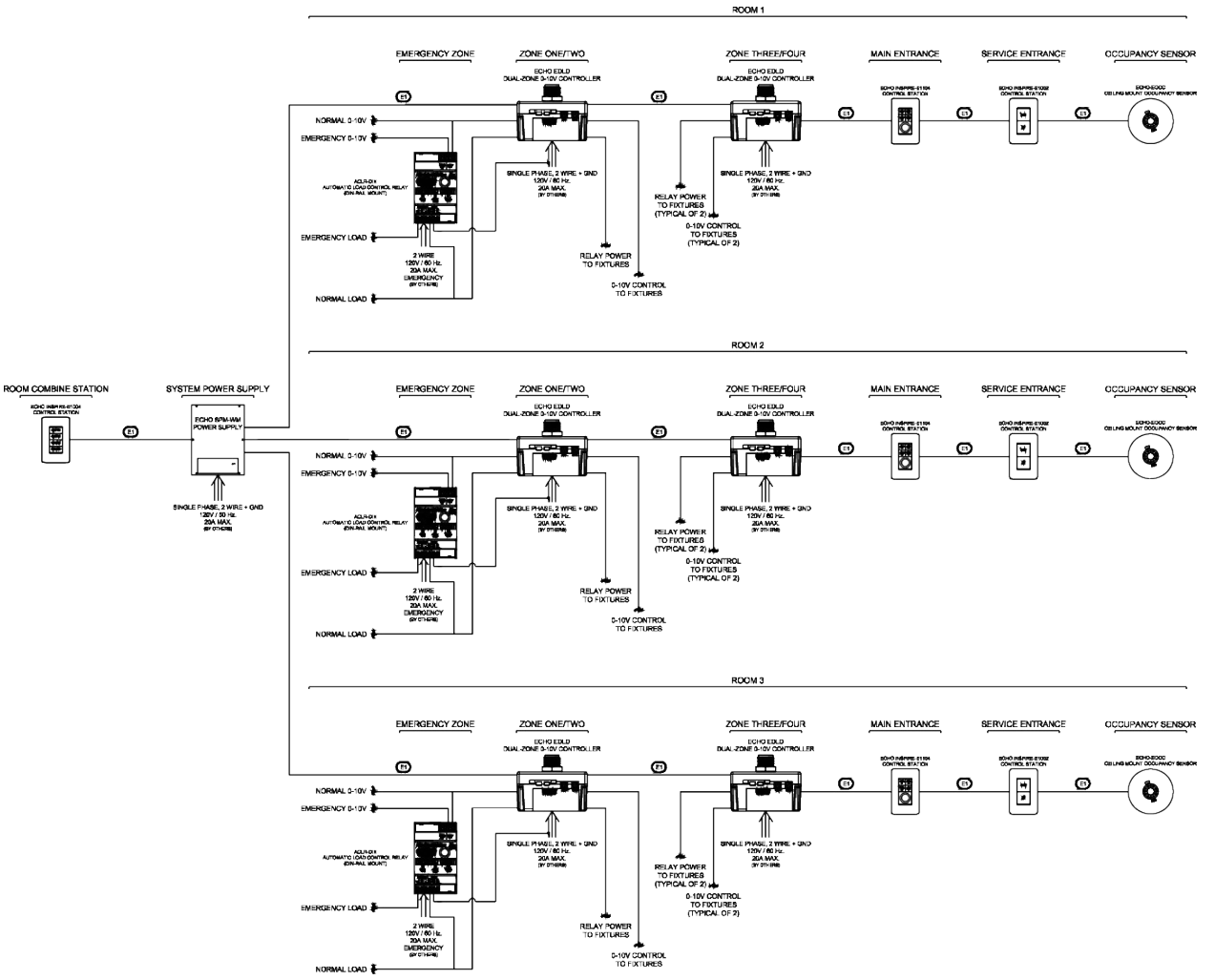


SMALL CONFERENCE ROOM



SAMPLE ECHO SYSTEMS

MEDIUM BALLROOM



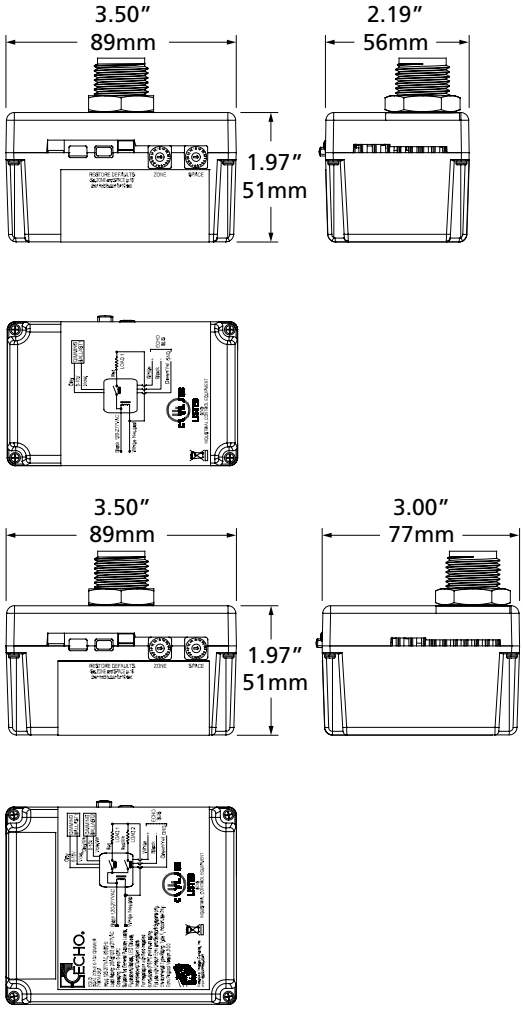
PHYSICAL

Dimmer Dimensions

MODEL	HEIGHT		WIDTH		DEPTH	
	inches	mm	inches	mm	inches	mm
ELD	2.0	50.8	3.5	88.9	2.2	55.9
EDLD	2.0	50.8	3.5	88.9	3.0	76.2

Dimmer Weight

MODEL	WEIGHT	
	lbs	kgs
ELD	0.5	0.23
EDLD	0.75	0.34



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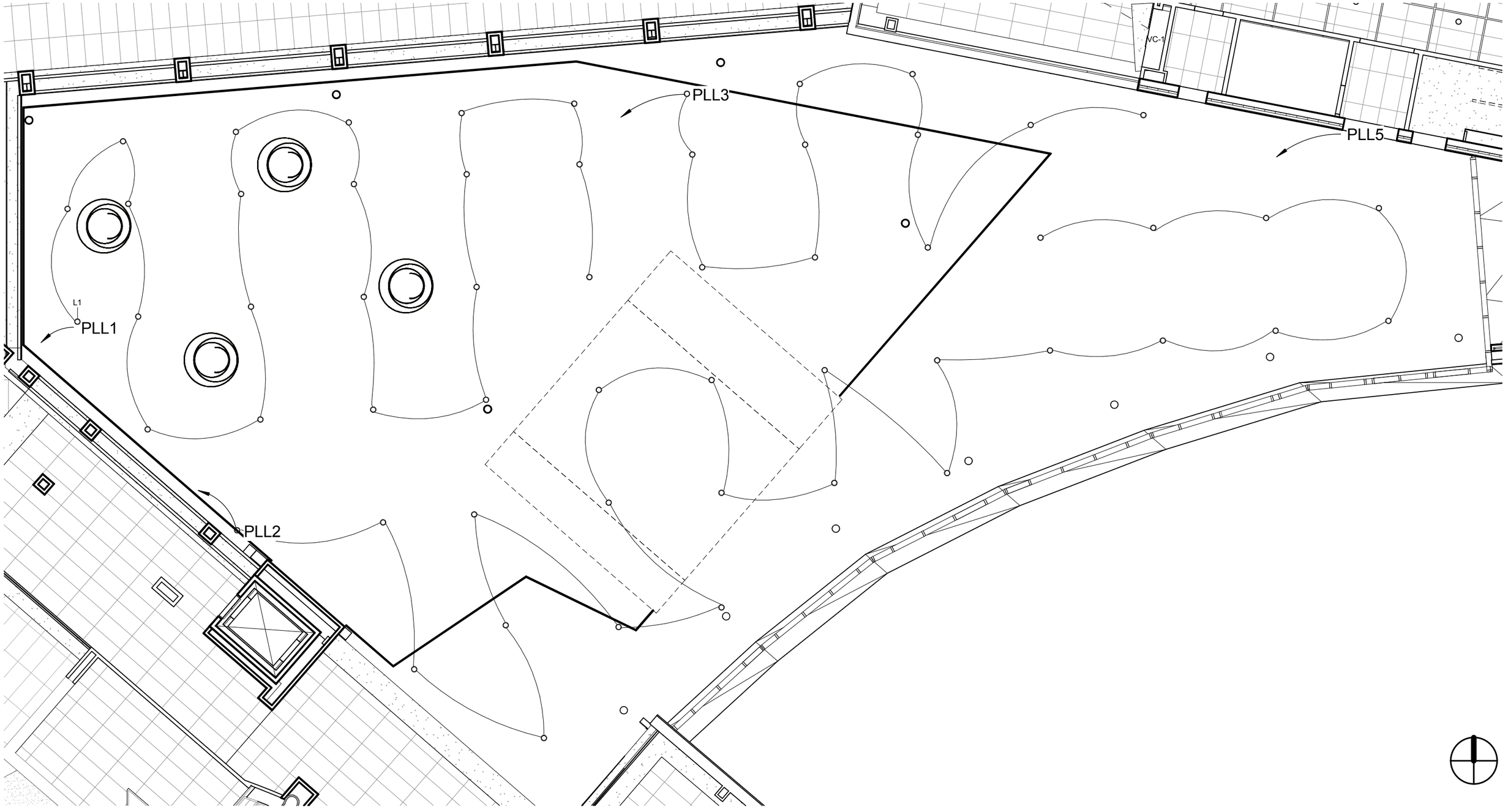
Appendix D



Pennsylvania State University

HUB Addition & Renovations

No.	Description	Date

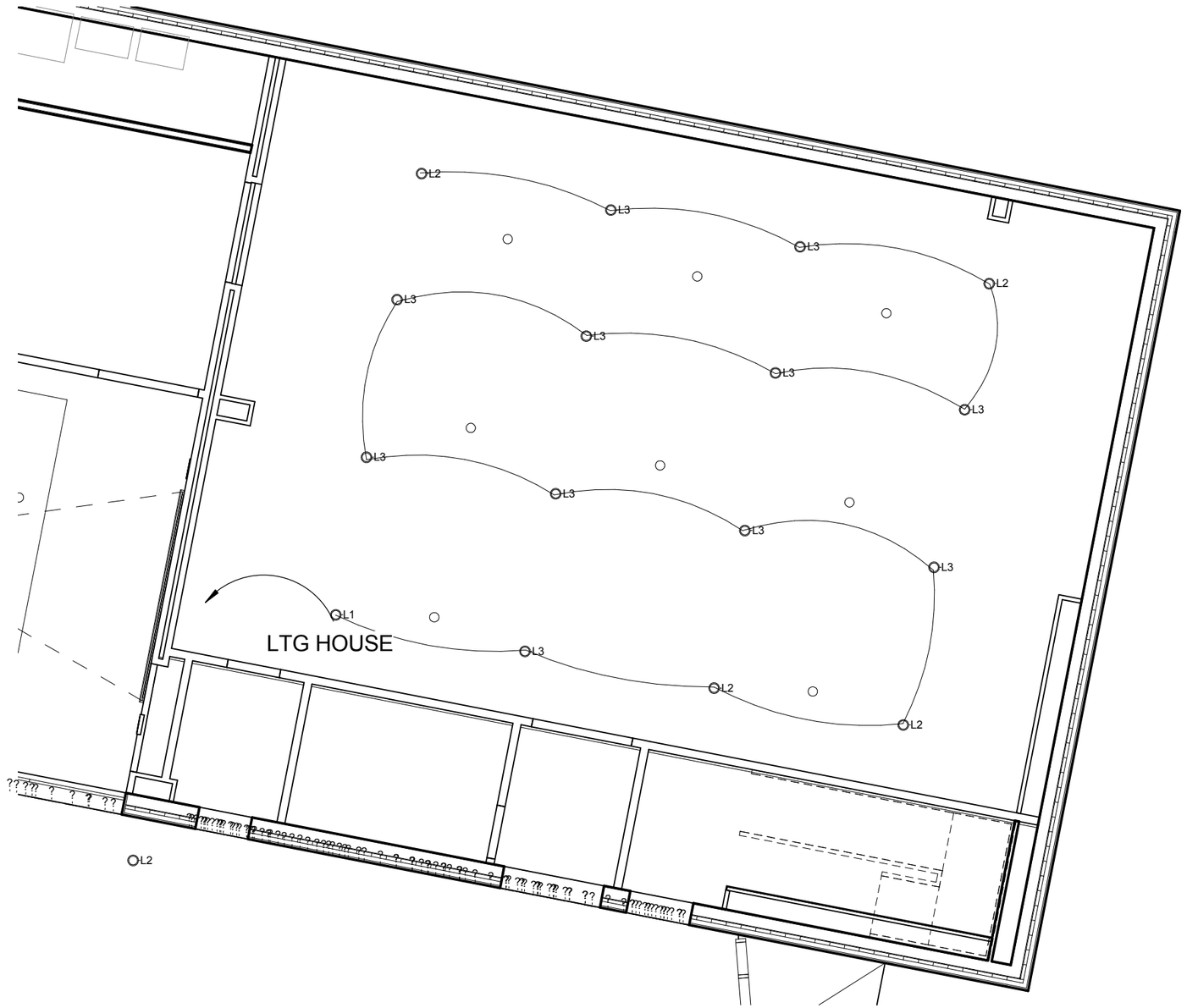
Atrium Circuiting

Project number	201103.00
Date	03/22/16
Drawn by	John Keyes
Checked by	Kevin Houser

L1.00

Scale 3/32" = 1'-0"

4/3/2016 7:57:31 PM



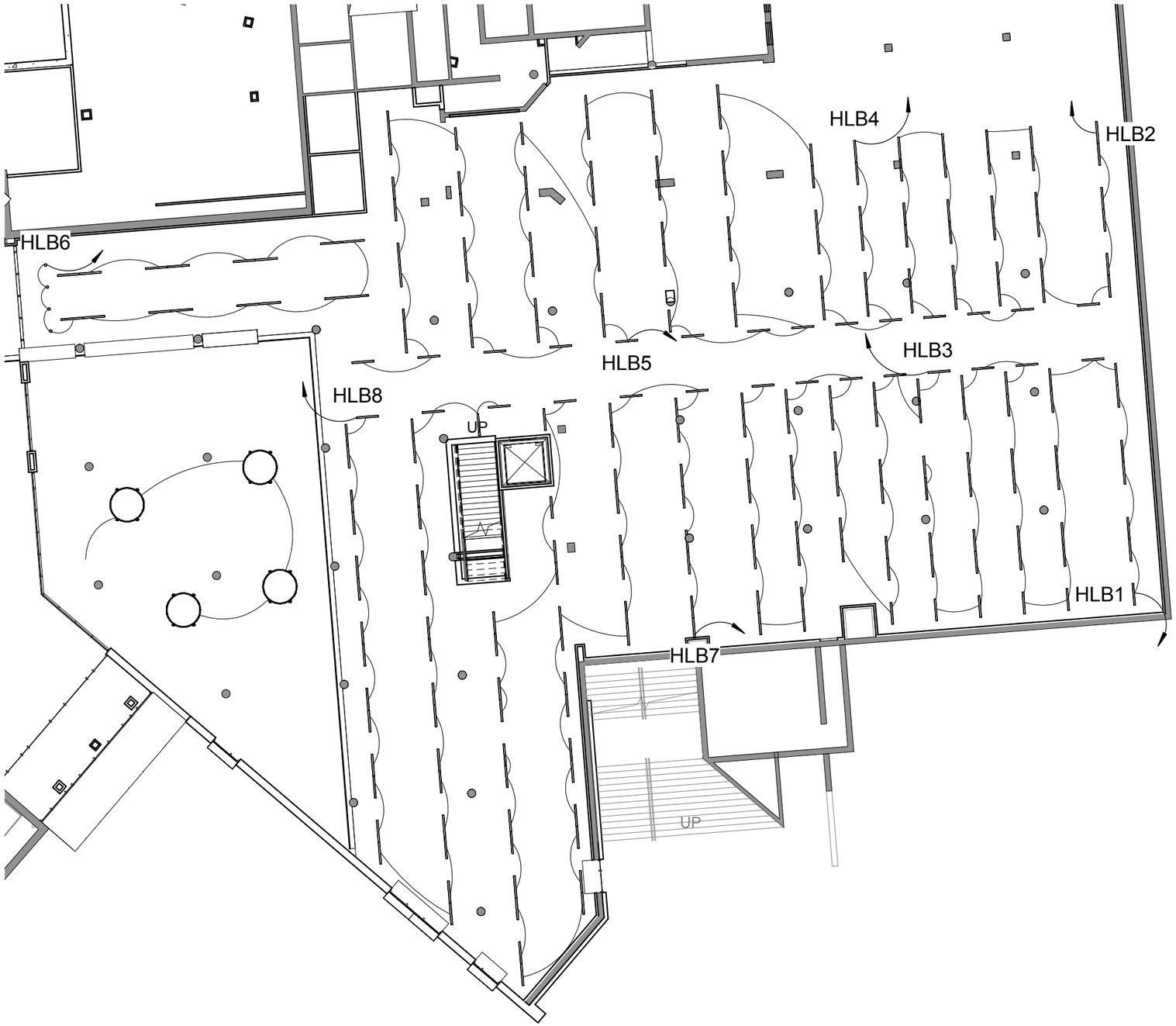
Pennsylvania State University	HUB Addition & Renovations

No.	Description	Date

Theater House Circuiting

Project number	201103.00	L1.01
Date	03/22/16	
Drawn by	John Keyes	
Checked by	Kevin Houser	Scale 1/8" = 1'-0"

4/3/2016 7:57:33 PM



Pennsylvania State University

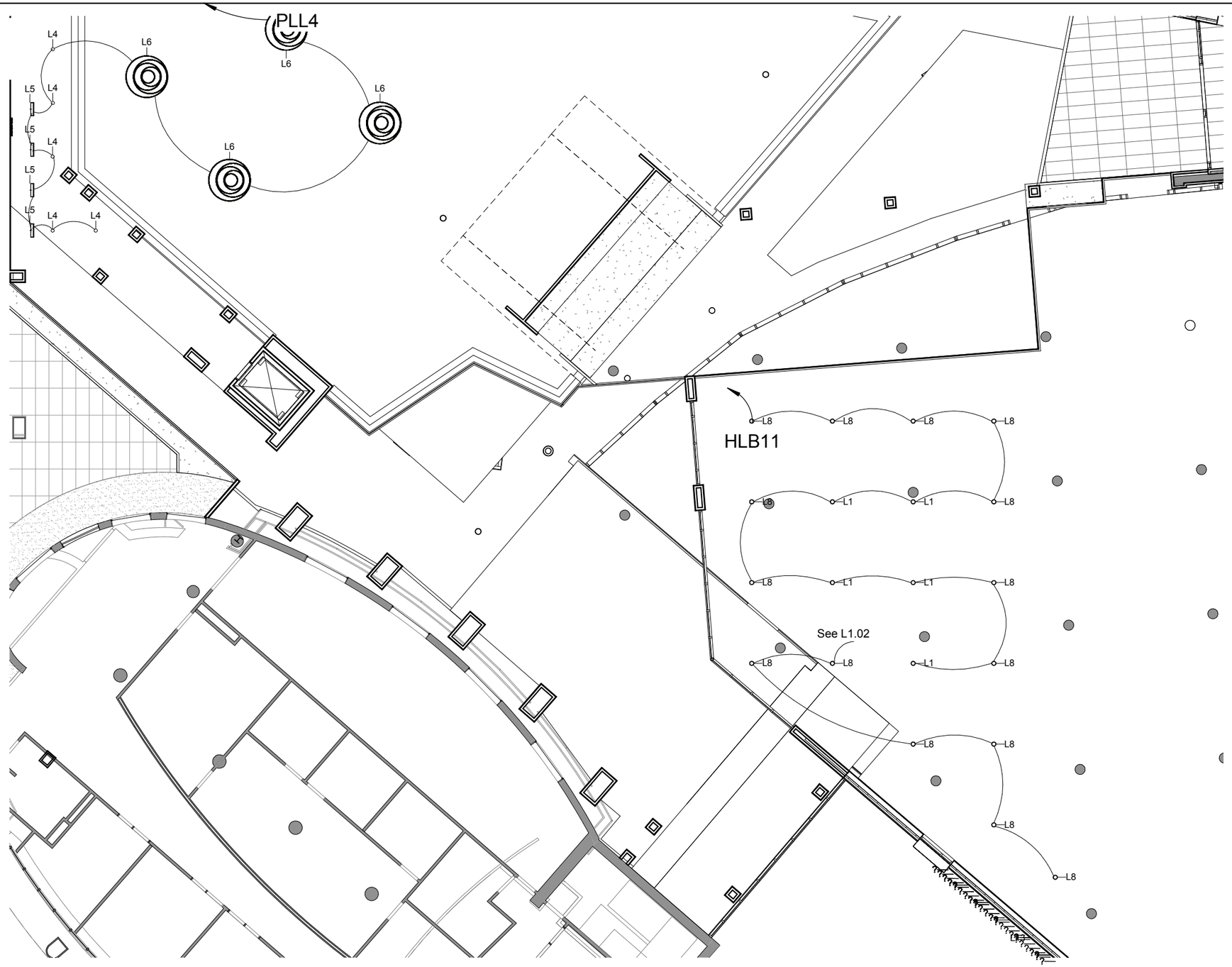
HUB Addition & Renovations

No.	Description	Date

Bookstore Circuiting

Project number	201103.00	L1.02
Date	03/22/16	
Drawn by	John Keyes	
Checked by	Kevin Houser	Scale 3/64" = 1'-0"

4/3/2016 7:57:34 PM



Pennsylvania State University

HUB Addition & Renovations

No.	Description	Date

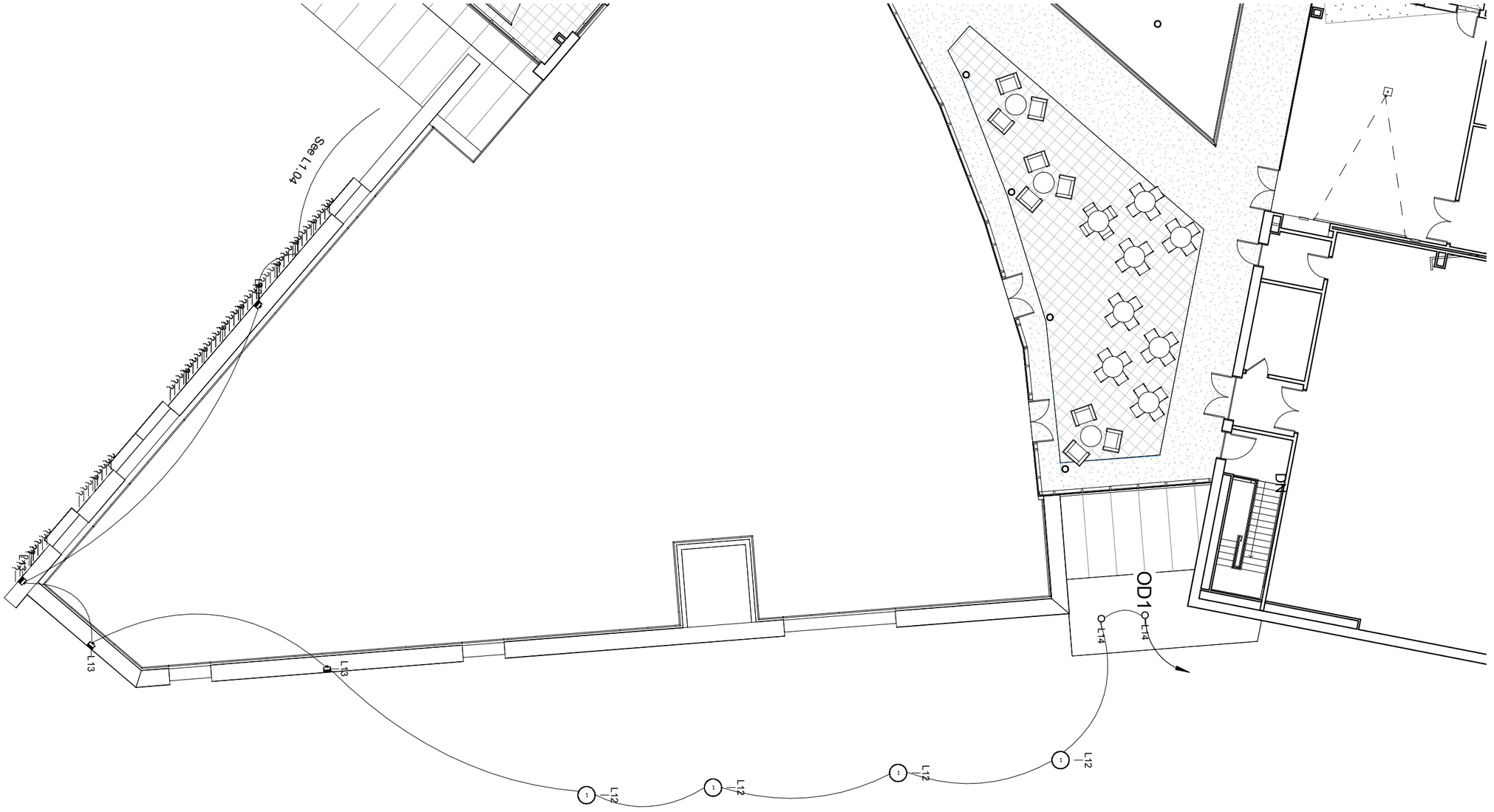
Level G Circuiting

Project number	201103.00
Date	03/22/16
Drawn by	John Keyes
Checked by	Kevin Houser

L1.03

Scale 1/16" = 1'-0"

4/3/2016 7:57:36 PM



Pennsylvania State University

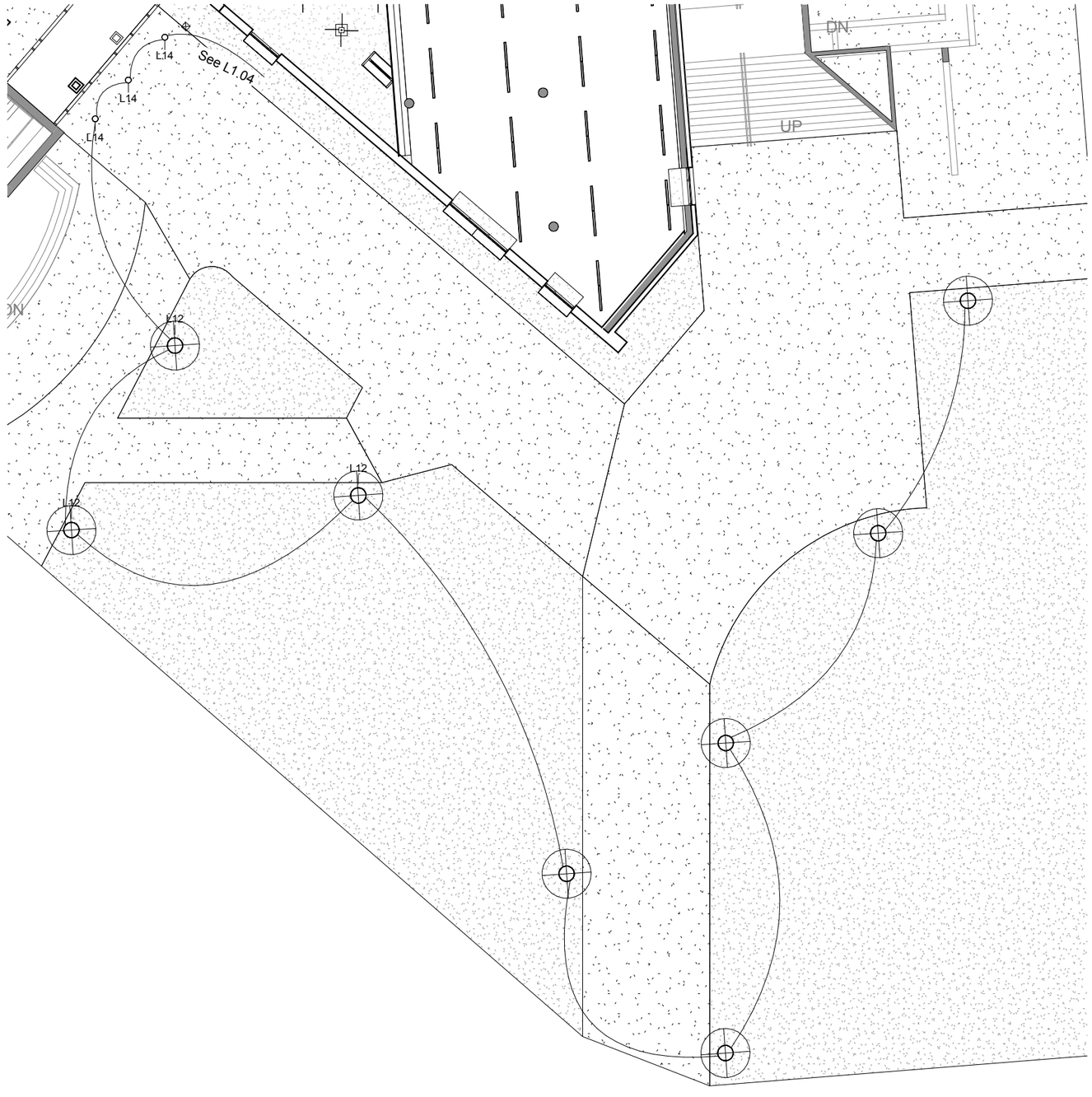
HUB Addition & Renovations

No.	Description	Date

Upper Outdoor Circuiting

Project number	201103.00	L1.04
Date	03/22/16	
Drawn by	John Keyes	
Checked by	Kevin Houser	Scale 1/16" = 1'-0"

4/3/2016 7:57:39 PM



Pennsylvania State University

HUB Addition & Renovations

No.	Description	Date

Lower Outdoor Circuiting

Project number	201103.00
Date	03/22/16
Drawn by	John Keyes
Checked by	Kevin Houser

L1.05

Scale 1" = 20'-0"

4/3/2016 7:57:40 PM

Appendix E

Panel: P3 BUS AMPS: 225 DISTR: 208Y/120

Supply From DPL2 MAIN: MLO NEUTRAL: 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	R	TLB BOX #4 DMX1	2 #12	20	1	1.8	1.8					1	20	2 #12	TLB BOX #5 DMX2	R	2
3	R	TLB BOX #6 DMX3	2 #12	20	1			1.8	1.8			1	20	2 #12	TLB BOX #7 DMX4	R	4
5	R	TLB BOX #8 CKT #1 DMX5	2 #12	20	1					1.8	1.8	1	20	2 #12	TLB BOX #8 CKT #2 DMX6	R	6
7	R	TLB BOX #9 CKT #1 DMX7	2 #12	20	1	1.8	1.8					1	20	2 #12	TLB BOX #9 CKT #2 DMX8	R	8
9	R	TLB BOX #10 CKT #1 DMX9	2 #12	20	1			1.8	1.8			1	20	2 #12	TLB BOX #10 CKT #2 DMX11	R	10
11	R	TLB BOX #11 CKT #1	2 #12	20	1					1.8	1.8	1	20	2 #12	TLB BOX #11 CKT #2	R	12
13	--	Spare - DMX13		20	1	0	0					1	20		Spare - DMX14	--	14
15	--	Spare - DMX15		20	1			0	0			1	20		Spare - DMX16	--	16
17	L	LTG HOUSE	2 #12	20	1					0.73	0.16	1	20	2 #12	LTG BALCONY	L	18
19	--	Spare		20	1							1	20		Spare	--	20
21	--	Spare		20	1							1	20		Spare	--	22
23	--	Spare		20	1					0		1	20		Spare	--	24
25	--	Spare		20	1		0					1	20		Spare	--	26
27	--	Spare		20	1			0	0			1	20		Spare	--	28
29	--	Spare		20	1					0	0	1	20		Spare	--	30
31	--	Spare		20	1	0	0					1	20		Spare	--	32
33	--	Spare		20	1			0	0			1	20		Spare	--	34
35	--	Spare		20	1					0	0	1	20		Spare	--	36
37	--	Spare		20	1	0	0					1	20		Spare	--	38
39	--	Spare		20	1			0	0			1	20		Spare	--	40
41	--	Spare		20	1					0	0	1	20		Spare	--	42
43	--	Spare		20	1	0	0					1	20		Spare	--	44
45	--	Spare		20	1			0	0			1	20		Spare	--	46
47	--	Spare		20	1					0	0	1	20		Spare	--	48
			Phase Load			7.20		7.20		8.09							
			Phase Amps			60.00		60.00		67.42							

Panel: LPG | BUS AMPS: 225 | DISTR: 208Y/120

Supply From SDP-LB | MAIN: MLO | NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	R	PRINTER 036	2 #12	20	1	0.18	0.54					1	20	2 #12	FLOOR BOX COPY	R	2
3	R	RECS TRAINING 024E	2 #12	20	1			0.72	1.04			2	20	2 #12	COPIER	R	4
5	R	COPIER 038	2 #12	20	1					0.18	1.04						6
7	R	COPIER 038	2 #12	20	1	0.18	0.18					1	20	2 #12	COPIER	R	8
9	R	COPIER 038	2 #12	20	1			0.18	0.18			1	20	2 #12	RECS AT OUTDOOR XF	R	10
11	R	MOTOR DOOR CEST F007	2 #12	20	1					1.5	1.5	1	20	2 #12	MOTOR DOOR VEST	R	12
13	R	FL BOXES TL	2 #12	20	1	0.72	0.72					1	20	2 #12	FL BOXES LOUNGE	R	14
15	R	FL BOXES LOUNGE 041	2 #12	20	1			0.72	0.36			1	20	2 #12	FL BOXES TECH LOUNGE	R	16
17	R	RECS SEATING 024	2 #12	20	1					0.9	0.54	1	20	2 #12	RECS SEATING	R	18
19	R	FL BOXES SEATING 024	2 #12	20	1	0.36	0.72					1	20	2 #12	FL BOXES SEATING	R	20
21	R	FL BOXES SEATING 024	2 #12	20	1			0.72	0.36			1	20	2 #12	POKE THRU WHIP	R	22
23	R	POLE THRU WHIP	2 #12	20	1					0.36	0.36	1	20	2 #12	POKE THRU WHIP	R	24
25	R	POLE THRU WHIP	2 #12	20	1	0.36	0.18					1	20	2 #12	REC JANITOR	R	26
27	R	RECS JANITOR 024	2 #12	20	1			0.36	0.43			3	20	3 #12	HAC-2 VEST	M	28
29	L	LTG COPY 038	2 #12	20	1					0.95	0.43						30
31	L	LTG COMP STORE	2 #12	20	1	1.48	0.43										32
33	L	LTG THON	2 #12	20	1			1.5	0.43			3	20	3 #12	HAC-2 VEST	M	34
35	R	RECS COPY STORE	2 #12	20	1					0.54	0.43						36
37	R	RECS COPY STORE	2 #12	20	1	0.36	0.43										38
39	R	RECS BULLPEN	2 #12	20	1			0.72	0.72			1	20	2 #12	RECS THON	R	40
41	R	RECS OFF	2 #12	20	1					0.9	1.13	1	20	2 #12	RECS THON	R	42
43	R	COUNTER RECS	2 #12	20	1	0.36	0.72					1	20	2 #12	RECS THON	R	44
45	R	FL BOX STUDIO	2 #12	20	1			0.54	0			1	20		Spare	--	46
47	R	RECS RADIO STUDIO	2 #12	20	1					0.9	1.2	1	20	2 #12	FS DAMPER LV G	M	48
49	R	FL BOX THON	2 #12	20	1	0.36	0.6					1	20	2 #12	FS DAMPER LV G	M	50
51	L	LTG THON	2 #12	20	1			0.44	0.2			1	20	2 #12	SEC PANEL THON	C	52
53	R	MICROWAVE COPY	2 #12	20	1					1.38	0.36	1	20	2 #12	RECS THON	R	54
55	R	FRIDGE COPY	2 #12	20	1	0.4	0.63					1	20	2 #12	LTG ZONE GC	L	56
57	L	LTG ZONE GD	2 #12	20	1			0.75	0			1	20		Spare	--	58
59	L	LTG ZONE GB	2 #12	20	1					0.78	0	1	20		Spare	--	60
61	L	KTG ZONE GK	2 #12	20	1	0.56	0					1	20		Spare	--	62
63	L	LTG CORRID	2 #12	20	1			0.68	0			1	20		Spare	--	64
65	--	Spare		20	1					0	0	1	20		Spare	--	66
67	--	Spare		20	1	0	0					1	20		Spare	--	68
69	--	Spare		20	1			0	0			1	20		Spare	--	70
71	--	Spare		20	1					0	0	1	20		Spare	--	72
73	--	Spare		20	1	0	0					1	20		Spare	--	74
75	--	Spare		20	1			0	0			1	20		Spare	--	76
77	--	Spare		20	1					0	0	1	20		Spare	--	78
79	--	Spare		20	1	0	0					1	20		Spare	--	80
81	--	Spare		20	1			0	0			1	20		Spare	--	82
83	--	Spare		20	1					0	0	1	20		Spare	--	84
			Phase Load			10.47		11.05		15.38							
			Phase Amps			87.25		92.08		128.17							

Panel: LPB2T7A | BUS AMPS: 150 | DISTR: 208Y/120

Supply From SDP-LB | MAIN: MLO | NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	R	FLOOR BOX BKST	2 #12	20	1	0.36	0.36					1	20	2 #12	FLOOR BOX BKST	R	2
3	R	FLOOR BOX BKST	2 #12	20	1			0.36	0.36			1	20	2 #12	FLOOR BOX BKST	R	4
5	R	FLOOR BOX BKST	2 #12	20	1					0.36	0.9	1	20	2 #12	RECS BKST	R	6
7	R	RECS BKST	2 #12	20	1	0.9	1.08					1	20	2 #12	RECS BKST	R	8
9	R	RECS BKST	2 #12	20	1			1.26	1.44			1	20	2 #12	RECS BKST	R	10
11	R	POKE THRU BKST	2 #12	20	1					0.72	0.54	1	20	2 #12	RECS BKST	R	12
13	R	RECS CASH REG	2 #12	20	1	0.36	0.36					1	20	2 #12	RECS CASH REG	R	14
15	R	MOTOR DOOR BKST	2 #12	20	1			0.75	0.36			1	20	2 #12	RECS CASH REG	R	16
17	--	Spare	--	20	1					0	0	1	20	--	Spare	--	18
19	--	Spare	--	20	1	0	0					1	20	--	Spare	--	20
21	--	Spare	--	20	1			0	0			1	20	--	Spare	--	22
23	--	Spare	--	20	1					0	0	1	20	--	Spare	--	24
25	--	Spare	--	20	1	0	0					1	20	--	Spare	--	26
27	--	Spare	--	20	1			0	0			1	20	--	Spare	--	28
29	--	Spare	--	20	1					0	0	1	20	--	Spare	--	30
31	--	Spare	--	20	1	0	0					1	20	--	Spare	--	32
33	--	Spare	--	20	1			0	0			1	20	--	Spare	--	34
35	--	Spare	--	20	1					0	0	1	20	--	Spare	--	36
37	--	Spare	--	20	1	0	0					1	20	--	Spare	--	38
39	--	Spare	--	20	1			0	0			1	20	--	Spare	--	40
41	--	Spare	--	20	1					0	0	1	20	--	Spare	--	42
			Phase Load			3.42		4.53		2.52							
			Phase Amps			28.50		37.75		21.00							

Panel: LPB2T7 BUS AMPS: 150 DISTR: 208Y/120

Supply From LPB2T7C MAIN: MLO NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	R	OUTDOOR RECS	2 #12	20	1	0.72	0.9					1	20	2 #12	RECS RETAIL 040B	R	2
3	R	CASH REG 040B	2 #12	20	1			0.18	0.72			1	20	2 #12	RECS RETAIL 040B	R	4
5	R	CONV STORE SIGN 040B	2 #12	20	1					0.18	0.9	1	20	2 #12	RECS STOCK 040A	R	6
7	R	MOTOR DOOR 040B	2 #12	20	1	0.75	0.18					1	20	2 #12	CASH REG 040B	R	8
9	--	Spare	--	20	1			0	0.9			1	20	2 #12	RECS CONV STORE 040B	R	10
11	--	Spare	--	20	1					0	0.36	1	20	2 #12	CASEWORK REC 040B	R	12
13	--	Spare	--	20	1	0	0.54					1	20	2 #12	TRACK LTG 040B	L	14
15	--	Spare	--	20	1			0	0			1	20	--	Spare	--	16
17	--	Spare	--	20	1					0	0	1	20	--	Spare	--	18
19	--	Spare	--	20	1	0	0					1	20	--	Spare	--	20
21	--	Spare	--	20	1			0	0			1	20	--	Spare	--	22
23	--	Spare	--	20	1					0	0	1	20	--	Spare	--	24
25	--	Spare	--	20	1	0	0					1	20	--	Spare	--	26
27	--	Spare	--	20	1			0	0			1	20	--	Spare	--	28
29	--	Spare	--	20	1					0	0	1	20	--	Spare	--	30
31	--	Spare	--	20	1	0	0					1	20	--	Spare	--	32
33	--	Spare	--	20	1			0	0			1	20	--	Spare	--	34
35	--	Spare	--	20	1					0	0	1	20	--	Spare	--	36
37	--	Spare	--	20	1	0	0					1	20	--	Spare	--	38
39	--	Spare	--	20	1			0	0			1	20	--	Spare	--	40
41	--	Spare	--	20	1					0	0	1	20	--	Spare	--	42
			Phase Load			3.09		1.80		1.44							
			Phase Amps			25.75		15.00		12.00							

Panel: LPB2T7C | BUS AMPS: 400 | DISTR: 208Y/120

Supply From SDP-LB | MAIN: MLO | NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	R	RECS CONF	2 #12	20	1	0.72	0.72					1	20	2 #12	RECS B015	R	2
3	R	RECS BKST	2 #12	20	1			0.36	0.18			1	20	2 #12	PERIM ALARM	R	4
5	R	RECS CASH RM	2 #12	20	1					0.72	0.9	1	20	2 #12	RECS BKST CORR	R	6
7	R	RECS ONLINE PICKUP	2 #12	20	1	0.72	0.54					1	20	2 #12	RECS OFF	R	8
9	R	RECS BATHRM	2 #12	20	1			0.36	1.08			1	20	2 #12	RECS BKST CORR	R	10
11	R	RECS BKST	2 #12	20	1					0.72	0.36	1	20	2 #12	RECS CASH REG	R	12
13	R	AUTO FLUSH	2 #12	20	1	0.4	1.4					1	20	2 #12	HAND DRY MEN	R	14
15	R	RECS OFF	2 #12	20	1			0.54	1.4			1	20	2 #12	HAND DRY WOMEN	R	16
17	--	Spare	--	20	1					0	0	1	20	--	Spare	--	18
19	--	Spare	--	20	1	0	0					1	20	--	Spare	--	20
21	--	Spare	--	20	1			0	0			1	20	--	Spare	--	22
23	--	Spare	--	20	1					0	0	1	20	--	Spare	--	24
25	--	Spare	--	20	1	0	0					1	20	--	Spare	--	26
27	--	Spare	--	20	1			0	0			1	20	--	Spare	--	28
29	--	Spare	--	20	1					0	0	1	20	--	Spare	--	30
31	--	Spare	--	20	1	0	0					1	20	--	Spare	--	32
33	--	Spare	--	20	1			0	0			1	20	--	Spare	--	34
35	--	Spare	--	20	1					0	0	1	20	--	Spare	--	36
37	R;L	LPGT7	--	150	3	3.09	0					1	20	--	Spare	--	38
39								1.8	0			1	20	--	Spare	--	40
41										1.44	0	1	20	--	Spare	--	42
			Phase Load			7.59		5.72		4.14							
			Phase Amps			63.25		47.67		34.50							

Panel: DPHB2 | BUS AMPS: 600 | DISTR: 480Y/277

Supply From MDS | MAIN: MLO | NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	M	AHU-4 SF (30HP)		80	3	10	10					3	80		AHU-3 SF (30HP)	M	2
3								10	10								4
5										10	10						6
7	--	Spare	--	20	3	0	5					3	40		CHWP-1 B4 LVL (15HP)	M	8
9								0	5								10
11										0	5						12
13	M	RF-1 (15HP)		40	3	3.33	3.33					3	40		RF-2 (15 HP)	M	14
15								3.33	3.33								16
17										3.33	3.33						18
19	--	Spare	--	30	3	0	0					3	50		AHU-5 (20HP)	R	20
21								0	0								22
23										0	0						24
25	--	Spare	--	30	3	0	0					3	60	--	Spare	--	26
27								0	0								28
29										0	0						30
31	--	Spare	--	60	3	0	0					3	100	--	Spare	--	32
33								0	0								34
35										0	0						36
37	--	Spare	--	100	3	0	0					3	100	--	Spare	--	38
39								0	0								40
41										0	0						42
43	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	44
45	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	46
47	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	48
49	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	50
51	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	52
53	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	54
55	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	56
57	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	58
59	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	60
61	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	62
63	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	64
65	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	66
67	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	68
69	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	70
71	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	72
73	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	74
75	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	76
77	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	78
79	--	SPACE	--	--	--	0	0					--	--	--	SPACE	--	80
81	--	SPACE	--	--	--			0	0			--	--	--	SPACE	--	82
83	--	SPACE	--	--	--					0	0	--	--	--	SPACE	--	84
			Phase Load			31.66		31.66		31.66							
			Phase Amps			114.30		114.30		114.30							

Panel: LP2 | BUS AMPS: 225 | DISTR: 218Y/120

Supply From SDP-LB | MAIN: MLO | NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1	R	FL BOXES MPR	2 #12	20	1	0.72	0.72					1	20	2 #12	FL BOXES MPR	R	2
3	R	FL BOXES MPR	2 #12	20	1			0.72	0.72			1	20	2 #12	RECS OFF	R	4
5	R	RECS CORR	2 #12	20	1					1.62	0.54	1	20	2 #12	RECS BATHROM	R	6
7	R	AHU-5 CRLTS	2 #12	20	1	0.18	1.92					1	20	2 #12	LTG MPR	L	8
9	L	LTG MPR	2 #12	20	1			1.77	1.92			1	20	2 #12	LTG MPR	L	10
11	L	LTG 229	2 #12	20	1					0.57	0.72	1	20	2 #12	RECS MECH	R	12
13	L	LTG CORR	2 #12	20	1	0.75	0.9					1	20	2 #12	RECS MPR	R	14
15	R	RECS MPR	2 #12	20	1			1.08	1.26			1	20	2 #12	RECS MPR	R	16
17	R	RECS MPR	2 #12	20	1					1.26	0.8	1	20	2 #12	PROJ & SCREEN	R	18
19	R	AV RACK STORAGE	2 #12	20	1	1	0.8					1	20	2 #12	PROJ & SCREEN	R	20
21	R	PROJ & SCREEN	2 #12	20	1			0.8	0.72			1	20	2 #12	FL BOXES MPR	R	22
23	R	PROJ & SCREEN	2 #12	20	1					0.8	0	--	--	--	Spare	--	24
25	L	LTG MECH	2 #12	20	1	1.38	1.4					1	20	2 #12	DRYER WOMENS	R	26
27	R	DRYER MENS	2 #12	20	1			1.4	0.25			1	20	2 #12	ER-2 BATHRM ROOF	M	28
29	R	AUTO FLUSH MENS	2 #12	20	1					0.25	0	--	--	--	Spare	--	30
31	R	AUTO FLUSH WOMENS	2 #12	20	1	0.35	0					--	--	--	Spare	--	32
33	M	SSAC-1 COND UNIT	M	25	2			1.35	0.6			1	20	2 #12	FS DAMPERS MECH	M	34
35										1.35	0	--	--	--	Spare	--	36
37	M	FCU-5 RM 229F	2 #12	20	1	0.4	0					--	--	--	Spare	--	38
39	--	Spare	--	--	--			0	0.72			1	20	2 #12	RECS FLEX BALC	R	40
41	--	Spare	--	--	--					0	0	--	--	--	Spare	--	42
43	--	Spare	--	--	--	0	0					--	--	--	Spare	--	44
45	R	R	2 #12	20	1			0.54	0			--	--	--	Spare	--	46
47	--	Spare	--	--	--					0	0	--	--	--	Spare	--	48
49	--	Spare	--	--	--	0	0					--	--	--	Spare	--	50
51	--	Spare	--	--	--			0	0			--	--	--	Spare	--	52
53	--	Spare	--	--	--					0	0	--	--	--	Spare	--	54
55	--	Spare	--	--	--	0	0					--	--	--	Spare	--	56
57	--	Spare	--	--	--			0	0			--	--	--	Spare	--	58
59	--	Spare	--	--	--					0	0	--	--	--	Spare	--	60
61	--	Spare	--	--	--	0	0					--	--	--	Spare	--	62
63	--	Spare	--	--	--			0	0			--	--	--	Spare	--	64
65	--	Spare	--	--	--					0	0	--	--	--	Spare	--	66
67	--	Spare	--	--	--	0	0					--	--	--	Spare	--	68
69	--	Spare	--	--	--			0	0			--	--	--	Spare	--	70
71	--	Spare	--	--	--					0	0	--	--	--	Spare	--	72
73	--	Spare	--	--	--	0	0					--	--	--	Spare	--	74
75	--	Spare	--	--	--			0	0			--	--	--	Spare	--	76
77	--	Spare	--	--	--					0	0	--	--	--	Spare	--	78
79	--	Spare	--	--	--	0	0					--	--	--	Spare	--	80
81	--	Spare	--	--	--			0	0			--	--	--	Spare	--	82
83	--	Spare	--	--	--					0	0	--	--	--	Spare	--	84
			Phase Load			10.52		13.85		7.91							
			Phase Amps			87.67		115.42		65.92							

Panel: DPHB1 BUS AMPS: 400 DISTR: 480Y/277

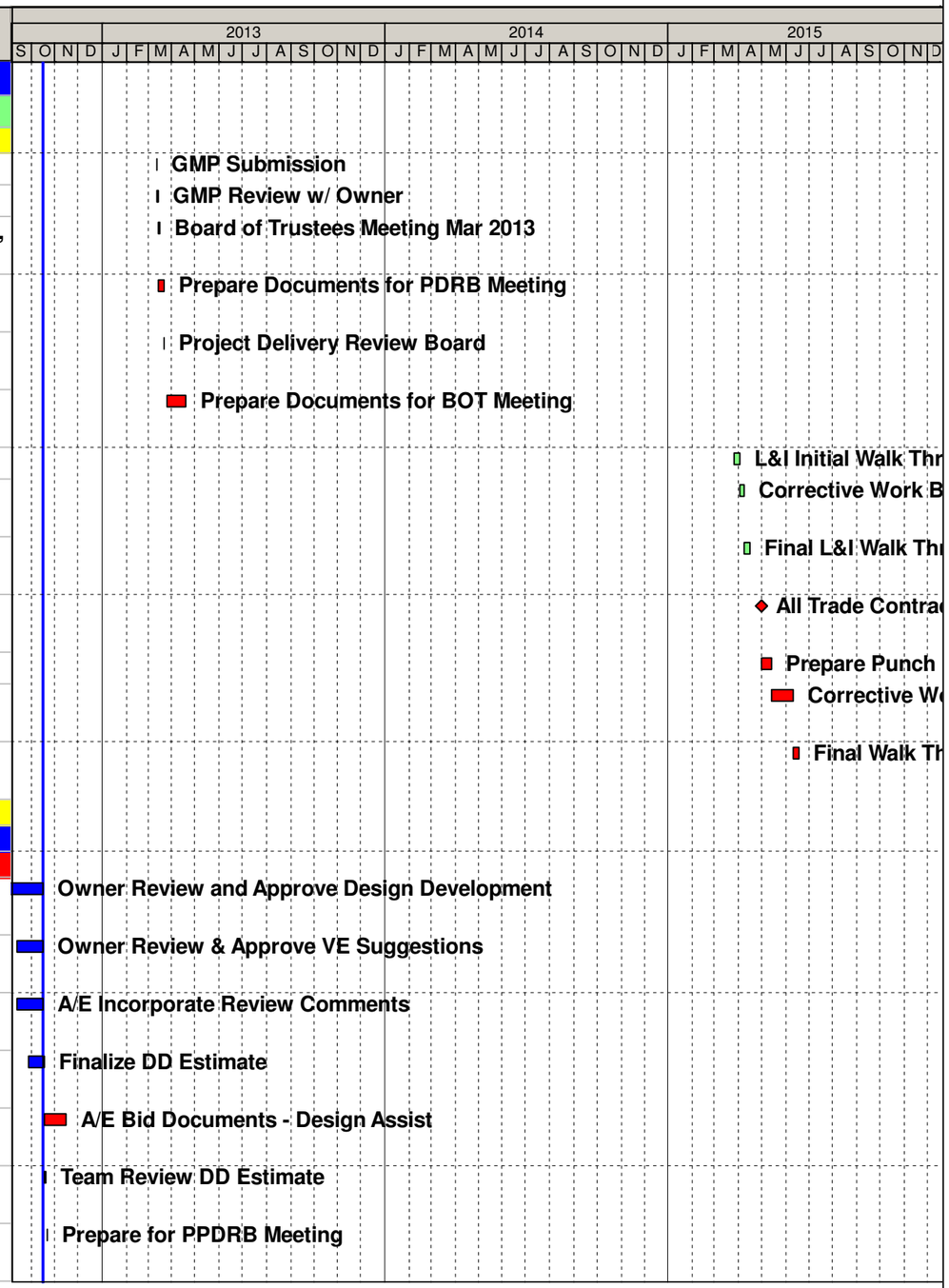
Supply From SDP-HB MAIN: MLO NEUTRAL 100%

CKT	TYPE	DESCRIPTION	WIRE	TRIP	POLE	A (kVA)		B (kVA)		C (kVA)		POLE	TRIP	WIRE	DESCRPTION	TYPE	CKT
1						9.4	3.88										2
3	M	AHU-1 SF (25HP)	R	70	3			9.4	3.88			3	40	R	AHU-1 RF (15HP)	M	4
5										9.4	3.88						6
7						9.4	3.87										8
9	M	AHU-2 SF (25HP)	R	70	3			9.4	3.87			3	40	R	AHU-2 (15HP)	M	10
11										9.4	3.87						12
13						0	0										14
15	--	Spare	--	30	3			0	0			3	20	--	Spare	--	16
17										0	0						18
19						0	0										20
21	--	Spare	--	20	3			0	0			3	30	--	Spare	--	22
23										0	0						24
25	--	SPACE	--	20	1	0	0					1	20	--	SPACE	--	26
27	--	SPACE	--	20	1			0	0			1	20	--	SPACE	--	28
29	--	SPACE	--	20	1					0	0	1	20	--	SPACE	--	30
31	--	SPACE	--	20	1	0	0					1	20	--	SPACE	--	32
33	--	SPACE	--	20	1			0	0			1	20	--	SPACE	--	34
35	--	SPACE	--	20	1					0	0	1	20	--	SPACE	--	36
37	--	SPACE	--	20	1	0	0					1	20	--	SPACE	--	38
39	--	SPACE	--	20	1			0	0			1	20	--	SPACE	--	40
41	--	SPACE	--	20	1					0	0	1	20	--	SPACE	--	42
			Phase Load			26.55		26.55		26.55							
			Phase Amps			95.85		95.85		95.85							

Appendix F

PSU - HUB Expansion Project 10-16-12U - Project ID: HUB Expansion | **Current Data Date: 10-16-12**

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
PSU - HUB Expansion Project 10-16-12U							
PSU - HUB Expansion Project							
Project Milestone							
80	GMP Submission	1	-25	03-12-13	03-12-13	2224	82
82	GMP Review w/ Owner	2	-25	03-13-13	03-14-13	80	90, 88
100	Board of Trustees Meeting Mar 2013	1	0	03-15-13	03-15-13*	90, 98	3000, 4000, 4100, 5500, 2500, 6500
88	Prepare Documents for PDRB Meeting	5	-25	03-15-13	03-21-13	82	90
90	Project Delivery Review Board	1	-25	03-22-13	03-22-13	82, 88	100, 98
98	Prepare Documents for BOT Meeting	19	-25	03-25-13	04-18-13	90	100
9340	L&I Initial Walk Thru	5	40	03-26-15	04-02-15	9120	9350
9350	Corrective Work Based on L&I Walk Thru	5	40	04-02-15	04-09-15	9340	9360
9360	Final L&I Walk Thru / Occupancy Certificate	5	40	04-09-15	04-16-15	9350	9330
9300	All Trade Contractor Work Complete	0	0		04-30-15	7500, 9140, 7820, 5380	9310
9310	Prepare Punch List	10	0	04-30-15	05-14-15	9300	9320
9320	Corrective Work Based on Punch List	20	0	05-14-15	06-11-15	9310	9330
9330	Final Walk Thru / Sign Off	5	0	06-11-15	06-18-15	9320, 9360	
Pre Construction							
Design							
Design Development							
1142	Owner Review and Approve Design Development	1	-25	08-29-12 A	10-16-12		1160, DI1000
1200	Owner Review & Approve VE Suggestions	1	-11	09-14-12 A	10-17-12	1180	1220
DI1000	A/E Incorporate Review Comments	1	-25	09-14-12 A	10-17-12	1142	DI1002
1220	Finalize DD Estimate	1	-11	09-27-12 A	10-18-12	1200	1240
DI1002	A/E Bid Documents - Design Assist	20	-25	10-18-12	11-14-12	DI1000	DI1004
1240	Team Review DD Estimate	1	-11	10-19-12	10-19-12	1220	1260, 1280
1280	Prepare for PPDRB Meeting	1	-11	10-22-12	10-22-12	1240	1300, 1260



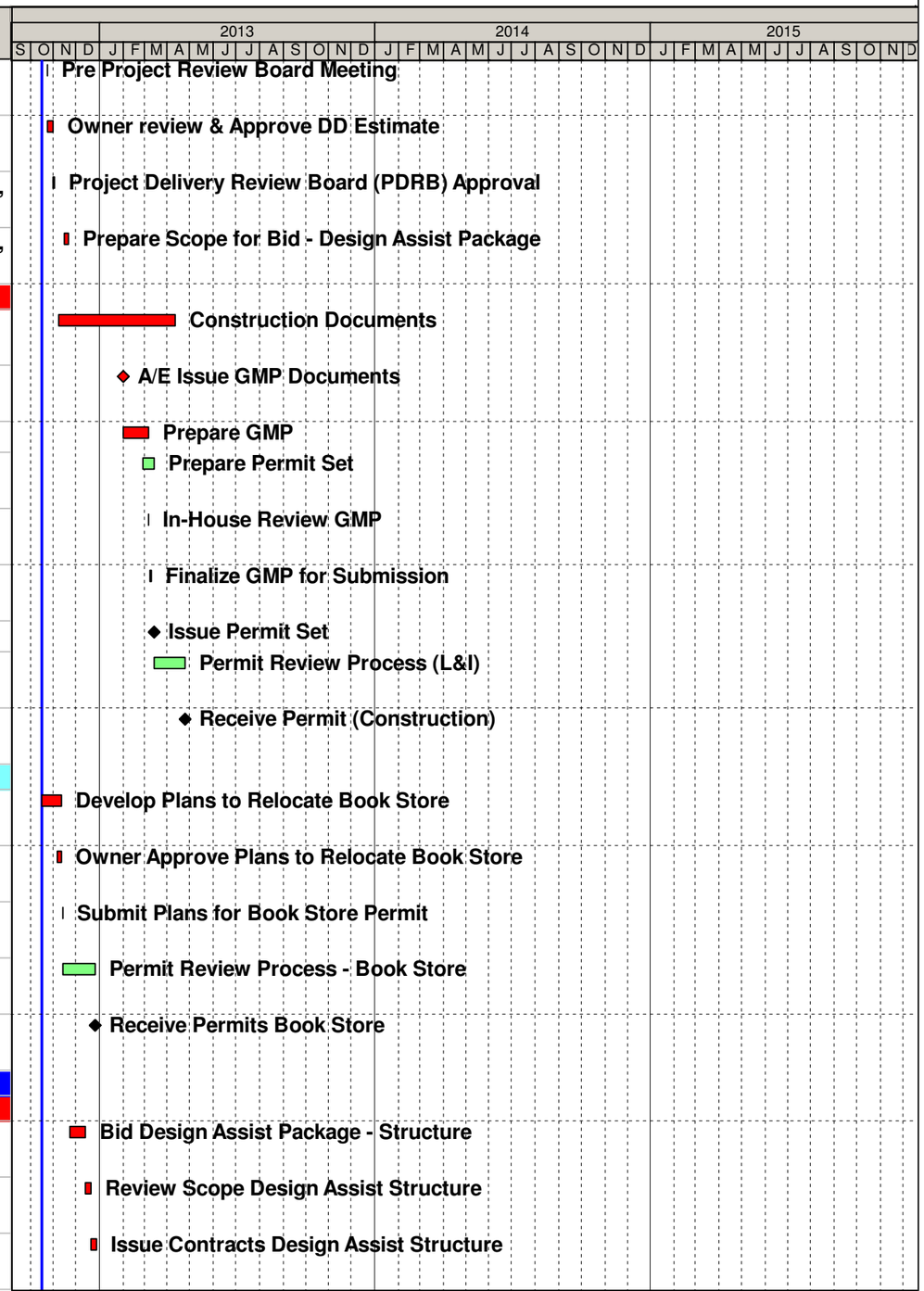
Start Date: 07-18-12
Finish Date: 06-18-15
Data Date: 10-16-12
Run Date: 10-16-12 14:20

PSU - HUB Expansion Project 10-16-12U
WBS Full Schedule - Basic Current

Gilbane

Date	Revision	Checked	Approved
10-16-12	For Review and Comments Includes 09/26/12 ...	Teddy	

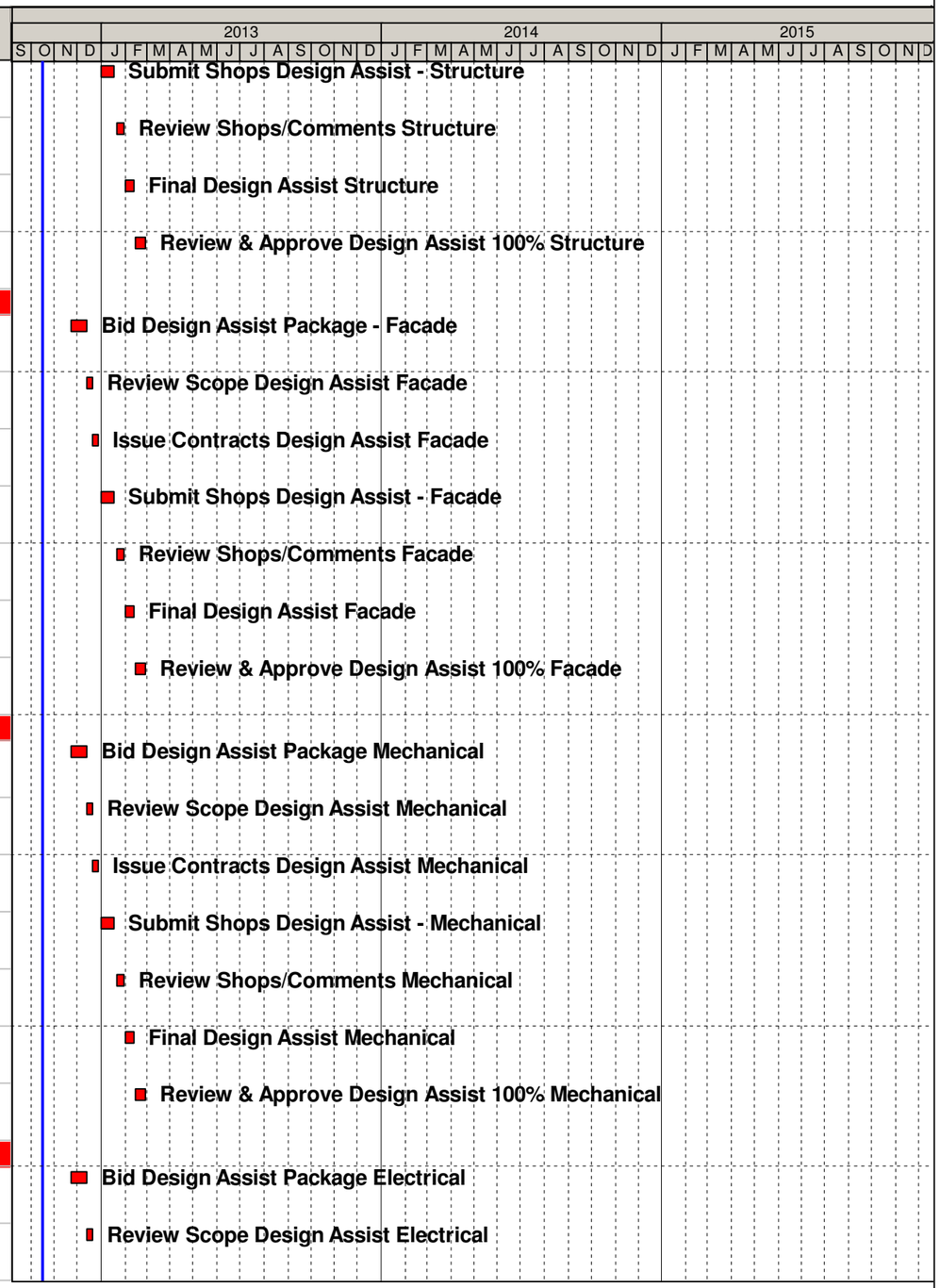
Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
1300	Pre Project Review Board Meeting	1	-11	10-23-12	10-23-12	1280	1320, 1260
1260	Owner review & Approve DD Estimate	6	-11	10-24-12	10-31-12	1240, 1280, 1300	1320
1320	Project Delivery Review Board (PDRB) Approval	1	-11	11-01-12	11-01-12	1260, 1300	1400, 1500, 1600, 1700, 1800, 1900, 2100, 2400
DI1004	Prepare Scope for Bid - Design Assist Package	5	-25	11-15-12	11-21-12	DI1002	1400, 1500, 1600, 1700, 1800, 1900
Construction Documents							
2100	Construction Documents	107	-7	11-08-12	04-10-13	1320, 1442, 1542, 1642, 1742, 1842, 1942	2200
2200	A/E Issue GMP Documents	0	-25	02-01-13		1422, 1522, 1622, 1722, 1822, 1922, 2100	2220
2220	Prepare GMP	24	-25	02-01-13	03-06-13	2200	2222
2240	Prepare Permit Set	10	40	02-28-13	03-13-13	1442, 1542, 1642, 1742, 1842, 1942	2242
2222	In-House Review GMP	1	-25	03-07-13	03-07-13	2220	2224
2224	Finalize GMP for Submission	2	-25	03-08-13	03-11-13	2222	80
2242	Issue Permit Set	0	40	03-14-13		2240	2244
2244	Permit Review Process (L&I)	30	40	03-14-13	04-24-13	2242	2246
2246	Receive Permit (Construction)	0	40		04-24-13	2244	3200, 4200
Book Store							
2400	Develop Plans to Relocate Book Store	20	0	10-16-12	11-12-12	1320	2420
2420	Owner Approve Plans to Relocate Book Store	5	0	11-06-12	11-12-12	2400	2422, 2440
2422	Submit Plans for Book Store Permit	1	58	11-13-12	11-13-12	2420	2424
2424	Permit Review Process - Book Store	29	58	11-14-12	12-26-12	2422	2480
2480	Receive Permits Book Store	0	58		12-26-12	2424	2500
Design Assist							
Structure							
1400	Bid Design Assist Package - Structure	15	-25	11-23-12	12-13-12	1320, DI1004	1402
1402	Review Scope Design Assist Structure	5	-25	12-14-12	12-20-12	1400	1404
1404	Issue Contracts Design Assist Structure	5	-25	12-21-12	12-28-12	1402	1420



Date	Revision	Checked	Approved
10-16-12	For Review and Comments Includes 09/26/12 ...	Teddy	

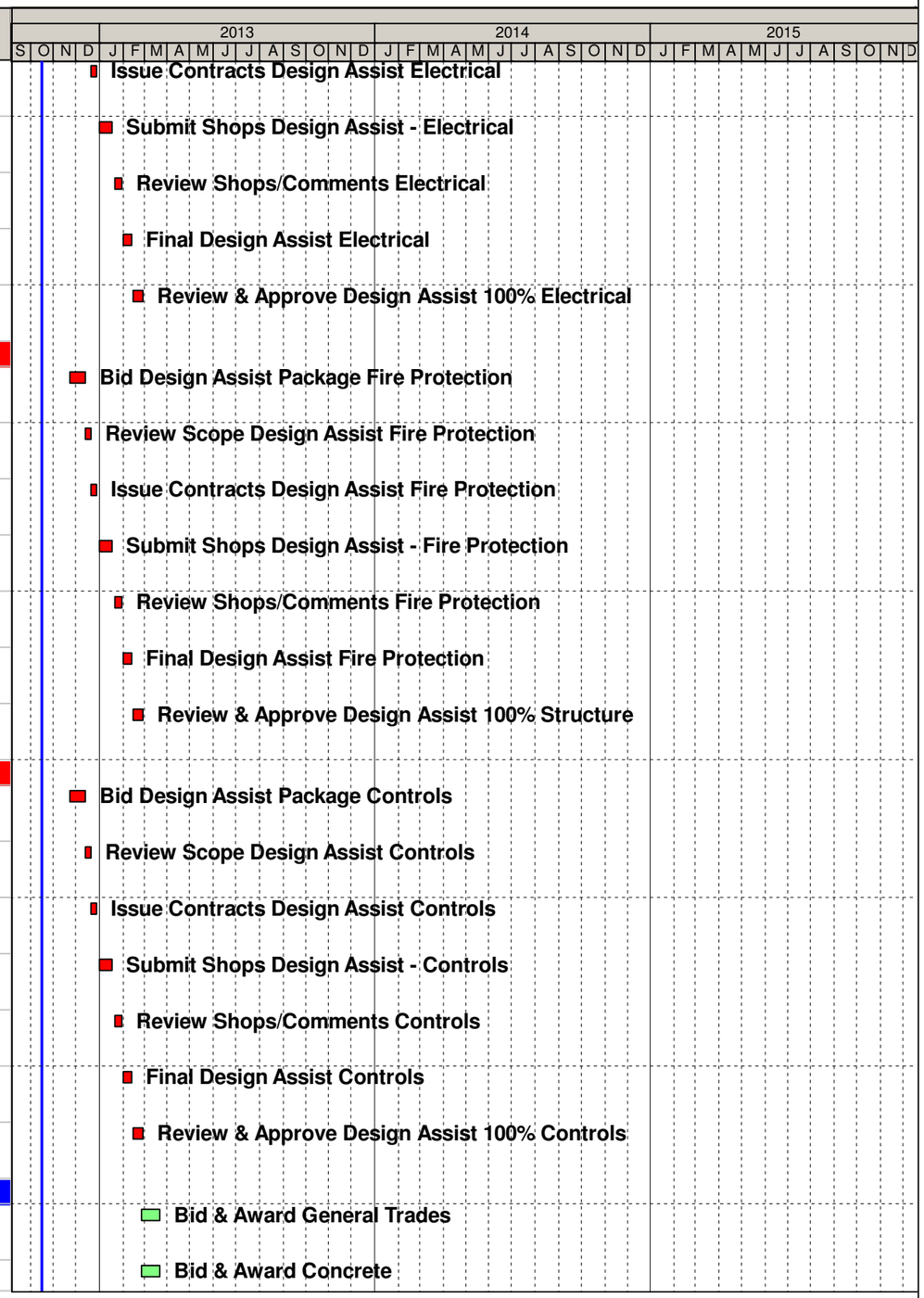
PSU - HUB Expansion Project 10-16-12U - Project ID: HUB Expansion | **Current Data Date: 10-16-12**

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
1420	Submit Shops Design Assist - Structure	14	-25	12-31-12	01-18-13	1404	1422
1422	Review Shops/Comments Structure	9	-25	01-21-13	01-31-13	1420	1440, 2200
1440	Final Design Assist Structure	9	-7	02-01-13	02-13-13	1422	1442
1442	Review & Approve Design Assist 100% Structure	10	-7	02-14-13	02-27-13	1440	2100, 2240
Facade							
1500	Bid Design Assist Package - Facade	15	-25	11-23-12	12-13-12	1320, DI1004	1502
1502	Review Scope Design Assist Facade	5	-25	12-14-12	12-20-12	1500	1504
1504	Issue Contracts Design Assist Facade	5	-25	12-21-12	12-28-12	1502	1520
1520	Submit Shops Design Assist - Facade	14	-25	12-31-12	01-18-13	1504	1522
1522	Review Shops/Comments Facade	9	-25	01-21-13	01-31-13	1520	1540, 2200
1540	Final Design Assist Facade	9	-7	02-01-13	02-13-13	1522	1542
1542	Review & Approve Design Assist 100% Facade	10	-7	02-14-13	02-27-13	1540	2100, 2240
Mechanical							
1600	Bid Design Assist Package Mechanical	15	-25	11-23-12	12-13-12	1320, DI1004	1602
1602	Review Scope Design Assist Mechanical	5	-25	12-14-12	12-20-12	1600	1604
1604	Issue Contracts Design Assist Mechanical	5	-25	12-21-12	12-28-12	1602	1620
1620	Submit Shops Design Assist - Mechanical	14	-25	12-31-12	01-18-13	1604	1622
1622	Review Shops/Comments Mechanical	9	-25	01-21-13	01-31-13	1620	1640, 2200
1640	Final Design Assist Mechanical	9	-7	02-01-13	02-13-13	1622	1642
1642	Review & Approve Design Assist 100% Mechanical	10	-7	02-14-13	02-27-13	1640	2100, 2240
Electrical							
1700	Bid Design Assist Package Electrical	15	-25	11-23-12	12-13-12	1320, DI1004	1702
1702	Review Scope Design Assist Electrical	5	-25	12-14-12	12-20-12	1700	1704



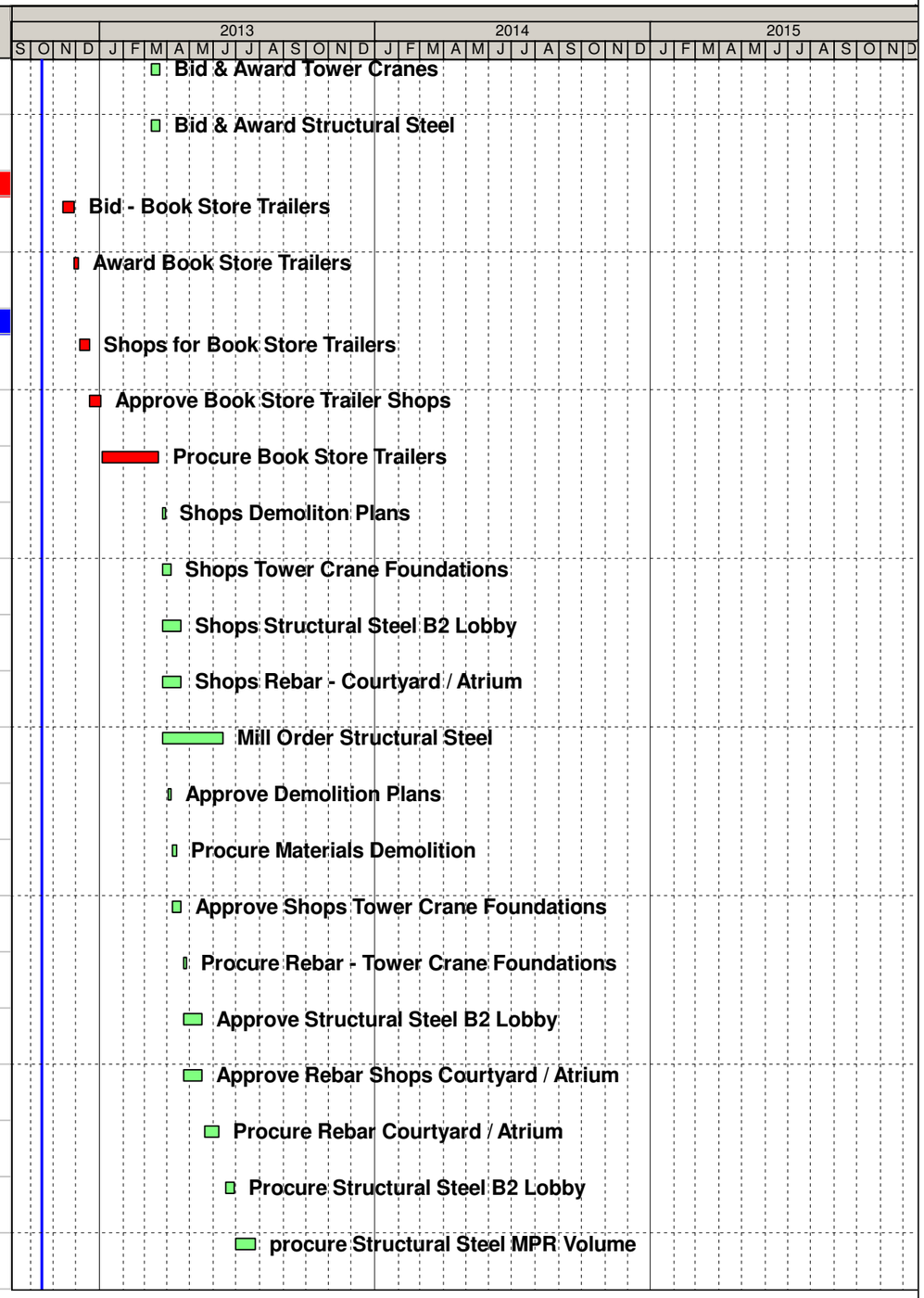
Date	Revision	Checked	Approved
10-16-12	For Review and Comments Includes 09/26/12 ...	Teddy	

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
1704	Issue Contracts Design Assist Electrical	5	-25	12-21-12	12-28-12	1702	1720
1720	Submit Shops Design Assist - Electrical	14	-25	12-31-12	01-18-13	1704	1722
1722	Review Shops/Comments Electrical	9	-25	01-21-13	01-31-13	1720	1740, 2200
1740	Final Design Assist Electrical	9	-7	02-01-13	02-13-13	1722	1742
1742	Review & Approve Design Assist 100% Electrical	10	-7	02-14-13	02-27-13	1740	2100, 2240
Fire Protection							
1800	Bid Design Assist Package Fire Protection	15	-25	11-23-12	12-13-12	1320, DI1004	1802
1802	Review Scope Design Assist Fire Protection	5	-25	12-14-12	12-20-12	1800	1804
1804	Issue Contracts Design Assist Fire Protection	5	-25	12-21-12	12-28-12	1802	1820
1820	Submit Shops Design Assist - Fire Protection	14	-25	12-31-12	01-18-13	1804	1822
1822	Review Shops/Comments Fire Protection	9	-25	01-21-13	01-31-13	1820	1840, 2200
1840	Final Design Assist Fire Protection	9	-7	02-01-13	02-13-13	1822	1842
1842	Review & Approve Design Assist 100% Structure	10	-7	02-14-13	02-27-13	1840	2100, 2240
Controls							
1900	Bid Design Assist Package Controls	15	-25	11-23-12	12-13-12	1320, DI1004	1902
1902	Review Scope Design Assist Controls	5	-25	12-14-12	12-20-12	1900	1904
1904	Issue Contracts Design Assist Controls	5	-25	12-21-12	12-28-12	1902	1920
1920	Submit Shops Design Assist - Controls	14	-25	12-31-12	01-18-13	1904	1922
1922	Review Shops/Comments Controls	9	-25	01-21-13	01-31-13	1920	1940, 2200
1940	Final Design Assist Controls	9	-7	02-01-13	02-13-13	1922	1942
1942	Review & Approve Design Assist 100% Controls	10	-7	02-14-13	02-27-13	1940	2100, 2240
Trade Contract Procurement							
4000	Bid & Award General Trades	20	239	02-25-13	03-22-13	100	4020
5500	Bid & Award Concrete	20	254	02-25-13	03-22-13	100	5600



Date	Revision	Checked	Approved
10-16-12	For Review and Comments Includes 09/26/12 ...	Teddy	

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
3000	Bid & Award Tower Cranes	10	39	03-11-13	03-22-13	100	3020
4100	Bid & Award Structural Steel	10	244	03-11-13	03-22-13	100	4030, 4036
Buy Out							
2440	Bid - Book Store Trailers	10	0	11-13-12	11-27-12	2420	2442
2442	Award Book Store Trailers	5	0	11-28-12	12-04-12	2440	2460
Engineering and Off-site Fabrication							
2460	Shops for Book Store Trailers	10	0	12-05-12	12-18-12	2442	2462
2462	Approve Book Store Trailer Shops	10	0	12-19-12	01-03-13	2460	2464
2464	Procure Book Store Trailers	53	0	01-04-13	03-19-13	2462	2500
4020	Shops Demoliton Plans	5	239	03-25-13	03-29-13	4000	4022
3020	Shops Tower Crane Foundations	10	39	03-25-13	04-05-13	3000	3022
4030	Shops Structural Steel B2 Lobby	20	264	03-25-13	04-19-13	4100	4032
5600	Shops Rebar - Courtyard / Atrium	20	254	03-25-13	04-19-13	5500	5602
4036	Mill Order Structural Steel	60	244	03-25-13	06-14-13	4100	4034
4022	Approve Demolition Plans	5	239	04-01-13	04-05-13	4020	4024
4024	Procure Materials Demolition	5	239	04-08-13	04-12-13	4022	4200
3022	Approve Shops Tower Crane Foundations	10	39	04-08-13	04-19-13	3020	3024
3024	Procure Rebar - Tower Crane Foundations	5	39	04-22-13	04-26-13	3022	3200
4032	Approve Structural Steel B2 Lobby	20	264	04-22-13	05-17-13	4030	4034
5602	Approve Rebar Shops Courtyard / Atrium	20	254	04-22-13	05-17-13	5600	5604
5604	Procure Rebar Courtyard / Atrium	15	254	05-20-13	06-07-13	5602	5760
4034	Procure Structural Steel B2 Lobby	10	244	06-17-13	06-28-13	4032, 4036	4320, 4044
4044	procure Structural Steel MPR Volume	20	244	07-01-13	07-26-13	4034	5200



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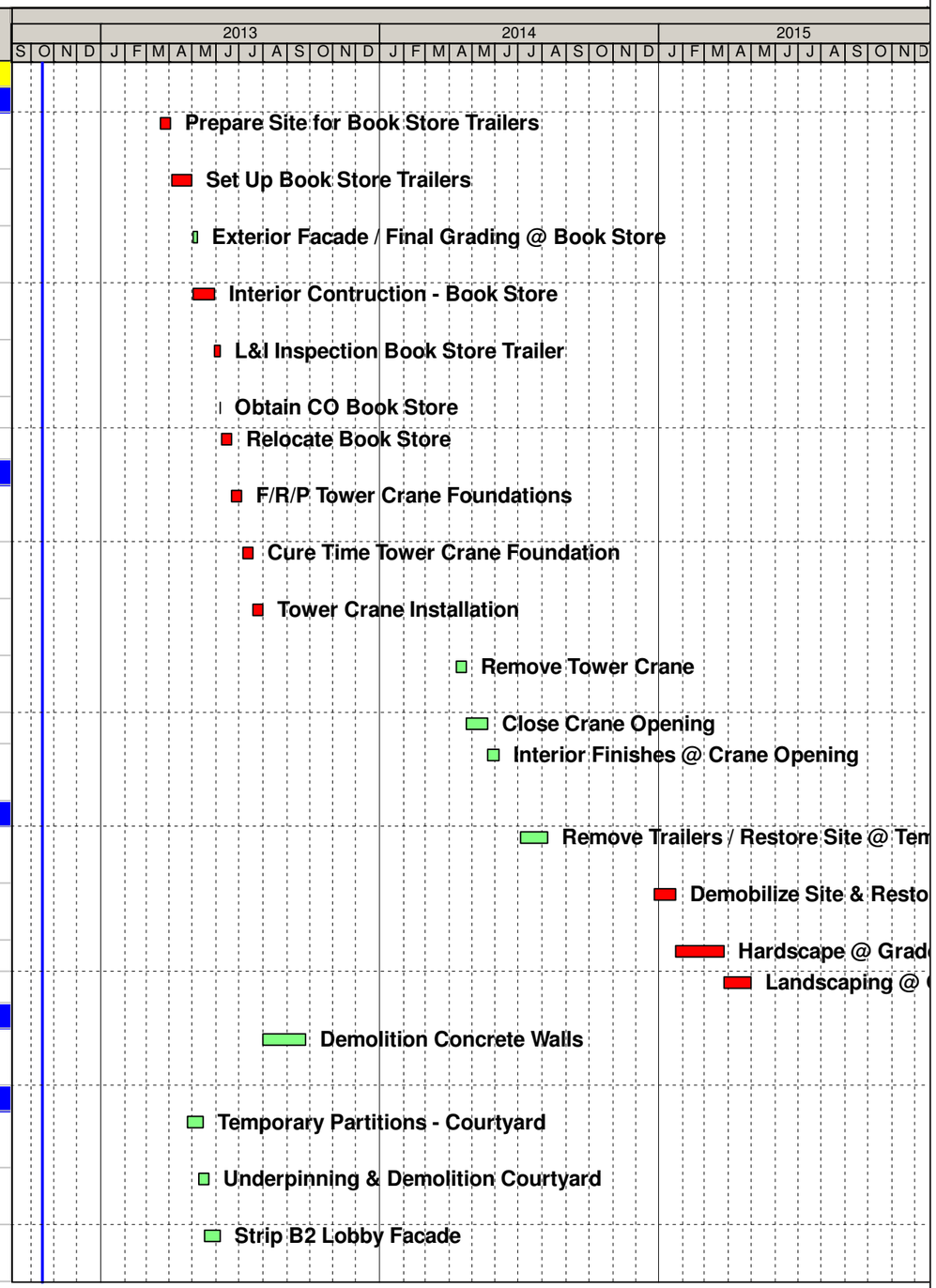
10-16-12	For Review and Comments Includes 09/26/12 ...	Teddy	

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
Construction							
Book Store							
2500	Prepare Site for Book Store Trailers	10	0	03-20-13	04-02-13	2464, 100, 2480	2520
2520	Set Up Book Store Trailers	20	0	04-03-13	04-30-13	2500	2540, 2560
2540	Exterior Facade / Final Grading @ Book Store	5	20	05-01-13	05-07-13	2520	2600
2560	Interior Contruction - Book Store	20	0	05-01-13	05-29-13	2520	2580
2580	L&I Inspection Book Store Trailer	5	0	05-30-13	06-05-13	2560	2600
2600	Obtain CO Book Store	1	0	06-06-13	06-06-13	2580, 2540	2800
2800	Relocate Book Store	10	0	06-07-13	06-20-13	2600	3200, 5700
Tower Crane							
3200	F/R/P Tower Crane Foundations	10	0	06-21-13	07-04-13	3024, 2800, 2246	3202
3202	Cure Time Tower Crane Foundation	14	0	07-05-13	07-18-13	3200	3220, 6680
3220	Tower Crane Installation	10	0	07-18-13	08-01-13	3202	3600, 4300, 6620
3240	Remove Tower Crane	10	150	04-10-14	04-24-14	4460, 5870, 8250, 5280	3260, 9000
3260	Close Crane Opening	20	270	04-24-14	05-22-14	3240	3280
3280	Interior Finishes @ Crane Opening	10	270	05-22-14	06-05-14	3260	
Sitework							
9000	Remove Trailers / Restore Site @ Temp Bookstore	25	100	07-03-14	08-07-14	6940, 3240	9100
9100	Demobilize Site & Restore	20	0	12-25-14	01-22-15	8720, 8680, 9000	9120
9120	Hardscape @ Grade	45	0	01-22-15	03-26-15	9100	9140, 9340
9140	Landscaping @ Grade	25	0	03-26-15	04-30-15	9120	9300
Concrete Walls Demolition							
3600	Demolition Concrete Walls	40	450	08-01-13	09-26-13	3220	
B2 Lobby / Courtyard							
4200	Temporary Partitions - Courtyard	15	231	04-25-13	05-15-13	4024, 2246	4240, 4220
4220	Underpinning & Demolition Courtyard	10	241	05-09-13	05-22-13	4200	4280
4240	Strip B2 Lobby Facade	15	231	05-16-13	06-05-13	4200	4280



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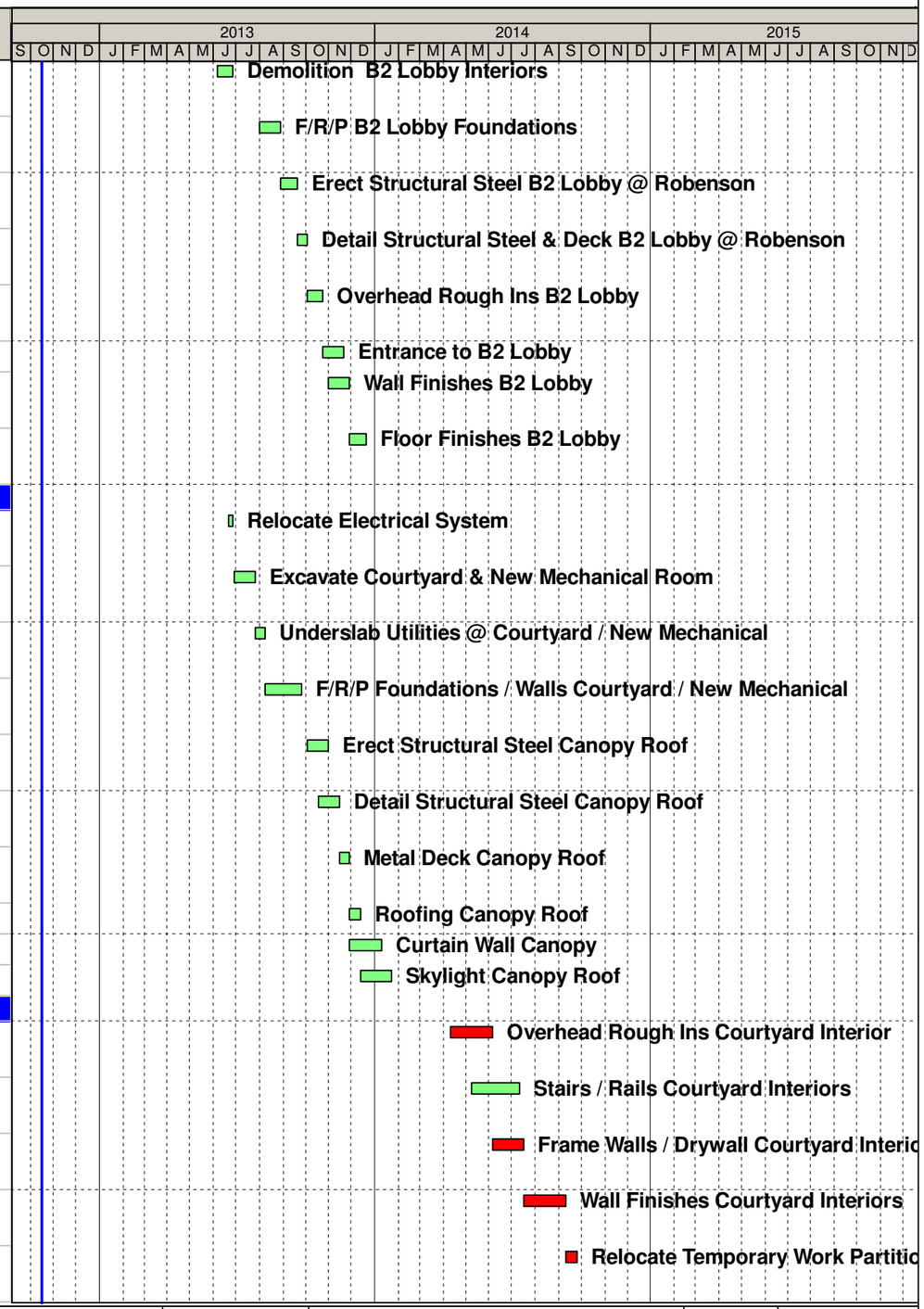
PSU - HUB Expansion Project 10-16-12U - Project ID: HUB Expansion | **Current Data Date: 10-16-12**

Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
4280	Demolition B2 Lobby Interiors	15	231	06-06-13	06-26-13	4240, 4220	4300
4300	F/R/P B2 Lobby Foundations	20	205	08-01-13	08-29-13	4280, 3220	4320
4320	Erect Structural Steel B2 Lobby @ Robenson	15	205	08-29-13	09-19-13	4300, 4034	4322, 5200
4322	Detail Structural Steel & Deck B2 Lobby @ Robenson	10	230	09-19-13	10-03-13	4320	4400, 4400
4400	Overhead Rough Ins B2 Lobby	15	230	10-03-13	10-24-13	4322, 4322	4420
4420	Entrance to B2 Lobby	20	230	10-24-13	11-21-13	4400	4440
4440	Wall Finishes B2 Lobby	20	230	10-31-13	11-28-13	4420	4460
4460	Floor Finishes B2 Lobby	15	230	11-28-13	12-19-13	4440	3240
Atrium / Courtyard							
5700	Relocate Electrical System	5	210	06-21-13	06-27-13	2800	5720
5720	Excavate Courtyard & New Mechanical Room	20	210	06-28-13	07-25-13	5700	5740
5740	Underslab Utilities @ Courtyard / New Mechanical	10	210	07-26-13	08-08-13	5720	5760
5760	F/R/P Foundations / Walls Courtyard / New Mechanical	35	210	08-09-13	09-26-13	5740, 5604	5780
5780	Erect Structural Steel Canopy Roof	20	205	10-03-13	10-31-13	5760, 5200	5800
5800	Detail Structural Steel Canopy Roof	20	205	10-17-13	11-14-13	5780	5820
5820	Metal Deck Canopy Roof	10	205	11-14-13	11-28-13	5800	5840, 5860
5840	Roofing Canopy Roof	10	205	11-28-13	12-12-13	5820	5870
5860	Curtain Wall Canopy	30	210	11-28-13	01-09-14	5820	5870
5870	Skylight Canopy Roof	30	205	12-12-13	01-23-14	5840, 5860	3240
Courtyard Interiors							
8600	Overhead Rough Ins Courtyard Interior	40	0	04-10-14	06-05-14	8250	8620, 8700
8700	Stairs / Rails Courtyard Interiors	45	5	05-08-14	07-10-14	8600	8640
8620	Frame Walls / Drywall Courtyard Interiors	30	0	06-05-14	07-17-14	8600	8640
8640	Wall Finishes Courtyard Interiors	40	0	07-17-14	09-11-14	8620, 8700	8660, 9200
9200	Relocate Temporary Work Partitions	10	0	09-11-14	09-25-14	8640	9220



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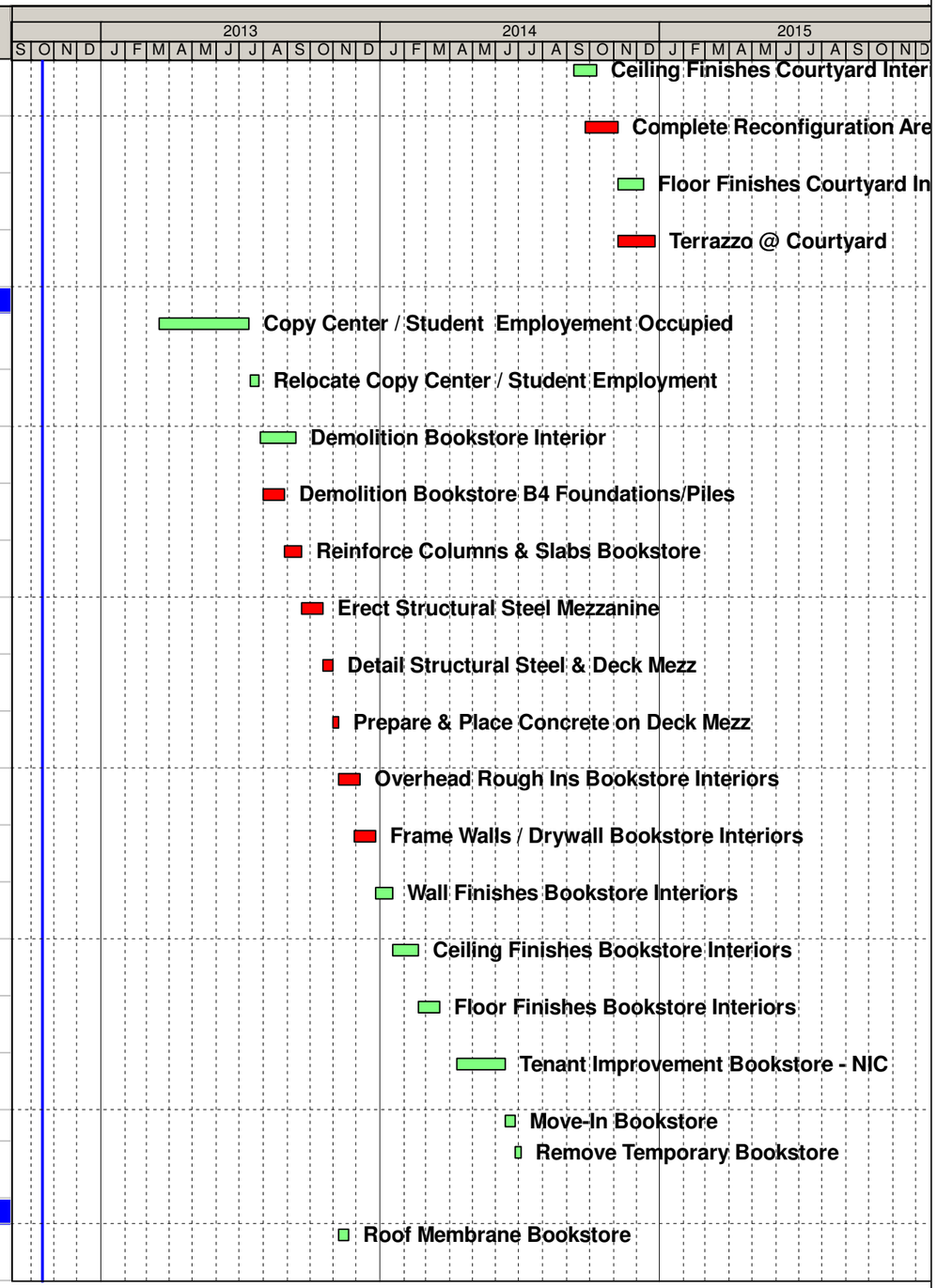
Activity ID	Activity Name	Rem Dur	Total Float	Start	Finish	Predecessors	Successors
8660	Ceiling Finishes Courtyard Interiors	20	20	09-11-14	10-09-14	8640	8680, 8720
9220	Complete Reconfiguration Area	30	0	09-25-14	11-06-14	9200	8680, 8720, 8680
8680	Floor Finishes Courtyard Interiors	25	10	11-06-14	12-11-14	8660, 9220, 9220, 9240	9100, 7800, 8000
8720	Terrazzo @ Courtyard	35	0	11-06-14	12-25-14	8660, 9220, 9240	9100, 7800, 8000
Book Store Interior							
6500	Copy Center / Student Employement Occupied	85	459	03-18-13	07-12-13	100	6600
6600	Relocate Copy Center / Student Employment	10	459	07-15-13	07-26-13	6500	6640
6640	Demolition Bookstore Interior	35	459	07-29-13	09-13-13	6600	
6620	Demolition Bookstore B4 Foundations/Piles	20	0	08-01-13	08-29-13	3220	6660
6660	Reinforce Columns & Slabs Bookstore	15	0	08-29-13	09-19-13	6620	6680
6680	Erect Structural Steel Mezzanine	20	0	09-19-13	10-17-13	6660, 3202	6700
6700	Detail Structural Steel & Deck Mezz	10	0	10-17-13	10-31-13	6680	6720
6720	Prepare & Place Concrete on Deck Mezz	5	0	10-31-13	11-07-13	6700	6740, 8200
6740	Overhead Rough Ins Bookstore Interiors	20	0	11-07-13	12-05-13	6720	6760
6760	Frame Walls / Drywall Bookstore Interiors	20	0	11-28-13	12-26-13	6740	6780, 8220
6780	Wall Finishes Bookstore Interiors	15	115	12-26-13	01-16-14	6760	6800
6800	Ceiling Finishes Bookstore Interiors	25	115	01-16-14	02-20-14	6780	6820
6820	Floor Finishes Bookstore Interiors	20	115	02-20-14	03-20-14	6800	6900
6900	Tenant Improvement Bookstore - NIC	45	100	04-10-14	06-12-14	6820, 8250	6920
6920	Move-In Bookstore	10	100	06-12-14	06-26-14	6900	6940, 7200
6940	Remove Temporary Bookstore	5	100	06-26-14	07-03-14	6920	9000
Bookstore Exterior							
8200	Roof Membrane Bookstore	10	25	11-07-13	11-21-13	6720	8220, 9230



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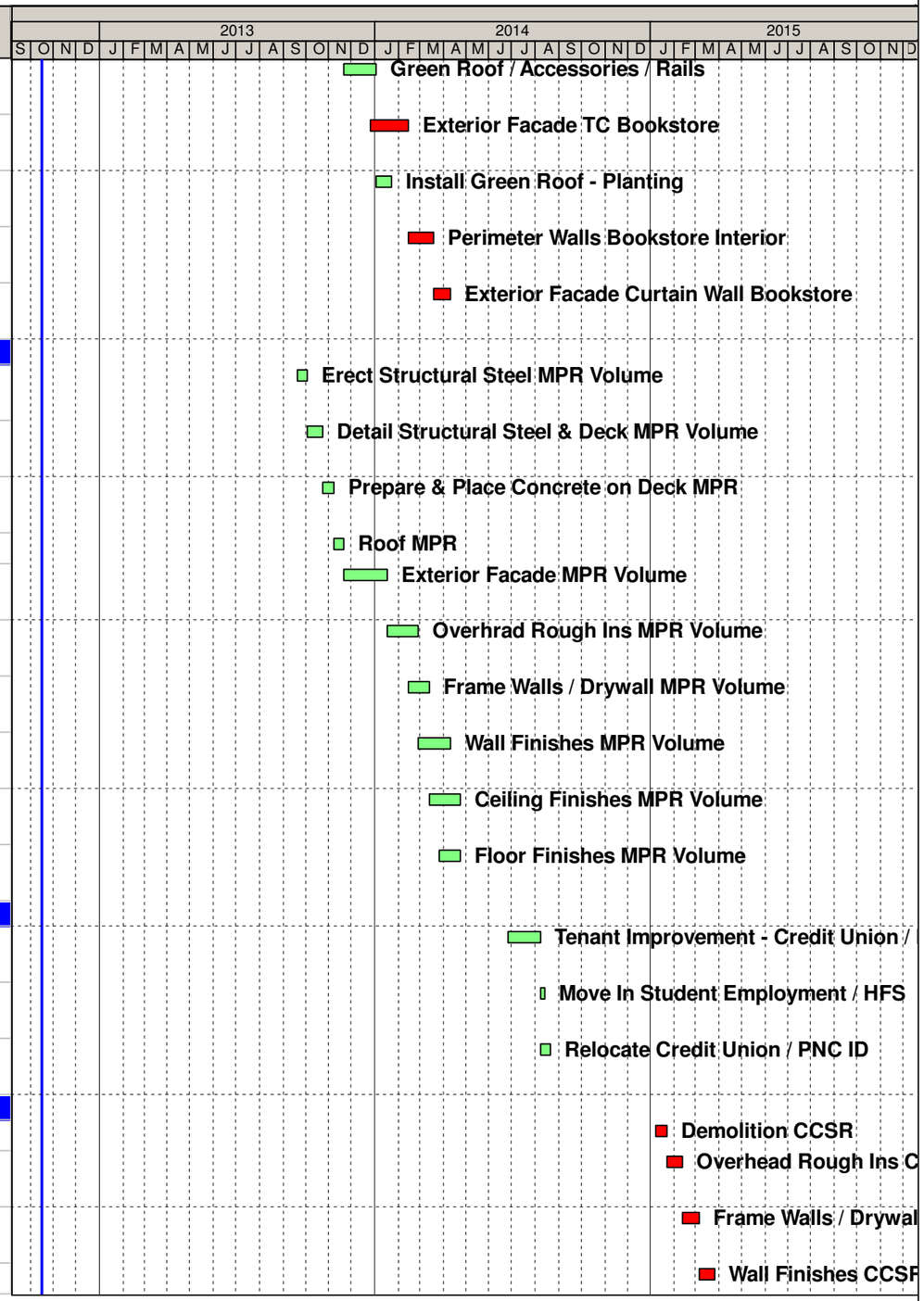
9230	Green Roof / Accessories / Rails	30	42	11-21-13	01-02-14	8200	9240
8220	Exterior Facade TC Bookstore	35	0	12-26-13	02-13-14	8200, 6760	8240
9240	Install Green Roof - Planting	15	42	01-02-14*	01-23-14	9230	8720, 8680
8240	Perimeter Walls Bookstore Interior	25	0	02-13-14	03-20-14	8220	8250
8250	Exterior Facade Curtain Wall Bookstore	15	0	03-20-14	04-10-14	8240	6900, 8600, 3240
MPR Volume							
5200	Erect Structural Steel MPR Volume	10	205	09-19-13	10-03-13	4320, 4044	5220, 5780
5220	Detail Structural Steel & Deck MPR Volume	15	210	10-03-13	10-24-13	5200	5240
5240	Prepare & Place Concrete on Deck MPR	10	210	10-24-13	11-07-13	5220	5260
5260	Roof MPR	10	210	11-07-13	11-21-13	5240	5280
5280	Exterior Facade MPR Volume	40	210	11-21-13	01-16-14	5260	5300, 3240
5300	Overhrad Rough Ins MPR Volume	30	265	01-16-14	02-27-14	5280	5320, 5340
5320	Frame Walls / Drywall MPR Volume	20	265	02-13-14	03-13-14	5300	5340, 5380
5340	Wall Finishes MPR Volume	30	265	02-27-14	04-10-14	5320, 5300	5360
5360	Ceiling Finishes MPR Volume	30	265	03-13-14	04-24-14	5340	5380
5380	Floor Finishes MPR Volume	20	265	03-27-14	04-24-14	5360, 5320	9300
Credit Union / PNC ID							
7200	Tenant Improvement - Credit Union / PNC ID	30	100	06-26-14	08-07-14	6920	7300, 7320
7320	Move In Student Employment / HFS	5	105	08-07-14	08-14-14	7200	7400
7300	Relocate Credit Union / PNC ID	10	100	08-07-14	08-21-14	7200	7400
CCSR							
7400	Demolition CCSR	10	0	01-08-15	01-22-15	7300, 7320, 8000	7420
7420	Overhead Rough Ins CCSR	15	0	01-22-15	02-12-15	7400	7440
7440	Frame Walls / Drywall CCSR	15	0	02-12-15	03-05-15	7420	7460
7460	Wall Finishes CCSR	15	0	03-05-15	03-26-15	7440	7480



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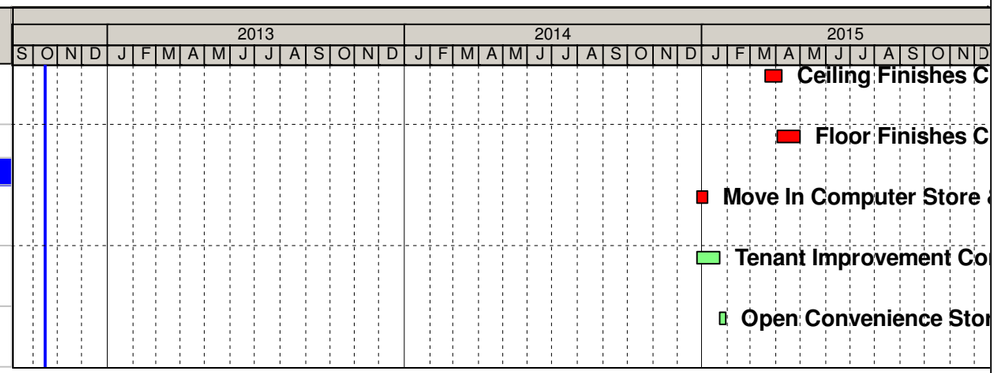
7480	Ceiling Finishes CCSR	15	0	03-19-15	04-09-15	7460	7500
7500	Floor Finishes CCSR	20	0	04-02-15	04-30-15	7480	9300
Computer Store / Copy Center							
8000	Move In Computer Store & Copy Center	10	0	12-25-14	01-08-15	8680, 8720	7400
7800	Tenant Improvement Convenience Store	20	65	12-25-14	01-22-15	8720, 8680	7820
7820	Open Convenience Store	5	65	01-22-15	01-29-15	7800	9300



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