

2011

# Shepherd University Wellness Center

Architectural Engineering Senior Thesis

Lighting | Electrical  
Dr. Kevin Houser and Ted Dannerth



# Shepherd University Wellness Center

Shepherdstown, West Virginia

## Architecture

The multi-function university facility provides a balanced recreational program through three key elements: the fitness zone, a pool area, and a multi-function gymnasium. The building contains open spaces adjacent to a large rotunda that promotes circulation and openness.

## Lighting

The majority of the general ambient light is provided by linear fluorescent recessed luminaires. Metal halide sources are used to illuminate the gymnasium and pool area. The rotunda incorporates linear fluorescent, metal halide, and xenon lamps to highlight the curved architectural features.

## Electrical

Primary service is provided by Alleghany Power. The system is comprised of 2500A, 480Y/277V, 3 phase, 4 wire, and 60 Hertz. An emergency propane fired generator provides 75kW. The main switchboard is sized for 2500A.

## Mechanical

The system consists of six rooftop units, two energy recovery rooftop units, and two pool dehumidification units. A variable air volume system allows for control of temperature zones.

## Structural

Steel frame construction with lateral bracing. Floor system consists of two different types of composite decking, one shored and one unshored, both with a total thickness of six and a half inches. Decking is topped with normal weight concrete and welded wire fabric.

## Statistics

Type | Academic Fitness and Education Center

Size | 73,400 square feet

Levels | Two

Cost | \$21.6 million

Completion | June 2009

## Project Team

Owner | Shepherd University

Architect | Hughes Group Architects

MEP | Brinjac Engineering

Structural | Ehlert/Bryan

Contractor | Palmer Construction Company



Lisha A Brown

The Pennsylvania State University  
Department of Architectural Engineering  
Lighting/ Electrical Option

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## Executive Summary

The Shepherd University Wellness Center allows for a balanced recreational program for the students, faculty, and staff of the University. Located in the center of Shepherd University's campus, the facility contains an eight-lane 25 yard swimming pool, two indoor gyms, an indoor elevated 1/10th mile jogging track, over 7,500 square foot weight and fitness area, two multi-purpose rooms, causal seating area, and administrative area.

The following report covers several topics regarding aesthetics, functionality, energy efficiency, and cost analysis. The lighting depth provides complete lighting re-designs for four spaces throughout the Wellness Center. Lighting design criteria, documentation, equipment, graphics, and performance data are provided for the Outdoor Entry, Rotunda, Multi-Purpose Room, and Fitness Room. The lighting designs for all spaces enhance the architecture and interior design while expressing excitement and movement throughout this exercise facility.

The existing electrical design was modified to meet the change in lighting design. Electrical depth topics include additional studies on equipment efficiency, cost, and functionality.

As part of the general goal to enhance the interior spaces and complete interdisciplinary studies in the design industry, an architectural breadth and an acoustical breadth aid in the redesign of the multi-purpose room.

The re-design solutions prove to be aesthetically pleasing, functional, and energy efficient. Each solution engages the users and emphasizes the Wellness Center's presence on campus.

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## **Building Information and Statistics**

**Building Name** | Shepherd University Wellness Center

**Location** | Shepherdstown, West Virginia

**Building Occupant** | Shepherd University

**Occupancy** | Fitness and Education Center

**Size** | 73,400 Square Feet

**Number of Stories** | 2

**Date of Construction** | June 11, 2009

**Construction Cost** | \$21,600,000.00

**Project Delivery Method** | Single Lump-Sum Contract

### **Primary Project Team**

**Owner** | Shepherd University

**General Contractor** | Palmer Construction Company in McConellsburg, PA

**Architect** | Hughes Group Architects in Sterling, VA

**Structural Engineer** | Ehlert/ Byan, Inc. in Mclean, VA

**MEP and Fire Protection Engineer** | Brinjac Engineers in Harrisburg, PA

## Lighting Depth

The Shepherd University Wellness Center is located on Shepherd University's campus in Shepherdstown, West Virginia. The facility is over 70,000 square feet with two stories and was completed in June of 2009 with the cost of construction of about 21.6 million dollars. As a university fitness and educational center, the building serves as a multi-function facility that provides a balanced recreational program for the students, faculty, and staff of the University. The three key elements are the fitness zone, a pool area, and a multi-function gymnasium. The building contains open spaces adjacent to a large rotunda that promote circulation and openness. Also included in the building are a 25 yard pool, 2 basketball courts, an indoor jogging track, an over 7,500 square foot fitness area, dining venue, and administrative offices.

The four spaces that will be studied are the outdoor entry, as the outdoor space, the rotunda, as a circulation space, the multi-purpose room, as a special purpose space, and the fitness room, as a large work space. The outdoor entry relates the building to the University campus. The rotunda enhances the architecture of the building entrance. The multi-purpose room allows for flexibility of the use of light for each type of aerobic activity, while the fitness room uses light to distinguish sub spaces of different workout tasks.

The architect's vision was to have "three key elements provide a balanced recreation program: fitness zone, new pool, and a multi-function gymnasium" (Hughes Group Architects). The lighting design will mirror this image of balance through the concepts of movement, navigation, and safety. Movement will energize the users and stimulate their interest to workout. Navigation is imperative to directing the users to and through the spaces. The design will provide enough light for the users to use the space and its components safely.



## Outdoor Entry | Outdoor Space

### Description

This gathering exterior space serves as the focal point of the building, drawing visitors inside. The space connects the parking lot and exterior pathways to the vestibule entrance and the building's front façade. The space serves as circulation and egress. The space contains the stairs and pathway leading up to the main entrance, the brick façade, and a two-story glass storefront.

### Dimension

Area= approximately 1970 sq. ft.

### Materials

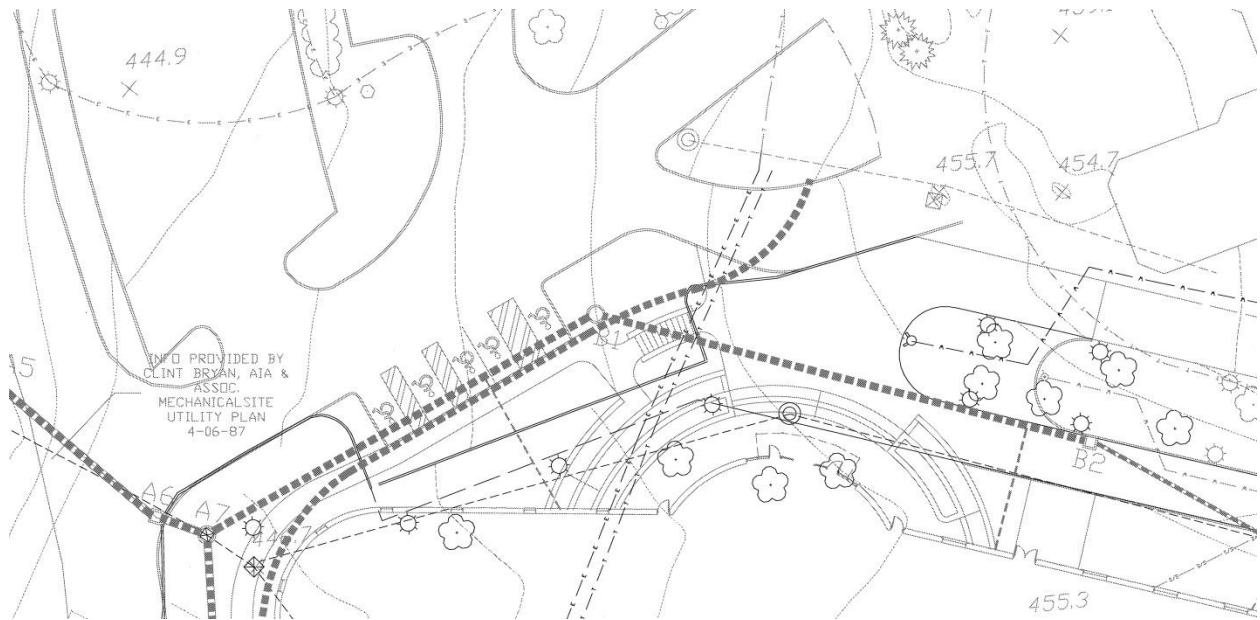
Table 1: Outdoor entry materials.

MATERIAL	OBJECT	COLOR	REFLECTANCE
Cement	Ground Covering	White	0.47
Asphalt	Ground Covering	N/A	0.26
Brick	Wall	Red	0.1

Note: For N/A colors, reflectance is designed for material specified.

## Drawings

Figure 1: Existing plan of the outdoor entry.



## Lighting Design Criteria and Considerations

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

- Classification: Building Exterior, Entrance, Active (pedestrian/ conveyance)
- Appearance of Space and Luminaires: Very Important
  - Spatial appearance shall be aesthetically pleasing to create a comfortable space.
- Color Appearance and Color Contrast: Very Important
  - The lighting shall allow visitors to distinguish objects and people from the backdrop of the sky and building. The color appearance and contrast shall allow for easy identification for the safety of visitors.
- Direct Glare, Reflected Glare: Very Important
  - Direct glare shall be avoided to minimize discomfort and visibility interference to pedestrians and drivers in this outdoor space.
- Light Pollution/ Trespass: Very Important
  - Light pollution could affect the surrounding campus buildings. Illumination exceeding the boundaries of this outdoor space shall be minimal.
- Light Distribution on Surfaces, Modeling of Faces or Objects, Peripheral Detection: Very Important
  - Visitors must be able to recognize people and vehicles traveling throughout the space for their own safety. The lighting shall reveal the depth and shape of the objects throughout the space for easy identification.
- Points of Interest: Important
  - The main doors shall be the point of interest to lead visitors into the building.

- Shadows: Very Important
  - Shadows shall be minimal to create a safe space for visitors.
- Source/ Task/ Eye Geometry: Very Important
  - Safety is a main concern that will need to be addressed by the illuminated ground surface plane.
- Horizontal Illuminance: Very Important
  - 5 footcandles is recommended for simple orientation for short visits.
- Vertical Illuminance: Very Important
  - 3 footcandles is recommended for public spaces.

*ASHRAE/IESNA Standard 90.1 2007*

- Lighting Power Density Allowance for Building Exteriors
  - Building Grounds: Tradable Surfaces
    - Plaza areas: 0.2 W/ square feet

*Architectural Lighting Design Third Edition by Gary Steffy*

Psychological Aspect

- This space is designed for visual clarity to emphasize the walkways and entrance of the building.


**Lighting Design Concept**

The outdoor entry should be an inviting and safe space. The large two-story storefront serves as the building core and will illuminate the building from within. Additionally, step lighting will guide the users to the building, while path lighting will draw the users to the space.

**Lighting Solution**

**Luminaire Schedule**

Table 2: Outdoor entry luminaire schedule.

TYPE	IMAGE	MANUFACTURER/ CATALOG NUMBER	DESCRIPTION	MOUNTING	POWER SUPPLY	VOLTAGE	LAMP	WATTAGE
L06		Bega-US 2289P	Recessed wall luminaire, unshielded for steps, die-cast and extruded aluminum housing, 1/8" thick, clear tempered glass with translucent white ceramic coating	Recessed Wall	Integral Magnetic	120/277V	(1) F9BX/827/ ECO	9W

### Light Loss Factors

IESNA Lighting Handbook 9<sup>th</sup> Edition

Table 3: Outdoor entry light loss factors.

Luminaire Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor Total
L06	0.83	0.88	0.98	0.72

### Controls

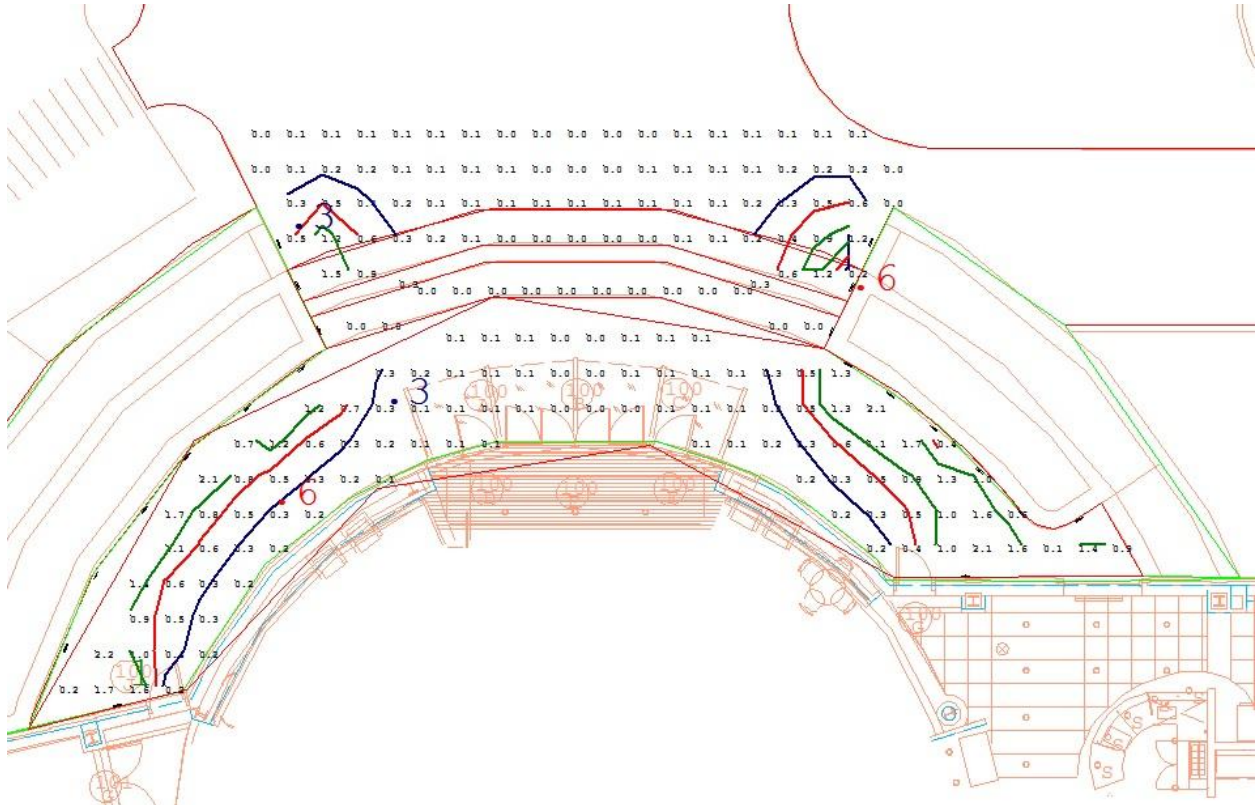
The outdoor entry lighting will be controlled by an astronomical time switch. The digital time switch will automatically turn lights off after a preset time when the facility closes.

Table 4: Outdoor entry controls.

Control Type	Product Name	Manufacturer	Catalog Number	Description	Location
TS	Digital Time Switch	WattStopper	TS-400	InteliSwitch TS-400 series digital time switches automatically turn lights off after a preset time	Rotunda 1 <sup>st</sup> level

### Performance Graphics

Figure 2: Outdoor entry illuminance contour lines. Navy, red, and green lines represent 0.3, 0.6, and 1.0 footcandles respectively.



## Energy Code Compliance

ASHRAE Standard 90.1

Table 5: Outdoor entry energy code compliance.

Area	Size	Power Density Allowable	Power Density Designed
Outdoor Entry	1973 sq. ft.	0.2 W/sq. ft.	0.132 W/ sq. ft.

## Performance Summary

Table 6: Outdoor entry performance summary.

Area	Average Illuminance	Maximum Illuminance	Minimum Illuminance	Max/ Min Ratio
Outdoor Entry	0.54 fc	2.2 fc	0.3 fc	7.3

## Summary

The outdoor entry defines the entrance to the Shepherd University Wellness Center. While the step and path lighting alone do not meet the average illuminance of 5 fc desired, the additional light provided by the core of the building spills onto the outdoor entry. Thus, the step, path, and core illumination adequately provide for safety of the users and direct users to the space. The Wellness Center makes its presence known with its inviting atmosphere through the use of outdoor lighting.

## Rotunda | Circulation Space

### Description

This two-story circular space provides views to outside the front of the building as well as to interior spaces, like the fitness room and gymnasium. The first level contains a casual seating area and front desk. On the second level, a circular walking path with a bisecting arc shaped walking path breaks up the openness of the space. The main purpose of the space is for circulation and egress.

### Dimension

Approximately 70 ft. in diameter  
 Ceiling height of first floor= 12.5 ft.  
 Ceiling height of second level= 23.5 ft.  
 Area= approximately 3,780 sq. ft.

### Materials

Table 7: Rotunda materials.

MATERIAL	OBJECT	COLOR	REFLECTANCE
Paver Tile	Flooring	Titanium P523, Gunmetal P504	0.32
Plastic Laminate	Walls	Wild Cherry 7054-60	0.18
Wall Covering	Walls	Watermark Moire Wheat	0.34
Acoustical Ceiling Tile	Ceiling	N/A	0.78
Acoustical Wood	Ceiling	N/A	0.55
Laminated Glazing	Door	N/A	0.20

Note: For N/A colors, reflectance is designed for material specified.

**Drawings**

Figure 3: Floor plan of the first level rotunda.

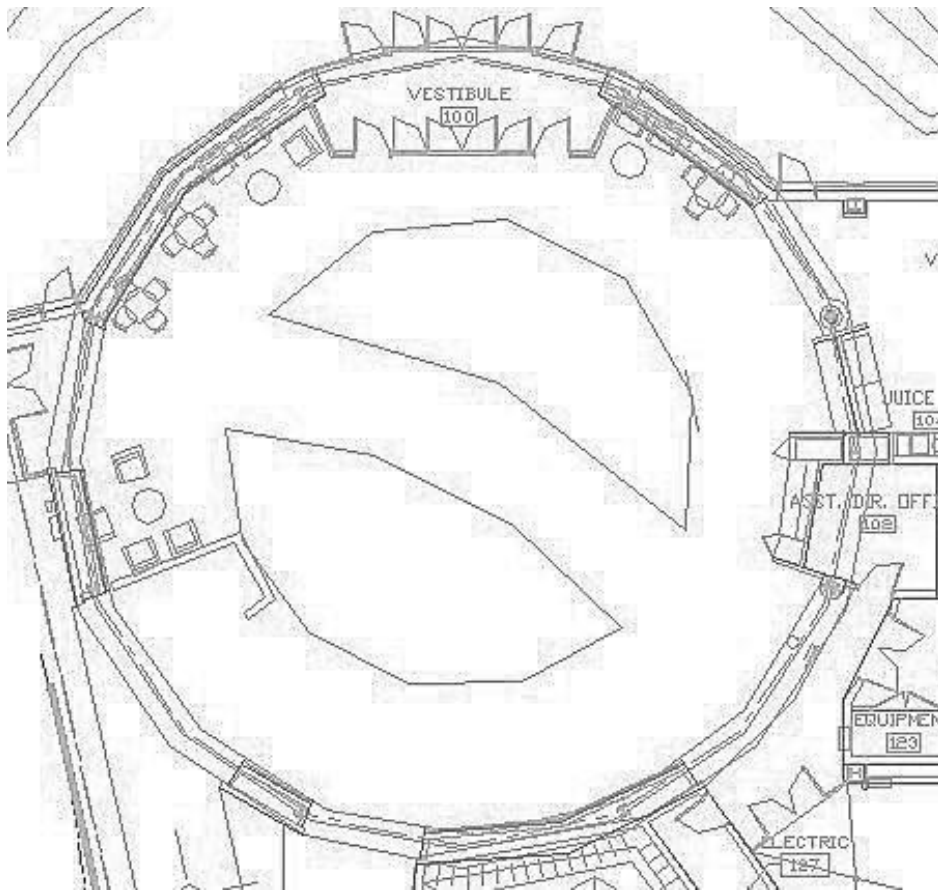




Figure 4: Floor plan of the second level rotunda.

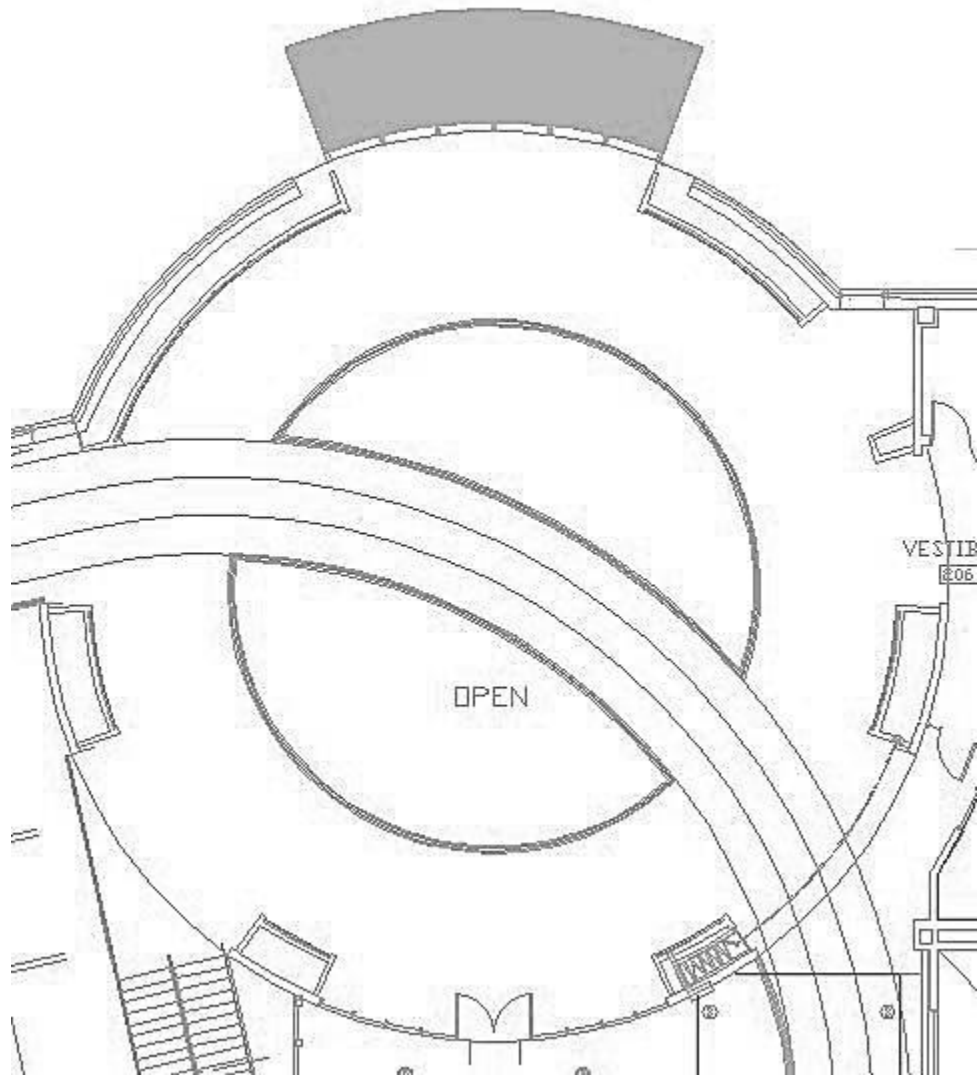


Figure 5: North elevation of the rotunda.

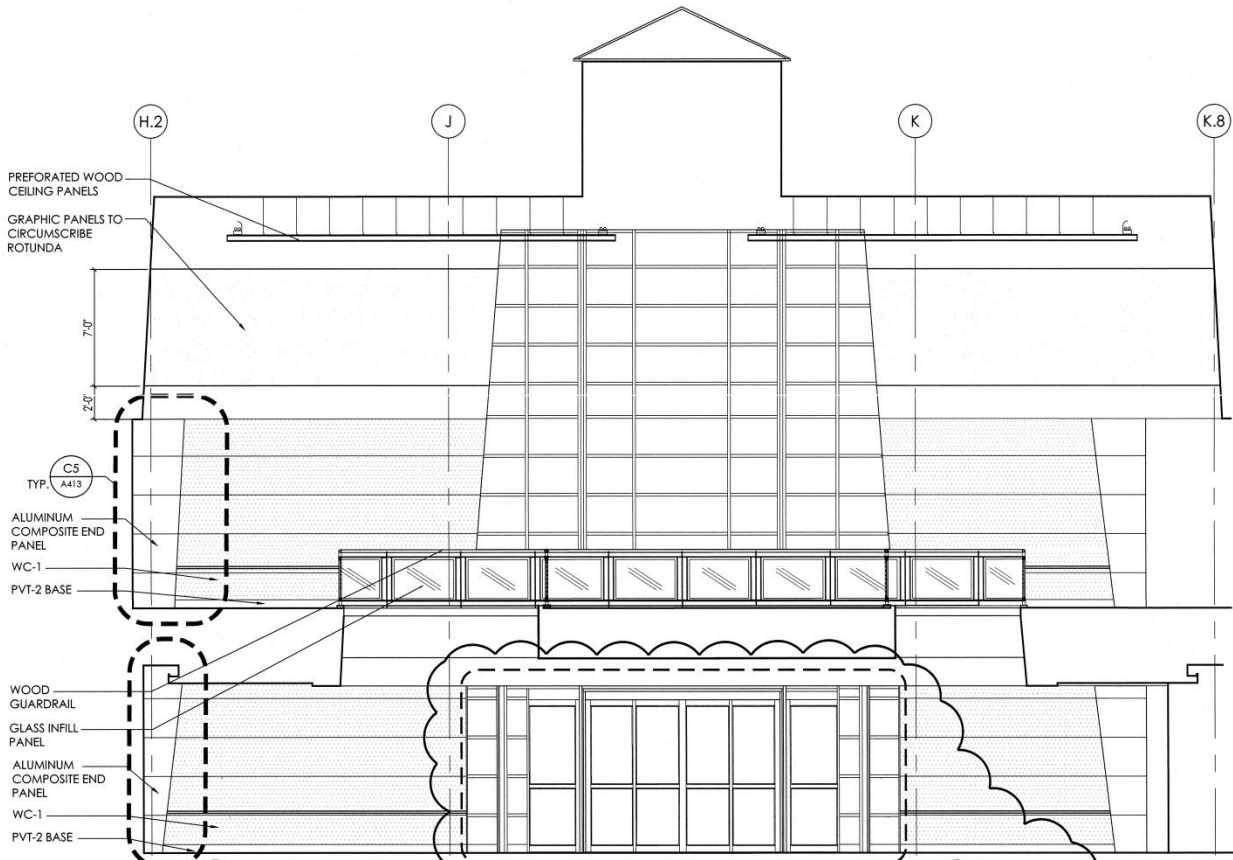
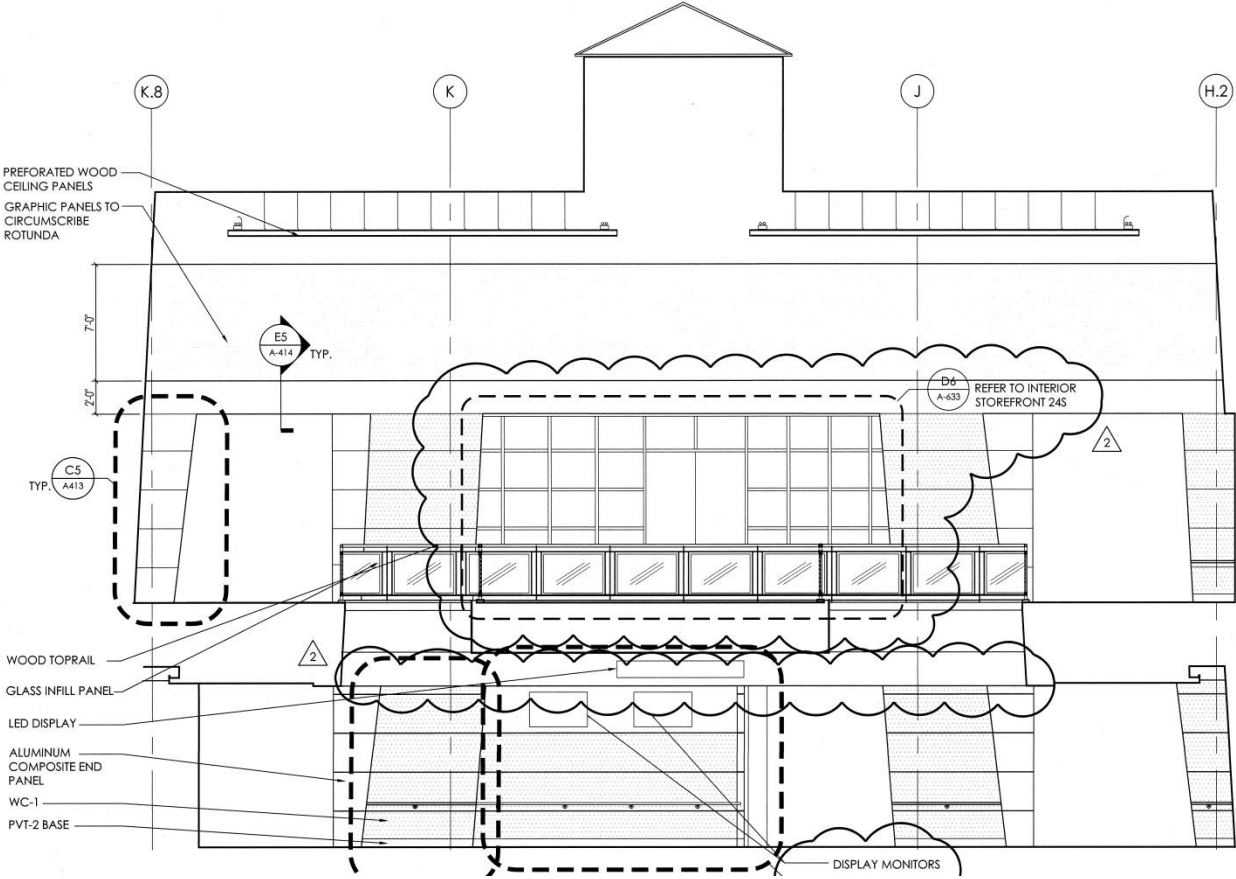


Figure 6: South elevation of the rotunda.



## Lighting Design Criteria and Considerations

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

- Classification: Educational Facility Corridor
- Daylighting Integration and Control: Very Important
  - Views of the outdoors through the large façade windows shall be utilized for psychological and physiological reasons, including to identify the time of day. Daylight and sunlight shall be utilized as ambient illumination.
- Direct Glare: Very Important
  - Direct glare shall be avoided to minimize discomfort and visibility interference in this circulation space.
- Light Distribution on Surfaces: Very Important
  - Illuminance patterns shall correspond with the circular architectural features of the walking path on the second level. The patterns of light shall take into consideration the tasks of visibility, comfort, and perception.
- Modeling of Faces or Objects: Very Important
  - The front desk must be able to recognize facility visitors. The lighting shall reveal the depth and shape of the objects throughout the space for easy identification of the designated flow of the space.
- Points of Interest: Very Important
  - The lighting shall draw attention to the front desk, as well as indicate the direction of pedestrian flow. Attention can be drawn using movement, luminance contrast, and color contrast.
- Vertical Illuminance: Very Important
  - For a working space where simple visual tasks are performed 10 footcandles are recommended.

*ASHRAE/IESNA Standard 90.1 2007*

- Lighting Power Density Allowance
  - Lobby
    - 1.3 W/ square feet

*Architectural Lighting Design Third Edition by Gary Steffy*

- Psychological Aspect
  - With the peripheral accent of the space and the use of daylight along the main entrance façade, this space creates an open atmosphere.




### Lighting Design Concept

The grand interior entrance and architecture of the rotunda should be accentuated through the use of light. Light will invoke the impression of spaciousness by emphasizing the perimeter of the space. The users will be directed through the space by a pathway of light.

**Lighting Solution**

**Luminaire Schedule**

Table 8: Rotunda luminaire schedule.

TYPE	IMAGE	MANUFACTURER/ CATALOG NUMBER	DESCRIPTION	MOUNTING	POWER SUPPLY	VOLTAGE	LAMP	WATTAGE
L01		Zumtobel 2LS1D1H32GX24Q3	8" Square aperture, Specular aluminum reflector above lamp, Faceted specular plastic reflector with patterned wall wash section above clear glass enclosure	Recessed	Universal	120/277V	(1)CF32DT/ E/IN/ 841/ECO	32W
L04		Elliptipar F204- H142-T-02-1-000	Small semi-recessed adjustable wall washer, Semi-gloss white finish, Two parabolic reflector sections	Semi-Recessed Adjustable	Integral Electronic	120V	(1) CFTR42W /GX24q, 3000K, 80 CRI	42W
L05		Elliptipar M200- 035G-T-02-1-000	Small semi-recessed adjustable wall washer, Semi-gloss white finish, Two parabolic reflector sections	Semi-Recessed Adjustable	Integral Electronic	120V	(1)CDM35/T6/8 30	35W

## Light Loss Factors

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

Table 9: Rotunda light loss factors.

Luminaire Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Room Surface Dirt Depreciation	Light Loss Factor Total
L01	0.85	0.88	0.98	0.92	0.67
L04	0.84	0.88	0.98	0.92	0.67
L05	0.76	0.88	0.98	0.92	0.60

## Controls

The rotunda lighting will be controlled by an astronomical time switch. The digital time switch will automatically turn lights off after a preset time when the facility closes.

Table 10: Rotunda controls.

Control Type	Product Name	Manufacturer	Catalog Number	Description	Location
TS	Digital Time Switch	WattStopper	TS-400	InteliSwitch TS-400 series digital time switches automatically turn lights off after a preset time	Rotunda 1 <sup>st</sup> level

## Renderings

Figure 7: Rotunda 1<sup>st</sup> level rendering.



Figure 8: Rotunda 2<sup>nd</sup> level rendering.

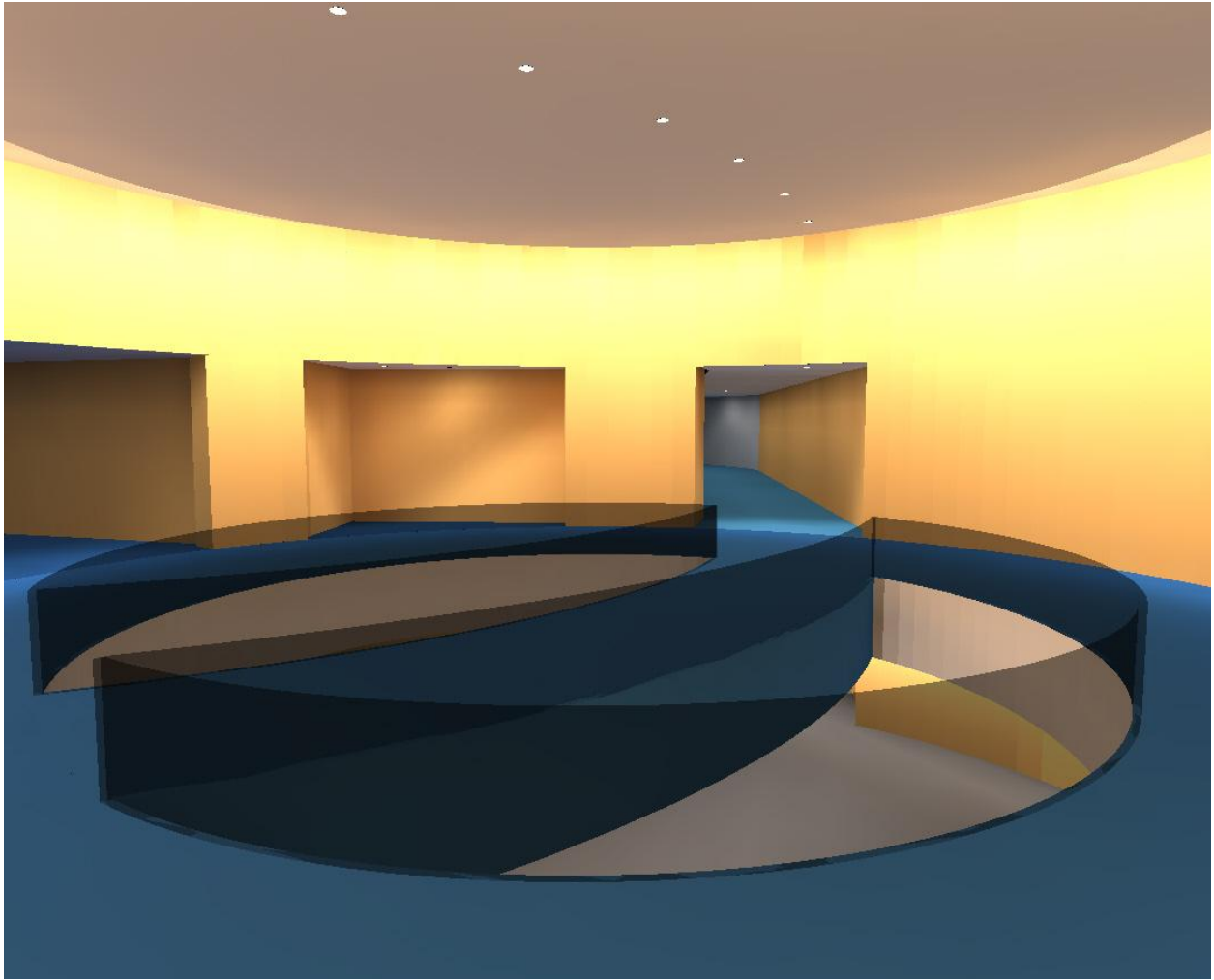
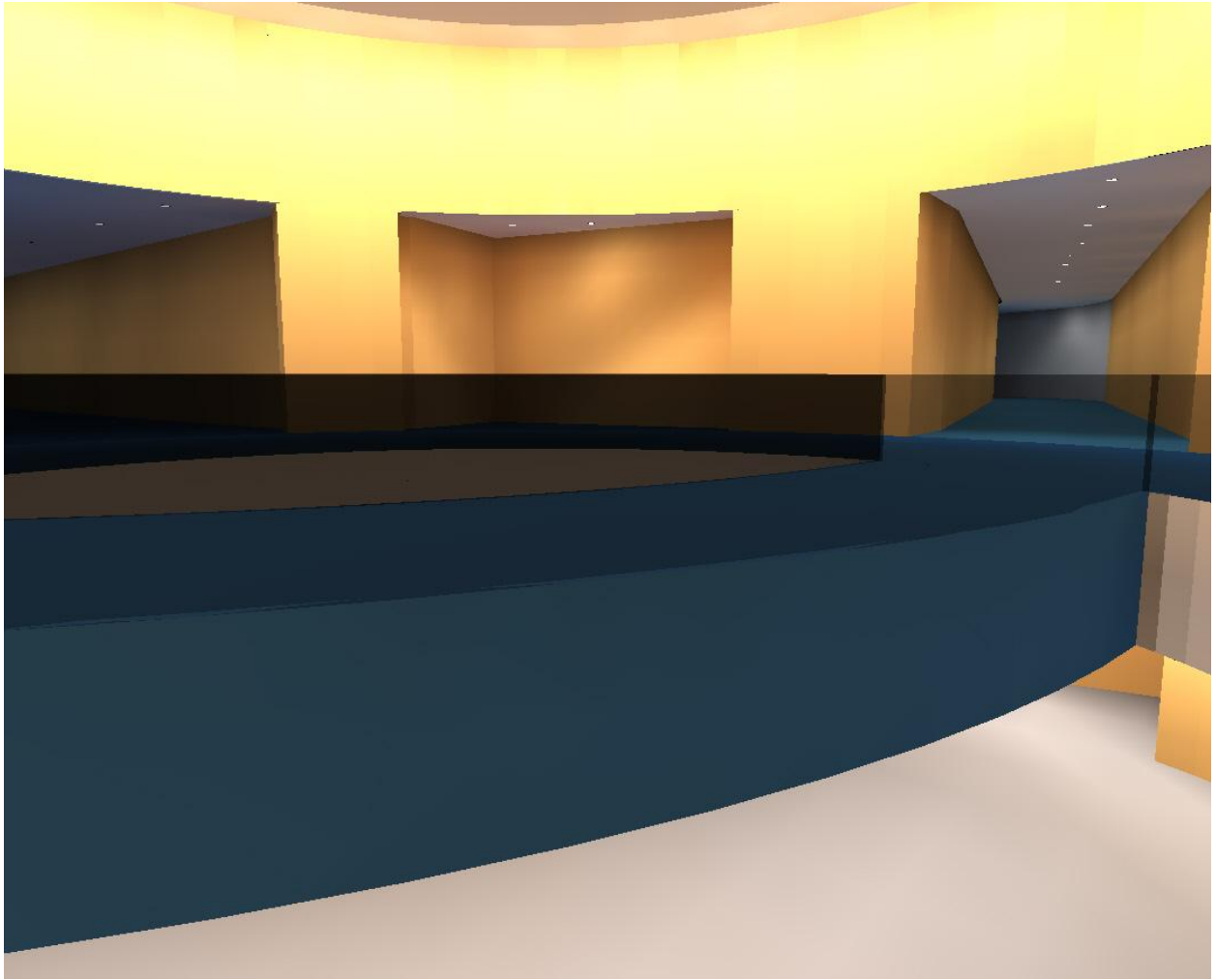




Figure 9: Rotunda rendering of both levels.



### Performance Graphics

Figure 10: Rotunda 1<sup>st</sup> level illuminance contour lines. Navy, red, and green lines represent 6, 8, and 12 footcandles respectively.

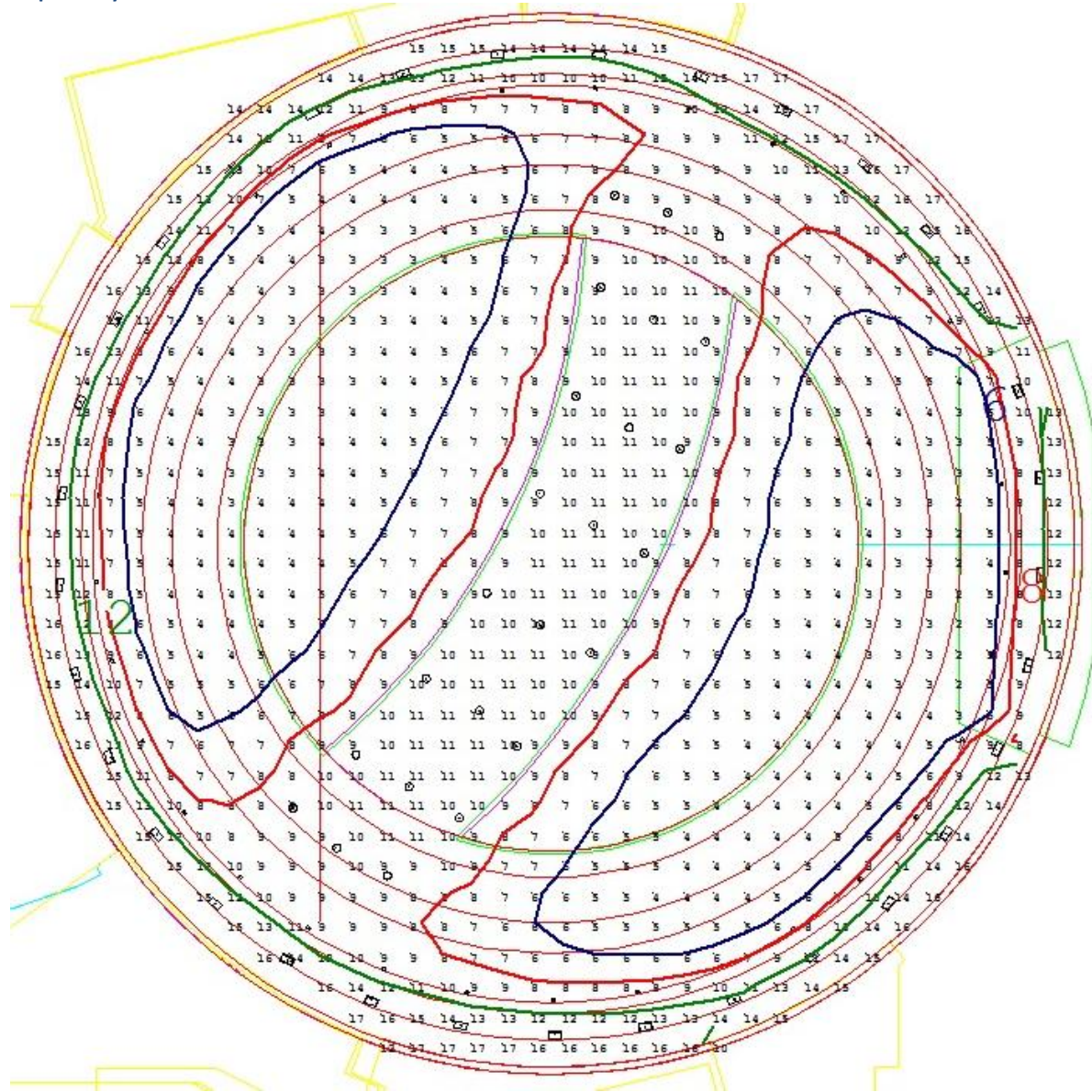


Figure 11: Rotunda 2<sup>nd</sup> level illuminance contour lines. Navy, red, and green lines represent 6, 8, and 12 footcandles respectively.

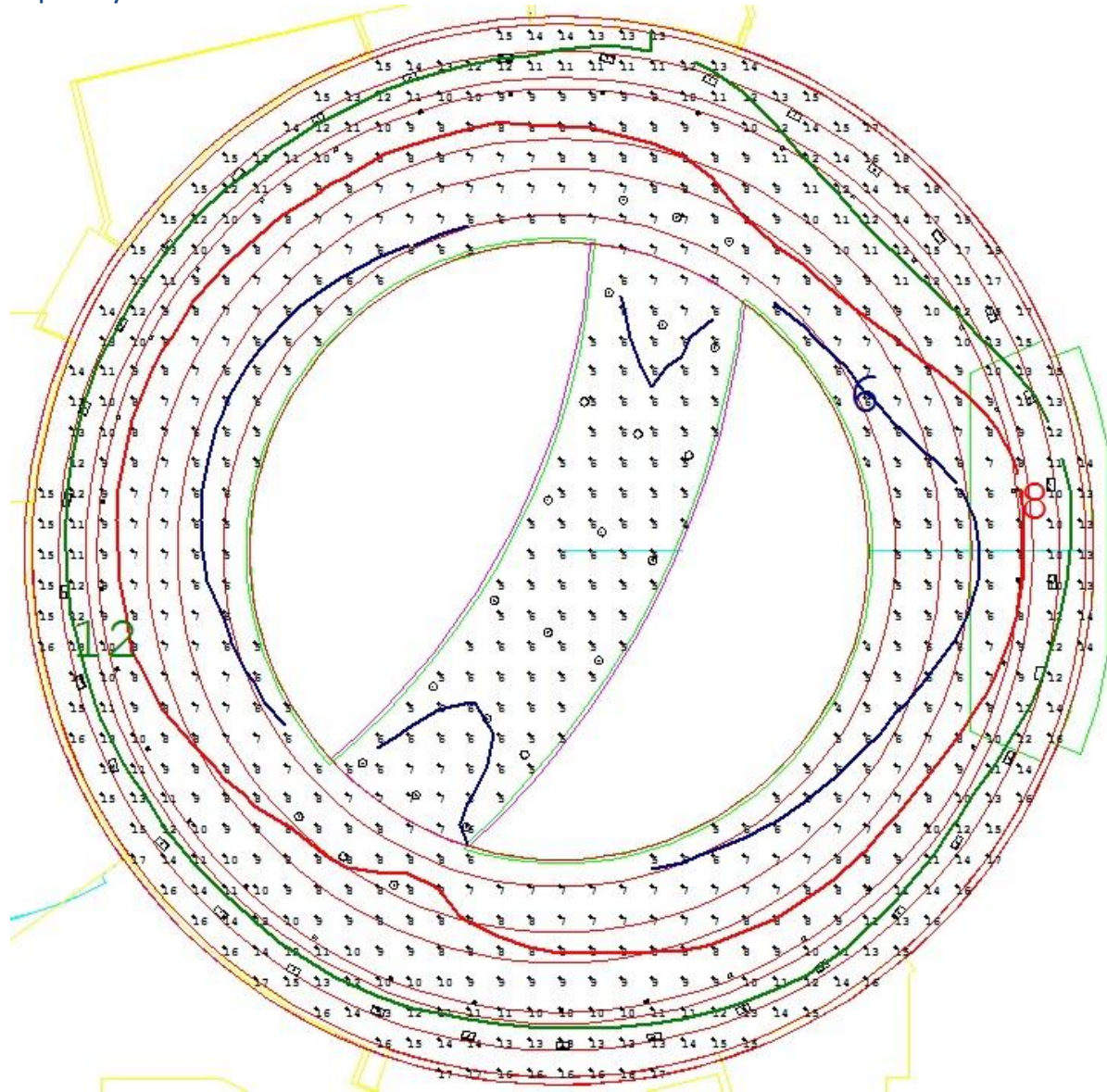


Figure 12: Rotunda 1<sup>st</sup> level illuminance pseudo color rendering in footcandles.

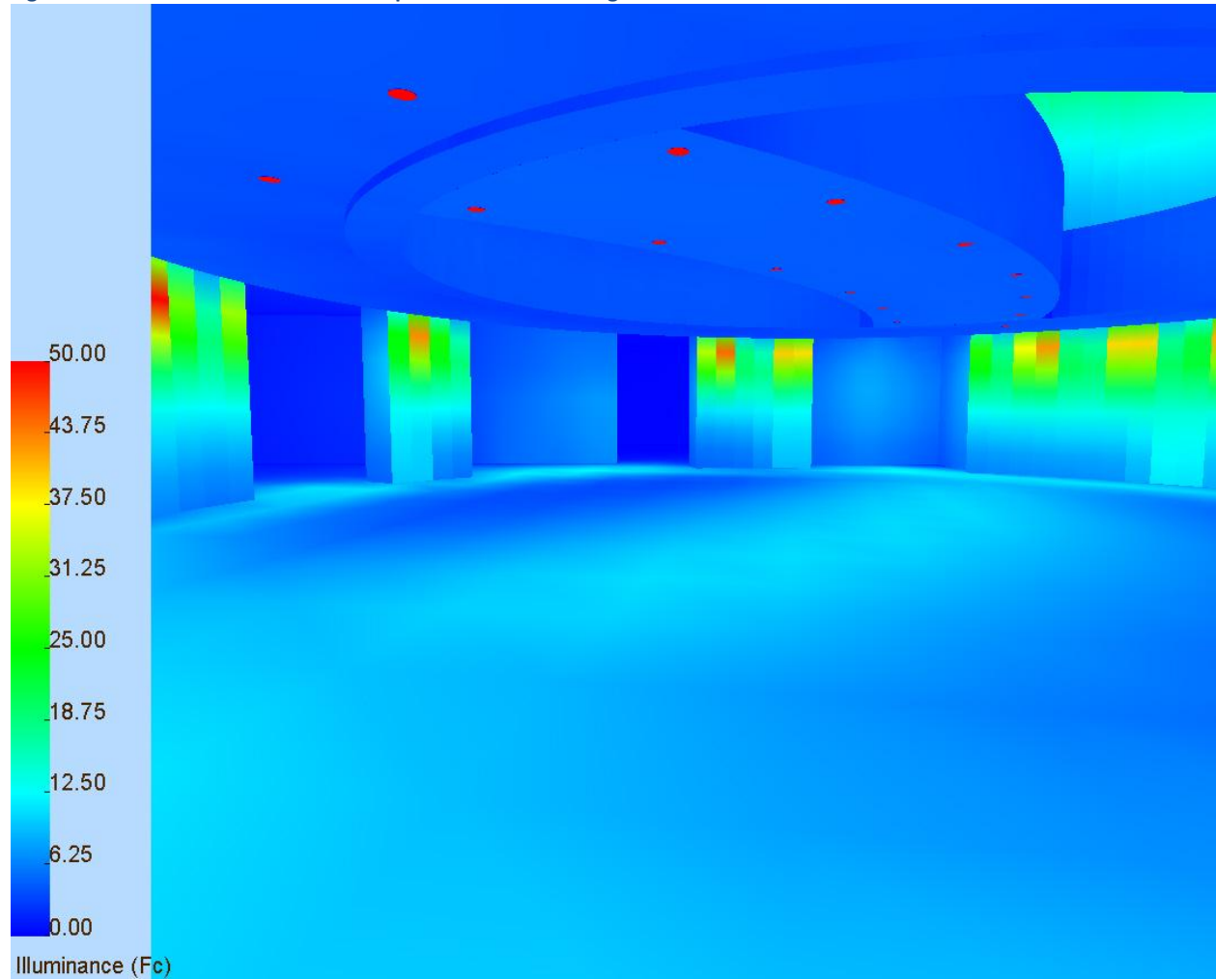


Figure 13: Rotunda 2<sup>nd</sup> level illuminance pseudo color rendering in footcandles.

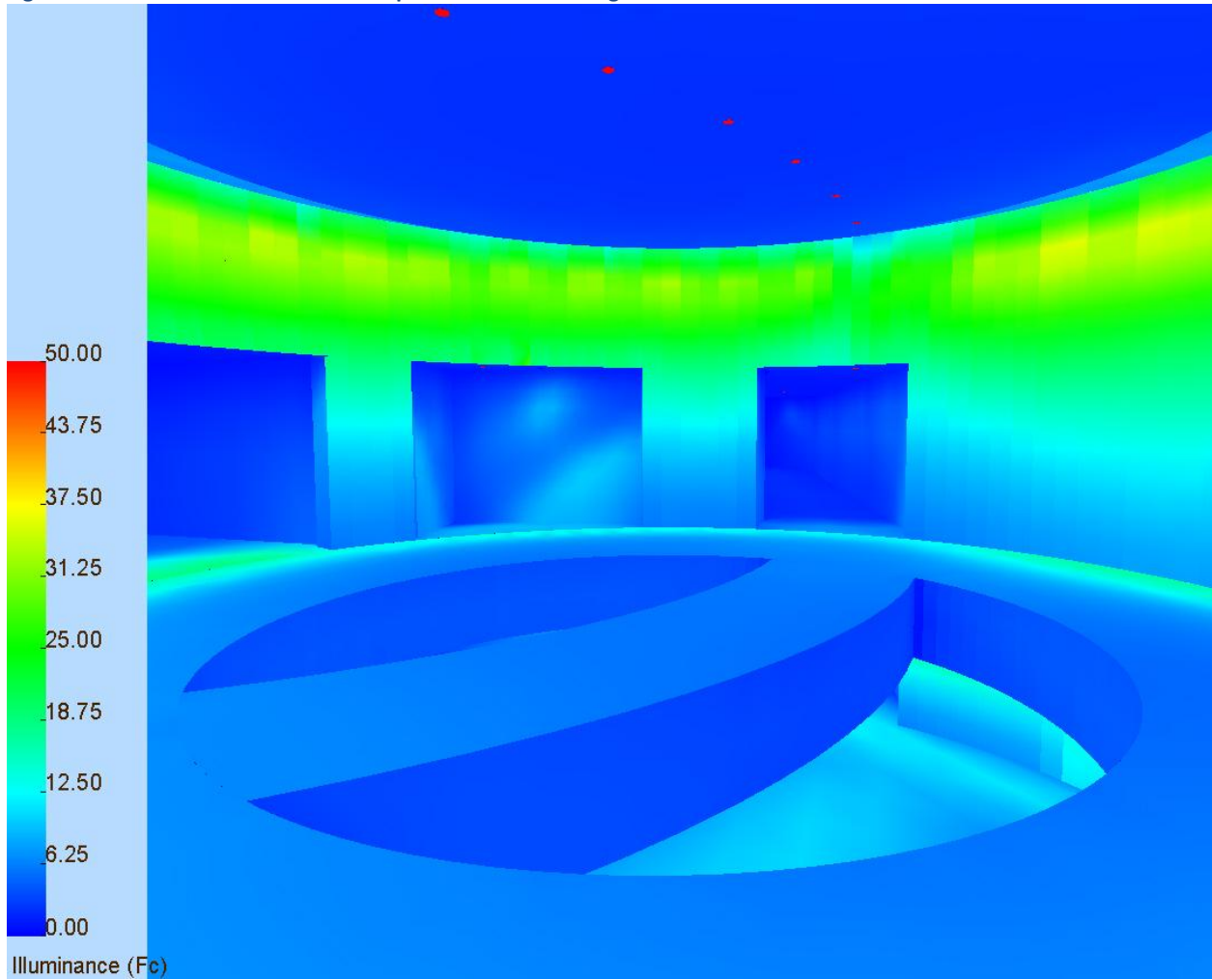
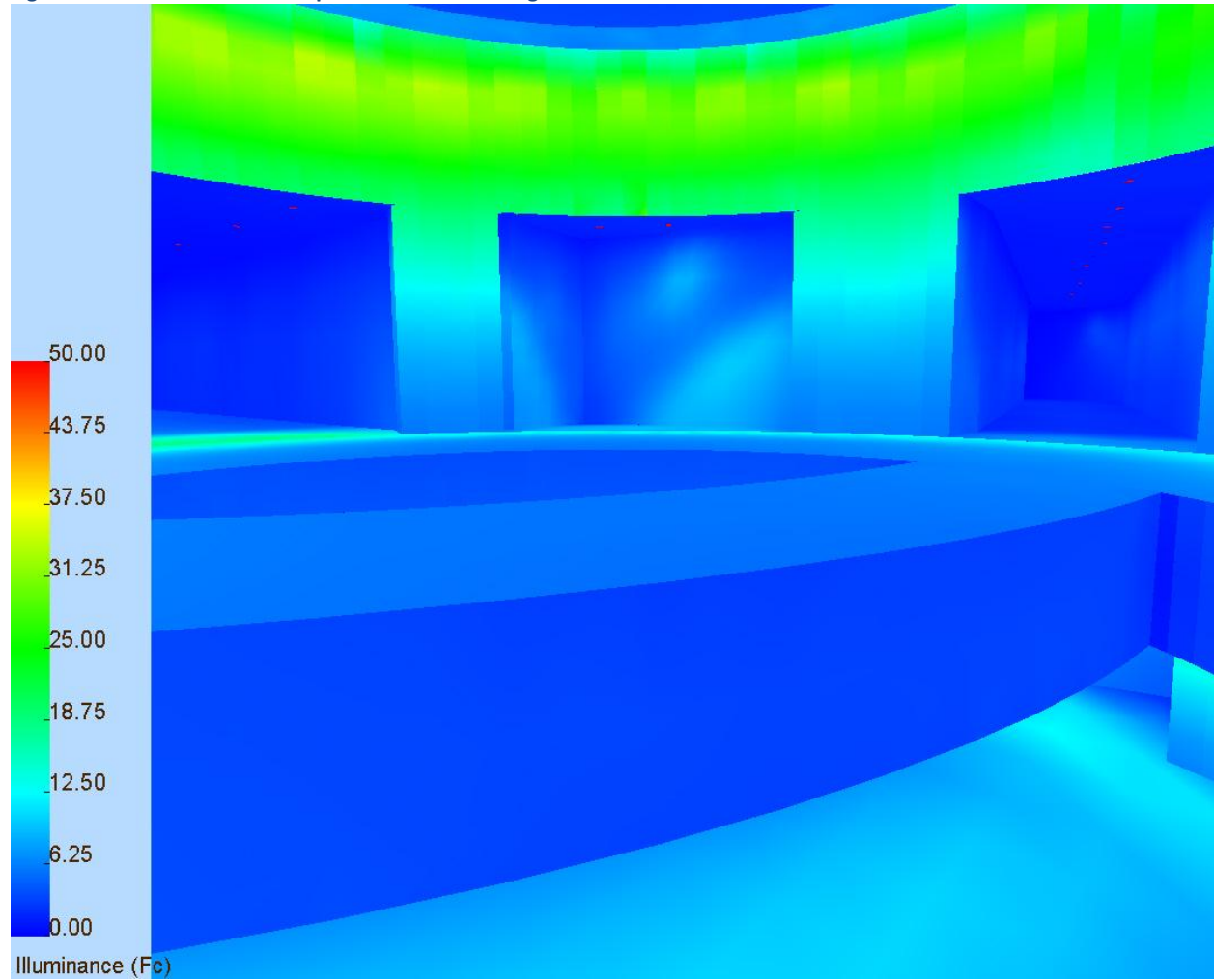


Figure 14: Rotunda illuminance pseudo color rendering of both levels in footcandles.



### Energy Code Compliance

ASHRAE Standard 90.1

Table 11: Rotunda energy code compliance.

Area	Size	Power Density Allowable	Power Density Designed
Rotunda	3780 sq. ft.	1.3 W/sq. ft.	1.256 W/ sq. ft.

### Performance Summary

Table 12: Rotunda performance summary.

Area	Average Illuminance	Maximum Illuminance	Minimum Illuminance	Max/ Min Ratio
Rotunda 1 <sup>st</sup> level	7.98 fc	17 fc	2 fc	4.75
Rotunda 2 <sup>nd</sup> level	8.93 fc	19 fc	4 fc	4.75

## Summary

The rotunda defines the grand interior entrance to the Shepherd University Wellness Center. Wall illumination adequately defines the boundaries through the use of wall washers. Small downlights guide the users through the curved space directing them to the facility's amenities. While the average illuminance does not meet the preferred 10 footcandles, the space reaches illuminance values above 10 footcandles at its perimeters where people need the light most. Daylight will provide additional light at times through the large two-story storefront; however, this space study does not take into account a daylighting analysis.

## Multi-Purpose Room | Special Purpose Space

### Description

Located on the second floor of the facility, the multi-purpose room is an open square for freedom of movement required by the aerobic and dance classes that take place here. Two large windows in the space overlook the building’s large gym. This space does not contain furniture or any permanent layout. The room is equipped for dance, aerobic, and wellness classes.

### Dimension

Approximately 40 ft. x 38 ft.

Ceiling height= 14 ft.

Area= approximately 4,300 sq. ft.

### Materials

Table 13: Multi-purpose room materials.

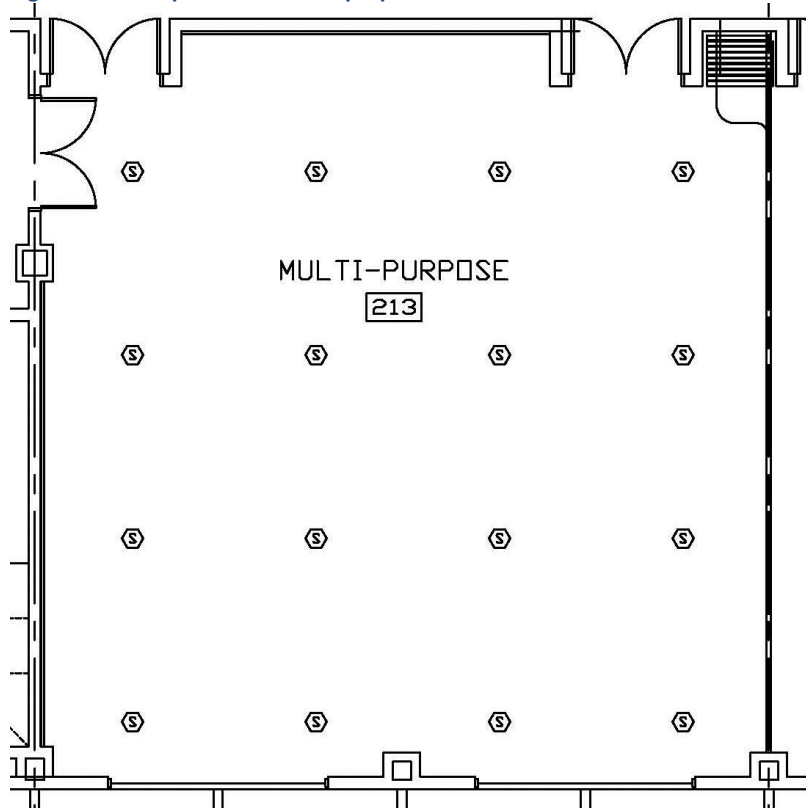
FINISH	OBJECT	COLOR	REFLECTANCE
<b>Wood Athletic Flooring</b>	Floor	N/A	0.55
<b>Glass</b>	Window	N/A	0.50
<b>Paint</b>	Wall	Elmira White HC-84	0.70
<b>Acoustical Ceiling Tile</b>	Ceiling	White	0.78

Note: For N/A colors, reflectance is designed for material specified.



## Drawings

Figure 15: Floor plan of the multi-purpose room.



## Lighting Design Criteria and Considerations

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

- Classification: Educational Facility, Gymnasium, Social Event
- Color Appearance and Color Contrast: Important
  - The use of warmer color temperatures will create a more pleasant feel to the aerobic environment. A higher Color Rendering Index, above 80, will improve the appearance of people and aerobic equipment. Good color renderings in the space will add visual interest and produce a welcoming environment.
- Direct and Reflected Glare: Important
  - Direct glare can increase the risk of injury of those participating in the aerobic classes, as well as cause discomfort for such participants. Indirect or inconspicuous lighting and luminaire placement out of the line of sight of participants is recommended.
- Modeling of Faces or Objects: Important
  - People's facial expressions are important to many forms of dance aerobics. The appearance of objects is important for proper aerobic equipment use.
- Shadows: Very Important
  - Shadows may cause risk of injury to the participants' visual limitation. The light shall be directed from several locations to minimize shadows.

- Sparkle/ Desirable Reflected Highlights: Very Important
  - High luminance on small specified points in the space will enhance the visual interest.
- System Control and Flexibility: Very Important
  - Switching and dimming can enhance the users' satisfaction within this large space, especially to accommodate the various types of aerobic and educational classes that will utilize the space.
- Horizontal Illuminance: Somewhat Important
  - 5 footcandles is recommended for orientation and simple visual tasks; however, for certain aerobic classes, such as kick-boxing, a higher illuminance value of at least 10 footcandles may be used.

*ASHRAE/IESNA Standard 90.1 2007*

- Lighting Power Density Allowance
  - Conference/ Meeting/ Multipurpose
    - 1.3 W/ square feet

*Architectural Lighting Design Third Edition by Gary Steffy*

- Psychological Aspect
  - The uniform overhead lighting coupled with the peripheral lighting along the wall with large windows allows for visual clarity. Since this room will be used for different forms of fitness activities, including aerobic dance and yoga, it should be designed for both festive and relaxation impressions.


### **Lighting Design Concept**

As an open square for freedom of movement, the multi-purpose room should reflect the playfulness of the users. Rhythmic patterns of light with longer wavelengths will reinforce the high energy within. Reflected light will create sparkle throughout the space. Light as visual clutter creates an enchanting festive impression. For some activities, a relaxation impression will be used by providing uniform lighting along the peripheral areas of the space. Such activities include more subdued fitness activities, like yoga, and educational teaching lectures. Thus, two scenes are specified for the multi-purpose room.

## Lighting Solution

### Luminaire Schedule

Table 14: Multi-purpose luminaire schedule.

TYPE	IMAGE	MANUFACTURER/ CATALOG NUMBER	DESCRIPTION	MOUNTING	POWER SUPPLY	VOLTAGE	LAMP	WATTAGE
L01		Zumtobel 2LS1D1H32GX24Q3	8" Square aperture, Specular aluminum reflector above lamp, Faceted specular plastic reflector with patterned wall wash section above clear glass enclosure	Recessed	Universal	120/277V	(1)CF32DT/ E/IN/ 832/ECO	32W

## Light Loss Factors

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

Table 15: Multi-purpose light loss factors.

Luminaire Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Room Surface Dirt Depreciation	Light Loss Factor Total
L01	0.85	0.88	0.98	0.92	0.67

## Controls

Two line-voltage switches are located in this room to control the two lighting scenes: relaxation and festive. The first switch controls the perimeter downlights for the relaxation scene, while the second switch controls the remaining downlights for the festive scene.

## Renderings

Figure 16: Multi-purpose room rendering.



### Performance Graphics

Figure 17: Multi-purpose room illuminance contour lines. Navy, red, and green lines represent 12, 14, and 16 footcandles respectively.

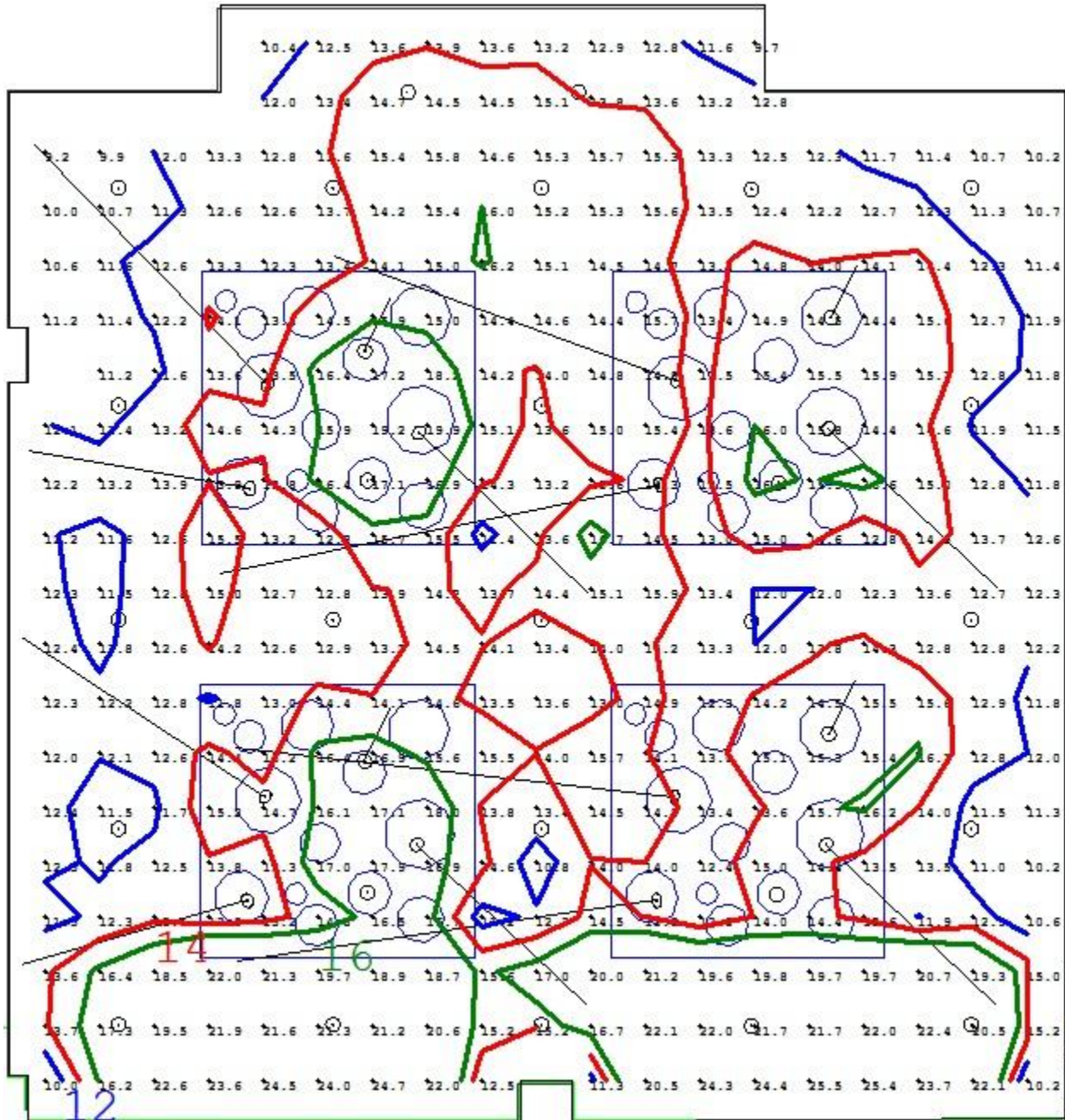
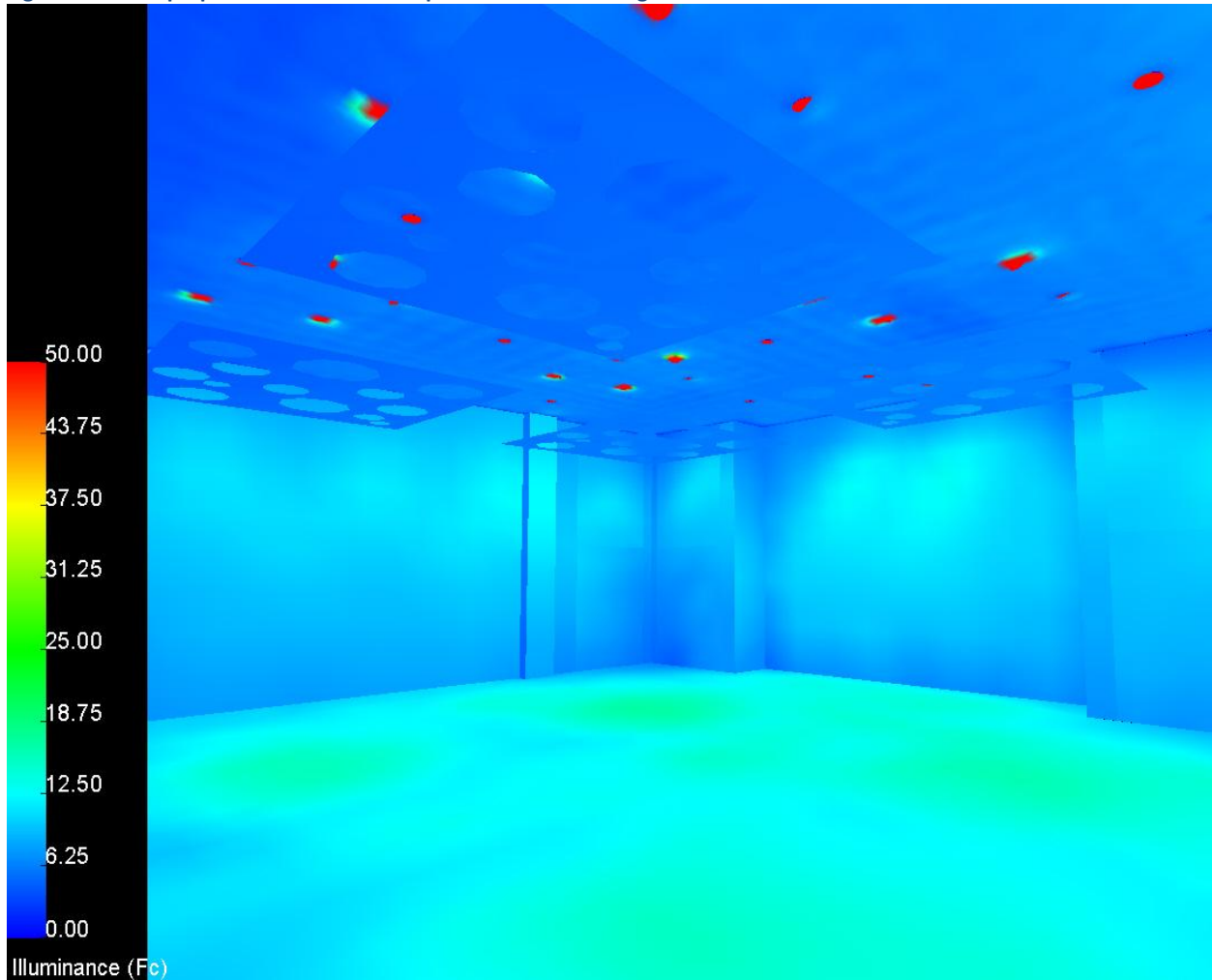


Figure 18: Multi-purpose room illuminance pseudo color rendering in footcandles.



### Energy Code Compliance

ASHRAE Standard 90.1

Table 16: Multi-purpose energy code compliance.

Area	Size	Power Density Allowable	Power Density Designed
<b>Multi-purpose</b>	1512 sq. ft.	1.3 W/sq. ft.	0.938 W/ sq. ft.

### Performance Summary

Table 17: Multi-purpose performance summary.

Area	Average Illuminance	Maximum Illuminance	Minimum Illuminance	Max/ Min Ratio
<b>Multi-purpose</b>	14.61 fc	25.5 fc	9.2 fc	2.77

## Summary

The controllable light allows this aerobic space to be playful. With an average illuminance of 14.61 footcandles, above the suggested 10 footcandles, this space is bright and lively for energetic movement. The festive impression is achieved through the random placement of light by small angled downlights. Light bounces off of the suspended ceiling metal panels to create sparkle throughout the space and on the users as they move. The relaxation impression is achieved by controlling the light to a lower light level and using uniform lighting that emphasizes the peripheral space.

## Fitness Room | Large Work Space

### Description

Located on the second floor of the facility, the fitness room is viewed as a “rotunda balcony” (Hughes Group Architects). The space provides views of the building amenities and outside onto the campus. This weight and fitness area consists of free weights, resistance machines, and cardio equipment. The space also contains nine flat screen televisions.

### Dimension

Approximately 155 ft. x 28 ft.

Ceiling height= 14 ft.

Area= approximately 4,300 sq. ft.

### Materials

Table 18: Fitness room materials.

FINISH	OBJECT	COLOR	REFLECTANCE
<b>Glass</b>	Windows	Diffuse	0.40
<b>Athletic Flooring</b>	Floor	Grey G707	0.23
<b>Paint</b>	Walls	Elmira White HC-84	0.70
<b>Acoustical Ceiling Tile</b>	Ceiling	Yellow Cream	0.78



Drawings

Figure 19: Finish floor plan of the fitness room.

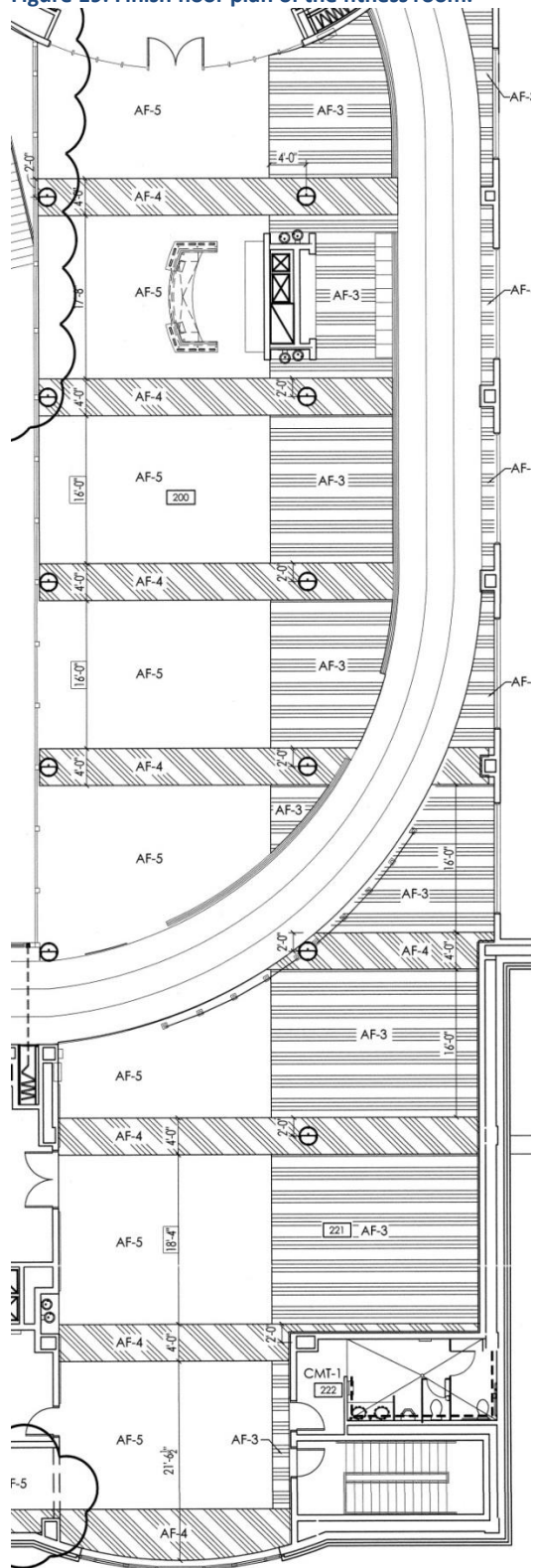


Figure 20: Architectural sketch of the fitness room.



## Lighting Design Criteria and Considerations

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

- Classification: Sports and Recreational Area Lighting; Class IV
- Direct Glare
  - Direct glare from light sources and luminaires must be prevented to avoid improper use of machinery.
- Light Distribution on Task Plane (Uniformity)
  - The task plane is the level at which the free weights, resistance machines, and cardio equipment rests. Uniform light distribution at proper illuminance levels will be important to mitigate risk of injury.
- Illuminance
  - General uniform and diffuse lighting of an average of 30 footcandles at the task plane.

*ASHRAE/IESNA Standard 90.1 2007*

- Lighting Power Density Allowance
  - Gymnasium/ Exercise Center

- Exercise Area: 0.9 W/ square feet

*Architectural Lighting Design Third Edition by Gary Steffy*

- Psychological Aspect
  - The overhead lighting along the ceiling is more central with some peripheral lighting to reinforce the work space's visual clarity.

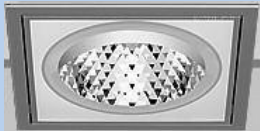
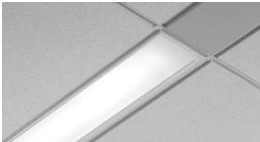

**Lighting Design Concept**

The design complements the architecture of the space and encourages the theme of movement. The lighting design for the fitness area provides for safety and visual clarity. The long narrow area is defined by spaces within through the use of three light levels: ambient, architectural, and task. Strips of light between the columns define the spaces within the fitness area and provide ambient light with linear recessed fluorescent luminaires. Adjustable downlights highlight the columns and define the architecture in the space. Task lighting draws attention to the reception desk for the fitness zone.

**Lighting Solution**

**Luminaire Schedule**

Table 19: Fitness room luminaire schedule.

TYPE	IMAGE	MANUFACTURER/ CATALOG NUMBER	DESCRIPTION	MOUNTING	POWER SUPPLY	VOLTAGE	LAMP	WATTAGE
L01		Zumtobel 2LS1D1H32GX24Q3	8" Square aperture, Specular aluminum reflector above lamp, Faceted specular plastic reflector with patterned wall wash section above clear glass enclosure	Recessed	Universal	120/277V	(1)CF32DT/ E/IN/ 841/ECO	32W
L02		Zumtobel PL-OLP-65-1805-U	Plateau, 6" recessed, Opal lens, 6" x 5', Narrow aperture recessed direct lensed luminaire for continuous row mounting	Recessed	Universal	120/277V	(1) 80W (5') T5HO 85 CRI, 4100K	80W
L03		Alfa P208- TOM-TOM	Drum Pendants, glass shade, 78" long cord, 12V 5W LED light engine with diffusing cover	Suspended	Electronic Transformer	12V	LED 80 CRI, 300K 50,000 hour life to 70% of light output	5W

## Light Loss Factors

*IESNA Lighting Handbook 9<sup>th</sup> Edition*

Table 20: Fitness room light loss factors.

Luminaire Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Room Surface Dirt Depreciation	Light Loss Factor Total
L01	0.85	0.88	0.98	0.92	0.67
L02	0.92	0.88	0.88	0.92	0.66
L03	0.88	0.88	--	0.92	0.71

## Controls

Three line-voltage switches are located in this room to control the three levels of light: ambient, accent, and task. The first switch controls the linear downlights for the ambient light level, the second switch controls the adjustable downlights that accent the architectural columns, and the third switch controls the pendants suspended above the reception desk for task lighting.

## Renderings

Figure 21: Fitness room rendering.



### Performance Graphics

Figure 22: Fitness room illuminance contour lines. Navy, red, and green lines represent 20, 30, and 40 footcandles respectively.

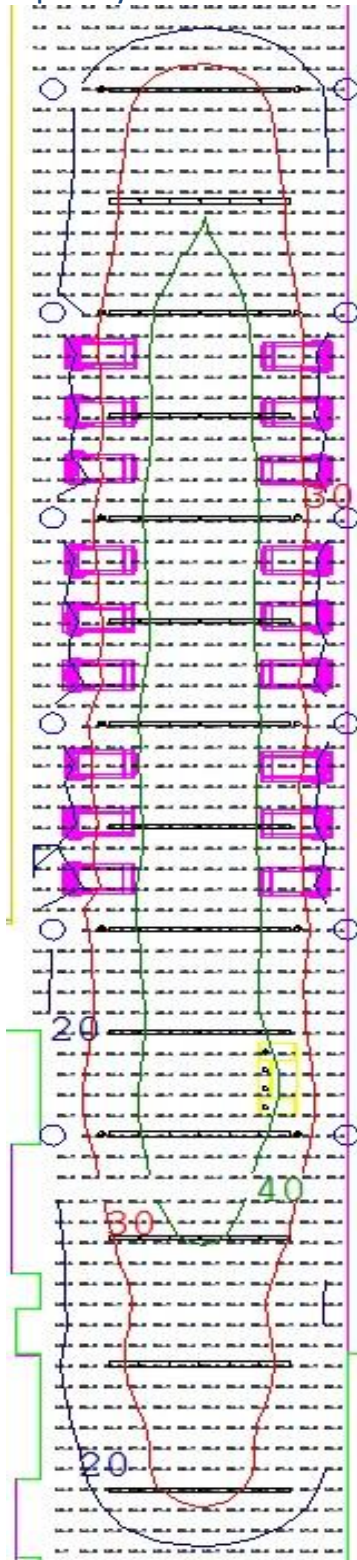
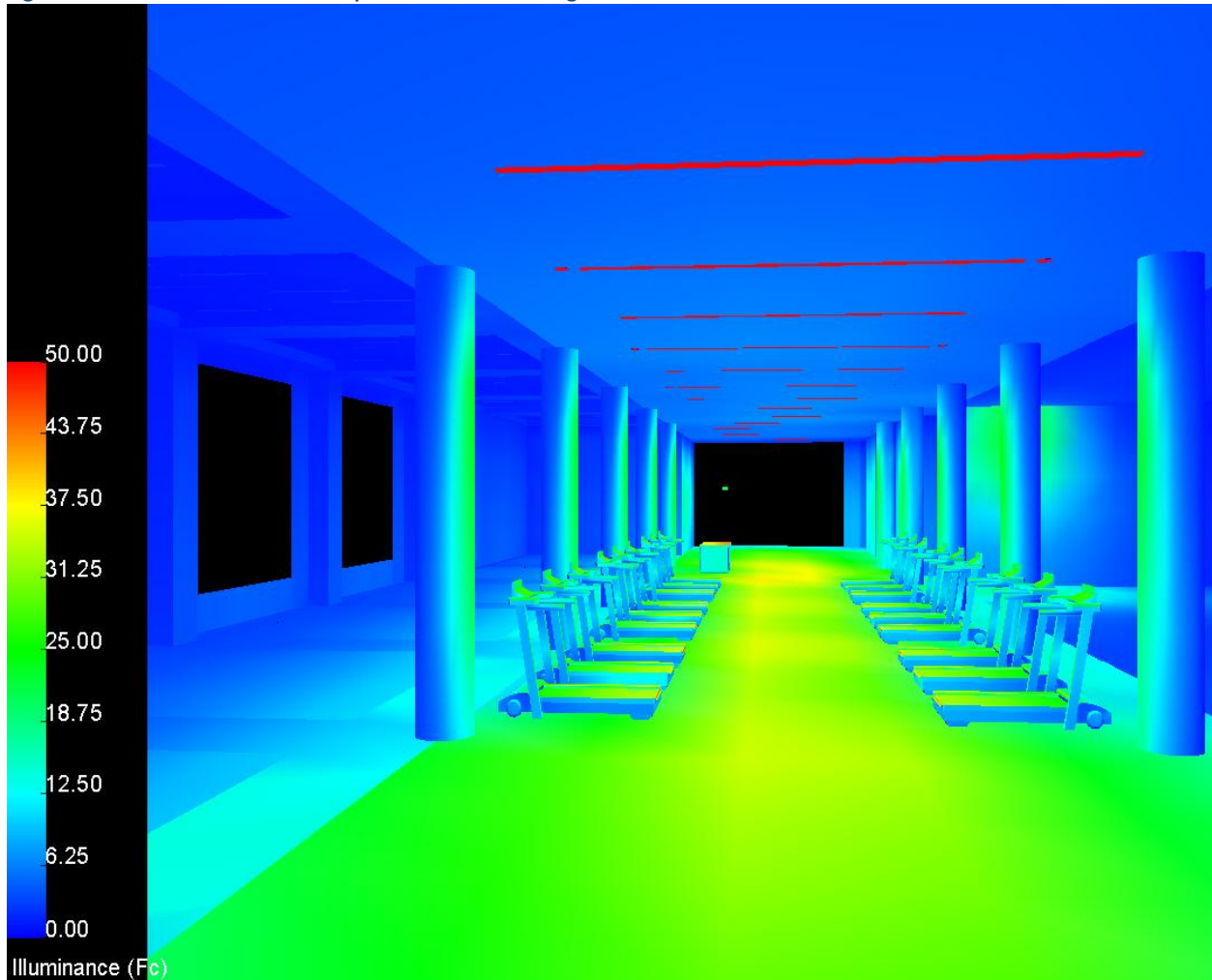


Figure 23: Fitness room illuminance pseudo color rendering in footcandles.



### Energy Code Compliance

ASHRAE Standard 90.1

Table 21: Fitness room energy code compliance.

Area	Size	Power Density Allowable	Power Density Designed
Exercise	4278 sq. ft.	0.90 W/sq. ft.	0.88 W/ sq. ft.

### Performance Summary

Table 22: Fitness room performance summary.

Area	Average Illuminance	Maximum Illuminance	Minimum Illuminance	Max/ Min Ratio
Exercise	31.7 fc	46.9 fc	5.3 fc	8.85



## Summary

The lighting design adequately provides the desired 30 footcandle average illuminance. The light clearly defines the space within and breaks up the long narrow area through the use of three light levels: ambient, accent, and task. The strips of light produce uniform light levels across the equipment task plane allowing for user safety of the machinery. The adjustable downlights highlight the columns to accent the architecture. Pendants effectively light the reception desk for secretarial tasks. The overall lighting solution complements the space by directing movement within the fitness room.

## Electrical Depth

The Shepherd University Wellness Center has a simple radial electrical system that enters the building through one service entrance point located in the building’s main electrical room. The main transformer, which is provided by the contractor, has a secondary voltage of 480Y/277V, 3Ph, 4W. The 2500A main distribution panel supplies power to subsequent feeders and panels. Emergency power is provided by a 75kW propane fired generator. The existing electrical design is modified to meet the change in lighting design. Through the re-design of the panelboards and feeders, the equipment will be sized appropriately to minimize cost and maximize efficiency.

## Four Lighting Spaces

### Description

The four spaces to be re-designed are the outdoor entry (exterior), rotunda, multi-purpose room, and fitness room. The outdoor entry exterior space serves as the focal point of the building, drawing visitors inside. The two-story circular rotunda provides views to outside the front of the building as well as to interior spaces, like the fitness room and gymnasium. The first level contains a casual seating area and front desk. On the second level, a circular walking path is bisected by an arc-shaped track. The outdoor entry and rotunda are both circulation and egress spaces. The multi-purpose room is an open square space used for aerobic and dance classes. This space does not contain furniture or any permanent layout. The room is equipped for dance, aerobic, and wellness classes. The fitness room is also located on the second floor. This space provides views of the building amenities and outside onto the campus. This weight and fitness area is about 4,300 square feet and consists of free weights, resistance machines, and cardio equipment. The lighting re-design complements the architecture of the space and encourages the theme of movement. The lighting provides for safety and visual clarity. Throughout all four spaces, the lighting creates a hierarchy of light from ambient to architectural to task.

## Existing Panelboards

Table 23: Existing panelboard information for four lighting spaces.

PANEL TAG	VOLTAGE	SYSTEM	EXTERIOR	ROTUNDA	MULTI-PURPOSE	FITNESS
HP1	480Y/277V, 3PH, 4W	N		X	X	X
EHP1	480Y/120V, 3PH, 4W	E	X	X		

## Luminaire Controls

The outdoor entry and rotunda lighting will each be controlled by their own astronomical time switch. Both digital time switches will automatically turn lights off after a preset time when the facility closes.

**Table 24: Outdoor entry and rotunda luminaire control information.**

Control Type	Product Name	Manufacturer	Catalog Number	Description	Location
TS	Digital Time Switch	WattStopper	TS-400	InteliSwitch TS-400 series digital time switches automatically turn lights off after a preset time	Rotunda 1 <sup>st</sup> level

Two line-voltage switches are located in this multi-purpose room to control the two lighting scenes: relaxation and festive. The first switch controls the perimeter downlights for the relaxation scene, while the second switch controls the remaining downlights for the festive scene.

Three line-voltage switches are located in this fitness room to control the three levels of light: ambient, accent, and task. The first switch controls the linear downlights for the ambient light level, the second switch controls the adjustable downlights that accent the architectural columns, and the third switch controls the pendants suspended above the reception desk for task lighting.

## Lighting Plans

Lighting plans for the four re-lighted spaces can be found in Appendix A.

### Existing Panelboard Schedules

Figure 24: Existing normal lighting/ power panelboard, panel tag HP1.

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W			PANEL TAG: HP1						MIN. C/B AIC: X			
SIZE/TYPE BUS: 225A			PANEL LOCATION: ELECTRICAL 127						OPTIONS:			
SIZE/TYPE MAIN: 225A/3P C/B			PANEL MOUNTING: SURFACE									
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTS	ROTUNDA	2100	20A/1P	1	*			2	20A/1P	3800	MULTIPURPOSE	LIGHTS
LIGHTS	CORRIDOR	1200	20A/1P	3		*		4	20A/1P	1500	ROTUNDA	LIGHTS
LIGHTS	OFFICE	3900	20A/1P	5			*	6	20A/1P	4300	ROTUNDA	LIGHTS
LIGHTS	OFFICE	3500	20A/1P	7	*			8	20A/1P	1300	CORRIDOR	LIGHTS
LIGHTS	RM 128,130	800	20A/1P	9		*		10	20A/1P	1400	ECH./GYM STO	LIGHTS
LIGHTS	CABANA	400	20A/1P	11			*	12	20A/1P	1600	POOL	LIGHTS
LIGHTS	GYM	1900	20A/1P	13	*			14	20A/1P	3200	POOL	LIGHTS
LIGHTS	GYM	3500	20A/1P	15		*		16	20A/1P	3200	POOL	LIGHTS
LIGHTS	GYM	3500	20A/1P	17			*	18	20A/1P	2900	FITNESS	LIGHTS
LIGHTS	GYM	2700	20A/1P	19	*			20	20A/1P	3900	FITNESS	LIGHTS
LIGHTS	ROOF	500	20A/1P	21		*		22	20A/1P	1100	114	LIGHTS
LIGHTS	CORR./SERV.	1600	20A/1P	23			*	24	20A/1P	2400	MURALS	LIGHTS
LIGHTS	LOCKER	2800	20A/1P	25	*			26	20A/1P	1600	GYM	LIGHTS
LIGHTS	RAQUETBALL	2000	20A/1P	27		*		28	20A/1P	2900	GYM	LIGHTS
DRYER		3700	20A/1P	29			*	30	20A/1P	2900		SPARE
---		10500	20A/1P	31	*			32	20A/1P	0		SPARE
---		10500	20A/1P	33		*		34	20A/1P	0		SPARE
---		10500	20A/1P	35			*	36	20A/1P	0		SPACE-PFFB
SPACE-PFFB		0	20A/1P	37	*			38	20A/1P	0		---
---		0	20A/1P	39		*		40	20A/1P	0		---
---		0	20A/1P	41			*	42	20A/1P	0		---
CONNECTED LOAD (KW) - A Ph.		37.30							TOTAL DESIGN LOAD (KW)		124.32	
CONNECTED LOAD (KW) - B Ph.		28.60							POWER FACTOR		0.80	
CONNECTED LOAD (KW) - C Ph.		37.70							TOTAL DESIGN LOAD (AMPS)		187	

Figure 25: Existing life safety branch emergency panelboard, panel tag EHP1.

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W			PANEL TAG: EHP1						MIN. C/B AIC: X			
SIZE/TYPE BUS: 100A			PANEL LOCATION: ELECTRICAL 127						OPTIONS:			
SIZE/TYPE MAIN: 100A/3P C/B			PANEL MOUNTING: SURFACE									
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTS	STEPS	500	20A/1P	1	*			2	20A/1P	2400	ROTUNDA	LIGHTS
LIGHTS	ROTUNDA	800	20A/1P	3		*		4	20A/1P	600	CORR. 212	LIGHTS
LIGHTS	CORR. 103	1100	20A/1P	5			*	6	20A/1P	2400	POOL	LIGHTS
LIGHTS	CORR. 131	1600	20A/1P	7	*			8	20A/1P	2400	POOL	LIGHTS
LIGHTS	R RMS/CABAN	1300	20A/1P	9		*		10	20A/1P	3200	NESS,MEN,WON	LIGHTS
LIGHTS	EXTERIOR	500	20A/1P	11			*	12	20A/1P	2700	GYM	LIGHTS
SPARE	0	0	20A/1P	13	*			14	20A/1P	900	POOL FILTER	LIGHTS
SPARE	0	0	20A/1P	15		*		16	20A/1P	500	ELECT 152	LIGHTS
SPARE	0	0	20A/1P	17			*	18	20A/1P	800	MULTIPURPOSE	LIGHTS
SPARE	0	0	20A/1P	19	*			20	20A/1P	0	0	SPARE
SPARE	0	0	20A/1P	21		*		22	20A/1P	0	0	SPARE
SPARE	0	0	20A/1P	23			*	24	20A/1P	0	0	SPARE
---	0	0	20A/1P	25	*			26	20A/1P	0	0	---
---	0	0	20A/1P	27		*		28	20A/1P	0	0	---
---	0	0	20A/1P	29			*	30	20A/1P	0	0	---
0		0	20A/1P	31	*			32	20A/1P	0		0
0		0	20A/1P	33		*		34	20A/1P	0		0
0		0	20A/1P	35			*	36	20A/1P	0		SPACE-PFFB
SPACE-PFFB		0	20A/1P	37	*			38	20A/1P	0		0
0		0	20A/1P	39		*		40	20A/1P	0		0
0		0	20A/1P	41			*	42	20A/1P	0		0
CONNECTED LOAD (KW) - A Ph.		7.80							TOTAL DESIGN LOAD (KW)		26.04	
CONNECTED LOAD (KW) - B Ph.		6.40							POWER FACTOR		0.80	
CONNECTED LOAD (KW) - C Ph.		7.50							TOTAL DESIGN LOAD (AMPS)		39	

## Branch Circuit Calculations

Table 25: Branch circuit calculations for panelboard HP1.

Panelboard HP1 Circuit Calculations					
Circuit 1					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L01	18	32	576	0.98	587.76
Circuit 2					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L01	43	32	1376	0.98	1404.08
Circuit 4					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L04	33	42	1386	0.98	1414.29
Circuit 6					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L05	33	35	1155	0.98	1178.57
Circuit 18					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L02	42	80	3360	0.88	3818.18
Circuit 20					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L01	12	32	384	0.98	391.84
L03	4	5	20	1.00	20.00
Total			404	0.99	411.84

Table 26: Branch circuit calculations for panelboard EHP1.

Panelboard EHP1 Circuit Calculations					
Circuit 2					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L01	3	32	96	0.98	97.96
Circuit 3					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L01	3	32	96	0.98	97.96
Circuit 11					
Type	Quantity	W/ Luminaire	Total W	PF	Total VA
L06	20	9	180	0.98	183.67

## Panelboard Worksheets

Figure 26: Panelboard sizing worksheet for panel tag HP1.

PANELBOARD SIZING WORKSHEET										
Panel Tag----->				HP1		Panel Location:			ELECTRICAL 127	
Nominal Phase to Neutral Voltage----->				277		Phase:			3	
Nominal Phase to Phase Voltage----->				480		Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	LIGHTS	1	ROTUNDA	576	w	0.98	576	588	
2	A	LIGHTS	1	MULTIPURPOSE	1376	w	0.98	1376	1404	
3	B	LIGHTS	1	CORRIDOR	1200	w		1200	1500	
4	B	LIGHTS	1	ROTUNDA	1386	w	0.98	1386	1414	
5	C	LIGHTS	1	OFFICE	3900	w		3900	4875	
6	C	LIGHTS	1	ROTUNDA	1155	w	0.98	1155	1179	
7	A	LIGHTS	1	OFFICE	3500	w		3500	4375	
8	A	LIGHTS	1	CORRIDOR	1300	w		1300	1625	
9	B	LIGHTS	1	RM 128,130	800	w		800	1000	
10	B	LIGHTS	1	MECH./GYM STOR.	1400	w		1400	1750	
11	C	LIGHTS	1	CABANA	400	w		400	500	
12	C	LIGHTS	1	POOL	1600	w		1600	2000	
13	A	LIGHTS	1	GYM	1900	w		1900	2375	
14	A	LIGHTS	1	POOL	3200	w		3200	4000	
15	B	LIGHTS	1	GYM	3500	w		3500	4375	
16	B	LIGHTS	1	POOL	3200	w		3200	4000	
17	C	LIGHTS	1	GYM	3500	w		3500	4375	
18	C	LIGHTS	1	FITNESS	3360	w	0.88	3360	3818	
19	A	LIGHTS	1	GYM	2700	w		2700	3375	
20	A	LIGHTS	1	FITNESS	404	w	0.99	404	408	
21	B	LIGHTS	1	ROOF	500	w		500	625	
22	B	LIGHTS	1	114	1100	w		1100	1375	
23	C	LIGHTS	1	CORR./SERV.	1600	w		1600	2000	
24	C	LIGHTS	1	MURALS	2400	w		2400	3000	
25	A	LIGHTS	1	LOCKER	2800	w		2800	3500	
26	A	LIGHTS	1	GYM	1600	w		1600	2000	
27	B	LIGHTS	1	RAQUETBALL	2000	w		2000	2500	
28	B	LIGHTS	1	GYM	2900	w		2900	3625	
29	C	DRYER	9		3700	w		3700	4625	
30	C	SPARE	2		2900	w		2900	3625	
31	A	---	3		10500	w		10500	13125	
32	A	SPARE	2		0	w		0	0	
33	B	---	3		10500	w		10500	13125	
34	B	SPARE	2		0	w		0	0	
35	C	---	3		10500	w		10500	13125	
36	C	SPACE-PFFB	3		0	w		0	0	
37	A	SPACE-PFFB	3		0	w		0	0	
38	A	---	3		0	w		0	0	
39	B	---	3		0	w		0	0	
40	B	---	3		0	w		0	0	
41	C	---	3		0	w		0	0	
42	C	---	3		0	w		0	0	
PANEL TOTAL								93.4	115.2	Amps= 138.6
PHASE LOADING										
PHASE TOTAL								A		kW kVA % Amps
PHASE TOTAL								B		29.9 36.8 32% 132.8
PHASE TOTAL								C		28.5 35.3 31% 127.4
PHASE TOTAL										35.0 43.1 37% 155.7
LOAD CATAGORIES				Connected			Demand			Ver. 104
				kW	kVA	DF	kW	kVA	PF	
1		lighting		55.3	67.6	0.60	33.2	40.5	0.82	
2		spare		2.9	3.6	0.60	1.7	2.2	0.80	
3		space		31.5	39.4	0.60	18.9	23.6	0.80	
4				0.0	0.0		0.0	0.0		
5				0.0	0.0		0.0	0.0		
6				0.0	0.0		0.0	0.0		
7				0.0	0.0		0.0	0.0		
8				0.0	0.0		0.0	0.0		
9		unassigned		3.7	4.6	0.60	2.2	2.8	0.80	
Total Demand Loads							56.0	69.1		
Spare Capacity				20%			11.2	13.8		
Total Design Loads							67.2	82.9	0.81	Amps= 99.8

Figure 27: Panelboard sizing worksheet for panel tag EHP1.

PANELBOARD SIZING WORKSHEET												
Panel Tag----->					EHP1	Panel Location:			ELECTRICAL 127			
Nominal Phase to Neutral Voltage----->					277	Phase:			3			
Nominal Phase to Phase Voltage----->					480	Wires:			4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks		
1	A	LIGHTS	1	STEPS	500	w		500	625			
2	A	LIGHTS	1	ROTUNDA	96	w	0.98	96	98			
3	B	LIGHTS	1	ROTUNDA	96	w	0.98	96	98			
4	B	LIGHTS	1	CORR. 212	600	w		600	750			
5	C	LIGHTS	1	CORR. 103	1100	w		1100	1375			
6	C	LIGHTS	1	POOL	2400	w		2400	3000			
7	A	LIGHTS	1	CORR. 131	1600	w		1600	2000			
8	A	LIGHTS	1	POOL	2400	w		2400	3000			
9	B	LIGHTS	1	RMS/CAB	1300	w		1300	1625			
10	B	LIGHTS	1	SS.MEN.W	3200	w		3200	4000			
11	C	LIGHTS	1	EXTERIOR	180	w	0.98	180	184			
12	C	LIGHTS	1	GYM	2700	w		2700	3375			
13	A	SPARE	2		0	w		0	0			
14	A	LIGHTS	1	POOL FILTE	900	w		900	1125			
15	B	SPARE	2		0	w		0	0			
16	B	LIGHTS	1	ELECT 152	500	w		500	625			
17	C	SPARE	2		0	w		0	0			
18	C	LIGHTS	1	ILTIPURPO	800	w		800	1000			
19	A	SPARE	2		0	w		0	0			
20	A	SPARE	2		0	w		0	0			
21	B	SPARE	2		0	w		0	0			
22	B	SPARE	2		0	w		0	0			
23	C	SPARE	2		0	w		0	0			
24	C	SPARE	2		0	w		0	0			
25	A	SPACE-PFFB	3		0	w		0	0			
26	A	SPACE-PFFB	3		0	w		0	0			
27	B	---	9		0	w		0	0			
28	B	---	9		0	w		0	0			
29	C	---	9		0	w		0	0			
30	C	---	9		0	w		0	0			
31	A		9		0	w		0	0			
32	A		9		0	w		0	0			
33	B		9		0	w		0	0			
34	B		9		0	w		0	0			
35	C		9		0	w		0	0			
36	C		9		0	w		0	0			
37	A		9		0	w		0	0			
38	A		9		0	w		0	0			
39	B		9		0	w		0	0			
40	B		9		0	w		0	0			
41	C		9		0	w		0	0			
42	C		9		0	w		0	0			
PANEL TOTAL								18.4	22.9	Amps= 27.5		
PHASE LOADING								kW	kVA	%	Amps	
PHASE TOTAL								A	5.5	6.8	30%	24.7
PHASE TOTAL								B	5.7	7.1	31%	25.6
PHASE TOTAL								C	7.2	8.9	39%	32.3
LOAD CATAGORIES			Connected			Demand			Ver. 104			
			kW	kVA	DF	kW	kVA	PF				
1	LIGHTS		18.4	22.9	0.60	11.0	13.7	0.80				
2	SPARE		0.0	0.0	0.60	0.0	0.0					
3	SPACE		0.0	0.0	0.60	0.0	0.0					
4			0.0	0.0		0.0	0.0					
5			0.0	0.0		0.0	0.0					
6			0.0	0.0		0.0	0.0					
7			0.0	0.0		0.0	0.0					
8			0.0	0.0		0.0	0.0					
9	unassigned		0.0	0.0		0.0	0.0					
Total Demand Loads						11.0	13.7					
Spare Capacity			20%			2.2	2.7					
Total Design Loads						13.2	16.5	0.80	Amps=	19.8		

## Revised Panelboard Schedules

Figure 28: Revised normal lighting/ power panelboard, panel tag HP1.

PANELBOARD SCHEDULE													
VOLTAGE: 480Y/277V,3PH,4W			PANEL TAG: HP1						MIN. C/B AIC:				
SIZE/TYPE BUS: 100A			PANEL LOCATION: ELECTRICAL 127						OPTIONS:				
SIZE/TYPE MAIN: 100A/3P C/B			PANEL MOUNTING: SURFACE										
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION	
LIGHTS	ROTUNDA	576	20A/1P	1	*			2	20A/1P	1376	MULTIPURPOSE	LIGHTS	
LIGHTS	CORRIDOR	1200	20A/1P	3		*		4	20A/1P	1386	ROTUNDA	LIGHTS	
LIGHTS	OFFICE	3900	20A/1P	5			*	6	20A/1P	1155	ROTUNDA	LIGHTS	
LIGHTS	OFFICE	3500	20A/1P	7	*			8	20A/1P	1300	CORRIDOR	LIGHTS	
LIGHTS	RM 128,130	800	20A/1P	9		*		10	20A/1P	1400	ECH./GYM STO	LIGHTS	
LIGHTS	CABANA	400	20A/1P	11			*	12	20A/1P	1600	POOL	LIGHTS	
LIGHTS	GYM	1900	20A/1P	13	*			14	20A/1P	3200	POOL	LIGHTS	
LIGHTS	GYM	3500	20A/1P	15	*	*		16	20A/1P	3200	POOL	LIGHTS	
LIGHTS	GYM	3500	20A/1P	17			*	18	20A/1P	3360	FITNESS	LIGHTS	
LIGHTS	GYM	2700	20A/1P	19	*			20	20A/1P	404	FITNESS	LIGHTS	
LIGHTS	ROOF	500	20A/1P	21		*		22	20A/1P	1100	114	LIGHTS	
LIGHTS	CORR./SERV.	1600	20A/1P	23			*	24	20A/1P	2400	MURALS	LIGHTS	
LIGHTS	LOCKER	2800	20A/1P	25	*			26	20A/1P	1600	GYM	LIGHTS	
LIGHTS	RAQUETBALL	2000	20A/1P	27		*		28	20A/1P	2900	GYM	LIGHTS	
DRYER		3700	20A/1P	29		*	*	30	20A/1P	2900		SPARE	
---		10500	20A/1P	31	*			32	20A/1P	0		SPARE	
---		10500	20A/1P	33		*		34	20A/1P	0		SPARE	
---		10500	20A/1P	35		*	*	36	20A/1P	0		SPACE-PFFB	
SPACE-PFFB		0	20A/1P	37	*			38	20A/1P	0		---	
---		0	20A/1P	39		*		40	20A/1P	0		---	
---		0	20A/1P	41		*	*	42	20A/1P	0		---	
CONNECTED LOAD (KW) - A Ph.		29.86							TOTAL DESIGN LOAD (KW)				67.22
CONNECTED LOAD (KW) - B Ph.		28.49							POWER FACTOR				0.81
CONNECTED LOAD (KW) - C Ph.		35.02							TOTAL DESIGN LOAD (AMPS)				100

Figure 29: Revised life safety branch emergency panelboard, panel tag EHP1.

PANELBOARD SCHEDULE													
VOLTAGE: 480Y/277V,3PH,4W			PANEL TAG: EHP1						MIN. C/B AIC: X				
SIZE/TYPE BUS: 100A			PANEL LOCATION: ELECTRICAL 127						OPTIONS:				
SIZE/TYPE MAIN: 100A/3P C/B			PANEL MOUNTING: SURFACE										
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION	
LIGHTS	STEPS	500	20A/1P	1	*			2	20A/1P	96	ROTUNDA	LIGHTS	
LIGHTS	ROTUNDA	96	20A/1P	3		*		4	20A/1P	600	CORR. 212	LIGHTS	
LIGHTS	CORR. 103	1100	20A/1P	5			*	6	20A/1P	2400	POOL	LIGHTS	
LIGHTS	CORR. 131	1600	20A/1P	7	*			8	20A/1P	2400	POOL	LIGHTS	
LIGHTS	RMS/CABANA	1300	20A/1P	9		*		10	20A/1P	3200	NESS,MEN,WOM	LIGHTS	
LIGHTS	EXTERIOR	180	20A/1P	11			*	12	20A/1P	2700	GYM	LIGHTS	
SPARE	0	0	20A/1P	13	*			14	20A/1P	900	POOL FILTER	LIGHTS	
SPARE	0	0	20A/1P	15		*		16	20A/1P	500	ELECT 152	LIGHTS	
SPARE	0	0	20A/1P	17			*	18	20A/1P	800	MULTIPURPOSE	LIGHTS	
SPARE	0	0	20A/1P	19	*			20	20A/1P	0	0	SPARE	
SPARE	0	0	20A/1P	21		*		22	20A/1P	0	0	SPARE	
SPARE	0	0	20A/1P	23			*	24	20A/1P	0	0	SPARE	
---	0	0	20A/1P	25	*			26	20A/1P	0	0	---	
---	0	0	20A/1P	27		*		28	20A/1P	0	0	---	
---	0	0	20A/1P	29		*	*	30	20A/1P	0	0	---	
0	0	0	20A/1P	31	*			32	20A/1P	0	0	0	
0	0	0	20A/1P	33		*		34	20A/1P	0	0	0	
0	0	0	20A/1P	35		*	*	36	20A/1P	0		SPACE-PFFB	
SPACE-PFFB	0	0	20A/1P	37	*			38	20A/1P	0	0	0	
0	0	0	20A/1P	39		*		40	20A/1P	0	0	0	
0	0	0	20A/1P	41		*	*	42	20A/1P	0	0	0	
CONNECTED LOAD (KW) - A Ph.		5.50							TOTAL DESIGN LOAD (KW)				13.23
CONNECTED LOAD (KW) - B Ph.		5.70							POWER FACTOR				0.80
CONNECTED LOAD (KW) - C Ph.		7.18							TOTAL DESIGN LOAD (AMPS)				20



## Dimming Wiring Diagrams

No dimming controls were specified for this project.

## Feeders Re-sized

Each panelboard re-design includes a resizing of the main circuit protection and feeder. Feeder sizing is based on copper wire, 75 degree C, THWN and IMC conduit. The building wiring is assumed to be 100 percent neutral due to the use of fluorescent and HID lighting.

Note: Panelboard EHP1 has a calculated load of less than 40 Amps. According to the NEC, this panelboard breaker has to protect the feeder. Therefore, this panelboard will be sized based off of a 100A panelboard and will take into account extra spare loads.

Table 27: Feeder sizing worksheet.

Feeder Sizing Worksheet		
Panelboard		
Tag	HP1	EHP1
Voltage	480Y/277V	480Y/277V
Calcuated Design Load (kW)	67.22	13.23
Resultant Power Factor	0.81	0.80
Calcuated Design Load (kVA)	82.99	16.54
Calculated Design Load (A)	99.82	19.89
Panel Size	100 A	100 A
Feeder		
Feeder Protection Size	100 A	100 A
Number of Sets	1	1
Wire Size		
Phase (NEC Table 310.13A)	(3) #3 AWG	(3) #3 AWG
Neutral	(1) #3 AWG	(1) #3 AWG
Ground	#8 AWG	#8 AWG
Wire Area (sq. in.) (NEC Table 5)		
Each Phase	0.0973	0.0973
Total- Phase Conductors	0.2919	0.2919
Neutral	0.0973	0.0973
Ground	0.0366	0.0366
Total Area	0.4258	0.4258
Min. Conduit Area (sq. in.) (above*2.5)	1.0645	1.0645
Conduit Size (NEC Table 4)	1 1/4 EMT	1 1/4 EMT
Conduit Size (NEC Table C.1)	1 1/4 EMT	1 1/4 EMT
Feeder Length	25 ft.	50 ft.
Final Voltage Drop (V)	0.49 V	0.99 V
Final Voltage Drop (%)	0.21%	0.10%
Feeder Re-Sizing	N/A	N/A

## Electrical Equipment Cut Sheets

Eaton Pow-R-Line panelboards are specified for the re-sized HP1 and EHP1 panelboards. Manufacturer’s information for the re-sized panelboards can be found in Appendix D.

## Short Circuit Analysis

An electrical distribution system should be safely designed and selective in design to ensure continuity of the service. A short circuit calculation is performed through a single path along the distribution system. The source will begin at the utility transformer and go through feeder MDS-2, the main distribution panel section 2, feeder #7 PB-H1, and panelboard H1.

## Calculation

This short circuit calculation is performed using the per-unit method with an assumed base kVA of 10,000kVA and an assumed utility contribution of 100MVA. The transformer load is sized off of the MDS-2.

Figure 30: Short circuit calculation chart.

Base kVA		10000													
Utility Contribution (MVA)		100													
Equipment Characteristics											Per-Unit Value Table				
Mark	%X	%R	%Z	kVA	X/1000ft	R/1000ft	Z/1000ft	Length	#sets	3Ph Voltage (V)	Mark	Xu	Ru	Zu	Isc
Utility	0.1			100000						12470	Utility	0.1		0.1	
TRANSFORMER	5.662	1.000	5.750	2500.000							TRANSFORMER	0.22648	0.04	0.229985	4629.914
FEEDER MDS-2					0.046	0.026	0.053	100	6.000	480.000	FEEDER MDS-2	0.033492	0.018591	0.038306	36450.52
MDS-2											MDS-2				32659.28
FEEDER #7 PB-H1					0.046	0.026	0.053	25	1.000	480.000	FEEDER #7 PB-H1	0.050239	0.027886	0.057459	32659.28
PB-H1											PB-H1				28251.58

## Overcurrent Protection Coordination Study

The overcurrent protection of an electrical system protects the power system from faults that may occur. The system protection isolates faulted parts from the rest of the electrical system by using current and voltage transformers, protective relays, and circuit breakers. This study focuses on the overcurrent protection provided by the circuit breakers.

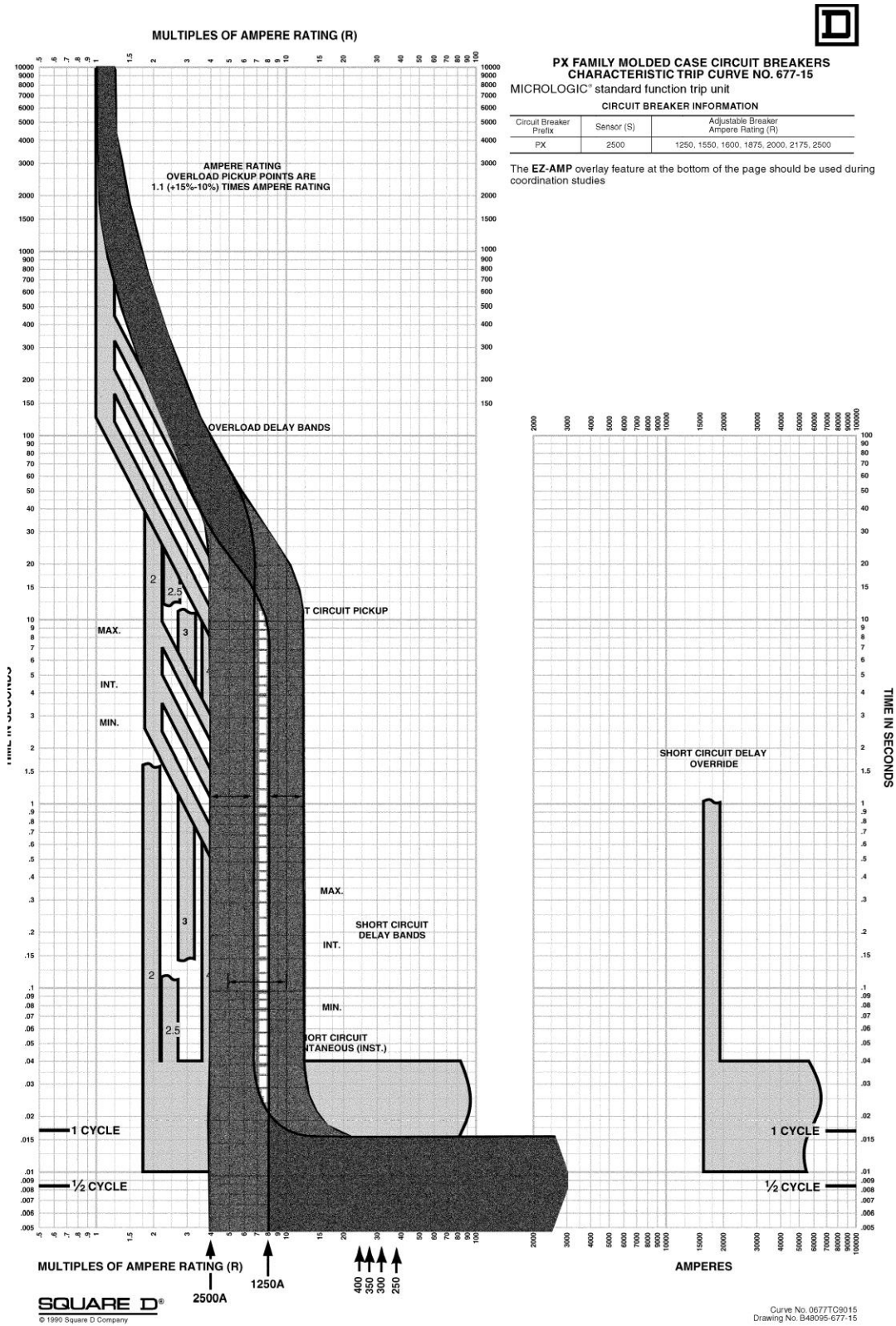
## Trip Curves

Table 28: Overcurrent protection information.

Overcurrent Protection			
Circuit Breaker	Voltage	Frame Size (A)	Trip Size (A)
<b>MCB MDS-2</b>	480Y/277V	2500	2500
<b>BCB PB-H1</b>	480Y/277V	400	400

Trip curve plots are based off of Square D's circuit breaker trip curves for the above rated circuit breakers. Molded case breakers were used for this study. Assume the circuit breaker trip size is the same as the circuit breaker trip size.

Figure 31: Trip curves plot where the light gray represents the MCB MDS-2 circuit breaker and the dark gray represents the BCB PB-H1 circuit breaker.



## Arc Fault Study

The arc fault study continues the short circuit analysis and overcurrent protection study of the electrical system. The short circuit analysis determines the momentary duty, interrupting duty, and short circuit rating of the electrical equipment. The overcurrent protection study determines the time required for the protective equipment to isolate an overload or short-circuit condition. An arc-flash hazard calculation is performed based on these two studies and determines the incident energy at assigned working distances throughout the electrical system and the arc-flash protection boundary. Thus, an arc-flash release of energy can be minimized by the proper protection of the electrical system.

## Photovoltaic Solar Roof Array

### Description

The Shepherd University Wellness Center will take advantage of incorporating solar power to save energy. Solar power will enable the facility to reduce operating costs, increase efficiency, and develop strategies to achieve sustainability. Photovoltaic solar roof arrays will be located on the Northwest side of the facility.

### Climate Conditions

Location: Shepherdstown, West Virginia

Average Wind Speed: 7.7mph

Average Snow Load: 30psf

### Solution

#### Equipment Selection

Mounting System: Unirac; SolarMount-I

Solar Module Type: Sharp; Monocrystalline NU-U235F1 (39.1" x 64.6")

Inverter: Sharp; (1) IGPlus10.0, (3) IGPlus7.5, (2) SB8000US, (2) SB7000US

Manufacturer's information for the equipment selected can be found in Appendix D.

Table 29: Photovoltaic array equipment schedule.

Array	System Size	Panel Quantity	Inverter Tag	Inverter Model
A	9.17 kW	39	IA	SB8000US
B	9.87 kW	42	IB	IGPlus10.0
C	9.17 kW	39	IC	SB8000US
D	8.46 kW	36	ID	IGPlus7.5
E	8.46 kW	36	IE	IGPlus7.5
F	8.46 kW	36	IF	IGPlus7.5
G	7.76 kW	33	IG	SB7000US
H	7.76 kW	33	IH	SB7000US
<b>Total</b>	<b>69.11</b>	<b>294</b>	--	--

## Equipment Sizing

Table 30: Photovoltaic array equipment sizing.

TAG	INVERTER	KW	PF	KVA	AMP	WIRE	CONDUIT SIZE
1	IA	9.17	0.8	7.34	8.82	(3) #14 AWG	16 EMT
1	IB	9.87	0.8	7.90	9.50	(3) #14 AWG	16 EMT
1	IC	9.17	0.8	7.34	8.82	(3) #14 AWG	16 EMT
1	ID	8.46	0.8	6.77	8.14	(3) #14 AWG	16 EMT
1	IE	8.46	0.8	6.77	8.14	(3) #14 AWG	16 EMT
1	IF	8.46	0.8	6.77	8.14	(3) #14 AWG	16 EMT
1	IG	7.76	0.8	6.21	7.47	(3) #14 AWG	16 EMT
1	IH	7.76	0.8	6.21	7.47	(3) #14 AWG	16 EMT
<b>DISTRIBUTION PANEL</b>				<b>55.29</b>	<b>66.50</b>		

Panelboard will be sized to 100 Amps.

## Results

### Array Information

Table 31: Photovoltaic array equipment cost and energy analysis.

No. Panels	Cost Per Array	No. Used	Total Cost of Array	kW/hr	Energy Output of Array
39	\$34,765.00	2	\$69,530.00	9.17	18.34 kW/hr
42	\$38,588.00	1	\$38,588.00	9.87	9.87 kW/hr
36	\$33,316.00	3	\$99,948.00	8.46	25.38 kW/hr
33	\$29,834.00	2	\$59,668.00	7.76	15.52 kW/hr

### Key Figures and Assumptions

Table 32: Photovoltaic array key figures.

Constant	Quantity
<b>Initial Cost of Arrays</b>	\$267,734.00
<b>Initial Cost of Mounting</b>	\$53,214.00
<b>Initial Cost of Installation</b>	\$100,000.00
<b>Federal Offset of Initial Cost</b>	30.0%
<b>Cost of Electricity in West Virginia</b>	\$0.137/ kW/hr
<b>Electricity Generated by System</b>	69.11 kW/hr
<b>Value of Electricity Generated by System</b>	\$15,205.72
<b>Usable Hours in West Virginia</b>	4.4 kWhr

**Time to Payback**

**Table 33: Photovoltaic array payback chart.**

Year	Cost of System/ Year
Year 1	\$279,457.88
Year 2	\$264,252.16
Year 3	\$249,046.44
Year 4	\$233,840.72
Year 5	\$218,635.00
Year 6	\$203,429.28
Year 7	\$188,223.56
Year 8	\$173,017.84
Year 9	\$157,812.12
Year 10	\$142,606.40
Year 11	\$127,400.68
Year 12	\$112,194.96
Year 13	\$96,989.24
Year 14	\$81,783.52
Year 15	\$66,577.80
Year 16	\$51,372.08
Year 17	\$36,166.36
Year 18	\$20,960.64
Year 19	\$5,754.92
Year 20	-\$9,450.80

**Summary**

The Array Information chart summarizes the costs of the complete roof array system. The total cost of all the panels is \$267,734.00. Each mount costs about \$181.00 per panel for a total of \$53,214.00. The initial installation is estimated at \$100,000.00. The yearly system maintenance costs are not taken into account for the photovoltaic solar roof array system costs. The federal government will offset the cost of a solar installation with a 30 percent Investment Tax Credit.

The payback year of the photovoltaic solar roof array system takes into account several factors. Given that the cost of electricity in West Virginia is \$0.137 per kilowatts/ hour, this can be multiplied by the total energy output of the arrays to get the amount of money generated per hour. With the average usable solar hours in West Virginia of 4.4 kilowatt-hours and assuming a year consists of 365 days, the total amount of money generated yearly is \$15,205.72. The first year takes 70 percent of the initial costs of the arrays and mounting minus the total amount of money generated in a year. Each year after continues to subtract the amount of money generated per year to calculate the cost of the system that year. After 20 years, the photovoltaic solar roof array system will have paid off its initial cost and will begin to benefit the university.

## **Generator vs. Distributed Batteries for Emergency Lighting**

### **Description**

The Shepherd University Wellness Center currently uses a 75KW, 480Y/277V, 3Ph, 4W propane fired generator that distributes emergency power to the circuit breaker for the equipment branch automatic transfer switch and the life safety branch automatic transfer switch, both 60A, 600V. When transferred to the emergency power position, power is distributed to the emergency distribution panels EL, for the emergency equipment and fire alarms, and EHP1, for the life safety equipment and egress lighting. A change to a distributed battery system may improve the system reliability and reduce cost.

### **Propane Generator**

#### **Equipment Selection**

Type: 75KW, 480Y/277V, 3Ph, 4W propane fired generator

Initial Cost: \$46,156.86

### **Distributed Batteries**

#### **Equipment Selection**

Types: PSDL, PS3000, and ELM2 LED

Note: Types of distributed batteries are determined from the emergency lighting schedule below. ELM2 LED emergency batteries are used in gym space where existing lighting consists of metal halide lamps. Manufacturer's information for the equipment selected can be found in Appendix D.



**Table 34: Emergency lighting schedule.**

EMERGENCY LIGHTING SCHEDULE											
TAG	SOURCE	TYPE	LAMP WATTAGE	NO. OF LAMPS	BALLAST TYPE	VOLTAGE	INPUT WATTS	BALLAST FACTOR	QUANTITY	LAMP LUMENS	EMERGENCY BATTERY
OA-64	TRIPLE TUBE CF	F32TBX/835/A/ECO	32	2	ELECTRONIC, PS	277	64	0.98	10	4080	PSDL
OB-32	TRIPLE TUBE CF	F32TBX/835/A/ECO	32	1	ELECTRONIC, PS	277	32	0.98	23	4080	PSDL
PB-400-A-250	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	6	26000	
PC-400-A-250	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	12	26000	
PD-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	7	2660	PS3000
PE-128	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	8	2660	PS3000
PL-96	T8 FLUOR.	F32T8/SP35/ECO	32	3	ELECTRONIC	277	92	0.88	9	2660	PS3000
RA-96	T8 FLUOR.	F32T8/SP35/ECO	32	3	ELECTRONIC	277	92	0.88	10	2660	PS3000
RB-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	2	2660	PS3000
RC-32	T8 FLUOR.	F32T8/SP35/ECO	32	1	ELECTRONIC	277	32	0.88	6	2660	PS3000
RD-32	TRT CF	F32T8/SP35/ECO	32	1	ELECTRONIC	120/277	32	0.88	63	2660	PS3000
RE-32	T8 FLUOR.	F32T8/SP35/ECO	32	1	ELECTRONIC	277	32	0.88	6	2660	PS3000
RG-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	14	2660	PS3000
SC-24	T5HO FLUOR.	F24W/T5/835/ECO	24	1	ELECTRONIC	277	28	1	23	1840	PS3000
WC-100	T8 FLUOR.	F32T8/SP35/ECO	32	3	ELECTRONIC	277	92	0.88	9	2660	PS3000
XA	LED	EMERGENCY LED	2.7	--	--	120/277	2.7	--	20		
XB	LED	EMERGENCY LED	2.7	--	--	120/277	2.7	--	22		
XC	LED	EMERGENCY LED	2.7	--	--	120/277	2.7	--	40		
EL1	LED	EMERGENCY LED	1.5	2	---	120/277	1.5	---	8		ELM2 LED

### Equipment Cost

**Table 35: Distributed battery equipment cost.**

EMERGENCY BATTERY	QUANTITY	BATTERY COST	TOTAL COST
PSDL	10	\$ 91.70	\$ 917.00
PSDL	23	\$ 91.70	\$ 2,109.10
PS3000	7	\$ 91.70	\$ 641.90
PS3000	8	\$ 91.70	\$ 733.60
PS3000	9	\$ 91.70	\$ 825.30
PS3000	10	\$ 91.70	\$ 917.00
PS3000	2	\$ 91.70	\$ 183.40
PS3000	6	\$ 91.70	\$ 550.20
PS3000	63	\$ 91.70	\$ 5,777.10
PS3000	6	\$ 91.70	\$ 550.20
PS3000	14	\$ 91.70	\$ 1,283.80
PS3000	23	\$ 91.70	\$ 2,109.10
PS3000	9	\$ 91.70	\$ 825.30
ELM2 LED	8	\$ 72.00	\$ 576.00
<b>TOTAL</b>			<b>\$ 17,999.00</b>

## **Solution**

The cost of the propane generator of \$46,156.86 is more than two and half times the total cost of the emergency lighting batteries of \$17,999.00. Thus, by cost alone the distributed batteries surpass the propane generator.

Other factors may be taken into consideration when deciding between using a generator or distributed batteries for the emergency lighting system. Battery backup power takes milliseconds to start up, while gas generators with automatic start up take 10 to 20 seconds to start running. Batteries operate emission-free. Gas generators must be operated outdoors due to their toxic exhaust and can be noisy. Gas generators also need a reserve supply of fuel, which requires outdoor storage as well as conditioning additives and periodic replacement of the fuel so the gas does not go bad while it sits. Batteries can only provide power for a few hours before needing a recharge, so they are most appropriate for short-term backup. Gas generators will run as long as you need them to, provided you keep filling them with gas. A large stationary unit, as required for the University building, can run for days on large propane tanks.

## **Architectural Breadth**

An architectural study of the multi-purpose room will evaluate and improve the interior space in addition to the lighting re-design of the space.

## **Description**

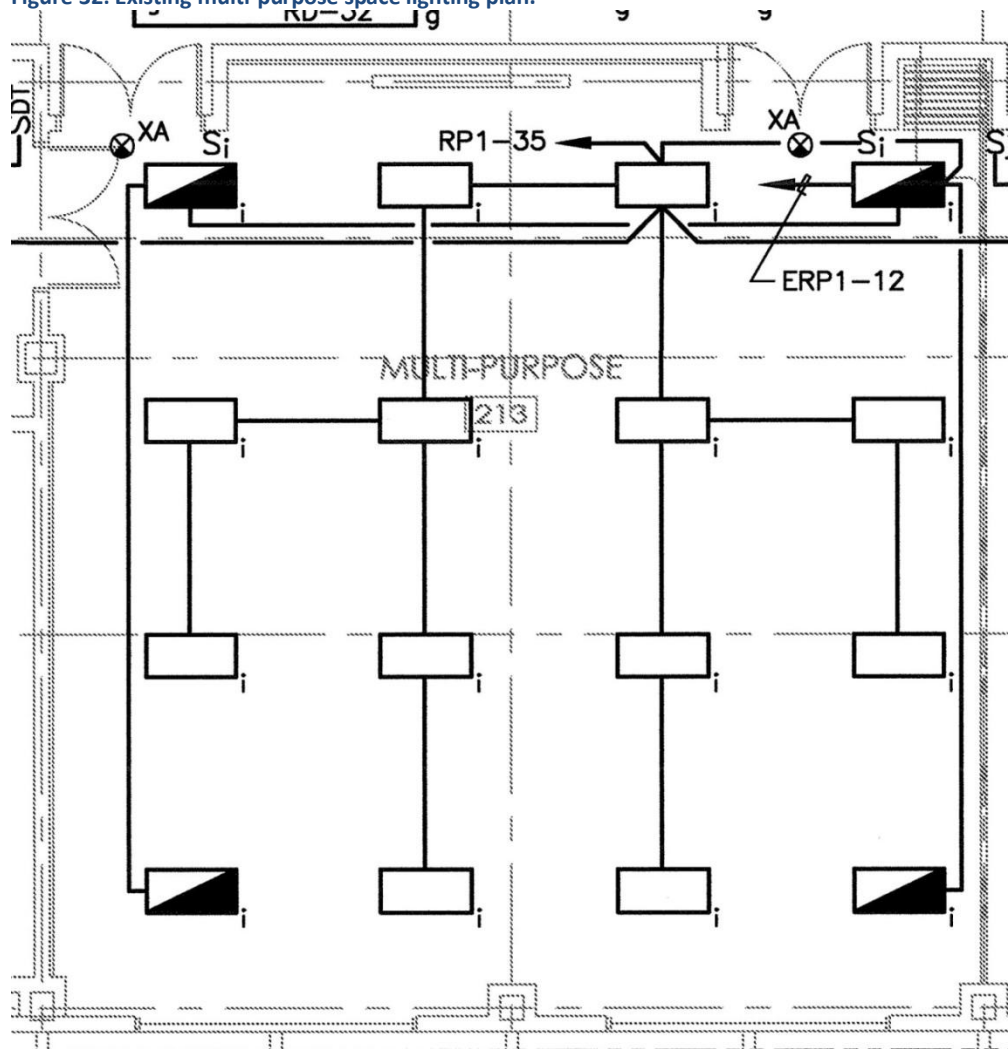
Located on the second floor of the facility, the multi-purpose room is an open square for freedom of movement required by the aerobic and dance classes that take place here. The room is approximately 40 feet by 38 feet with a 14 foot ceiling. Two large windows in the space look out into the building's large gym. In addition to the glass windows, other room materials include wood athletic flooring, cream-colored painted walls, and ceiling tile. This space does not contain furniture or any permanent layout. The room is equipped for dance, aerobic, and wellness classes. As a space for energetic activities, the space should complement its use. The multi-purpose room should be an exciting space that engages the users throughout their workout.

## **Existing Conditions**

The existing multi-purpose room is an open square of freedom for movement with a typical 2 foot by 4 foot fluorescent troffer lighting layout.

Plans

Figure 32: Existing multi-purpose space lighting plan.



## Renderings

Figure 33: Existing multi-purpose space rendering.

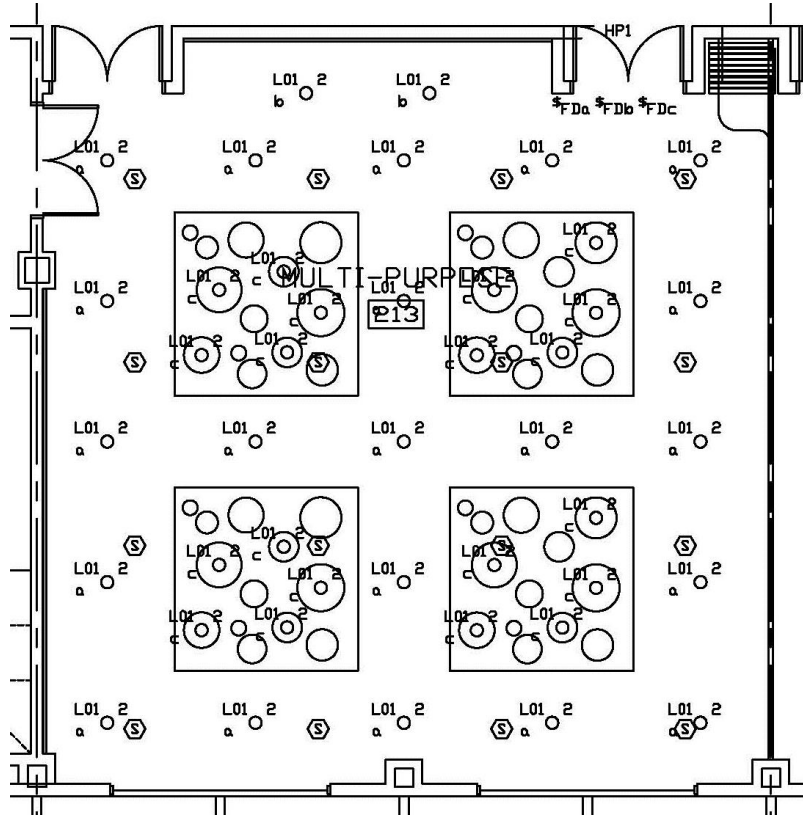


## Re-Design Solution

The multi-purpose room should complete the high intensity of the activities within the space. The lighting depth re-designs the space to create a festive impression. A random pattern of point sources are used to create sparkle within the space. For this architectural study, sheets of perforated metal are incorporated in the space to allow for light to reflect onto the surfaces and emphasize the playfulness of the space.

## Plans

Figure 34: Re-designed multi-purpose space lighting plan.



## Details

Perforated metal panels are designed to suspend from the ceiling by cable cords. Metal L-shaped angles will be used to frame the square shaped panels and keep them in rigid form. Holes are cut out of the metal as an aesthetic detail and allow for light to penetrate into the space.

Figure 35: Detail of metal panel. Black color represents the metal and white space represents cutout spaces.

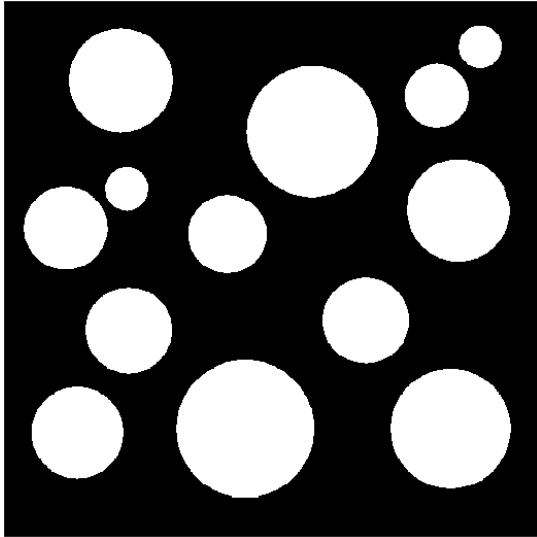


Figure 36: Detail of metal panel suspended from ceiling grid. Image is courtesy of Hunter Douglas Contract.

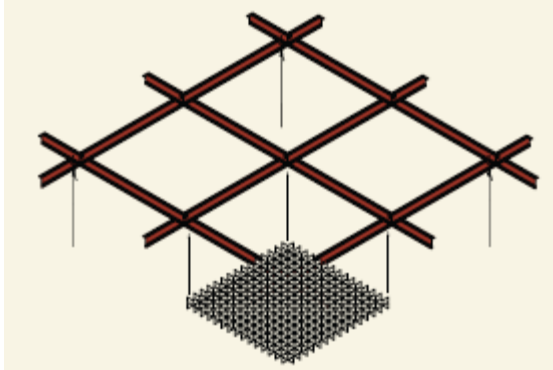
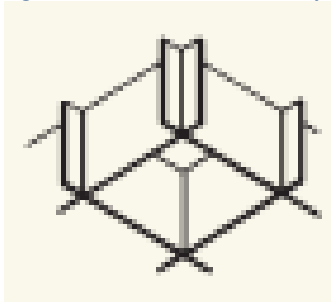


Figure 37: Detail of metal L-shaped angle that will frame the metal panel. Image is courtesy of Hunter Douglas Contract.



## Renderings

Figure 38: Re-designed multi-purpose space rendering.



## Summary

The architectural re-design of the multi-purpose room takes a simple space and makes it more visually appealing. Focal points and stimulating elements are added to increase movement throughout the space. Users will experience the space differently depending on their stance and the light reflection at that point. Thus, the re-design meets the needs of the aerobic space and successfully improves the existing room.



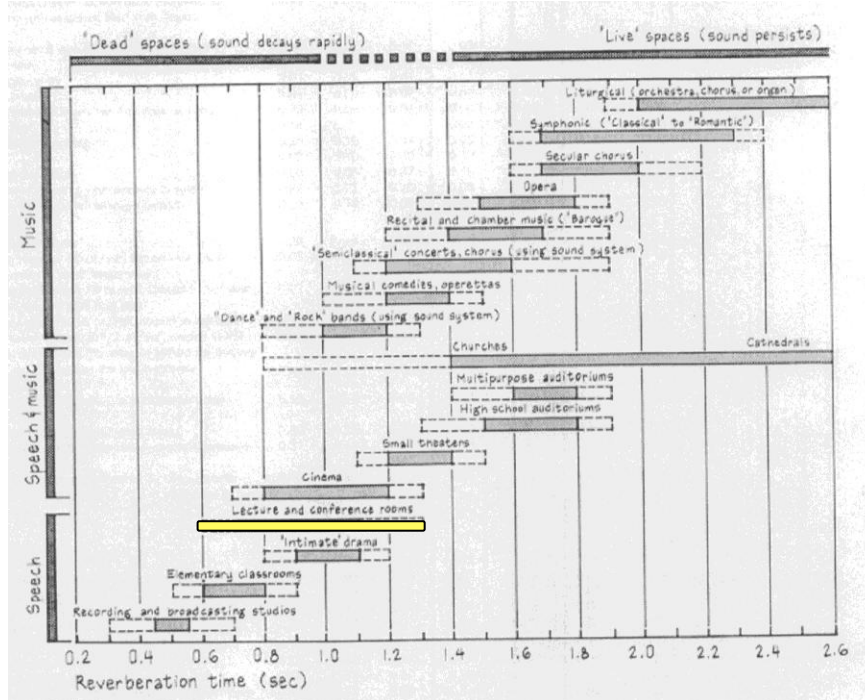
## Acoustical Breadth

An acoustical study of the multi-purpose room will evaluate the noise level in the existing space and the noise level in the re-designed interior architectural space.

## Description

The multi-purpose room is an open square space with a 14 foot high ceiling. The space is used for fitness classes and educational purposes and will contain speech from the instructor and music for dance lessons. The space is categorized as a "Lecture and Conference room." The optimum reverberation time for this space is high-lighted in the figure below.

**Figure 39: Optimum reverberation time bar graph indicating. The average reverberation time at mid-frequency (average at 500 and 1000Hz) are given for a variety of activities.**



## Existing Conditions

Room Volume: 21,317 ft<sup>3</sup>

**Table 36: Multi-purpose room surface area calculations.**

SURFACE AREA	
CEILING	1511.44 ft <sup>2</sup>
WALLS	1937 ft <sup>2</sup>
DOORS	120 ft <sup>2</sup>
WINDOWS	216 ft <sup>2</sup>
FLOOR	1511.44 ft <sup>2</sup>

### Assumed Materials

Ceiling= Thin, porous sound-absorbing material, 3/4 inch thick

Walls= Plaster on concrete block

Doors= Wood, 1-inch paneling with airspace behind

Windows= Ordinary glass windows

Floor= Wood

Table 37: Multi-purpose room material absorption calculations.

MATERIAL ABSORPTION			
	S (ft <sup>2</sup> )	$\alpha$	a (sabins)
<b>CEILING</b>	1511.44	0.80	1209.15
<b>WALLS</b>	1937	0.07	135.59
<b>DOORS</b>	120	0.09	10.80
<b>WINDOWS</b>	216	0.18	38.88
<b>FLOOR</b>	1511.44	0.10	151.144
<b>TOTAL a</b>			<b>1545.57</b>

Table 38: Multi-purpose room reverberation time calculations.

REVERBERATION TIME AT MID-FREQUENCY		
V (ft <sup>3</sup> )	a	T (s)
21317	1545.57	0.69

### Analysis

The existing conditions of the multi-purpose room indicate a reverberation time of 0.69 seconds. For a lecture and conference room, this time is located within the preferred range of reverberation times at mid-frequency. Thus, the existing conditions are adequate for the acoustics within the space and no acoustical re-design is necessary.

### Re-Design Evaluation

As part of the re-design of the architectural interior of the multi-purpose space, an acoustical analysis evaluates the new acoustical levels. In the re-design, the perforated metal panels are factored into the acoustical calculations.

Table 39: Multi-purpose room material absorption calculations.

<b>MATERIAL ABSORPTION</b>			
	<b>S (ft<sup>2</sup>)</b>	<b>α</b>	<b>a (sabins)</b>
<b>METAL</b>	68.15	0.57	38.85
<b>HOLES</b>	31.85	1.00	31.85
		<b>METAL AVG. a</b>	<b>35.35</b>
<b>CEILING</b>	1411.44	0.8	1129.15
<b>WALLS</b>	1937	0.07	135.59
<b>DOORS</b>	120	0.09	10.80
<b>WINDOWS</b>	216	0.18	38.88
<b>FLOORS</b>	1511.44	0.1	151.14
		<b>TOTAL a</b>	<b>1500.91</b>

Table 40: Multi-purpose room reverberation time calculations.

<b>REVERBERATION TIME AT MID-FREQUENCY</b>		
<b>V (ft<sup>3</sup>)</b>	<b>a</b>	<b>T (s)</b>
21317	1500.91	0.71

### Summary

The re-design conditions of the multi-purpose room indicate a reverberation time of 0.71 seconds. For a lecture and conference room, this time is located within the preferred range of reverberation times at mid-frequency. Thus, the re-design conditions are adequate for the acoustics within the space and deemed acceptable to implement.

## References

### Text

- (1) ASHRAE Standard 90.1: Energy Standard for Building Except Low-Rise Residential Buildings. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta, GA. 2007.
- (2) The IESNA Lighting Handbook: Reference and Application, 9th Edition. Illuminating Engineering Society of North America. New York, NY. 2000.
- (3) National Fire Protection Association. *NFPA 70- National Electric Code*. 2008 Edition. Quincy, Massachusetts: National Fire Protection Association, 2007.

### Software Tools

AGI32  
Adobe Photoshop  
AutoCAD 2010

## Acknowledgements

Thank you to the Penn State Architectural Engineering faculty for their devotion to their senior thesis students, especially my thesis director Professor Robert Holland. A special thanks to my thesis advisors Dr. Kevin Houser and Ted Dannerth for their support throughout the senior thesis process.

Thank you to Shawn Good for your guidance and providing me this building to use for my thesis project.

Lastly, thank you to my family and friends for your unconditional love and encouragement throughout this journey.

## **Appendix A**

Lighting plans are provided in the following order:

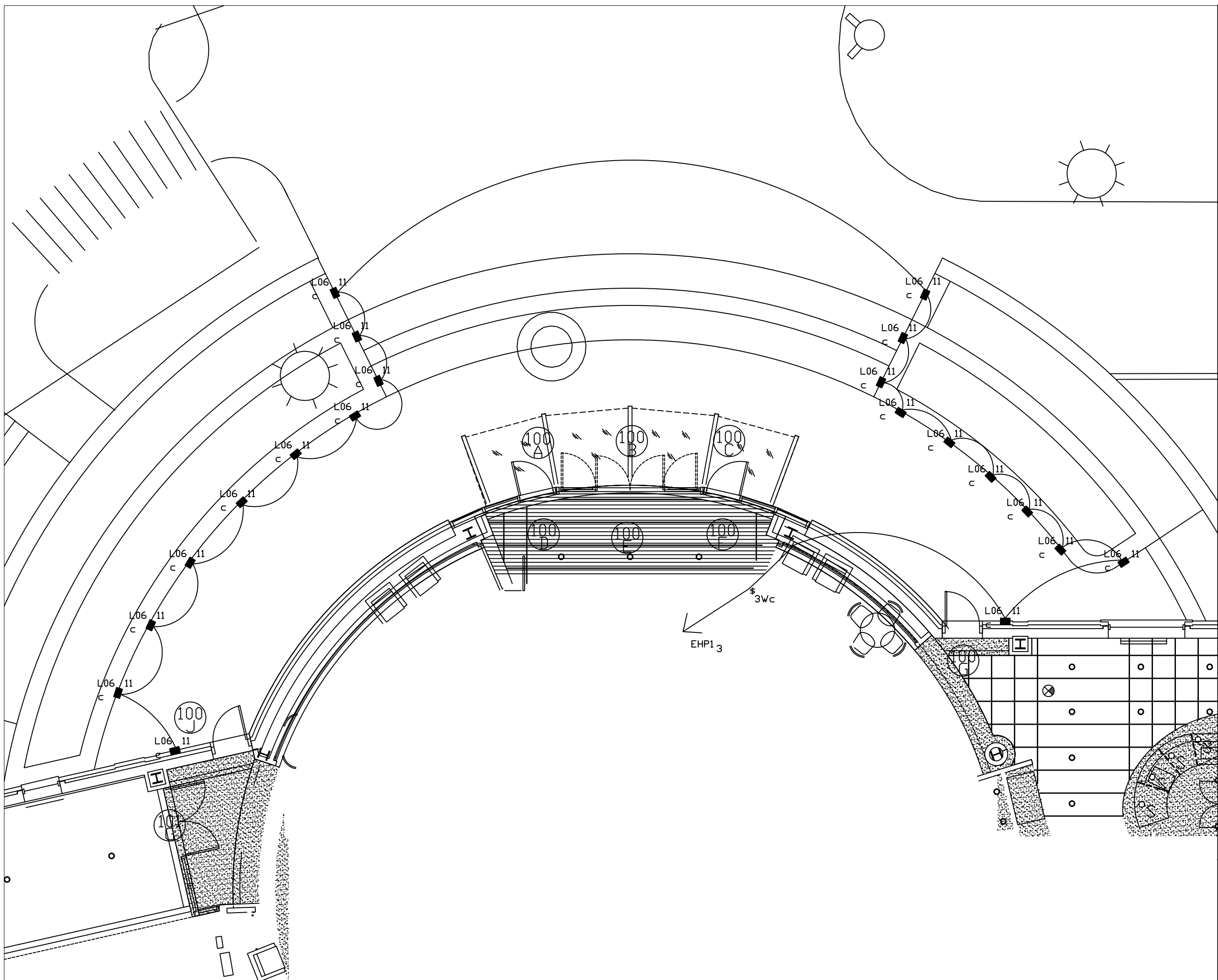
### **E 1.0 Outdoor Entry Lighting Plan**

### **E 1.1 Rotunda First Level Lighting Plan**

### **E 1.2 Rotunda Second Level Lighting Plan**

### **E 1.3 Multi-Purpose Room Lighting Plan**

### **E 1.4 Fitness Room Lighting Plan**



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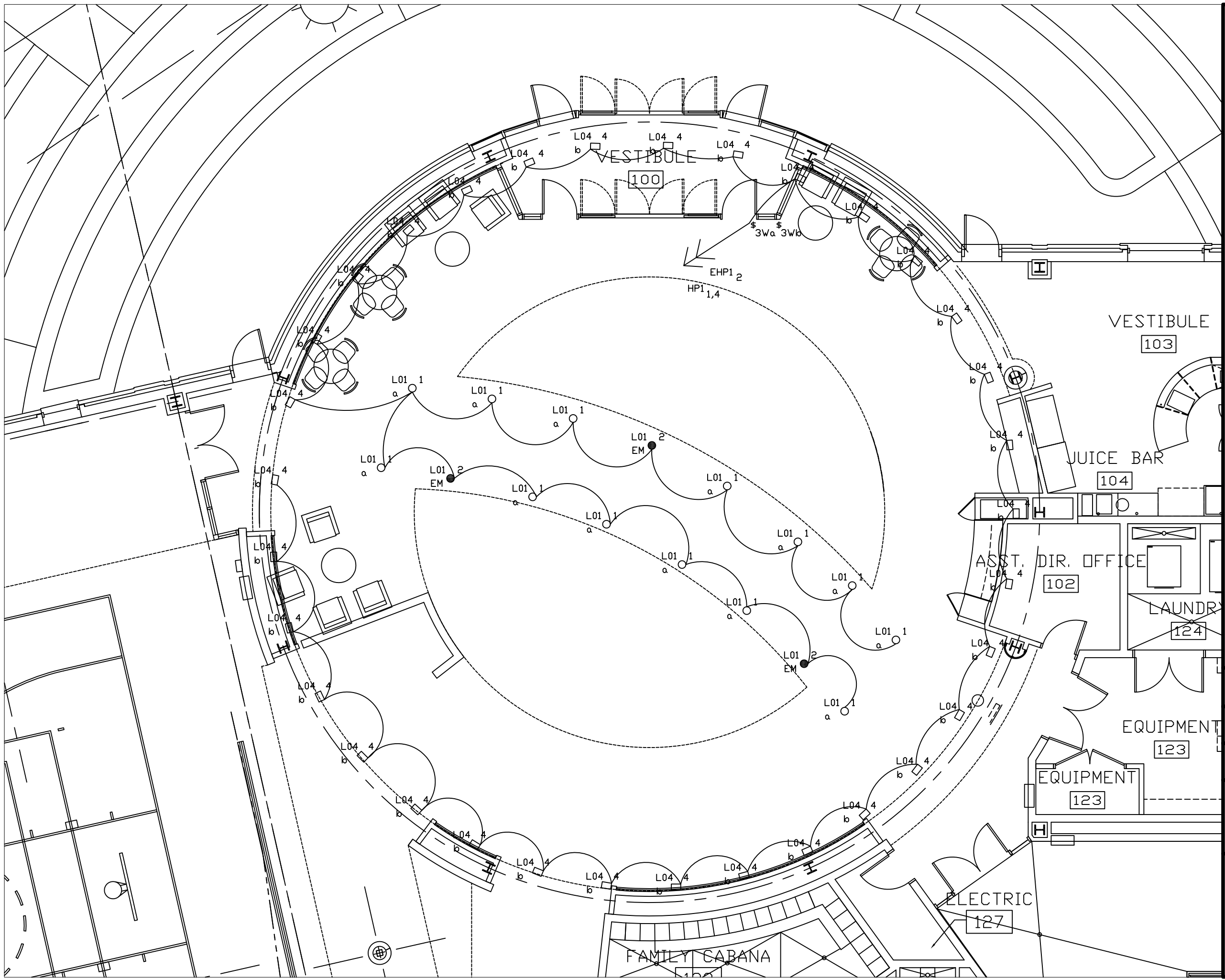
LISHA A BROWN

A E 481: SENIOR THESIS

SCALE: 1/8" = 1'-0"

OUTDOOR ENTRY  
 LIGHTING PLAN

E 1.0



SHEPHERD UNIVERSITY  
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 WEST VIRGINIA

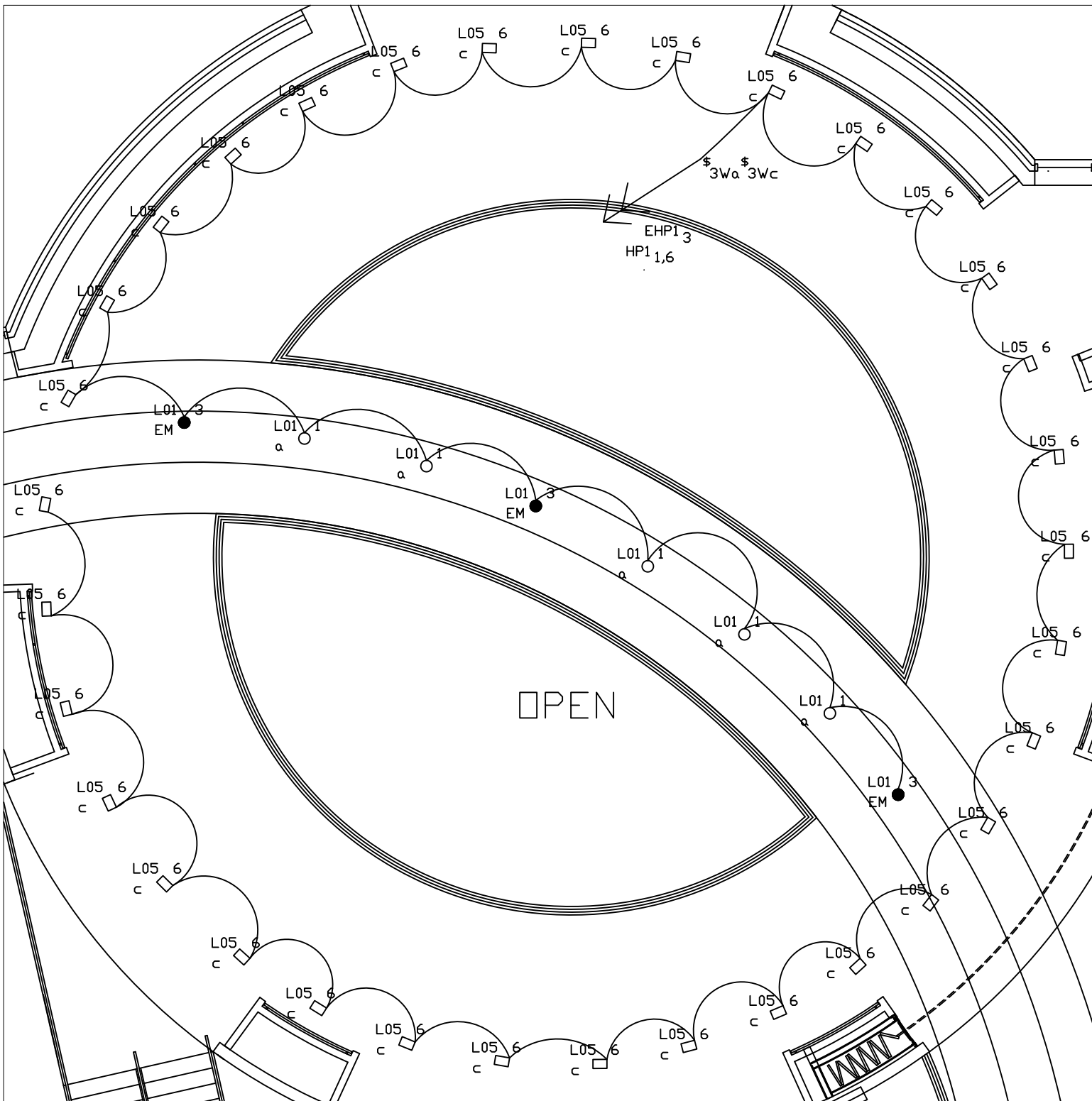
LISHA A BROWN

A E 481: SENIOR THESIS

SCALE: 1/8" = 1'-0"

ROTUNDA FIRST LEVEL  
 LIGHTING PLAN

E 1.1



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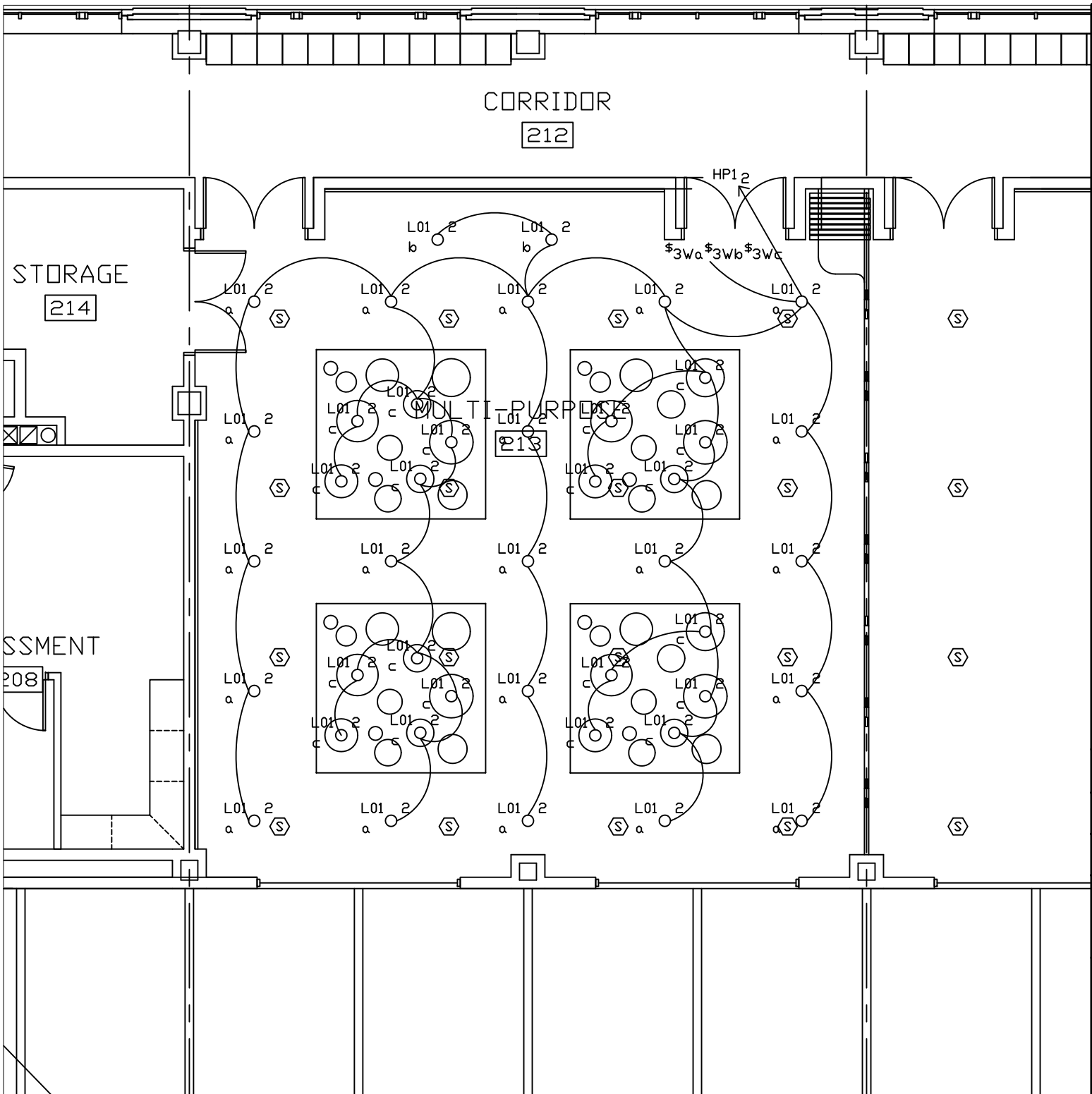
A E 481: SENIOR THESIS

SCALE: 1/8" = 1'-0"

ROTUNDA SECOND LEVEL  
 LIGHTING PLAN

E 1.2





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WEST VIRGINIA

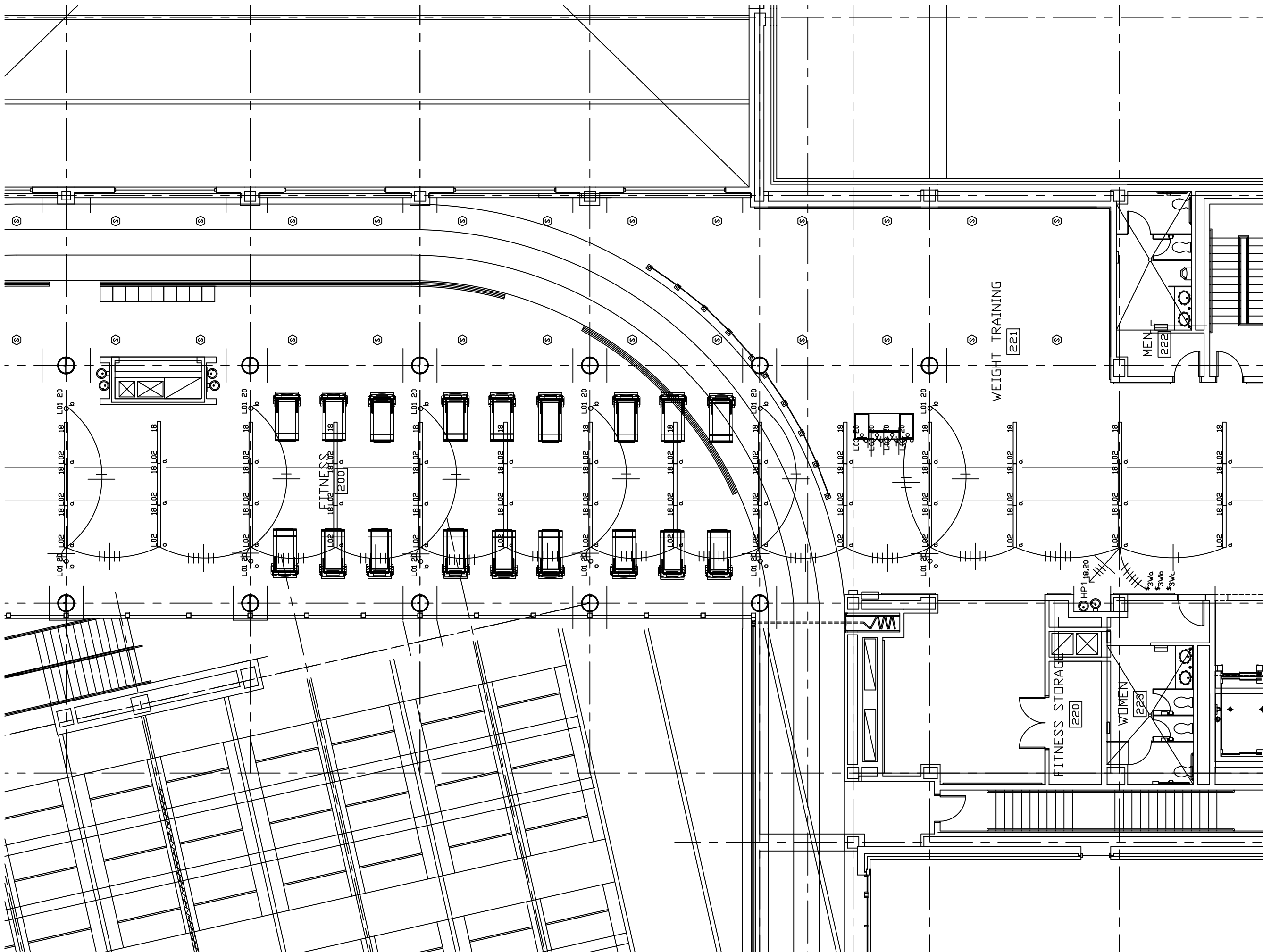
LISHA A BROWN

A E 481: SENIOR THESIS

SCALE: 1/8" = 1'-0"

MULTI-PURPOSE  
LIGHTING PLAN

E 1.3



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WEST VIRGINIA

LISHA A BROWN  
A E 481: SENIOR THESIS  
SCALE: 3/32" = 1'-0"

FITNESS  
LIGHTING PLAN

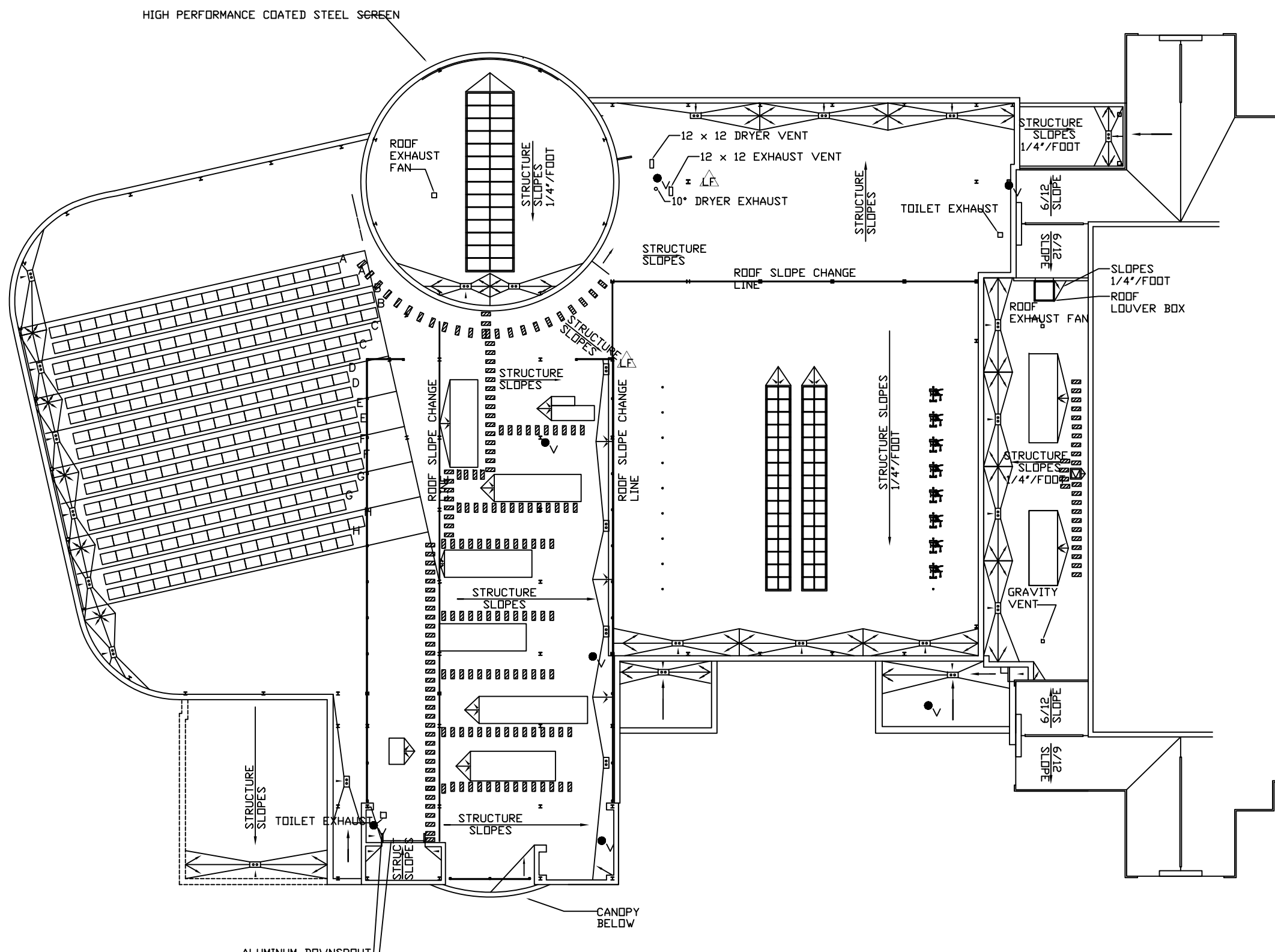
E 1.4

## **Appendix B**

Electrical drawings are provided in the following order:

### **E 2.0 Photovoltaic Array Roof Plan**

### **E 2.1 Photovoltaic Array Wiring Diagram**



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 WEST VIRGINIA

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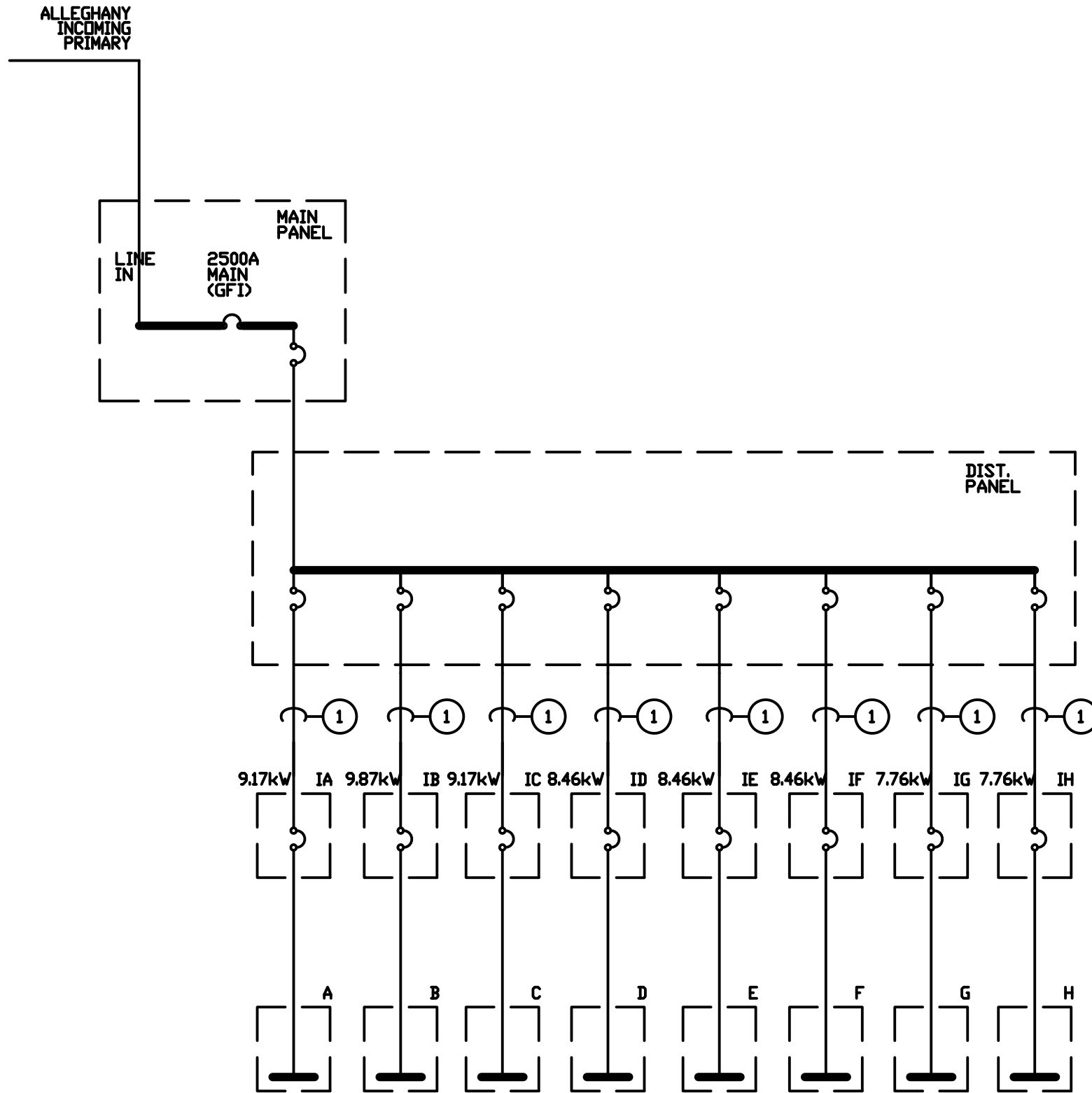
A E 481: SENIOR THESIS

SCALE: 1/32" = 1'-0"

PHOTOVOLTAIC ARRAY  
 ROOF PLAN

E 2.0





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 WEST VIRGINIA

LISHA A BROWN

A E 481: SENIOR THESIS

SCALE: NTS

PHOTOVOLTIC ARRAY  
WIRING DIAGRAM

E 2.1

## **Appendix C**

Lighting equipment manufacturer information is provided in the following order:

**L01- Luminaire**

**L01- Lamp**

**L01- Ballast**

**L02- Luminaire**

**L02- Lamp**

**L02- Ballast**

**L03- Luminaire**

**L04- Luminaire**

**L04- Lamp**

**L05- Luminaire**

**L05- Lamp**

**L06- Luminaire**

**L06- Lamp**

**L06- Ballast**

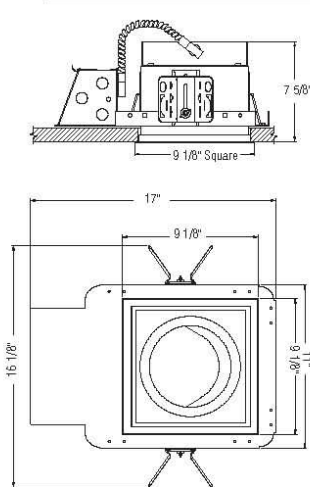
L01- Luminaire



<b>2LIGHT</b>	<b>Recessed</b>	<b>Square</b>	<b>Non-IC</b>	<b>8"</b>
<b>Wallwasher</b>	<b>Horizontal</b>	<b>32W</b>	<b>GX24q-3</b>	
Type: _____				online Find it Fast <b>424</b>
Project: _____				

2LS1W	1H32GX24Q3	FF		
FIXTURE	BALLAST/VOLTAGE	REFLECTOR	FINISH	OPTIONS
<b>2LIGHT Recessed Square 8" Aperture Non-IC Standard Wet Location Wallwasher</b> Horizontal, 32W GX24q-3 Base	<b>U</b> Universal 120V/277V <b>S3</b> Dedicated 347V <b>LH1</b> LUTRON HiLume® (1%) 120V <b>LH2</b> LUTRON HiLume (1%) 277V <b>LC1</b> LUTRON Compact SE™ (5%) 120V <b>LC2</b> LUTRON Compact SE (5%) 277V <b>LT1</b> LUTRON TuWire® (5%) 120V <b>LT2</b> LUTRON TuWire (5%) 277V <b>AM1</b> ADVANCE® MARK VII® (5%) 120V <b>AM2</b> ADVANCE MARK VII (5%) 277V	<b>FF</b> Faceted	<b>SRM</b> Titan Frame <b>WHM</b> White Frame	<b>MDLSBL</b> Mellow Downlight Filter - Blue <b>MDLSYL</b> Mellow Downlight Filter - Yellow <b>MDLSGR</b> Mellow Downlight Filter - Green <b>EM</b> Standby Battery Pack - Standard Lumen <b>EH</b> Standby Battery Pack - High Lumen <b>CP</b> Chicago Plenum <b>F</b> Fusing <b>9930</b> Set of two 27" C-Channel mounting bars. <b>9952</b> Set of two 52" C-Channel mounting bars. <b>9956</b> Set of two 28" 10 ga. one-piece universal mounting bars.

**VIEWS MECHANICAL ELECTRICAL OPTICAL SYSTEM**



**Mounting Frame**  
16-gauge galvanized steel plate suitable for accessible or inaccessible ceiling types. Rigid mounting brackets provide 4" vertical adjustment from side of mounting frame. Brackets accommodate 1 1/2" C-Channel, 3/8" EMT, 3/4" lathing channel, Caddy 517A, B, and C-Channels for flexibility in mounting. (mounting bars ordered as an optional accessory).

**Optical Housing**  
Square steel housing, welded corners, post-painted white powder coat paint is light-tight, completely enclosed, exceeding IP44 requirements. Optical housing is installed from below with swing-out mounting arms for vertical adjustment in ceilings up to 1 3/8" thick.

**Door Frame/Trim**  
Toolless "Push and Release" die-cast aluminum door frame inclusive of lower reflector and diffuser swings down for easy relamping and cleaning. Die-cast aluminum trim provides 5/16" overlap for ceiling opening. Door frame and trim in titan or white color finish.

**Junction Box**  
Integral 16-gauge galvanized steel junction box provided on mounting frame. UL Listed for thru wiring (4 in 4 out at 90° C). Flexible electrical whip with quick connect is provided for field connection to the junction box of the optical assembly. Ground wire is supplied.

**Ballast**  
Electronic 120/277 universal voltage Class P electronic ballast is thermally protected, high power factor, with auto-reset shutdown circuit for one compact fluorescent lamp.

**Socket**  
(1) triple tube compact fluorescent lamp, 4-pin: GX24q-3 (32W). Lamp supplied by others.

**Code Compliance / Listing**  
UL Listed for Wet Location. Covered Ceiling Mount Only. Fixtures with standby battery packs are rated for dry locations only. Approved for thru wiring. Above ceiling access not required.

**Upper Reflector**  
High performance, high reflectance aluminum planar reflector.

**Lower Reflector**  
Round lower reflector is injection-molded of high-grade recyclable polycarbonate with diamond-shaped mirror-like facets in high specular silver, free of iridescence due to a surface of high purity aluminum applied by sputtering, and coated with a transparent hard silicone finish for durability and easy cleaning. An integral kicker reflector with stippled specular finish provides wall wash illumination. Kicker rotates 360° independently from fixture housing. A standard opal lens on outside of reflector provides diffuse lighting.

Optional colored filters can be used in place of opal diffuser for a subtle introduction of color without affecting the quality of light.

**Weight**— 10.0 lbs.

COMPANION DOWNLIGHTS USING SAME SOCKET/VOLTAGE				PHOTOMETRICS			
TYPE	CATALOG NUMBER	FIF #	SPEC SHEET PAGE	FINISH/REFLECTOR	REPORT #	%EFF	NOTES
Downlight	2LS1D1H32GX24Q3	418	2LS-2	Faceted	LTL #12106	35.5%	

**2LIGHT**

**TECHNICAL DATA**



**LUMINAIRE TESTING LABORATORY, INC.**

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IESNA

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LTL NUMBER: 12106

DATE: 10-22-2007

PREPARED FOR: ZUMTOBEL LIGHTING, INC.

CATALOG NUMBER: 2LS1W32GX24Q3UFWSRM

LUMINAIRE: FORMED WHITE ENAMEL STEEL HOUSING, SPECULAR ALUMINUM REFLECTOR ABOVE LAMP, FACETED SPECULAR PLASTIC REFLECTOR WITH PATTERNED WALL WASH SECTION ABOVE CLEAR GLASS ENCLOSURE.

LAMP: ONE HORIZONTAL 32 WATT TRIPLE TUBE COMPACT FLUORESCENT LAMP RATED AT 2400 LUMENS.

LAMP CATALOG NUMBER: SYLVANIA CF32DT/E/IN/835/ECO

BALLAST: ONE UNIVERSAL LIGHTING TECHNOLOGIES C2642UNVSE

MOUNTING: RECESSED

TOTAL INPUT WATTS = 32.8 AT 120.0 VOLTS

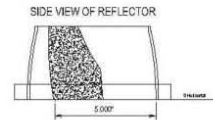
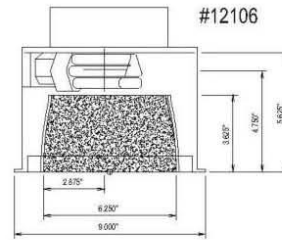
**CANDELA DISTRIBUTION**

	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5
0	289	289	289	289	289	289	289	289
5	295	306	317	325	329	323	334	352
15	368	375	371	366	386	402	396	425
25	365	336	311	315	349	404	384	410
35	312	253	219	229	280	318	374	339
45	259	229	202	191	199	199	174	187
55	225	228	209	145	91	68	66	64
65	149	165	159	81	39	29	25	24
75	60	79	76	29	16	14	15	18
85	6	8	8	3	3	2	3	3
90	0	0	0	0	0	0	0	0

	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0	289	289	289	289	289	289	289	289
5	353	359	358	353	342	323	296	274
15	415	384	373	392	416	373	321	330
25	348	322	315	331	328	323	307	339
35	321	316	304	292	277	257	280	315
45	212	244	265	253	189	153	207	308
55	59	61	61	66	66	83	142	221
65	26	26	24	27	32	49	98	106
75	19	19	15	13	14	20	44	39
85	2	3	2	0	0	2	4	3
90	0	0	0	0	0	0	0	0

**ZONAL LUMEN SUMMARY**

ZONE	LUMENS	%LAMP	%FIXT
0- 30	297	12.4	34.8
0- 40	480	20.0	56.3
0- 60	750	31.3	88.0
0- 90	853	35.5	100.0
90-180	0	0.0	0.0
0-180	853	35.5	100.0



**LUMEN TABULATION**

0- 10	32
10- 20	107
20- 30	158
30- 40	183
40- 50	165
50- 60	105
60- 70	66
70- 80	33

TOTAL LUMINAIRE EFFICIENCY: 35.5%

CIE TYPE: DIRECT  
 PLANE: 0-DEG 90-DEG 180-DEG 270-DEG  
 SPACING CRITERIA: 1.6 1.5 1.6 1.4  
 LUMINOUS DIAMETER: 6.250

Approved By: MG

**THIS REPORT BASED ON LM-41 AND OTHER PERTINENT IESNA PROCEDURES.**



**2LIGHT**

**TECHNICAL DATA**



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LTL NUMBER: 12106

DATE: 10-22-2007

PREPARED FOR: ZUMTOBEL LIGHTING, INC.

CANDELA	DISTRIBUTION								
	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	
0	289	289	289	289	289	289	289	289	289
5	295	306	317	325	329	323	334	352	
10	333	346	351	360	372	372	371	397	
15	368	375	371	366	386	402	396	425	
20	378	376	364	359	381	398	377	420	
25	365	336	311	315	349	404	384	410	
30	338	289	253	266	303	376	409	380	
35	312	253	219	229	280	318	374	339	
40	288	229	197	210	239	277	282	286	
45	259	229	202	191	199	199	174	187	
50	244	236	214	178	142	112	101	103	
55	225	228	209	145	91	68	66	64	
60	190	202	191	111	60	44	39	36	
65	149	165	159	81	39	29	25	24	
70	103	122	118	51	24	22	19	23	
75	60	79	76	29	16	14	15	18	
80	25	37	34	12	7	7	9	13	
85	6	8	8	3	3	2	3	3	
90	0	0	0	0	0	0	0	0	

CANDELA	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
	0	289	289	289	289	289	289	289
5	353	359	358	353	342	323	296	274
10	397	392	389	393	387	357	313	305
15	415	384	373	392	416	373	321	330
20	396	357	346	368	377	354	311	337
25	348	322	315	331	328	323	307	339
30	341	286	271	274	294	303	298	332
35	321	316	304	292	277	257	280	315
40	301	317	315	300	249	219	257	311
45	212	244	265	253	189	153	207	308
50	102	112	123	126	104	99	161	278
55	59	61	61	66	66	83	142	221
60	32	34	37	41	45	66	123	159
65	26	26	24	27	32	49	98	106
70	25	24	22	19	22	34	71	68
75	19	19	15	13	14	20	44	39
80	13	10	9	7	6	9	21	17
85	2	3	2	0	0	2	4	3
90	0	0	0	0	0	0	0	0

**2LIGHT**

**TECHNICAL DATA**



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LTL NUMBER: 12106

DATE: 10-22-2007

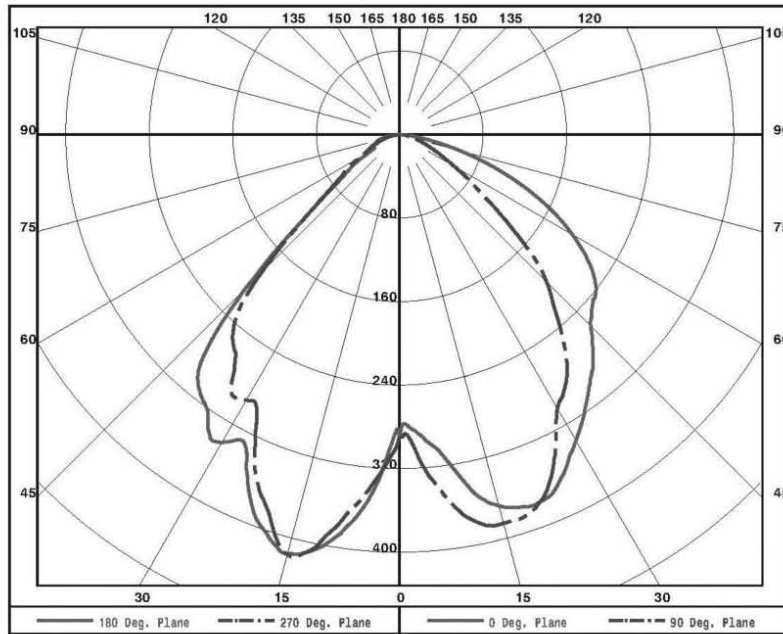
PREPARED FOR: ZUMTOBEL LIGHTING, INC.

ZONAL LUMEN SUMMARY

0- 5	7.
5- 10	25.
10- 15	45.
15- 20	62.
20- 25	75.
25- 30	83.
30- 35	89.
35- 40	94.
40- 45	92.
45- 50	74.
50- 55	57.
55- 60	48.
60- 65	37.
65- 70	29.
70- 75	20.
75- 80	12.
80- 85	4.
85- 90	0.

LUMINANCE IN CANDELA PER SQUARE METER

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
0	14600.	14600.	14600.
45	18504.	14432.	14217.
55	19817.	18408.	8015.
65	17811.	19006.	4662.
75	11711.	14834.	3123.
85	3478.	4637.	1739.



**2LIGHT**

**TECHNICAL DATA**



**LUMINAIRE TESTING LABORATORY, INC.**

SUSTAINING  
MEMBER  
of the  
IESNA

905 Harrison Street · Allentown, PA 18103 · 610-770-1044 · Fax 610-770-8912 · www.LuminaireTesting.com

LTL NUMBER: 12106

DATE: 10-22-2007

PREPARED FOR: ZUMTOBEL LIGHTING, INC.

COEFFICIENTS OF UTILIZATION - ZONAL CAVITY METHOD

EFFECTIVE FLOOR CAVITY REFLECTANCE 0.20

RC	80				70				50			30			10			0	
	RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	42	42	42	42	41	41	41	41	40	40	40	38	38	38	36	36	36	36	36
1	40	38	37	36	39	37	36	35	36	35	34	35	34	33	33	33	32	31	31
2	37	34	32	31	36	34	32	30	32	31	30	31	30	29	30	29	28	28	28
3	34	31	28	26	33	30	28	26	29	27	26	28	27	25	27	26	25	24	24
4	31	28	25	23	31	27	25	23	26	24	23	26	24	22	25	23	22	21	21
5	29	25	22	20	28	25	22	20	24	21	20	23	21	19	23	21	19	19	19
6	27	23	20	18	26	22	20	18	22	19	17	21	19	17	21	19	17	16	16
7	25	20	18	16	24	20	17	15	20	17	15	19	17	15	19	17	15	15	15
8	23	18	16	14	22	18	15	14	18	15	13	17	15	13	17	15	13	13	13
9	21	17	14	12	21	16	14	12	16	13	12	16	13	12	15	13	12	11	11
10	20	15	12	11	19	15	12	10	15	12	10	14	12	10	14	12	10	10	10

NOTE: THE ZONAL CAVITY CALCULATION TECHNIQUE IS ACCURATE WHEN LUMINAIRES WITH SYMMETRIC CANDELA DISTRIBUTIONS ARE EMPLOYED AND WHEN THE LUMINAIRES ARE LOCATED SYMMETRICALLY THROUGHOUT THE ROOM. THIS UNIT HAS SPECIAL CHARACTERISTICS AND THEREFORE THESE COEFFICIENTS SHOULD BE USED WITH CAUTION.

THIS TEST WAS CONDUCTED USING RELATIVE PHOTOMETRY TECHNIQUES ACCORDING TO STANDARD IESNA PROCEDURES. THE USER MUST THEREFORE USE CAUTION IN THE FOLLOWING SITUATIONS: 1) THIS TEST WAS PERFORMED USING A SPECIFIC BALLAST/LAMP COMBINATION. EXTRAPOLATION OF THESE DATA FOR OTHER BALLAST/LAMP COMBINATIONS MAY PRODUCE ERRONEOUS RESULTS. 2) ACCORDING TO IESNA PROCEDURES, THE BALLAST(S) AND LAMP(S) ARE PRESUMED TO PRODUCE 100% OF RATED OUTPUT. AN APPROPRIATE BALLAST FACTOR MUST BE APPLIED TO THE LUMEN OUTPUT RATINGS AND LUMINOUS INTENSITY VALUES GIVEN. 3) THIS TEST WAS CONDUCTED IN A CONTROLLED LABORATORY ENVIRONMENT WHERE THE AMBIENT TEMPERATURE WAS HELD AT 25°C ±1°C. FIELD PERFORMANCE MAY DIFFER PARTICULARLY IN REGARDS TO CHANGE IN LUMINOUS OUTPUT AS A RESULT OF DIFFERENCE IN AMBIENT TEMPERATURE AND METHOD OF MOUNTING THE LUMINAIRE.

10/31/08

2LS-11D



**L01- Lamp**



GE  
Lighting

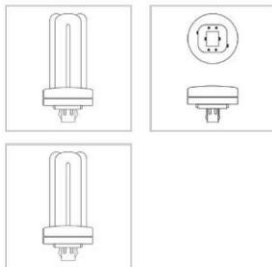
**97632 - F32TBX/841/A/ECO**

GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse



Photo  
Not Available

Savings



Energy

**CAUTIONS & WARNINGS**

**Caution**

- Lamp may shatter and cause injury if broken
- Remove and install by grasping only plastic portion of the lamp.

**NOTES**

- 4-Pin lamp minimum starting temperature is a function of the ballast. Most ballasts are rated with a minimum starting temperature of 50 degrees F (10 C). Ballasts are also available that provide reliable starting to 0 degrees F (-18C) and -20 F (-29C).
- Amalgam product experience stable brightness over a wider temperature range and in various operating positions.
- Based on 60Hz reference circuit.
- Fluorescent lamp lumens decline during life

**GENERAL CHARACTERISTICS**

Lamp Type	Compact Fluorescent - Plug-In
Bulb	T4
Base	GX24q-3
Wattage	32
Voltage	120/100
Rated Life	17000 hrs
Starting Temperature	0 K (32 °F)
Cathode Resistance	2.7 Ohm
LEED-EB MR Credit	87 picograms Hg per mean lumen hour
Rated Life (rapid start) @ Time	17000.0 @ 3.0/20000.0 @ 12.0 h
Additional Info	Dimmable with appropriate dimming ballast./End of Life Protection (EOL)/TCLP compliant
Primary Application	Facilities;Retail Display;Hospitality;Office;Restaurant;W

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	2400
Mean Lumens	2040
Nominal Initial Lumens per Watt	75
Color Temperature	4100 K
Color Rendering Index (CRI)	82

**ELECTRICAL CHARACTERISTICS**

Current (max)	5.25 A
Open Circuit Voltage (after preheating)	265 V
Open Circuit Voltage	515 V
Lamp Current	0.32 A
Preheat Voltage	4.25 V
Current Crest Factor	1.7
Supply Current Frequency	20000 Hz

**DIMENSIONS**

Maximum Overall Length (MOL)	5.5 cm
Nominal Length	5.5 cm
Base Face to Top of Lamp	4.9 cm

**PRODUCT INFORMATION**

Product Code	97632
Description	F32TBX/841/A/ECO
ANSI Code	60901-IEC-7432-2
Standard Package	Case
Standard Package GTIN	10043168976326
Standard Package Quantity	10
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168976329

**L01- Ballast**

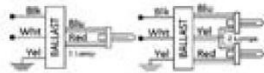
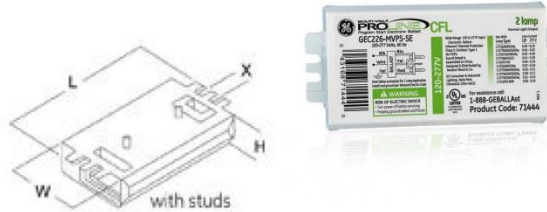


GE  
Lighting

**71443 - GEC226-MVPS-BES**

GE CFL Multi-Volt ProLine™ Electronic Program / Rapid Start Ballast

- Multi-Voltage technology means a single ballast handles voltage from 108V to 305V
- Programmed starting for extended lamp life
- End-of-Lamp-Life Protection
- Color Coded Poke-In Connectors simplifies wiring



**GENERAL CHARACTERISTICS**

Application	2-CFQ26W, FT24 or 1-42W, CFTR32 Bottom Exit w Studs 120-277V Proline PS
Category	Compact Fluorescent
Ballast Type	Electronic - Program / Rapid Start
Starting Method	Programmed start
Lamp Wiring	Series
Line Voltage Regulation (+/-)	10 %
Case Temperature	75 °C(167 °F)
Ballast Factor	Normal
Power Factor Correction	Active
Sound Rating	A (20-24 decibels)
Enclosure Type	Metal
Additional Info	Auto-restart/Thermally protected/Universal voltage

**PRODUCT INFORMATION**

Product Code	71443
Description	GEC226-MVPS-BES
Standard Package	Case
Standard Package GTIN	10043168714430
Standard Package Quantity	10
Sales Unit	Individual Pack
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168714433

**DIMENSIONS**

Case dimensions	
Length (L)	5.0 in(127.00 mm)
Width (W)	2.4 in(60.96 mm)
Height (H)	1.0 in(25.40 mm)
Mounting dimensions	
Mount Length (M)	4.6 in(117.60 mm)
Weight	0.57 lb
Exit Type	Poke-in
Remote Mounting Distance to Lamp	12 ft
Remote Mounting Wire Gauge	18 AWG

**ELECTRICAL CHARACTERISTICS**

Supply Current Frequency	50 Hz/60 Hz
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**SAFETY & PERFORMANCE**

- CSA
- UL Class P
- UL Listed
- UL Type 1 Outdoor
- UL Type CC
- UL Type HL
- FCC Part 18 Class B at 120 volts

**SPECIFICATIONS BY LAMP & WATTAGE**

Lamp	# of Lamps	Line Volts	System Watts	Nom. Line Current	System Ballast Factor	Ballast Efficacy Factor	Power Factor% (>=)(<=)	Crest Factor THD% (<=)	Min. Starting Temp (°F/°C)	
FT24W/2G10	2	120	48	0.41 A	0.93	NaN	99	1 1/2	10	-20.0 / -29
FT24W/2G10	2	277	48	0.18 A	0.93	NaN	99	1 1/2	10	-20.0 / -29
FC16T9/40W	1	120	43	0.16 A	1.00	2.33	97	1 1/2	10	-20.0 / -29
FC16T9/40W	1	277	43	0.16 A	1.00	2.33	97	1 1/2	10	-20.0 / -29
FC16T9	1	120	43	0.16 A	1.00	2.33	97	1 1/2	10	-20.0 / -29
FC16T9	1	277	43	0.16 A	1.00	2.33	97	1 1/2	10	-20.0 / -29
F24T5/HO	2	120	51	0.44 A	1.00	1.96	99	1 1/2	10	-20.0 / -29
F24T5/HO	2	277	51	0.19 A	1.00	1.96	98	1 1/2	10	-20.0 / -29
CFTR42W/4P	1	120	46	0.38 A	0.98	2.13	98	1 1/2	10	-20.0 / -29
CFTR42W/4P	1	277	46	0.17 A	0.98	2.13	98	1 1/2	10	-20.0 / -29
CFTR32W/4P	1	120	36	0.31 A	0.98	2.72	98	1 1/2	10	-20.0 / -29
CFTR32W/4P	1	277	36	0.13 A	0.98	2.72	98	1 1/2	10	-20.0 / -29
CFTR26W/4P	1	120	29	0.24 A	1.10	3.79	98	1 1/2	10	-20.0 / -29
CFTR26W/4P	1	277	29	0.11 A	1.10	3.79	98	1 1/2	10	-20.0 / -29
CFTR26W/4P	2	120	54	0.45 A	1.00	1.85	99	1 1/2	10	-20.0 / -29
CFTR26W/4P	2	277	54	0.2 A	1.00	1.85	99	1 1/2	10	-20.0 / -29
CFS21W/4P	2	120	51	0.42 A	1.12	2.20	99	1 1/2	10	-20.0 / -29
CFS21W/4P	2	277	51	0.18 A	1.12	2.20	99	1 1/2	10	-20.0 / -29
CFQ26W/4P	1	120	27	0.23 A	1.00	3.70	99	1 1/2	10	-20.0 / -29

For additional information, visit [www.gelighting.com](http://www.gelighting.com)

# Shepherd University Wellness Center

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Lisha A Brown

CFQ26W/4P	1	277	27	0.1 A	1.00	3.70	99	1 1/2	10	-20.0 /-29
CFQ26W/4P	2	120	51	0.43 A	1.00	1.96	98	1 1/2	10	-20.0 /-29
CFQ26W/4P	2	277	51	0.19 A	1.00	1.96	98	1 1/2	10	-20.0 /-29

**WARRANTY INFORMATION**

GE Lighting warrants to the purchaser that each ballast will be free from defects in material or workmanship for period as defined in the attached documents from the date of manufacture when properly installed and under normal conditions of use.

L02- Luminaire

# PLATEAU™

Armstrong® TechZone™ compatible  
USG Logix compatible  
Can be modified for Hunter Douglas grids -  
please consult factory.



**Fluorescent**  
**One or Two Lamp 28W/35W T5**  
**One or Two Lamp 54W T5HO**  
**One Lamp 80W T5HO**  
**One or Two Lamp 32W/40W T8**

**Recessed  
Lensed**

**6" x 4'  
6" x 5'**

online Find It Fast **376**

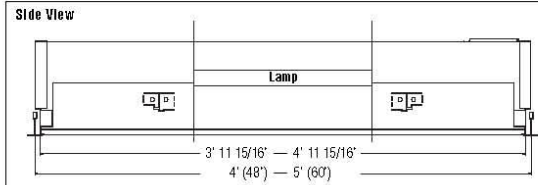
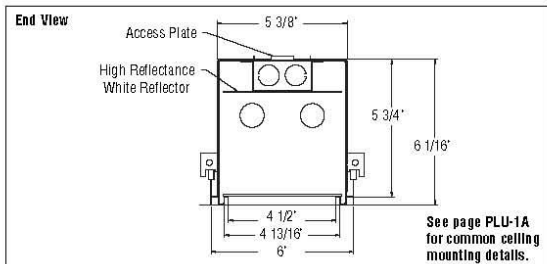
**Applications:** The PL luminaire is a narrow aperture recessed direct lensed luminaire for individual or continuous row mounting.

**Compatible with standard 15/16" Lay-in, Flush, 9/16" Slot Grid, Flush and 9/16" Lay-in, Regular tees placed 6" o.c.**

**Type:** \_\_\_\_\_ **Quantity:** \_\_\_\_\_ **Project:** \_\_\_\_\_

PLU	OLP					
FIXTURE/CEILING TYPE	OPTIC	LENGTH	LAMPING	BALLAST/VOLTAGE	OPTIONS	
PLU PLATEAU, 6" Recessed 15/16" Lay-In, Flush 9/16" Slot-Grid, Flush 9/16" Lay-In, Tegular	OLP Opal Lens	64 6" x 4'	1285 (1) 28W T5 1545 (1) 54W T5 HO 2285 (2) 28W T5 2545 (2) 54W T5 HO	U Universal 120/277V 347V DA_* Dimming, Analog (0-10V) DD_* Dimming, DALI DE_* Dimming, Lutron ECO-10™ DH_* Dimming, Lutron HiLume® DSC_* Dimming, Lutron EcoSystem™, Control Fixture DSN_* Dimming, Lutron EcoSystem™, Non-control Fixture STD*_* Dimming, Step	WF Whip Flex 3/8" x 6' 14/3 AWG WN_* Whip Flex 3/8" x 6' 14/3 AWG (NYC) SS Separate Switching F Fusing EM1_* Standby Battery Pack, 1 lamp	
		65 6" x 5'	1355 (1) 35W T5 1805 (1) 80W T5 HO 2355 (2) 35W T5 1408 (1) 40W T8 2408 (2) 40W T8			

\* Specify "1" for 120V or "2" for 277V. Some lamp types may not be available.  
EHI not available for 80W T5 HO lamp.  
EHI battery pack for 35W T5 lamp only suitable for dry location.  
Analog dimming ballast for 80W T5 HO lamp not available for 120V or 347V.  
DALI Dimming ballast not available for 80W T5 HO lamp.  
Lutron ECO-10 dimming ballast not available for 35W T5, 80W T5 HO or 40W T8 lamps.  
Lutron HiLume dimming ballast not available for 28W T5, 35W T5 or 80W T5 HO lamps.  
Lutron EcoSystem not available for 80W T5 HO or 40W T8 lamps.  
Step Dimming not available for 347V. Also not available for (1) 28W T5, (1) or (2) 54W T5 HO, (1) or (2) 35W T5, (1) 80W T5 HO, (1) or (2) 40W T8 for any voltage.



**UL LISTED**  
Suitable for damp locations  
NYC Approved  
IBEW Union Made  
Lead Time? Double-click on -  
<http://www.zumtobel.us/PDB?lang=EN&g id=12419&iso2=US>  
A = ZOOM! Quick Ship - ships in 2 weeks  
B = ships in 4 weeks C = ships in 8 weeks

- Housing** - 20 gauge cold-rolled steel. Fixtures have white powder coat paint finish. Post painted.
- Sockets** - Bi-pin. Twist lock lamp installation.
- Lamping** - Choices are one or two 28W (4") T5, 35W (5") T5, 54W (4") T5HO, 32W (4") T8, 40W (5") T8 or one 80W (5") T5HO fluorescent lamps. Supplied by others. Access to lamps is from below the fixture after the removal of the lens.
- Reflector** - High-reflectance white finish.
- Optic** - Shift and tilt Opal Acrylic Lens (OLP).
- Ballast** - Universal voltage electronic 120/277V. Ballast is mounted in housing of luminaire. Ballast access from below the fixture.
- Dimming** - In control fixtures with Lutron EcoSystem dimming, control wires are brought to an interface. Consult factory for location of control wire feed. Consult factory for specific dimming requirements other than those listed above.
- Mounting** - Fixtures for mounting in lay-in ceilings. Depth of housing is 6 1/16". Electrical access plate in housing top. Fixtures can be mounted in continuous runs. Standard installation via bend out tabs that rest on ceiling tees alongside fixture.
- Weight** - 20 lbs. (4' fixture); 23 lbs. (5' fixture).

OTHER RECESSED TECHZONE/LOGIX COMPATIBLE LUMINAIRES	FIF #
Recessed Bivergence® (RB)	288
Recessed Lensed (RL)	307
Recessed Louver with Light Chamber (RLLC)	292

ECO-10 and EcoSystem are trademarks of Lutron Electronics Co., Inc. HiLume is a registered trademark of Lutron Electronics Co., Inc.  
Zumtobel Lighting Inc. ©2008 TEL (845) 691-6262 (800) 932-0633 FAX (845) 691-6289  
3300 Route 9W Highland, NY 12528-2630  
In a continuing effort to offer the best product possible we reserve the right to change, without notice, specifications or materials. Technical specification sheets that appear on www.zumtobel.us are the most recent version and supersede all other versions that exist in any other printed or electronic form.



8/21/08 [www.zumtobel.us](http://www.zumtobel.us) PLU-1

L02- Lamp



GE Lighting

**46804 - F80W/T5/841/ECO**

GE Ecolux® Starcoat® T5

- Passes TCLP, which can lower disposal costs.



**CAUTIONS & WARNINGS**

**Caution**

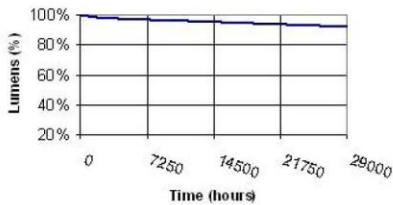
- Lamp may shatter and cause injury if broken
  - Wear safety glasses and gloves when handling lamp.
  - Do not use excessive force when installing lamp.

**Warning**

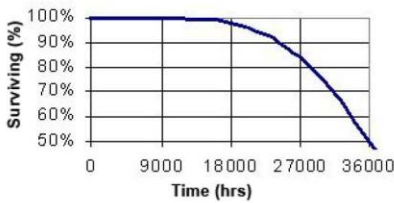
- Risk of Electric Shock
  - Turn power off before inspection, installation or removal.

**GRAPHS & CHARTS**

**Lumen Maintenance**



**Lamp Mortality**



**Spectral Power Distribution**

For additional information, visit [www.geighting.com](http://www.geighting.com)

**GENERAL CHARACTERISTICS**

Lamp Type	Linear Fluorescent - Straight Linear
Bulb	T5
Base	Miniature Bi-Pin (G5)
Wattage	80
Voltage	145
Rated Life	30000 hrs
Rated Life (rapid start) @ Time	30000.0 @ 3.0/36000.0 @ 12.0 h
Bulb Material	Soda lime
Starting Temperature	-20 °C (-4 °F)
LEED-EB MR Credit	13 picograms Hg per mean lumen hour
Additional Info	TCLP compliant

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	7000
Mean Lumens	6440
Nominal Initial Lumens per Watt	87
Color Temperature	4100 K
Color Rendering Index (CRI)	85
S/P Ratio (Scotopic/Photopic Ratio)	1.7

**ELECTRICAL CHARACTERISTICS**

Open Circuit Voltage (rapid start) Min @ Temperature	580 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor	1.7

**DIMENSIONS**

Maximum Overall Length (MOL)	57.6060 in(1463.2 mm)
Nominal Length	57.100 in(1450.3 mm)
Bulb Diameter (DIA)	0.625 in(15.9 mm)
Bulb Diameter (DIA) (MAX)	0.625 in(15.9 mm)
Max Base Face to Base Face (A)	57.050 in(1449.1 mm)
Face to End of Opposing Pin (B) (MIN)	57.230 in(1453.6 mm)
Face to End of Opposing Pin (B) (MAX)	57.330 in(1456.2 mm)

**PRODUCT INFORMATION**

Product Code	46804
Description	F80W/T5/841/ECO
Standard Package	Case
Standard Package GTIN	10043168468043
Standard Package Quantity	40
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	40
UPC	043168468046



L02- Ballast

<10% THD Electronic TT5 Fluorescent Programmed Rapid Start Systems

**QUICKTRONIC® PROStart® DL40**

Professional Series

Normal Light Output

**Lamp/Ballast Guide**

40W T5 - DULUX® L  
 1-lamp QTP1x40TT5 PSN-F  
 2-lamp QTP2x40TT5 PSN-F  
 3-lamp QTP3x40TT5 PSN-B

Primary Lamp Type:  
 FT40DL

**SYLVANIA QUICKTRONIC PROStart DL40** operates DULUX L 40 lamps with maximum efficacy and high lumen output.

PROStart DL40 provides over 20% more lumen output than 34T12 systems. Also, the small lamp diameter and sleek profile provide new design options and improved fixture optics.

SYSTEM DL40 ballasts contain QUICKSENSE ballast technology, a patented circuitry designed to shut down the system reliably and safely when the lamps have reached their end-of-life.

Setting the standard for quality, SYSTEM DL40 is also covered by our QUICK 60+® warranty, the first and most comprehensive system warranty in the industry.



**Key System Features**

- PROStart Programmed Rapid Start Ballast
- 88% Ballast factor
- QUICKSENSE® ballast technology (end-of-lamp-life sensing)
- 0°F Starting
- High luminous efficacy
- Virtually eliminates lamp flicker
- Quiet operation
- High power factor
- Low harmonic distortion
- Lightweight
- Wiretrap connectors – available with or without leads pre-inserted
- UL, CSA, FCC
- Auto Reset

**System Information**

QUICKTRONIC PROStart ballasts provide optimum starting conditions to provide over 50,000 switching cycles for occupancy sensor and building control system applications.

QUICKSENSE ballast technology helps to protect against overheated bases and sockets, as well as cracking of the glass wall, and uses dynamic end-of-lamp-life sensing to avoid false shutdowns caused by some static sensing methods. QUICKSENSE ballast technology will auto reset when the lamps are replaced with new ones.

A complete OSRAM SYLVANIA System Performance Guide showing performance characteristics for all combinations of lamps and ballasts is available upon request.

SYSTEM PROStart DL40 is available in one, two, and three lamp models in 120V and 277V to cover a wide range of applications.

System Type (2 x 2)	Input Wattage	Initial Lumens	System LPW
FB40T12 - Std. Magnetic Ballast	96	5795	60
E.S. Magnetic Ballast	86	5795	67
FB34T12 - E.S. Magnetic Ballast	72	4575	66
FB032T8 - Magnetic	71	5415	76
DL40 - QTP2x40TT5-PSN	76	5545	73
DL40 - QTP3x40TT5-PSN	110	8315	76

**Application Information**

**SYLVANIA QUICKTRONIC PROStart DL40** is ideally suited for:

- Occupancy Sensors
- Building Control Systems
- Any applications where maximum lamp life is required to reduce maintenance costs



<10% THD Electronic TT5 Compact Fluorescent Systems

Item Number	Description	Input Voltage (VAC)	Input Current (AMPS)	Lamp Type	Rated Lumens (lm)	No. of Lamps	Ballast Factor (BF)	System Lumens	Input Wattage (W)	System Efficacy (lm/W)
50320	QTP 1x40TT5/120 PSN-F <i>Formerly: M1-PN-TT5/40-F-120</i>	120	0.32	FT40T5	3150	1	0.88	2770	38	73
50330	QTP 1x40TT5/277 PSN-F <i>Formerly: M1-PN-TT5/40-F-277</i>	277	0.13	FT40T5	3150	1	0.88	2770	37	75
50340	QTP 2x40TT5/120 PSN-F <i>Formerly: M2-PN-TT5/40-F-120</i>	120	0.63	FT40T5	3150	2	0.88	5545	76	73
50350	QTP 2x40TT5/277 PSN-F <i>Formerly: M2-PN-TT5/40-F-277</i>	277	0.27	FT40T5	3150	2	0.88	5545	73	76
50360	QTP 3x40TT5/120 PSN-B <i>Formerly: M3-PN-TT5/40-B-120</i>	120	0.92	FT40T5	3150	3	0.88	8315	110	76
50370	QTP 3x40TT5/277 PSN-B <i>Formerly: M3-PN-TT5/40-B-277</i>	277	0.39	FT40T5	3150	3	0.88	8315	108	77

<sup>1</sup> Also compatible with other manufacturer's equivalent lamp types that meet ANSI standards.  
<sup>2</sup> Rated lamp lumens and performance data based on DULUX® L 40 series lamps.

PROStart® DL40

Normal Ballast Factor

Performance Guide

Specifications<sup>1,2</sup>

System Life / Warranty

Ordering Guide

**Dimensions "B" Enclosure:**  
Overall: 9.5" L x 2.38" W x 1.25" H  
Mounting: 8.91"  
Weight: 1.3 lbs each

**Dimensions "F" Enclosure:**  
Overall: 9.5" L x 1.6" W x 1.0" H  
Mounting: 8.91"  
Weight: 0.75 lbs each

**Wiring/Packaging Configurations:** All PSN-F,B products are available in the following packaging/wiring configurations:

Last Digit of Item Code	Configuration	Description Suffix
0	Dist. Pack, Leads Pre-Inserted	None (no suffix)
1	Dist. Pack, Connectors Only (No Leads)	NL
2	OEM Pack, Leads Pre-Inserted	OEM
3	OEM Pack, Connectors Only (No Leads)	OEM NL

Item Code: 5035(#)  
QUICKTRONIC PROFESSIONAL  
Number of Lamps (1, 2, 3)  
Primary Lamp Type (FT40T5)

QTP 2 x 40TT5 / 277 PSN F (suffix)  
Enclosure Type (F)  
Starting Type/Ballast Factor  
Line Voltage

**Starting Method:** Programmed Rapid Start  
**Ballast Factor:** 0.88  
**Circuit Type:** Series  
**Lamp Frequency:** > 40 KHz  
**Lamp CCF:** Less than 1.5  
**Starting Temp:** 0°F<sup>2</sup>  
**Input Frequency:** 60 Hz  
**Low THD:** < 10%  
**Power Factor:** > 99%  
**Voltage Range:** +/-10% of Rated Input

UL Listed Class P, Type 1 Outdoor  
 CSA Certified  
 70°C Max Case Temperature  
 FCC 47CFR Part 18 Non-Consumer  
 Class A Sound Rating  
 ANSI C62.41 Cat. A Transient Protection  
 Remote Mounting up to 10 feet

<sup>1</sup> Data based on DL40 lamps. See the SYLVANIA QUICKTRONIC Electronic Ballast Technology and Specification Guide (ECS-ELECTRONIC) for other system combinations.  
<sup>2</sup> Operation below 50°F may affect light output or lamp operation – see "Low Temp. Starting" definition.

**System Life / Warranty**

QUICKTRONIC® products are covered by our QUICK 60+® warranty, a comprehensive lamp and ballast system warranty. For additional details, refer to our QUICK 60+ warranty bulletin.

**Ordering Guide**

Specifications subject to change without notice.

L03- Luminaire

P1.374



**DRUM PENDANTS**  
**P208 - TOM-TOM**  
**12V LED**

Project: \_\_\_\_\_

Fixture Type: \_\_\_\_\_

Location: \_\_\_\_\_

Contact/Phone: \_\_\_\_\_

**PRODUCT DESCRIPTION**

Pendant Kit includes: Quick Jack Cord Set - 78" Coaxial Cable  
• Glass Shade • 12V 5W LED light engine with diffusing cover  
• Cordset can be shortened in the field.

Note: The fabric shades should never be submerged in water. A soft brush or brush attachment on a vacuum should be sufficient. If the shade becomes soiled and better cleaning is necessary, we recommend spot cleaning only with a soft rag, Woolite or a similar gentle detergent, and warm water.



**ORDERING INFORMATION**

Model	Mounting Adapter	Lamp	Hardware Finish	Shade Finish	Example
P208	QJ	LA2	STN	F003	P208QJLA2-STN-F003
	QJ Quick Jack Adapter*	LA2 LED - GEN A, 2700K	BRZ Vintage Bronze	F001 Black Linen	
	MP Single Dome MonoPoint	LA3 LED - GEN A, 3000K	STN Satin Nickel	F002 Tan Linen	
	MB3 3X Pendants on Arched Bar			F003 White Linen	
	MP3 3X Pendants on Large Disc				
	MY3 3X Pendants on Triple Side Port Disc				

\*For use on Alfa Quick Jack Systems

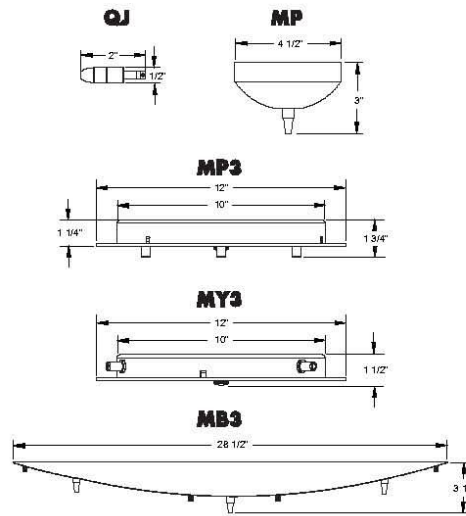
**PRODUCT SPECIFICATIONS**

**Electrical**  
LED: 5W (operating), 2700K or 3000K, >80CRI, 50,000 hour life to 70% of light output

**Agency Approval**  
Labels: ETL Listed to UL 2108 for use in U.S. • ETL Listed to CSA C22.2 No. 250 for use in Canada.

**Mounting Specifications**  
**QJ:** Supplied with Quick Jack Adapter for use on MonoTrack.  
**MP:** Supplied on a Non-Quick Jack (905 type) Slim Line MonoPoint. LED capable Electronic Transformer. Dimmable\*.  
**MB3:** 3X Pendants supplied on a Non-Quick Jack (99003 type) Triple Arched Bar MonoPoint. Internal 60W Electronic Transformer. Dimmable\*.  
**MP3:** 3X Pendants supplied on a Non-Quick Jack (99014 type) Triple Large Disc MonoPoint. Internal 60W Electronic Transformer. Dimmable\*.  
**MY3:** 3X Pendants supplied on a Non-Quick Jack (99015 type) Triple Large Disc Side Port MonoPoint. Internal 60W Electronic Transformer. Includes 3 pendant swags. Dimmable\*.

**ADAPTER DIMENSIONS**

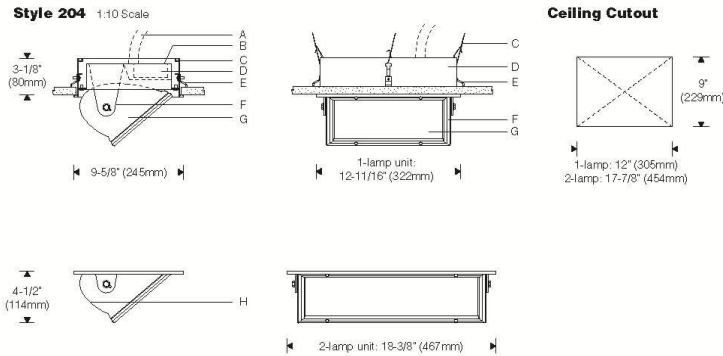


\*Alfa recommends the use of Solid State (Electronic) Dimmers with Alfa products with Electronic Transformers. Magnetic Transformers may be dimmed with a quality Incandescent Dimmer.



L04- Luminaire

**Lighting the Wall** Large semi-recessed adjustable  Hex Tube Compact Fluorescent **Style 204**



**Specifications**

<b>A</b> Conduit (by others)	<b>D</b> Integral electronic ballast with cover	<b>H</b> Specular extruded aluminum reflector	<b>K</b> Micro-prismatic tempered glass lens
<b>B</b> Aluminum back box	<b>E</b> Spring clips (4 provided)	<b>J</b> Mitred extruded aluminum door frame with silicone gasket	<b>L</b> Supplemental support wires (by others)
<b>C</b> Extruded aluminum mounting/trim frame	<b>F</b> Aluminum yoke arms		
	<b>G</b> Die-cast aluminum end plates		

**Finish:**

Semi-gloss white reflector, door frame, end plates, yoke arms and trim frame. Black back box.

Painted surfaces – 6 stage pretreatment and electrostatically applied thermoseal powder coat for stable, long lasting and corrosion resistant finish.

Reflector and internal end plates – extruded high purity aluminum with clear anodized specular finish. All luminaire hardware – stainless steel. All mounting hardware – zinc or cadmium plated.

**Mounting:**

Mounting/trim frame installs from below finished ceiling. Retrofit into existing non-accessible ceilings.

Spring clips provided for rigid ceilings (drywall, plaster) up to 1-3/4" (44mm) thick.

Supplemental support wires, bar hangers, etc. (by others) required for accessible ceilings. Where wire suspension is prohibited, order accessory universal mounting brackets for use with 1/2" EMT, 1-1/2" lathing or C channel (by others).

**Electrical:**

Use 90°C wire for supply connections.

Integral electronic HFF thermally protected class P ballast with end-of-life protection. Ballast compartment includes a 7/8" diameter entry and splice access cover on top of back box. Cover removes from below ceiling for access to splices and ballast. Twist and lock lampholder allows for easy lamp installation and removal.

Optional electronic dimming ballast, compatible dimmer switch required (by others). Consult sales representative for compatibility and specifications.

For complete ballast specifications, see Accessories Section.

**Standard:**

UL listed or CSA certified for damp locations.

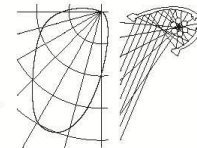
**Features**

- Scaled for 8' to 12' high walls – adjustable reflector
- Door and lens for finished appearance – precured silicone gaskets keep dirt and moisture out; maintain performance
- Extruded aluminum door and trim; die-cast end plates
- Integral electronic ballast – dimming, emergency optional
- Shallow recessed depth – fits under ducts at core walls



**Performance**

Two parabolic reflector sections drive light to the bottom of the wall. An elliptical section shields the lamp from normal viewing angles and redirects its light to a parabola. Glare is minimized and asymmetry of the beam is maximized resulting in high beam efficiency and superior surface uniformity.



For complete photometrics, visit [thelightingquotient.com](http://thelightingquotient.com)

**elliptipar**   
There is no equal™

9/10 **U.S. Patent RE37,310E. Canadian 2,147,106. EPO 0679835, Australia 680116, Mexico 193817, other foreign Patents Pending.**

<b>To Order</b>	<b>Style 204</b>																		
<p><b>To form a Catalog Number</b></p> <p>F   2   0   4   -   H   -   T   -   0   2   -   <input type="text"/>   <input type="text"/>   <input type="text"/>   <input type="text"/></p> <p>1    2    3    4    5    6    7    8</p>																			
<p><b>1 Source</b></p> <p>F = Hex tube compact fluorescent</p>																			
<p><b>2 Style</b></p> <p>204 = Large semi-recessed adjustable, integral ballast</p>																			
<p><b>3 Lamp</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Lamp Code</th> <th>Wattage</th> <th>Lamp Number</th> </tr> </thead> <tbody> <tr> <td colspan="3">Hex Tube Compact Fluorescent </td> </tr> <tr> <td>H132</td> <td>1x32W</td> <td>CFTR32W/GX24q</td> </tr> <tr> <td>H232</td> <td>2x32W</td> <td>(2) CFTR32W/GX24q</td> </tr> <tr> <td>H142</td> <td>1x42W</td> <td>CFTR42W/GX24q</td> </tr> <tr> <td>H242</td> <td>2x42W</td> <td>(2) CFTR42W/GX24q</td> </tr> </tbody> </table> <p><small>For complete lamp and ballast information, see Accessories Section. Standard hex tube lamp color is 3000K/80+ CRI.</small></p>		Lamp Code	Wattage	Lamp Number	Hex Tube Compact Fluorescent			H132	1x32W	CFTR32W/GX24q	H232	2x32W	(2) CFTR32W/GX24q	H142	1x42W	CFTR42W/GX24q	H242	2x42W	(2) CFTR42W/GX24q
Lamp Code	Wattage	Lamp Number																	
Hex Tube Compact Fluorescent																			
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H142	1x42W	CFTR42W/GX24q																	
H242	2x42W	(2) CFTR42W/GX24q																	
<p><b>4 Mounting</b></p> <p>T = Overlapping trim</p>																			
<p><b>5 Finish</b></p> <p>02 = Semi-gloss white</p>																			
<p><b>6 Voltage/Ballast</b></p> <table style="width: 100%;"> <tr> <td><i>Electronic</i></td> <td><i>Dimming*</i></td> </tr> <tr> <td>1 = 120V</td> <td>T = 120V</td> </tr> <tr> <td>2 = 277V</td> <td>V = 277V</td> </tr> <tr> <td>3 = 347V (Canada)</td> <td></td> </tr> </table> <p><small>* Dimming availability for wattages and voltages varies with ballast manufacturer and control type – see <a href="http://theLightingQuotient.com">theLightingQuotient.com</a> for dimming specifications and limitations.</small></p>		<i>Electronic</i>	<i>Dimming*</i>	1 = 120V	T = 120V	2 = 277V	V = 277V	3 = 347V (Canada)											
<i>Electronic</i>	<i>Dimming*</i>																		
1 = 120V	T = 120V																		
2 = 277V	V = 277V																		
3 = 347V (Canada)																			
<p><b>7 Option</b> (see Accessories Section for specifications)</p> <p>00 = No options                  0C = Modified to comply with Chicago plenum code                  0E = Remote emergency battery pack; maximum distance from battery pack to fixture is 5' (1.5m) for 1-lamp and 2' (0.6m) for 2-lamp. For use with non-dimming ballasts only.                  XX = For modification not listed, include detailed description. Consult factory prior to specification.</p>																			
<p><b>8 Destination Requirement</b></p> <p>0 = UL listed or CSA certified for U.S.                  J = UL listed or CSA certified for Canada</p>																			
<p><b>Example</b></p> <p><b>F204 - H142 - T - 02 - T - 000</b></p> <p>Large semi-recessed adjustable model for use with 42W hex tube compact fluorescent lamp. Overlapping trim. Semi-gloss white reflector, door frame, end plates, yoke arms and trim frame, with black back box. Integral 120V electronic dimming ballast. UL listed or CSA certified for U.S.</p>																			
<p><b>Accessories</b></p> <p>Order separately. See Accessories Section for specifications.</p> <p>AE <input type="text"/> V <input type="text"/> 000 = External vertical blade baffle, black                  2 = 25° shielding                  4 = 45°                  C = 1-lamp unit                  D = 2-lamp unit</p> <p>ASRBKT00 = Universal mounting brackets (set of two), accepts 1/2" EMT, 1-1/2" lathing, C channel or bar hangers (by others)</p> <p>AFK000X <input type="text"/> = Ballast fuse kit                  0 = U.S.                  J = Canada</p>																			



elliptipar from The Lighting Quotient  
 114 Boston Post Road, West Haven, Connecticut 06516, USA  
 Voice 203.931.4455 • Fax 203.931.4464 • [theLightingQuotient.com](http://theLightingQuotient.com)

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**L04- Lamp**



GE  
Lighting

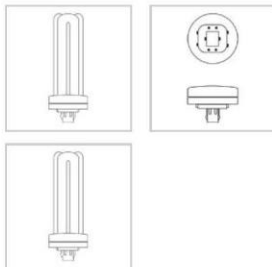
**97634 - F42TBX/830/A/ECO**

GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse



Photo  
Not Available

Savings



Energy

**CAUTIONS & WARNINGS**

Caution

.

**NOTES**

- 4-Pin lamp minimum starting temperature is a function of the ballast. Most ballasts are rated with a minimum starting temperature of 50 degrees F (10 C). Ballasts are also available that provide reliable starting to 0 degrees F (-18C) and -20 F (-29C).
- Amalgam product experience stable brightness over a wider temperature range and in various operating positions.
- Based on 60Hz reference circuit.
- Fluorescent lamp lumens decline during life

**GENERAL CHARACTERISTICS**

Lamp Type	Compact Fluorescent - Plug-In
Bulb	T4
Base	GX24-q4
Rated Life	17000 hrs
Starting Temperature	-18 °C (-0 °F)
Cathode Resistance	2.7 Ohm
LEED-EB MR Credit	66 picograms Hg per mean lumen hour
Rated Life (rapid start) @ Time	17000.0 @ 3.0/20000.0 @ 12.0 h
Additional Info	Dimmable with appropriate dimming ballast./End of Life Protection (EOL)/TCLP compliant
Primary Application	Facilities;Retail Display;Hospitality;Office;Restaurant;W

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	3200
Mean Lumens	2690
Nominal Initial Lumens per Watt	76
Color Temperature	3000 K
Color Rendering Index (CRI)	82

**ELECTRICAL CHARACTERISTICS**

Wattage	42
Voltage	120
Current (max)	5.25 A
Open Circuit Voltage (after preheating)	265 V
Open Circuit Voltage	515 V
Lamp Current	0.32 A
Preheat Voltage	4.25 V
Current Crest Factor	1.7
Supply Current Frequency	20000 Hz



**DIMENSIONS**

Maximum Overall Length (MOL)	6.4000 in(162.6 mm)
Nominal Length	6.400 in(162.6 mm)
Base Face to Top of Lamp	5.770 in(146.6 mm)

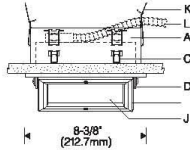
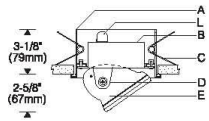
**PRODUCT INFORMATION**

Product Code	97634
Description	F42TBX/830/A/ECO
ANSI Code	60901-IEC-7442-2
Standard Package	Case
Standard Package GTIN	10043168976340
Standard Package Quantity	10
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168976343

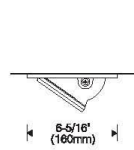
L05- Luminaire

**Lighting the Wall** Small semi-recessed adjustable  Ceramic Metal Halide  Tungsten Halogen **Style 200**

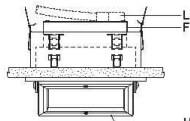
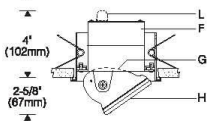
**Style T200** 1/8 Scale (Halogen)



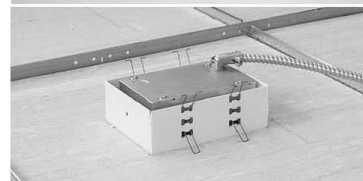
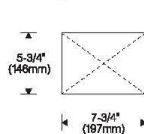
**Profile** (below ceiling)



**Style M200** 1/8 Scale (Integral ceramic metal halide)



**Ceiling Cutout**



**Specifications**

- |  |  |   |   |
|--|--|---|---|
| <b>A</b> Extruded aluminum mounting/trim frame | <b>E</b> Die-cast aluminum end plates                        | <b>H</b> Milled extruded aluminum door frame, silicone gasket | <b>L</b> TH units – provided with 5' leads in flexible metal conduit (remote j-box by others) |
| <b>B</b> Aluminum back box                     | <b>F</b> Integral ballast with splice compartment (CMH only) | <b>J</b> Micro-prismatic tempered glass lens                  | <b>MH</b> units – conduit and connectors by others  |
| <b>C</b> Spring mounting clips (4 included)    | <b>G</b> Specular extruded aluminum reflector                | <b>K</b> Supplemental wire supports (by others)               |   |
| <b>D</b> Aluminum yoke arms                    |  |   |   |

**Finish:**

Semi-gloss white reflector, door, end plates, yoke arms and ceiling trim, with black back box.  
Painted surfaces – 6 stage pretreatment and electrostatically applied thermoset powder coat.  
Reflector – extruded high purity aluminum with clear anodized specular finish. All luminaire hardware – stainless steel.

**Mounting:**

Mounting/trim frame installs from below finished ceiling. Retrofits into existing non-accessible ceilings.  
Spring clips provided for ceilings up to 1-3/4" (44mm) thick. Supplemental support wires, bar hangers, etc. (by others) required for accessible ceilings. Where wire suspension is prohibited, order accessory universal mounting brackets for use with 1/2" EMT, 1-1/2" lathing or C channel (by others).

**Electrical:**

Use 90°C wire for supply connections.  
Tungsten halogen – DC bayonet lampholder in patented clamping supports for maximum heat dissipation. 5' (1.5m) wire leads in flexible conduit (molded) exit back-box for connection to accessible junction box (by others – installation prior to finished ceiling recommended).  
Ceramic metal halide – G12 lampholder for use with single ended lamp. Integral electronic HPF ballast offers improved voltage regulation and color stability. Automatic shutoff feature eliminates end-of-life lamp cycling. Splice compartment with two 7/8" diameter conduit entries – connector(s) and conduit supplied by others.  
For complete ballast specifications, see Accessories Section.

**Standard:**

UL listed or CSA certified for damp locations.

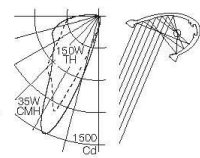
**Features**

- Adjustable aiming – tailor distribution to the wall height and setback distance; scaled for walls 8' – 12' high
- Shallow recessed depth – easily fits in stud construction
- Small yet powerful – up to 150W halogen; 35W CMH
- Ceramic metal halide – warm color, high CRI, long life
- Integral electronic ballast – simplifies installation



**Performance**

Two parabolic reflector sections drive light to the bottom of the wall. An elliptical section shields the lamp from normal viewing angles and redirects its light to a parabola. Glare is minimized and asymmetry of the beam is maximized resulting in high beam efficiency and superior surface uniformity.



For complete photometrics, visit [thelightingquotient.com](http://thelightingquotient.com)

**To Order**

To form a Catalog Number

**1 Source**  
M = Metal halide  
T = Tungsten halogen

**2 Style**  
200 = Small semi-recessed adjustable (integral ballast for ceramic metal halide)

**3 Lamp**

Lamp Code	Wattage	Lamp Number	Voltage(s)	Ballast
Ceramic Metal Halide*				
020G	20	CDM20/T6/830	1, 2	Electronic
035G	35	CDM35/T6/830	1, 2	Electronic
Tungsten Halogen				
0100	100	Q100DC	A	
0150	150	Q150DC	A	

**4 Mounting**  
T = Overlapping trim

**5 Finish**  
02 = Semi-gloss white

Project:

Type:

**6 Voltage/Ballast**

Tungsten Halogen  
A = 120V

Metal Halide Electronic  
1 = 120V  
2 = 277V

**7 Option** (See Accessories Section for specifications)  
00 = No options  
0C = Style T200 modified to comply with Chicago plenum code  
0Y = Style T200 (halogen) modified to comply with New York City code (Style M200 integral complies as is without modification)  
V0 = Cutoff visor (recommended when wall mounted for uplighting)  
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

**Example**  
**M200 - 035G - T - 02 - 1 - 000**  
Small semi-recessed adjustable unit for use with 35W ceramic metal halide lamp. Overlapping ceiling trim. Semi-gloss white. Integral 120V electronic ballast. UL listed or CSA certified for U.S.

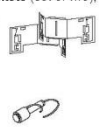
**Style 200**

**Accessories**

Order separately. See Accessories Section for specifications.

ASRBKT00 = Universal mounting brackets (set of two), accepts 1/2" EMT, 1-1/2" lathing, C channel or bar hangers (by others)

AFK000X  = Ballast fuse kit  
0 = U.S.  
J = Canada





For complete lamp and ballast information, see Accessories Section.  
\* Metal halide lamps using ceramic arc tubes yield higher light output than lamps with quartz arc tubes. They offer improved lamp-to-lamp color consistency and a more stable color temperature over their life (±200K). Standard lamp color is 3000K/80+ CRI.



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Voice 203.931.4455 • Fax 203.931.4464 • [thelightingquotient.com](http://thelightingquotient.com)

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L05- Lamp

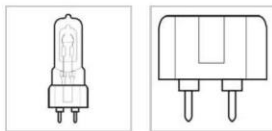


GE  
Lighting

**20016 - CMH70TU/830/G12**

GE ConstantColor® PulseArc® CMH® Ceramic Metal Halide T6

Photo  
Not Available



**CAUTIONS & WARNINGS**

R- WARNING: This lamp can cause serious skin burn and eye inflammation from shortwave ultraviolet radiation if outer envelope of the lamp is broken or punctured, and the arc tube continues to operate. Do not use where people will remain for more than a few minutes unless adequate shielding or other safety precautions are used. Certain types of lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. Visit the FDA website for more information: <http://www.fda.gov/cdrh/radhealth/products/urburns.html> minutes unless adequate shielding or other safety precautions are used. Certain types of lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. Visit the FDA website for more information: <http://www.fda.gov/cdrh/radhealth/products/urburns.html>

**Caution**

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**Warning**

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**GENERAL CHARACTERISTICS**

Lamp Type	High Intensity Discharge - Ceramic Metal Halide
Bulb	T6
Base	Bi-Pin (G12)
Rated Life	15000 hrs
Bulb Material	Quartz
Lamp Enclosure Type (LET)	Enclosed fixtures only
LEED-EB MR Credit	65 picograms Hg per mean lumen hour
Additional Info	UV control

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	6200
Mean Lumens	4700
Nominal Initial Lumens per Watt	88
Color Temperature	3000 K
Color Rendering Index (CRI)	83

**ELECTRICAL CHARACTERISTICS**

Wattage	70
Burn Position	Universal burning position
Warm Up Time to 90% (MAX)	2 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

**DIMENSIONS**

Maximum Overall Length (MOL)	3.5600 in(90.4 mm)
Light Center Length (LCL)	2.180 in(55.4 mm)

**PRODUCT INFORMATION**

Product Code	20016
Description	CMH70TU/830/G12
ANSI Code	C139/M139
Standard Package	Case
Standard Package GTIN	10043168200162
Standard Package Quantity	12
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	12
UPC	043168200165

**L06- Luminaire**

Recessed wall luminaires · unshielded for wall and steps

**Housing:** Constructed of die-cast and extruded aluminum with integral wiring compartment. Mounting tabs provided.

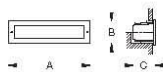
**Enclosure:** One piece die-cast aluminum faceplate, 1/8" thick, clear tempered glass with translucent white ceramic coating. Faceplate is secured by two (2) socket head, stainless steel, captive screws threaded into stainless steel inserts in the housing casting. Continuous high temperature O-ring gasket for weather tight operation.

**Electrical:** (Fluorescent) Lampholder, type G23 (9W), rated 75W, 250V. Ballasts are magnetic, available 120V or 277V - specify. Through Wiring: All units are suitable for a maximum of four (4) No. 12 AWG conductors (plus ground) suitable for 75°C. Provided with two 1/2" NPT threaded conduit entries.

**Finish:** Available in four standard BEGA colors: Black (BLK); White (WHT); Bronze (BRZ); Silver (SLV). To specify, add appropriate suffix to catalog number. Custom colors supplied on special order.

**UL** listed, suitable for wet locations and for installation within 3 feet of ground. Suitable for all types of construction including poured concrete. Protection class: IP64.

Type:  
 BEGA Product:  
 Project:  
 Voltage:  
 Color:  
 Options:  
 Modified:



Recessed luminaires · unshielded						
			Lumen	A	B	C
2289P	1	9W CF twin-2p	800	9 1/2	2 5/8	4 1/4



**BEGA-US** 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 FAX (805) 566-9474 www.bega-us.com  
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**L06- Lamp**



GE  
Lighting

**97558 - F9BX/827/ECO**

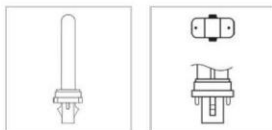
GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse



Photo  
Not Available

Savings

Energy



**GENERAL CHARACTERISTICS**

Lamp Type	Compact Fluorescent - Plug-In
Bulb	T4
Base	G23
Equivalent Wattage	10000 W
Rated Life	10000 hrs
Starting Temperature	-18 °C (-0 °F)
Cathode Resistance	11.1 Ohm
LEED-EB MR Credit	800 picograms Hg per mean lumen hour
Additional Info	TCLP compliant
Primary Application	Facilities;Retail Display;Hospitality;Office;Restaurant;W

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	66 66667 /600 /600
Mean Lumens	500
Nominal Initial Lumens per Watt	66
Color Temperature	2700 K
Color Rendering Index (CRI)	82

**ELECTRICAL CHARACTERISTICS**

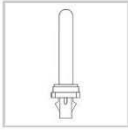
Amps	60 A
Wattage	9
Voltage	120
Open Circuit Voltage Across Starter	198 V
Lamp Current	0.18 A
Current Crest Factor	1.7
Supply Current Frequency	60 Hz

**DIMENSIONS**

Maximum Overall Length (MOL)	6.5900 in(167.4 mm)
Nominal Length	6.600 in(167.6 mm)
Base Face to Top of Lamp	5.670 in(144.0 mm)

**PRODUCT INFORMATION**

Product Code	97558
Description	F9BX/827/ECO
ANSI Code	60901-IEC-0009-1
Standard Package	BUNDLE
Standard Package GTIN	
Standard Package Quantity	100
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	100
UPC	043168975582



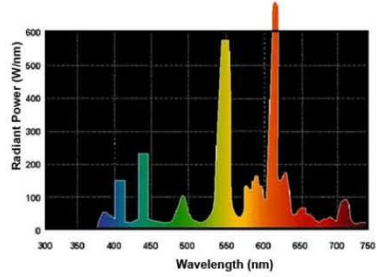
**CAUTIONS & WARNINGS**

**Caution**

.

**GRAPHS & CHARTS**

**Spectral Power Distribution**



**NOTES**

- Based on 60Hz reference circuit.
- Fluorescent lamp lumens decline during life

## **Appendix D**

Electrical equipment manufacturer information is provided in the following order:

**Panelboard- Pow-R-Line**

**Photovoltaic Mounting System- Unirac SolarMount-I**

**Photovoltaic Solar Module- Sharp NU-U235P1**

**Photovoltaic Inverter- IGPlus**

**Photovoltaic Inverter- SBUS**

**Photovoltaic Inverter- PSDL**

**Photovoltaic Inverter- PS3000**

**Photovoltaic Inverter- ELM2 LED**

Panelboard- Pow-R-Line

Pow-R-Line Fusible panelboards PRL1aF  
PRL2aF

# Pow-R-Line 1aF and Pow-R-Line 2aF fusible panelboards

Eaton's Cutler-Hammer® Pow-R-Line 1aF (PRL1aF) and Pow-R-Line 2aF (PRL2aF) lighting panelboards are designed principally for selectively coordinated system applications where high fault current levels are present.



Easy Access to CC Fuse from Deadfront



**Pow-R-Line 1aF and 2aF**

Selective coordination is mandated by the National Electrical Code® (NEC®) in Articles 700.27 (Emergency Systems), 701.18 (Legally Required Standby Systems) and 708.54 (Critical Operations Power Systems).

Coordination is defined by the NEC as the localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the choice of overcurrent protective devices and their ratings or settings.

In order to achieve high fault current ratings, the PRL1aF and PRL2aF panelboards incorporate "Class CC" fuses for branch circuit protection. When applied with the appropriate upstream fuses, selective coordination ratings may be achieved for available fault currents at the panel of up to 200,000 AIC.

The fuses are coupled with breakers on the line side of the fuse. The fuse is enclosed in a fuse holder that is factory connected from the line-side breaker. Both the fuse holder and the breaker disconnect handle are accessible from the panelboard deadfront, as on any typical lighting panel.

**Standard features**

- Neutral bar
- Complete assembly (box, trim and chassis are shipped together)
- All circuits include factory-installed breaker and fuse holder
- 28"-wide enclosures
- Neon fuse status indicator

**Optional features**

- Copper bus
- Copper neutral
- Copper ground bar
- Branch "Class CC" fuses factory installed (factory-selected fuse manufacturer only)

**Specifications**

Listing:	UL® 67 chassis, UL 50 enclosure
Voltages:	120/240 Vac, single-phase, three-wire
	208Y/120 Vac, three-phase, four-wire
	480Y/277 Vac, three-phase, four-wire
Circuits:	12-, 18-, 24-, 30- and 42-circuit chassis
	Bus ratings: 100A, 225A and 400A
Bus material:	Aluminum (standard) Copper (optional)
Branch circuit amperages:	0.2A–30A with the appropriate Class CC fuse
	Short circuit current ratings: Up to 200 kAIC

**Selection recommendations**

Proper selection of upstream main and feeder overcurrent devices is critical. Systems requiring selective coordination should be carefully designed. Overcurrent devices should be selected by professionals based on the characteristics of each overcurrent device at the appropriate fault current at the panel and by location.

For proper selection of the branch fuse, consult the specific fuse manufacturer's information with respect to selective coordination. Selection of the correct combination of overcurrent devices is essential for selective coordination. Fuses throughout the distribution system must be from the same manufacturer for both the initial installation and all replacement fuses in the future, as fuse characteristics vary from manufacturer to manufacturer.

These choices should be confirmed by a licensed professional engineer to ensure compliance with selective coordination mandates.

Both the Pow-R-Line 1aF and Pow-R-Line 2aF are enclosed in 28"-wide enclosures. The oversized boxes allow ample wiring room for field electricians to connect branch load conductors.

**Other considerations**

There are other factors, such as elevator distribution systems, that should also be addressed. Regardless of whether the electrical distribution system or part of the electrical distribution system requires selective coordination, any elevator within a facility is required to be selectively coordinated. Several different codes, including NFPA 70 (National Electrical Code), NFPA 72 (National Fire Alarm Code), ANSI/ASME A17.1 (Safety Code for Elevators and Escalators) and NFPA 13 (Installation of Sprinkler Systems), determine electrical system requirements for elevators. A combination of all four codes typically applies for every installation.

Eaton provides two different offerings to achieve compliance with these codes. The elevator control switch is offered for individual elevator feeds. The elevator control panelboard is offered for elevator banks where several elevators are fed from a central location. For more information on these products, please consult our Web site at [www.eaton.com](http://www.eaton.com).

The PRL1aF and PRL2aF may also be used for other critical power loads. These include loads such as UPS and inverter applications.

**Beyond selective coordination**

In applications where there is a need for circuit limitation below 15A (the minimum overcurrent device allowed by UL® 67), the PRL1aF and PRL2aF are an ideal solution. This is accomplished with the upstream Cutler-Hammer breaker immediately ahead of the fuse, conforming to the UL standard. The fuse on the load side of the breaker can be selected with lower ratings than the upstream breaker disconnect for that circuit.

These applications include test facilities and other applications where customers require overcurrent devices below 15A. Typically, for these applications, the fuse device is placed in another enclosure. Class CC fuse offerings provide amperage ratings down to 0.2A.

**Tell me more**

The Pow-R-Line 1aF and Pow-R-Line 2aF are available exclusively from Eaton's Satellite operations. Call or visit your local Satellite plant or see us on the Web at [www.eaton.com](http://www.eaton.com).



28"-Wide Boxes Ensure Ample Wiring Space



**Eaton Corporation**  
Electrical Group  
1000 Cherrington Parkway  
Moon Township, PA 15108  
United States  
877-ETN-CARE (877-386-2273)  
[Eaton.com](http://Eaton.com)

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May 2009



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Photovoltaic Mounting System- Unirac SolarMount-I

SolarMount-I™ Technical Datasheets



SolarMount-I™ Roof Mount Technical Datasheet

Pub 101109-1td V1.1 November 2010

SolarMount-I Module Connection Hardware

- Slider and Mid Clamp..... 1
- Slider and End Clamp..... 2
- SolarMount-I Series Accessory Mount..... 2

SolarMount-I Beam Connection Hardware

- 1- Flange Foot..... 3
- 2- Flange Foot..... 3
- Beam Splice..... 4

SolarMount-I Beam

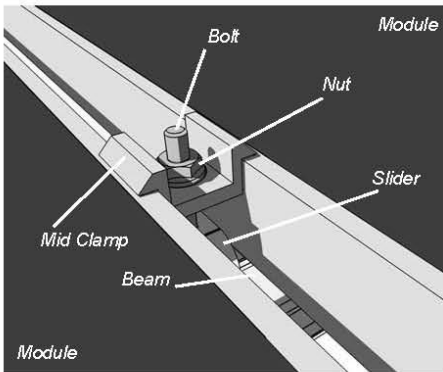
- SolarMount-I Beams..... 5

SolarMount-I Engineering Reports

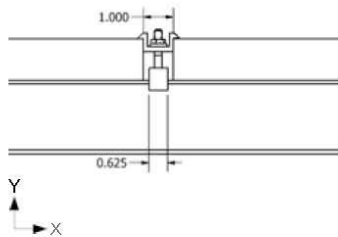
- SolarMount-I 1.0 Beams..... 6
- SolarMount-I 2.5 Beams..... 8

SolarMount-I Module Connection Hardware

SolarMount-I Series Slider with Mid Clamp  
Part No. 02027C, 02028C, 02029C, 02030C



- **Slider and Mid Clamp Material:** One of the following mill finished extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6  
**Ultimate Tensile:** 38ksi, **Yield:** 35 ksi
- **Slider Weight:** 0.026 lbs (12g), **Mid Clamp Weight:** 0.050 lbs (23g)
- Allowable and design loads are valid when components are assembled with SolarMount-I Beams according to authorized UNIRAC documents
- Sliders are compatible with SolarMount-I Beams
- Assemble with one ¼-20 ASTM F593 bolt and one ¼-20 ASTM F594 serrated flange nut
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual



Dimensions specified in inches unless noted

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, $\phi$
Sliding, X±	1194 (5311)	490 (2180)	2.44	741 (3296)	0.620
Tension, Y+	1503 (6686)	677 (3011)	2.22	1024 (4555)	0.682
Transverse, Z±	2080 (9252)	915 (4070)	2.27	1383 (6152)	0.665

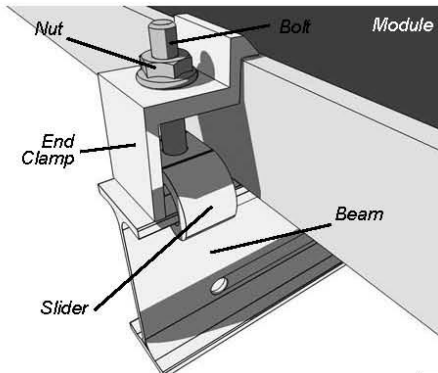


SolarMount-I™ Technical Datasheets

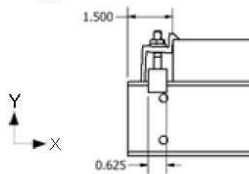


SolarMount-I Module Connection Hardware

SolarMount-I Slider with End Clamp  
Part No. 02001C through 02006C, 02009C, 02010C



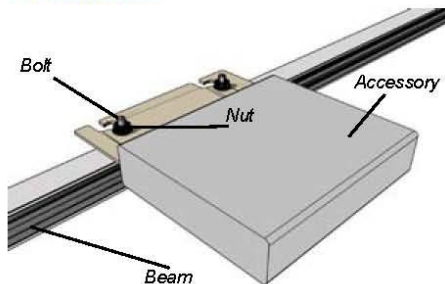
- **Slider and End Clamp Material:** One of the following mill finished extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6  
**Ultimate Tensile:** 38 ksi, Yield: 35 ksi
- **Slider Weight:** 0.026 lbs (12g), end clamp weight varies based on height: ~0.058 lbs (26g)
- Allowable and design loads are valid when components are assembled with SolarMount-I 1.0 or 2.5 Beams according to authorized UNIRAC documents
- Sliders are compatible with SolarMount-I Beams
- Assemble with one ¼-20 ASTM F593 bolt and one ¼-20 ASTM F594 serrated flange nut
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual
- Modules must be installed at least 1.5" from either end of a beam



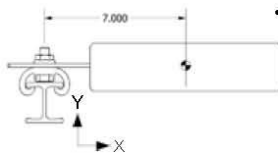
Dimensions specified in inches unless noted

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Loads lbs (N)	Resistance Factor, ϕ
Sliding, X±	283 (1259)	104 (463)	2.72	157 (698)	0.555
Tension, Y+	332 (1477)	88 (391)	3.77	133 (592)	0.401
Transverse, Z±	1367 (6081)	533 (2371)	2.56	806 (3585)	0.590

SolarMount-I Accessory Mount  
Part No. 08010M



- **Slider Material:** One of the following mill finished extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6  
**Ultimate Tensile:** 38 ksi, Yield: 35 ksi
- **Slider Weight:** 0.026 lbs (12g)
- Allowable and design loads are valid when components are assembled with SolarMount-I 1.0 or 2.5 Beams according to authorized UNIRAC documents
- SolarMount-I Series Accessory Mounts are compatible with SolarMount-I Beams
- Use two Accessory Mounts per accessory
- **Assemble each pair of clamps with the following stainless steel hardware:** two ¼-20 set screws, two ¼-20 heavy hex jam nuts, and two ¼-20 F594 serrated flange nuts
- Use anti-seize and tighten to 5-10 ft-lbs of torque
- Resistance factors and safety factors are determined according to calculations and UNIRAC testing



Dimensions specified in inches unless noted

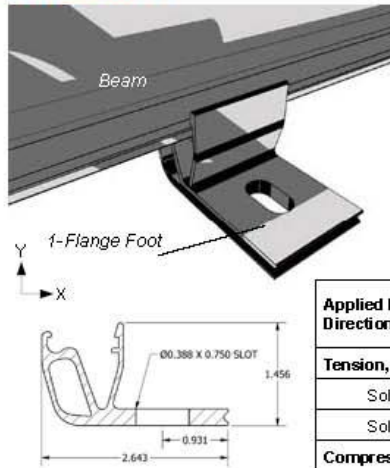
Maximum distance of accessory center of gravity from beam center in (mm)	Maximum weight of accessory lbs (kg)
7 (178)	32 (14.5)

**SolarMount-I™ Technical Datasheets**



**SolarMount-I Beam Connection Hardware**

**SolarMount-I 1 - Flange Foot**  
Part No. 04011M

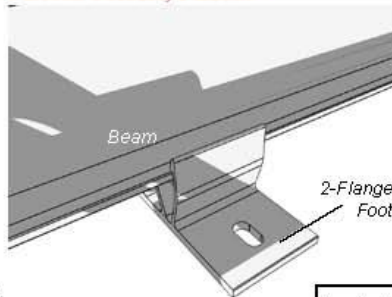


Dimensions specified in inches unless noted

- **1-Flange Foot Material:** One of the following mill finished extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6  
**Ultimate Tensile:** 38 ksi, Yield: 35 ksi
- **1-Flange Foot Weight:** 0.101 lbs (46 g)
- Allowable and design loads are valid when components are assembled with SolarMount-I 1.0 or 2.5 Beams according to authorized UNIRAC documents
- 1-Flange feet are compatible with SolarMount-I Beams
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual
- Design and allowable loads are for the beam to foot connection
- **Be sure to check load limits for roof attachments and standoffs**

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
<b>Tension, Y+</b>					
SolarMount-I 1.0 Beam	1388 (5952)	591 (2629)	2.26	894 (3977)	0.668
SolarMount-I 2.5 Beam	1514 (6735)	648 (2882)	2.34	980 (4359)	0.647
<b>Compression, Y-</b>					
SolarMount-I 1.0 Beam	2931 (13038)	1288 (5729)	2.28	1948 (8665)	0.664
SolarMount-I 2.5 Beam	2750 (12233)	1223 (5440)	2.25	1849 (8225)	0.672
<b>Transverse, X-, downhill</b>					
Transverse, X+, uphill	635 (2825)	313 (1392)	2.03	473 (2104)	0.745
Sliding, Z±	(see Beam Splice)				

**SolarMount-I 2 - Flange Foot**  
Part No. 04002M, 04003M



Dimensions specified in inches unless noted

- **2-Flange Foot Material:** One of the following mill finished extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6  
**Ultimate Tensile:** 38 ksi, Yield: 35 ksi
- **2-Flange Foot Weight:** 0.103 lbs (47 g)
- Allowable and design loads are valid when components are assembled with SolarMount-I 1.0 or 2.5 Beams according to authorized UNIRAC documents
- 2-Flange Feet are compatible with SolarMount-I Beams
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual
- Design and allowable loads are for the beam to foot connection
- **Be sure to check load limits for roof attachments and standoffs**

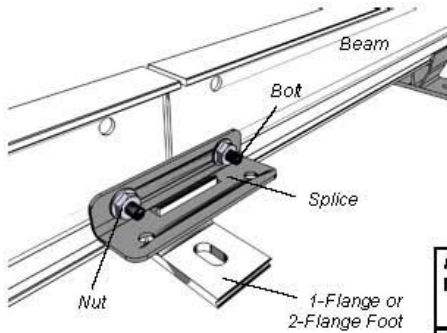
Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
<b>Tension, Y+</b>					
SolarMount-I 1.0 Beam	1931 (8950)	864 (3843)	2.23	1307 (5814)	0.667
SolarMount-I 2.5 Beam	2478 (11023)	1111 (4942)	2.23	1681 (7477)	0.678
<b>Compression, Y-</b>					
SolarMount-I 1.0 Beam	3788 (16850)	1706 (7589)	2.22	2581 (11481)	0.681
SolarMount-I 2.5 Beam	3694 (16432)	1562 (6948)	2.36	2363 (10511)	0.640
<b>Transverse, X-, downhill</b>					
Transverse, X+, uphill	635 (2825)	313 (1392)	2.03	473 (2104)	0.745
Sliding, Z±	(see Beam Splice)				

**SolarMount-I™ Technical Datasheets**



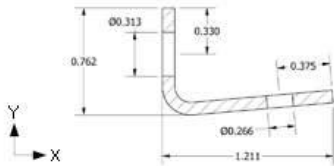
**SolarMount-I Beam Connection Hardware**

**SolarMount-I Beam Splice**  
Part No. 03020M, 03021M



- **Beam Splice Material:** Aluminum 5052-H32  
**Ultimate Tensile:** 31 ksi, Yield: 23 ksi
- **Beam Splice Weight:** 0.053 lbs (24 g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
- Beam Splices are compatible with SolarMount-I Beams when used with 1-Flange or 2-Flange feet
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, $\Phi$
Sliding, $\pm$	1428 (6352)	620 (2758)	2.30	938 (4172)	0.657



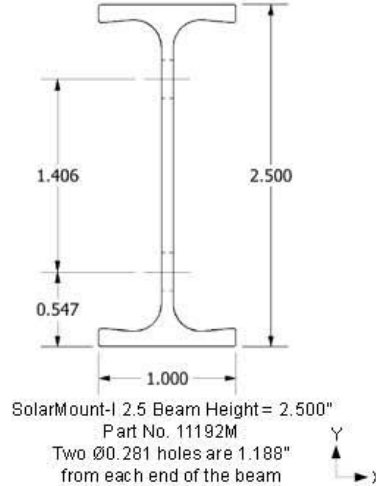
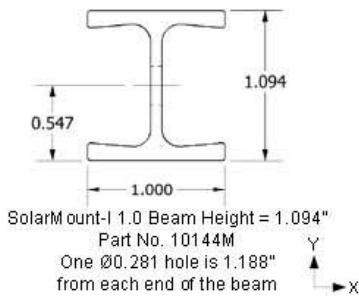
Dimensions specified in inches unless noted

**SolarMount-I™** Technical Datasheets



**SolarMount-I Beam**

<b>MATERIAL: One of the following extruded aluminum alloys: 6005-T5, 6105-T5, or 6061-T6, Mill Finish</b>			
Properties	Units	Beam Height (in)	
		1.094	2.500
Approximate Weight (per linear ft)	plf	0.356	0.548
Total Cross Sectional Area	in <sup>2</sup>	0.3037	0.4665
Section Modulus (X-Axis)	in <sup>3</sup>	0.1101	0.3687
Section Modulus (Y-Axis)	in <sup>3</sup>	0.0390	0.0422
Moment of Inertia (X-Axis)	in <sup>4</sup>	0.0602	0.4609
Moment of Inertia (Y-Axis)	in <sup>4</sup>	0.0195	0.0211
Radius of Gyration (X-Axis)	in	0.4453	0.9940
Radius of Gyration (Y-Axis)	in	0.2536	0.2127



Dimensions specified in inches unless noted

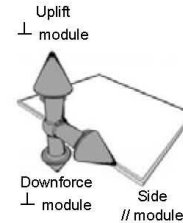
SolarMount-I™ Technical Datasheets



UNIRAC SolarMount-I 1.0 Engineering Report, Page 1 of 2

**90 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	56 229/ 262/ 54	52 211/ 305/ 96	48 197/ 327/ 123	44 177/ 384/ 140
<b>65" x 40"</b>	49 250/ 286/ 58	44 222/ 321/ 101	41 207/ 345/ 129	37 186/ 384/ 148
<b>77" x 51"</b>	40 238/ 273/ 56	35 212/ 307/ 96	33 198/ 329/ 123	30 178/ 366/ 141



**110 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	49 305/ 323/ 47	48 295/ 334/ 88	45 277/ 356/ 113	42 261/ 377/ 136
<b>65" x 40"</b>	41 321/ 340/ 49	40 311/ 352/ 92	38 292/ 375/ 119	36 275/ 397/ 143
<b>77" x 51"</b>	33 306/ 325/ 47	32 297/ 336/ 88	30 278/ 358/ 113	29 263/ 379/ 136

**Know your limits!**

Check attachment load limits.

**120 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	45 337/ 350/ 43	45 334/ 353/ 83	42 315/ 374/ 107	40 299/ 394/ 130
<b>65" x 40"</b>	38 355/ 369/ 45	38 352/ 372/ 87	36 332/ 394/ 113	34 315/ 415/ 137
<b>77" x 51"</b>	31 339/ 352/ 43	30 336/ 355/ 83	29 317/ 376/ 108	27 301/ 396/ 130

**150 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	37 432/ 427/ 35	37 432/ 427/ 68	37 432/ 432/ 93	35 415/ 449/ 114
<b>65" x 40"</b>	31 455/ 450/ 37	31 455/ 450/ 71	31 455/ 455/ 98	30 438/ 473/ 120
<b>77" x 51"</b>	25 434/ 429/ 35	25 434/ 429/ 68	25 434/ 434/ 93	24 418/ 452/ 114

Installation of products related to this engineering report is subject to the requirements below:

- Flush roof installations only; modules must be < 10" from roof surface
- The building has either a flat roof, a gable roof ≤ 45°, or a hip roof ≤ 27°
- The roof has a minimum slope of 1.2°
- Installation must have at least 4 modules grouped together (minimum 50 ft<sup>2</sup>)
- Surrounding ground area must not slope more than 10 degrees
- Location must fall into Wind Exposure Category B or C
- Building height must be less than or equal to 30 feet
- For roof zones 2 and 3 use 1/2 Max Span
- Max cantilever = 1/3 Max Span
- Ground snow loads are adjusted for roof slope and temperature based on ASCE 7-05
- Long edge of module must be perpendicular to the beam
- The installer must comply with the responsibilities and instructions described in the install manual
- The installer must confirm that the method of attachment (components and hardware) and structure can handle the given point loads
- In regions with ground snow loads less than 20 psf but not zero, the roof angle in degrees must be greater than the horizontal distance from eave to ridge / 50
- System dead load, including modules and mounting hardware, must be between 2 and 3.5 psf.
- Importance factors are equal to 1.0 in all cases.
- Unbalanced and drift snow loads have not been considered.
- Installations must be in seismic site class A, B, C, or D
- Spectral response acceleration, S<sub>s</sub>, is ≤ 1.5 (and ≤ 0.35 if snow loads are ≥ 30 psf).

**SolarMount-I™ Technical Datasheets**



**UNIRAC SolarMount-I 1.0 Engineering Report, Page 2 of 2**

**Engineering Variables**

Description	Variable	Value	Units
Building Height	h	30	ft
Roof Pitch		0-45	degrees
Wind Exposure Category		C	
Importance Factor	I	1	
Effective Wind Area		50+	ft <sup>2</sup>
Topographic Factor	Kzt	1	
Roof Zone		1	(use 1/2 span for zones 2 and 3)

**Design Wind Loads**

Basic Wind Speed (mph)	<u>90</u>	<u>110</u>	<u>120</u>	<u>150</u>
Max Design Wind Load, Pnet; Uplift (psf)	-19.2	-28.7	-34.2	-53.3
Max Design Wind Load, Pnet; Downforce (psf)	17.5	26.0	31.1	48.4

**Dead, Snow, and Earthquake Loads**

Dead Load; min/ max	2 / 3.5	psf		
Earthquake Load	2.8	psf		
Ground Snow Load, Pg, (pounds/ ft <sup>2</sup> )	<u>0</u>	<u>20</u>	<u>30</u>	<u>40</u>
Max Sloped roof snow load (psf)	0.0	20.0	25.2	33.6
Max Distance between splices (inches, feet)	653, 54	336, 28	245, 20	193, 16

**Distributed Loads for 65" x 40" module, pounds/ inch  
(smaller modules -20%, larger modules +18%)**

Wind Load (mph)	Ground Snow Load (psf)				
	0	20	30	40	
<u>90</u>	4.06	4.06	4.06	4.06	Uplift, ⊥ to module
	4.65	5.87	6.75	8.37	Downforce, ⊥ to module
	0.95	1.84	2.53	3.22	Side, // module
<u>110</u>	6.21	6.21	6.21	6.21	Uplift, ⊥ to module
	6.57	7.02	7.98	8.94	Downforce, ⊥ to module
	0.95	1.84	2.53	3.22	Side, // module
<u>120</u>	7.44	7.44	7.44	7.44	Uplift, ⊥ to module
	7.71	7.88	8.83	9.79	Downforce, ⊥ to module
	0.95	1.84	2.53	3.22	Side, // module
<u>150</u>	11.77	11.77	11.77	11.77	Uplift, ⊥ to module
	11.63	11.63	11.77	12.73	Downforce, ⊥ to module
	0.95	1.84	2.53	3.22	Side, // module

⊥ : perpendicular/ normal  
// : parallel

**For installations that do not comply with the limitations on page 1, refer to [www.unirac.com](http://www.unirac.com) for an engineering design guide to manually calculate loads or contact your distributor.**

The design is based on and in compliance with the following codes/standards:

1. 2003 International Building Code, by International Code Council , Inc., 2003.
2. 2006 International Building Code, by International Code Council , Inc., 2006.
3. Aluminum Design Manual: Specifications and Guidelines for Aluminum Structures, by The Aluminum Association, Washington, D.C., 2005.
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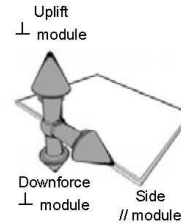
**SolarMount-I™ Technical Datasheets**



**UNIRAC SolarMount-I 2.5 Engineering Report, Page 1 of 2**

**90 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	76 310/ 355/ 73	67 271/ 392/ 123	57 231/ 385/ 144	51 205/ 423/ 163
<b>65" x 40"</b>	63 319/ 365/ 75	56 284/ 410/ 129	51 259/ 430/ 161	45 229/ 473/ 182
<b>77" x 51"</b>	50 300/ 344/ 70	44 267/ 386/ 121	41 249/ 414/ 155	37 224/ 461/ 177



**110 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	64 399/ 423/ 61	62 386/ 437/ 115	57 354/ 455/ 144	51 314/ 452/ 163
<b>65" x 40"</b>	53 410/ 434/ 63	51 397/ 449/ 118	48 372/ 479/ 152	45 351/ 505/ 182
<b>77" x 51"</b>	42 386/ 409/ 59	41 373/ 422/ 111	38 350/ 450/ 143	36 331/ 477/ 172

**Know your limits!**

Check attachment load limits.

**120 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	59 442/ 458/ 56	59 437/ 463/ 108	55 413/ 490/ 140	51 376/ 495/ 163
<b>65" x 40"</b>	49 454/ 470/ 58	48 449/ 475/ 111	46 424/ 503/ 144	43 403/ 530/ 174
<b>77" x 51"</b>	39 427/ 443/ 55	38 423/ 447/ 105	36 399/ 474/ 136	34 379/ 499/ 164

**150 mph Wind Chart**

Module Size	Max Span (inches)			
	Point Loads (pounds): Up/ Down/ Side			
Ground Snow	0	20	30	40
<b>52" x 35"</b>	48 566/ 559/ 46	48 566/ 559/ 89	48 565/ 566/ 122	46 544/ 588/ 149
<b>65" x 40"</b>	40 581/ 574/ 47	40 581/ 574/ 91	39 581/ 581/ 125	38 559/ 604/ 153
<b>77" x 51"</b>	31 547/ 540/ 44	31 547/ 540/ 86	31 547/ 547/ 118	30 526/ 569/ 144

Installation of products related to this engineering report is subject to the requirements below:

- Flush roof installations only; modules must be < 10" from roof surface
- The building has either a flat roof, a gable roof ≤ 45°, or a hip roof ≤ 27°
- The roof has a minimum slope of 1.2°
- Installation must have at least 4 modules grouped together (minimum 50 ft<sup>2</sup>)
- Surrounding ground area must not slope more than 10 degrees
- Location must fall into Wind Exposure Category B or C
- Building height must be less than or equal to 30 feet
- For roof zones 2 and 3 use 1/2 Max Span
- Max cantilever = 1/3 Max Span
- Ground snow loads are adjusted for roof slope and temperature based on ASCE 7-05
- Long edge of module must be perpendicular to the beam
- The installer must comply with the responsibilities and instructions described in the install manual
- The installer must confirm that the method of attachment (components and hardware) and structure can handle the given point loads
- In regions with ground snow loads less than 20 psf but not zero, the roof angle in degrees must be greater than the horizontal distance from eave to ridge / 50
- System dead load, including modules and mounting hardware, must be between 2 and 3.5 psf.
- Importance factors are equal to 1.0 in all cases.
- Unbalanced and drift snow loads have not been considered.
- Installations must be in seismic site class A, B, C, or D
- Spectral response acceleration, S<sub>s</sub>, is ≤ 1.5 (and ≤ 0.35 if snow loads are ≥ 30 psf).



UNIRAC SolarMount-I 2.5 Engineering Report, Page 2 of 2

**Engineering Variables**

Description	Variable	Value	Units
Building Height	h	30	ft
Roof Pitch		0-45	degrees
Wind Exposure Category		C	
Importance Factor	I	1	
Effective Wind Area		50+	ft <sup>2</sup>
Topographic Factor	Kzt	1	
Roof Zone		1	(use 1/2 span for zones 2 and 3)

**Design Wind Loads**

Basic Wind Speed (mph)	<u>90</u>	<u>110</u>	<u>120</u>	<u>150</u>
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Photovoltaic Solar Module- Sharp NU-U235P1

**SHARP.**

solar electricity

235 WATT

MULTI-PURPOSE MODULE

NEC 2008 Compliant



NU-U235F1

MULTI-PURPOSE 235 WATT  
MODULE FROM THE WORLD'S  
TRUSTED SOURCE FOR SOLAR.

Using breakthrough technology, made possible by nearly 50 years of proprietary research and development, Sharp's NU-235F1 solar module incorporates an advanced surface texturing process to increase light absorption and improve efficiency. Common applications include commercial and residential grid-tied roof systems as well as ground mounted arrays. Designed to withstand rigorous operating conditions, this module offers high power output per square foot of solar array.



Sharp's most powerful commercial  
module manufactured today.

**ENGINEERING EXCELLENCE**

High module efficiency for an outstanding balance of size and weight to power and performance.

**DURABLE**

Tempered glass, EVA lamination and weatherproof backskin provide long-life and enhanced cell performance.

**RELIABLE**

25-year limited warranty on power output.

**HIGH PERFORMANCE**

This module uses an advanced surface texturing process to increase light absorption and improve efficiency.

**INNOVATIVE**

156 mm monocrystalline solar cells provide high power output. Ideal for large commercial rooftops where space is a premium.



The NU-U235F1 offers industry-leading performance for a variety of applications.

Improved Frame Technology

**SHARP: THE NAME TO TRUST**

When you choose Sharp, you get more than well-engineered products. You also get Sharp's proven reliability, outstanding customer service and the assurance of our 25-year limited warranty on power output. A global leader in solar electricity, Sharp powers more homes and businesses than any other solar manufacturer worldwide.

**BECOME POWERFUL**



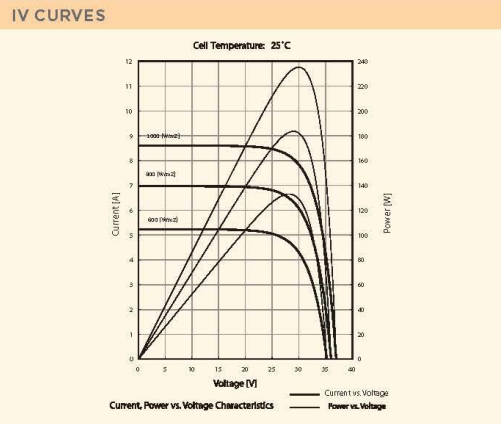
# 235 WATT

## NU-U235F1

NEC 2008 Compliant  
Module output cables 12 AWG with locking connectors

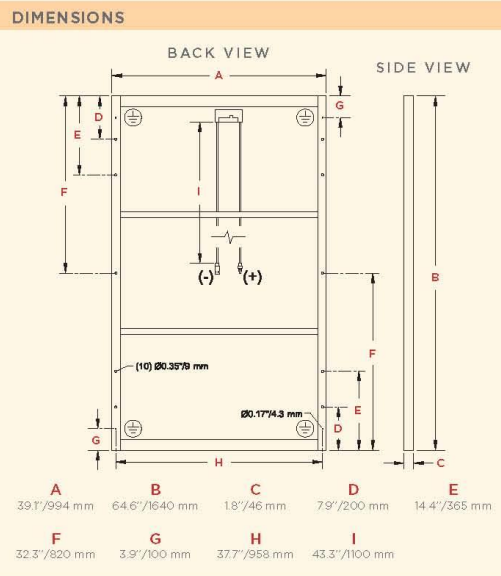
ELECTRICAL CHARACTERISTICS	
Maximum Power (Pmax)*	235 W
Tolerance of Pmax	+10%/-5%
Type of Cell	Monocrystalline silicon
Cell Configuration	60 in series
Open Circuit Voltage (Voc)	37.0 V
Maximum Power Voltage (Vpm)	30.0 V
Short Circuit Current (Isc)	8.60 A
Maximum Power Current (Ipm)	7.84 A
Module Efficiency (%)	14.4%
Maximum System (DC) Voltage	600 V
Series Fuse Rating	15 A
NOCT	47.5°C
Temperature Coefficient (Pmax)	-0.485%/°C
Temperature Coefficient (Voc)	-0.351%/°C
Temperature Coefficient (Isc)	0.053%/°C

\*Measured at (STC) Standard Test Conditions: 25°C, 1 kW/m² insolation, AM 1.5



MECHANICAL CHARACTERISTICS	
Dimensions (A x B x C below)	39.1" x 64.6" x 1.8"/994 x 1640 x 46 mm
Cable Length (L)	43.3"/1100 mm
Output Interconnect Cable**	12 AWG with MC4 Locking Connector
Weight	44.1 lbs / 20.0 kg
Max Load	50 psf (2400 Pascals)
Operating Temperature (cell)	-40 to 194°F / -40 to 90°C

\*\*A safety lock clip (Multi Contact part number PV-SSH4) may be required in readily accessible locations per NEC 2008 690.33 (C)



Contact Sharp for tolerance specifications

QUALIFICATIONS	
UL Listed	UL 1703
Fire Rating	Class C



**WARRANTY**  
25-year limited warranty on power output  
Contact Sharp for complete warranty information

Design and specifications are subject to change without notice. Sharp is a registered trademark of Sharp Corporation. All other trademarks are property of their respective owners. Contact Sharp to obtain the latest product manuals before using any Sharp device. Cover photo: Solar Installation by SPG Solar.



**SHARP**

SHARP ELECTRONICS CORPORATION  
5901 Bolsa Avenue, Huntington Beach, CA 92647  
1-800-SOLAR-06 • Email: sharpsolar@sharpusa.com  
www.sharpusa.com/solar

**Photovoltaic Inverter- IGPlus**



Maximum energy harvest –  
cloudy or clear

**Fronius IG Plus PV Inverter**

The first complete solution. Reliable. Proven. Smart.

An outstanding addition to the family: The next generation Fronius IG Plus inverter builds on a successful model with multiple enhancements, including maximum power harvest, a built-in six circuit string combiner, integrated, lockable DC Disconnect, significantly improved efficiency, and unbeatable reliability. New, larger power stages expand the proven Fronius IG family from 2 to 12 kW in a single inverter.



**POWERING YOUR FUTURE**

INPUT DATA		Fronius IG Plus	3.0-1 <sub>UNI</sub>	3.8-1 <sub>UNI</sub>	5.0-1 <sub>UNI</sub>	6.0-1 <sub>UNI</sub>	7.5-1 <sub>UNI</sub>	10.0-1 <sub>UNI</sub>	11.4-1 <sub>UNI</sub>	11.4-3 <sub>Delta</sub>	12.0-3 <sub>WYE277</sub>
Recommended PV-Power (Wp)			2500-3450	3200-4400	4250-5750	5100-6900	6350-8600	8500-11500	9700-13100	9700-13100	10200-13800
MPPT-Voltage Range			230 ... 500 V								
DC Startup Voltage			245 V								
Max. Input Voltage (at 1000 W/m <sup>2</sup> )			600 V								
14°F (-10°C) in open circuit operation)			600 V								
Nominal Input Current			8.3 A	10.5 A	13.8 A	16.6 A	20.7 A	27.6 A	31.4 A	31.4 A	33.1 A
Max. usable Input Current			14.0 A	17.8 A	23.4 A	28.1 A	35.1 A	46.7 A	53.3 A	53.3 A	56.1 A
Admissible conductor size (DC)			No. 14 - 6 AWG								
Number of DC Input Terminals			6								
Max. Current per DC Input Terminal			20 A; Bus bar available for higher input currents								
OUTPUT DATA		Fronius IG Plus	3.0-1 <sub>UNI</sub>	3.8-1 <sub>UNI</sub>	5.0-1 <sub>UNI</sub>	6.0-1 <sub>UNI</sub>	7.5-1 <sub>UNI</sub>	10.0-1 <sub>UNI</sub>	11.4-1 <sub>UNI</sub>	11.4-3 <sub>Delta</sub>	12.0-3 <sub>WYE277</sub>
Nominal output power (P <sub>AC nom</sub> )			3000 W	3800 W	5000 W	6000 W	7500 W	9995 W	11400 W	11400 W	12000 W
Max. continuous output power			3000 W / 3800 W / 5000 W / 6000 W / 7500 W / 9995 W / 11400 W / 11400 W / 12000 W								
104°F (40°C) 208 V / 240 V / 277 V			3000 W	3800 W	5000 W	6000 W	7500 W	9995 W	11400 W	11400 W	12000 W
Nominal AC output voltage			208 V / 240 V / 277 V								
Operating AC voltage range	208 V		183 - 229 V (-12 / +10 %)								
(default)	240 V		211 - 264 V (-12 / +10 %)								
	277 V		244 - 305 V (-12 / +10 %)								
Max. continuous output current	208 V	14.4 A	18.3 A	24.0 A	28.8 A	36.1 A	48.1 A	54.8 A	31.6 A*	n.a.	
	240 V	12.5 A	15.8 A	20.8 A	25.0 A	31.3 A	41.7 A	47.5 A	27.4 A*	n.a.	
	277 V	10.8 A	13.7 A	18.1 A	21.7 A	27.1 A	36.1 A	41.2 A	n.a.	14.4 A*	
Admissible conductor size (AC)			No. 14 - 4 AWG								
Max. continuous utility back feed current			0 A								
Nominal output frequency			60 Hz								
Operating frequency range			59.3 - 60.5 Hz								
Total harmonic distortion			< 3 %								
Power factor			1								
GENERAL DATA		Fronius IG Plus	3.0-1 <sub>UNI</sub>	3.8-1 <sub>UNI</sub>	5.0-1 <sub>UNI</sub>	6.0-1 <sub>UNI</sub>	7.5-1 <sub>UNI</sub>	10.0-1 <sub>UNI</sub>	11.4-1 <sub>UNI</sub>	11.4-3 <sub>Delta</sub>	12.0-3 <sub>WYE277</sub>
Max. Efficiency			96.2 %								
CEC Efficiency	208 V	95.0 %	95.0 %	95.5 %	95.5 %	95.0 %	95.0 %	95.5 %	95.5 %	95.0 %	n.a.
	240 V	95.5 %	95.5 %	95.5 %	96.0 %	96.0 %	95.5 %	95.5 %	96.0 %	95.5 %	n.a.
	277 V	95.5 %	95.5 %	96.0 %	96.0 %	96.0 %	96.0 %	96.0 %	96.0 %	n.a.	96.0 %
Consumption in standby (night)			< 1 W								
Consumption during operation			8 W		15 W				22 W		
Cooling			Controlled forced ventilation, variable fan speed								
Enclosure Type			NEMA 3R								
Unit Dimensions (W x H x D)			17.1 x 24.8 x 9.6 in.			17.1 x 36.4 x 9.6 in.			17.1 x 48.1 x 9.6 in.		
Power Stack Weight			31 lbs. (14 kg)			57 lbs. (26 kg)			82 lbs. (37 kg)		
Wiring Compartment Weight			24 lbs. (11 kg)			26 lbs. (12 kg)			26 lbs. (12 kg)		
Admissible ambient operating temperature			-4 ... 122°F (-20 ... +50°C)								
Compliance			UL 1741-2005, IEEE 1547-2003, IEEE 1547.1, ANSI/IEEE C62.41, FCC Part 15 A&B, NEC Article 690, C22. 2 No. 107.1-01 (Sept. 2001)								
PROTECTION DEVICES		Fronius IG Plus	3.0-1 <sub>UNI</sub>	3.8-1 <sub>UNI</sub>	5.0-1 <sub>UNI</sub>	6.0-1 <sub>UNI</sub>	7.5-1 <sub>UNI</sub>	10.0-1 <sub>UNI</sub>	11.4-1 <sub>UNI</sub>	11.4-3 <sub>Delta</sub>	12.0-3 <sub>WYE277</sub>
Ground fault protection			Internal GFDI (Ground Fault Detector/Interrupter); in accordance with UL 1741-2005 and NEC Art. 690								
DC reverse polarity protection			Internal diode								
Islanding protection			Internal; in accordance with UL 1741-2005, IEEE 1547-2003 and NEC								
Over temperature			Output power derating / active cooling								

\* per Phase



**Fronius USA LLC Solar Electronic Division**  
 10421 Citation Drive, Suite 1100, Brighton, Michigan, 48116  
 E-Mail: pv-us@fronius.com  
 www.fronius-usa.com

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40.0006,2981,AE-101 2009 as02

**Photovoltaic Inverter- SBUS**



SUNNY BOY 5000US / 6000US / 7000US / 8000US



**SB 8000US AVAILABLE IN 2010**

- |   |   |   |  |
|---|---|---|--|
| <ul style="list-style-type: none"><li>• Highest CEC efficiency in its class</li><li>• Integrated load-break rated lockable DC disconnect switch</li><li>• Integrated fused series string combiner</li></ul> | <ul style="list-style-type: none"><li>• Sealed electronics enclosure &amp; Opticool™</li><li>• Comprehensive SMA communications and data collection options</li></ul> | <ul style="list-style-type: none"><li>• Ideal for residential or commercial applications</li><li>• Sunny Tower compatible</li><li>• 10 year standard warranty</li><li>• UL 1741/IEEE-1547 compliant</li></ul> |  |
|---|---|---|--|

**SUNNY BOY 5000US / 6000US / 7000US / 8000US**

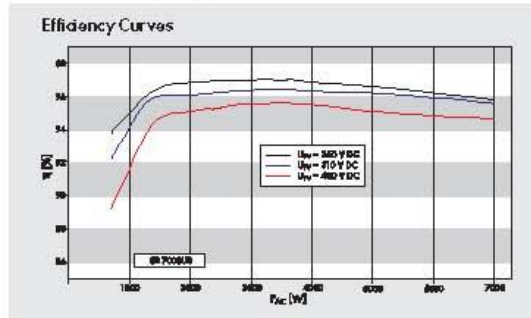
The best in their class

Our US series inverters utilize our proven technology and are designed specifically to meet IEEE-1547 requirements. Sunny Boy 6000US, Sunny Boy 7000US and Sunny Boy 8000US are also compatible with the Sunny Tower. Increased efficiency means better performance and shorter payback periods. All four models are field-configurable for positive ground systems making them more versatile than ever. Throughout the world, Sunny Boy is the benchmark for PV inverter performance and reliability.

Technical Data

	SB 5000US	SB 6000US	SB 7000US	SB 8000US
Recommended Maximum PV Power (Module STC)	6250 W	7500 W	8750 W	10000 W
DC Maximum Voltage	600 V	600 V	600 V	600 V
Peak Power Tracking Voltage	250-480 V	250-480 V	250-480 V	300-480 V
DC Maximum Input Current	21 A	25 A	30 A	30 A
Number of Fused String Inputs	3 [inverter], 4 x 20 A [DC disconnected]	3 [inverter], 4 x 20 A [DC disconnected]	3 [inverter], 4 x 20 A [DC disconnected]	3 [inverter], 4 x 20 A [DC disconnect]
PV Start Voltage	300 V	300 V	300 V	365 V
AC Nominal Power	5000 W	6000 W	7000 W	8000 W
AC Maximum Output Power	5000 W	6000 W	7000 W	8000 W
AC Maximum Output Current (@ 208, 240, 277 V)	24 A, 21 A, 18 A	29 A, 25 A, 22 A	34 A, 29 A, 25 A	N/A, 32 A, 29 A
AC Nominal Voltage Range	183 - 229 V @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V	183 - 229 V @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V	183 - 229 V @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V	N/A @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V
AC Frequency: nominal / range	60 Hz / 59.3 - 60.5 Hz	60 Hz / 59.3 - 60.5 Hz	60 Hz / 59.3 - 60.5 Hz	60 Hz / 59.3 - 60.5 Hz
Power Factor [Nominal]	0.99	0.99	0.99	0.99
Peak Inverter Efficiency	96.8%	97.0%	97.1%	96.5%
CEC Weighted Efficiency	95.5% @ 208 V 95.5% @ 240 V 95.5% @ 277 V	95.5% @ 208 V 95.5% @ 240 V 96.0% @ 277 V	95.5% @ 208 V 96.0% @ 240 V 96.0% @ 277 V	N/A @ 208 V 96.0% @ 240 V 96.0% @ 277 V
Dimensions: W x H x D in inches	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5
Weight / Shipping Weight	141 lbs / 148 lbs	141 lbs / 148 lbs	141 lbs / 148 lbs	148 lbs / 152 lbs
Ambient Temperature Range	-13 to 113 °F	-13 to 113 °F	-13 to 113 °F	-13 to 113 °F
Power consumption at night	0.1 W	0.1 W	0.1 W	0.1 W
Topology	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave
Cooling Concept	OptiCool™ forced active cooling	OptiCool™ forced active cooling	OptiCool™ forced active cooling	OptiCool™ forced active cooling
Mounting location: indoor / outdoor (NEMA 3R)	●/●	●/●	●/●	●/●
LCD Display	●	●	●	●
Communication: RS485 / wireless	○/○	○/○	○/○	○/○
Warranty: 10 years / 15 years / 20 years	●/○/○	●/○/○	●/○/○	●/○/○
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	●	●	●	●
Specifications for nominal conditions	● Included ○ Optional			

NOTE: US inverters ship with gray lids.



Tel. +1 916 625 0870  
 Toll Free +1 888 4 SMA USA  
 www.SMA-America.com

SMA America, LLC

Photovoltaic Inverter- PSDL



**FEATURES**

**INTENDED USE**

Factory- or field-install inside or outside (field only) fluorescent fixture to operate lamp(s) at an initial output of 10% to 95% of rated lamp lumens, providing optimum, glare-free illumination for 90 minutes upon interruption of normal power.

**CONSTRUCTION**

Black, 20-gauge steel, permanently sealed housing. Dual-voltage input capability (120V or 277V). Polarized quick-connect light/switch assembly simplifies installation (not included on the PSDL1 2LP). Remote test plate with pilot light and test switch standard for PSDL1 2LP.

Patent-pending integrated test switch/pilot light that requires only one-hole drilling (PSDL3).

U.S. Patent No. (PSDL3) 6,522,147.

**PERFORMANCE**

PSDL1 operates one two-pin 18W or 26W quad-tube compact fluorescent lamp. PSDL1 2LP operates two (2) two-pin (13-26W) quad-tube fluorescent lamps. PSDL2 operates one two-pin 7W, 9W, or 13W quad-tube compact fluorescent lamp. PSDL3 operates one or two four-pin twin-tube (9-13W), triple-tube (18-42W\*), quad-tube (13-26W) or 2D compact fluorescent lamp(s). \*42W triple-tube is one lamp only.

Low-glare, shadow-free illumination provides excellent visibility for safe building evacuation.

**BATTERY**

Sealed, maintenance-free, high-temperature nickel-cadmium battery. Ensures long life over a wide range of temperatures.

Polarized battery connector simplifies maintenance and prevents charger damage due to improper connection.

Pilot light and test switch provide visual and manual means of monitoring system operation.

Automatic battery recharge after 90-minute discharge.

**ELECTRONIC**

Constant-current series resistor-type charger.

High-efficiency push-pull inverter is the most effective method of converting DC power to AC power. It provides maximum light output, battery life and reliability.

**INSTALLATION**

Unit can be remote mounted up to half the distance recommended by the ballast manufacturer or 50 feet, whichever is less.

Optional external mounting tray provides quick and flexible mounting means for most applications.

Unit wired into building circuit in two ways: on night light circuit (permanently energized) or on switchable circuit (unswitched circuit to the battery charger and switched circuit to the fixture ballast). Unit will strike *normally off* lamp.

**LISTING**

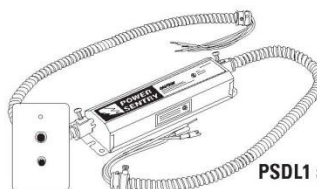
UL listed. Meets UL 924, NFPA 101 (current Life Safety Code), NEC and OSHA

Catalog Number	
Notes	Type

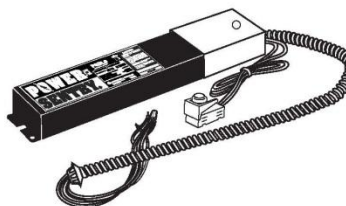


Compact Fluorescent Battery Packs

**PSDL**



PSDL1 and PSDL2



PSDL3

illumination standards.

**WARRANTY**

Three-year total customer satisfaction warranty. (For complete details, see warranty sheet in Product Selection Guide.) PSDL3 includes a five-year total customer satisfaction warranty.

**ORDERING INFORMATION**

For shortest lead times, configure product using **standard options (shown in bold)**.

Example: PSDL1

Designation	Options
<b>PSDL1 Bi-pin (18-26W) battery pack</b>	<b>2LP Two-lamp operation (PSDL1 only)</b>
<b>PSDL2 Bi-pin (7-13W) battery pack</b>	DL UL listed for damp location <sup>1</sup>
<b>PSDL3 Four-pin (9-42W) battery pack</b>	0° – 50° C (32° – 122° F)
	<b>SD Self-diagnostics</b> <sup>1,2</sup>

**NOTES:**

Factory installation is available on most Lithonia fixtures. Consult EL downlighting spec sheet for details. Remotes can be mounted up to 25' away from fixture.

<sup>1</sup> Only available on the PSDL3.

<sup>2</sup> SD option includes the PSSD module and the ELA PSMKSD mounting kit.

Accessories<sup>2</sup>

Order as separate item.

ELA PSDMT	External mounting tray
ELA RTS	Remote test plate with pilot light and test switch (PSDL1 2LP only)
ELA TSPLP	Remote or replacement test switch/pilot light; mounts up to 25' away from fixture <sup>1</sup>
ELA TSPLPSD	Remote or replacement test switch/pilot light for self-diagnostics; mounts up to 25' away from fixture <sup>1</sup>
<b>PSSD</b>	<b>Field-installable self-diagnostics module</b> <sup>1,2</sup>
ELA PSMKSD	Self-diagnostics mounting kit (must be ordered separately to install the PSSD on a PSDL3 product) <sup>2</sup>

**Emergency**

Sheet #: PSDL

PSBP-190

## PSDL Compact Fluorescent Battery Packs

### SPECIFICATIONS

#### BATTERY

##### Sealed Nickel-Cadmium

	Voltage	Shelf life <sup>1</sup>	Expected life <sup>1</sup>	Maintenance	Optimum temperature <sup>2</sup>
PSDL1	3.6	3 yrs.	10 yrs.	none <sup>3</sup>	32–100°F (0–38°C)
PSDL2	3.6	3 yrs.	10 yrs.	none <sup>3</sup>	32–100°F (0–38°C)
PSDL3	6	3 yrs.	10 yrs.	none <sup>3</sup>	32–100°F (0–38°C)

#### NOTES:

- At 77°F (25°C).
- Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.
- Periodic system status test recommended.

#### ELECTRICAL

	Volts	Maximum Amps	AC input Watts
PSDL1/PSDL2	120	.275	3.5
	277	.255	3.5
PSDL1 2LP	120	.27	3.5
	277	.27	3.5
PSDL3	120	.27	3.3
	277	.25	3.2

### Lamp Compatibility & Emergency Output

Catalog Number	Lamp Description	Lamp Base	Lamp Manuf.			Initial Lumens Lamp 1	Initial Lumens Lamp 2 <sup>1</sup>	
			Philips	Osrani/ Sylvania	GE			
PSDL1/ PSDL2P	Quad-Tube (2-pin)	G23-4	"PLC Lamps" PL-C 13W/USA 10mm/13W	"Dulux D" CF13DD	"Double Biac" F13DBX23T4	OS-780 GE-810 PL-860	*	500
	Super Compact 10mm Quad-Tube (2-pin)	G24d-2	"PLC Lamps" PL-C 18W 10mm/18W	"Dulux D" CF18DD	"Double Biac" F18DBXT4	OS & PL-1250 GE-1150	675	650
		G24d-3	"PLC Lamps" PL-C 26W 10mm/26W	"Dulux D" CF26DD	"Double Biac" F26DBXT4	OS & PL-1800 GE-1710	925	950
PSDL2	Compact Twin-Tube (2-pin)	G23	"PL Lamps" PL-S7W	"Dulux S" CF7DS	"Biac" F7BX	OS & PL-400 GE-400	350	*
		G23	"PL Lamps" PL 9	"Dulux S" CF9DS	"Biac" F9BX	OS-580 GE-600	500	*
		GX23	"PL Lamps" PL13	"Dulux S" CF13DS	"Biac" F13BX	OS-800 GE-825	650	*
	Quad-Tube (2-pin)	GX23-2	"PLC Lamps" PL-C 13W/USA 10mm/13W	"Dulux D" CF13DD	"Double Biac" F13DBX23T4	OS-780 GE-810 PL-860	450	*
PSDL3 <sup>2</sup>	Compact Twin-Tube (4-pin)	2G7	*	"Dulux S/E" CF9DS/E 9W	*	580	NA	NA
		2GX7	*	"Dulux S/E" CF13DS/E 13W	*	800	NA	NA
	Super Compact	GX24q-1	"PL Cluster" PL-C 13W/4P 13W	"Dulux D/E" CF13DD/E/8 13W	"Double Biac" F13DBX/4P	900	580	635
		GX24q-2	"PL Cluster" PL-C 18W/4P 18W	"Dulux D/E" CF18DD/E/8 18W	"Double Biac" F18DBX/4P	OS & PL-1250 GE-1150	675	750
		GX24q-3	"PL Cluster" PL-C 26W/4P 26W	"Dulux D/E" CF26DD/E/8 26W	"Double Biac" F26DBX/4P	OS & PL-1800 GE-1710	790	900
	Super Compact	GX24q-2	"PL Triple" PL-T 18W/4P 18W	"Dulux T/E" CF18DT/E/N/8 18W	"Triple Biac" F18TBX/SPX	1200	595	615
	Triple-Tube (4-pin)	GX24q-3	"PL Triple" PL-T 26W/4P 26W	"Dulux T/E" CF26DT/E/N/8 26W	"Triple Biac" F26TBX/SPX	1800	412	749
GX24q-3		"PL Triple" PL-T 32W/4P 32W	"Dulux T/E" CF32DT/E/N/8 32W	"Triple Biac" F32TBX/SPX	OS & PL-2400 GE-2200	657	1038	
	GX24q-3	"PL Triple" PL-T 42W/4P 42W	"Dulux T/E" CF42DT/E/N/8 42W	*	3200	948	NA	

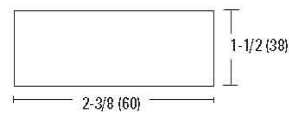
#### NOTES:

- NA = Not available.
- When using the PSDL3 with 26-42W triple-tube lamps, the Triad/Universal ballast C242 UNV BE is recommended. Inconsistent operation and performance may be experienced with the Advance ballast ICF-2S42-M2-LD and is therefore not recommended for use with PSDL3 product.

### MOUNTING

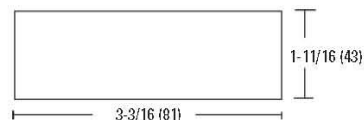
All dimensions are inches (millimeters).

#### PSDL1 and PSDL2



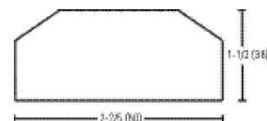
Cross section end view  
Length: 10-5/8 (270)  
Shipping weight: 2.14 lbs. (.90 kgs.)

#### PSDL3



Cross section end view  
Length: 17-1/8 (435)  
Shipping weight: 5.0 lbs. (2.3 kgs.)

#### PSDL1 2LP



Cross section end view  
Length: 12 (304)  
Shipping weight: 3.0 lbs. (1.4 kgs.)



Sheet #: PSDL

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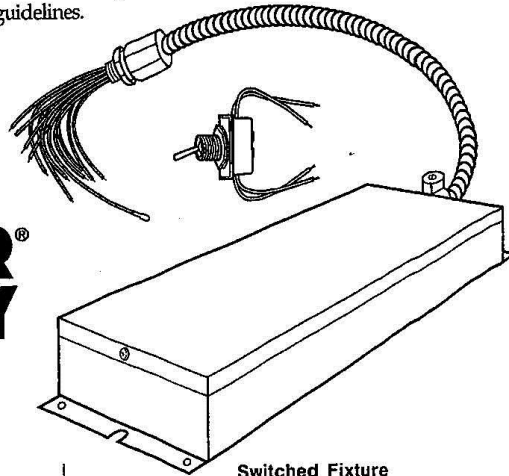
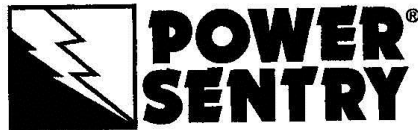
Lithonia Lighting  
Emergency Systems Group  
One Lithonia Way, Conyers, GA 30012  
Phone: 800-334-8634 Fax: 770-981-8141  
www.lithonia.com



Photovoltaic Inverter- PS3000

**APPLICATION GUIDE: PS3000**

The PS3000 is Lithonia's full-lumen-output battery pack. The PS3000 operates most fluorescent lamps found in commercial facilities today. This application guide is designed to assist the specifier with details of the PS3000, such as remote mounting, lamp compatibility and typical spacing guidelines.

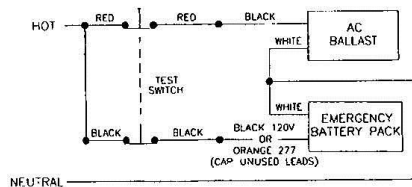


**TYPES OF CIRCUITS**

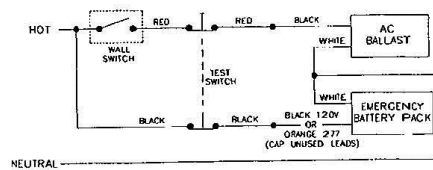
The PS3000 can be installed on a night-light circuit (unswitched) or a switched circuit. The following diagrams show the wiring for both of these applications. The PS3000 always requires an unswitched power supply connection. Through this connection, the PS3000 monitors the power supply, detects any interruptions and maintains the power to the battery charger.

For the switched application, the AC ballast receives a switched power supply, and the PS3000 receives continuous power. If the power fails, the PS3000 will automatically turn the emergency lamps on, regardless of the status of the switch.

**Unswitched Fixture**

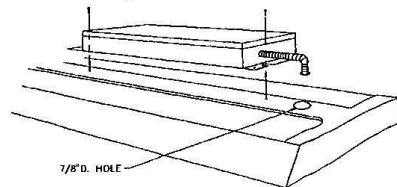


**Switched Fixture**



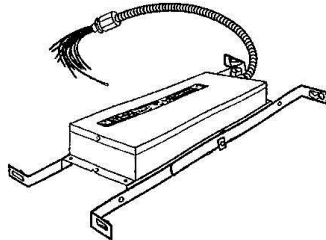
**MOUNTING AND REMOTE APPLICATIONS**

A large nickel-cadmium battery is used to produce 3000 lumens in the PS3000. Due to the larger housing, it cannot be mounted inside the ballast channel like some 300-lumen to 1100-lumen battery packs. The PS3000 can be remote mounted or externally mounted to the top of the fixture housing as shown below.

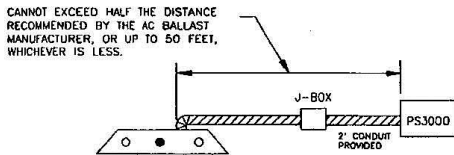


**APPLICATION GUIDE: PS3000**

For remote mounting, Lithonia offers a mounting tray as an accessory (ELA PSDMT). This tray will mount to the T-bar grid in the plenum or to wood joists. The drawing below shows the PS3000 installed on the ELA PSDMT.

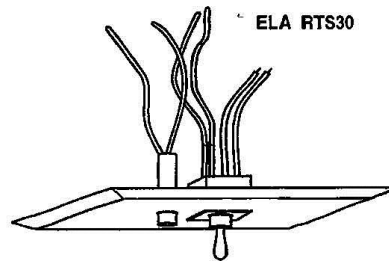


The distance allowed for remote mounting the PS3000 depends on the specifications of the AC ballast used in the fixture. The maximum distance for remote mounting the PS3000 is 50' or half the remote distance recommended by the AC ballast manufacturer — whichever is less. It should be noted that typical remote mounting recommendations for AC ballasts range from 0' to 20'. The drawing below summarizes this guideline.



If the PS3000 is mounted on the top of the fixture or remote mounted within 8' of the fixture, the pilot light and test switch can be located inside the fixture housing by simply drilling two 1/2" holes in the ballast channel cover and then attaching them to the cover. For parabolic fixtures, the pilot light and test switch are visible and accessible. For lensed fixtures, the pilot light can be extended so the indicator is close to the lens and visible from below the fixture.

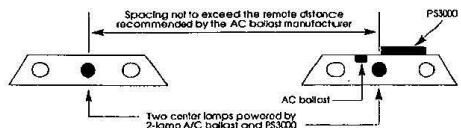
If a remote pilot light/test switch is desired or the PS3000 is remote mounted further than 8' from the fixture, the remote pilot light/test switch accessory (ELA RTS30) should be used. The ELA RTS30 must be mounted within 8' of the PS3000.



**TANDEM WIRING — OPERATING TWO LAMPS**

The PS3000 can operate two 2'- 4' standard output lamps. The lamps can be in the same fixture or two separate fixtures. However, when operating two lamps in separate fixtures, the same AC ballast must be operating the two lamps and the wiring configuration must allow both lamps to have a common connection point. The PS3000 cannot power two lamps operating from two separate AC ballasts.

The maximum distance between fixtures for tandem wiring applications is the remote distance recommended by the AC ballast manufacturer. It should be noted that typical remote mounting recommendations for AC ballasts range from 0' to 20'. The drawing below shows a tandem wiring application.



**APPLICATION GUIDE: PS3000**

**"NORMALLY OFF" EMERGENCY**

**FLUORESCENT SYSTEMS**

Sometimes the aesthetics and functionality of a space require the use of incandescent or HID light sources rather than fluorescent. This is common for hotels, upscale restaurants and retail warehouse stores. However, these applications may still utilize "normally off" fluorescent fixtures for emergency lighting purposes. All Power Sentry products, including the PS3000, will start and operate both "normally on" and "normally off" fluorescent fixtures. An AC ballast is not needed to operate a "normally off" fixture.

**SPACING EXAMPLES**

The following chart shows examples of fixture spacing guidelines with the PS3000 designed to meet the light level requirements of the Life Safety Code. Currently, the Life Safety Code requires one footcandle *average* and 0.1 FC *minimum* along the path of egress, while some cities and local codes require one footcandle minimum. For a more detailed lighting calculation, please contact your Lithonia Lighting sales representative.

**Corridor application\*:**

**100' length, 8' width, 9' height**

*Reflectances: 80/50/20, 6' path of egress, T8 lamp*

**2' x 2' lensed troffer—**

spacing for 1 f.c. minimum: 39'

1 f.c. average and 0.1 f.c. minimum: 167'

**2' x 2' parabolic—**

spacing for 1 f.c. minimum: 31'

1 f.c. average and 0.1 f.c. minimum: 133'

**Open office application\*:**

**80' length, 80' width, 9' height**

*Reflectances: 80/50/20, 6' path of egress, T8 lamp*

**2' x 4' lensed troffer—**

spacing for 1 f.c. minimum: 29'

1 f.c. average and 0.1 f.c. minimum: 57'

**2' x 4' parabolic—**

spacing for 1 f.c. minimum: 30'

1 f.c. average and 0.1 f.c. minimum: 45'

\* These are intended to be guidelines. Results will vary if your application deviates from these dimensions and assumptions.

**BALLAST COMPATIBILITY**

The PS3000 is compatible with standard magnetic, energy-saving magnetic and electronic ballasts. It also is compatible with the various starting circuits, including rapid-start and instant-start (slimline) ballasts.

**LAMP COMPATIBILITY —**

**ONE-LAMP OR TWO-LAMP OPERATION**

If using 2', 3' or 4' fluorescent lamps (T8 or T12), the PS3000 can operate one lamp at 3000 lumens or two lamps at 1500 lumens each. If operating two T8 lamps, the "2T8" option must be specified. Energy-saving lamps (34-watt), high-lumen lamps (like the Ultralume) and T10 lamps are also compatible with the PS3000. For more details, see the chart below.

**LAMP COMPATIBILITY CHART**

Lamp Type	Wattage	Compatibility
U-lamp T8	16-31	■ ◆
24"-48" T8	17-32	■ ◆
60"-96" T8	40-59	■
Circline T9	20-40	■ •
U-lamp T12	34-40	■ •
24"-48" T12	20-40	■ •
60"-96" T12	50-75	■
24"-48" T12 HO	35-60	■
60"-96" T12 HO	70-110	■
24"-48" T12 VHO	74-115	■
60"-96" T12 VHO	135-215	■
12"-24" twin-tube (4-pin)	18-50	■
Triple-tube (4-pin)	26-32	■

- One-lamp emergency operation for 1-4 lamp ballasts.
- Two-lamp emergency operation for 2-4 lamp ballasts.
- ◆ "2T8" option required for 2-lamp emergency operation for 2-4 lamp ballasts.

## APPLICATION GUIDE: PS3000

### PS3000 SPECIFICATION GUIDELINES

#### GENERAL

The fluorescent battery pack shall be of the Power Sentry family manufactured by Lithonia Emergency Systems. The battery pack shall be capable of operating one or two 2' - 4' fluorescent T8 - T12 lamps, one 2' - 4' fluorescent HO or VHO long compact fluorescent lamp or one 6' - 8' (T8 - T12) fluorescent lamp for 90 minutes. The unit shall be constructed to conform to the standards of the National Electrical Code, OSHA and the current Life Safety Code (NFPA 101). It shall be UL listed for installation on top of the fixture or in the plenum. The battery pack shall be made in the U.S.A.

#### CONSTRUCTION

The battery pack shall consist of one compact (2" x 5-5/8" x 15-3/8") housing constructed of 20-gauge steel with a 24" length of flexible conduit. A pilot light and double-pole test switch assembly shall be provided as a visual and manual means of monitoring system operation. A remote test switch shall be available as an option and shall be capable of mounting up to 8' from the battery pack. An optional external mounting tray shall be available to provide quick and flexible mounting for the battery pack in various applications. The battery pack shall have the capability of mounting up to 50' from the lamp.

#### ELECTRONICS

The electronics shall consist of a constant current type battery charger designed to provide increased reliability and maximize battery life. The battery pack shall have AC reset. This allows battery connection before AC power is applied and prevents battery damage from deep discharge. The charging circuitry shall be capable of automatically recharging the battery. Dual-input voltage (120/277 VAC, 60 Hz) capability shall be standard. The inverter circuitry shall be

of the highly-efficient push-pull type providing maximum light output during emergency operation.

#### BATTERY

A sealed, maintenance-free nickel-cadmium battery shall be included. The nickel-cadmium battery shall be of high-temperature design. The optimum operating temperature range for the nickel-cadmium battery shall be 32°F - 100°F, with a life expectancy of 10 years.

#### OPERATION

During normal operation, the AC power applied to the battery pack is regulated and controlled by the electronic circuitry to provide proper automatic charging of the battery. Upon loss of the normal utility power, the electronic circuitry will automatically operate one fluorescent lamp up to 3000 lumens of initial emergency light output. For two-lamp operation, the battery pack shall evenly divide the light output between the two lamps.

#### WARRANTY

The battery pack shall have a five-year total customer satisfaction warranty. The warranty shall include the electronics and the battery.

*For additional information or questions about the PS3000, please contact your local Lithonia Lighting sales representative.*



Form No. 680.143  
e4.103.pms  
5/96

Photovoltaic Inverter- ELM2 LED



FEATURES & SPECIFICATIONS

**INTENDED USE** — Provides a minimum of 90 minutes of illumination for the rated wattage upon loss of AC power. Ideal for applications requiring attractive unit equipment with quick installation. **Certain airborne contaminants can diminish integrity of acrylic.**

[Click here for Acrylic Environmental Compatibility table, for suitable uses.](#)

**CONSTRUCTION** — White, compact, low-profile contemporary design. Engineering-grade thermoplastic housing is impact-resistant, scratch-resistant and corrosion-proof. UL94V-0 flame rating. UV-stable resin resists discoloration from natural and man-made light sources.

Two LED lamp heads with T2 series parallel white LEDs each, provide redundant light sources to ensure emergency lighting performance. Expected LED lamp life up to 10 years.

Dual-voltage input capability (120/277V). Edge connector on printed circuit board ensures long-term durability. Low-profile, integrated test switch/pilot light. Easily visible bright red status indicator.

Unique track-and-swivel arrangement permits full range of direction of lamp head adjustment. Universal J-box mounting pattern. Tool-less access for maintenance. Flexible conduit entry provision on top of the unit.

Ceiling- or wall-mount standard.

**ELECTRICAL** — Current-limiting charger maximizes battery life and minimizes energy consumption. Provides low operating costs.

Short-circuit protection — current-limiting charger circuitry protects printed circuit board from shorts.

Thermal compensation adjusts charger output to provide optimum charge voltage relative to ambient temperature.

Regulated charge voltage maintains constant-charge voltage over a wide range of line voltages. Prevents over/undercharging that shortens battery life and reduces capacity.

Filtered charger input minimizes charge voltage ripple and extends battery life.

AC/LVD reset allows battery connection before AC power is applied and prevents battery damage from deep discharge.

Single multi-color LED indicator to display two-state charging, test activation and three-state diagnostic test. Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection. Self-diagnostic testing for 30 seconds every 30 days, 30 minute every 180 days and 90 minutes annually. Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition.

**BATTERY:** Sealed, maintenance-free nickel-cadmium battery delivers 90 minute capacity to emergency lamps. Two-state constant-current charge maximizes battery life and automatically recharges after battery discharge. Low-voltage disconnect prevents excessively deep discharge that can permanently damage the battery. Optional high-output battery available to power both local and optional LED remote lamp heads simultaneously.

**LISTING** — UL damp location listed standard (10-40°C). Meets UL 924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards.

**WARRANTY** — Full fixture five-year warranty.

Catalog Number
Notes
Type



Thermoplastic Emergency Light

ELM2 LED



LED Lamp Head  
Ni-Cad Battery



ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: ELM2 LED

Family	Lamp type	Housing	Options
ELM2	LED Two 1.5W/3.6V white LED	(blank) White B Black	H0 High-output ni-cad battery for 6W remote capacity SD Self-diagnostics NOM Meets Mexican standards <sup>1</sup>

Accessories: <sup>2,3</sup> Order as separate catalog number.	
ELA Q L0304	Single LED indoor remote head, white
ELAT Q L0304	Twin LED indoor remote head, white
ELA QWP L0304	Single LED weather-proof remote head, gray
ELAT QWP L0304	Twin LED weather-proof remote head, gray
ELA WG1	Wireguard, 15"W x 13-1/2" H x 6" D <sup>4</sup>

Notes

- Available in black or white. Consult factory for options.
- Also available in black. Add "B" after ELA to order black finish. Example: ELA B Q L0304.
- Only compatible with Quantum LED series. For use with self-diagnostics fixture, add SD to end of catalog number. Example: ELA Q L0304 SD.
- See spec sheet ELA-WG.

**ELM2 LED QUANTUM® Thermoplastic Emergency Light**

**SPECIFICATIONS**

**ELECTRICAL**

**Primary Circuit**

Rated LED Life <sup>1</sup>	Supply Voltage	Max. Amps	Max. Watts
10 years	120	.04	1.44
	277	.03	1.44

**BATTERY**

**Ni-Cad (N)**

Voltage	Shelf life <sup>2</sup>	Expected life <sup>2</sup>	Maintenance <sup>3</sup>	Optimum temperature <sup>4</sup>
3.6	3 years	7-9 yrs.	none	50-104°F (10-40°C)

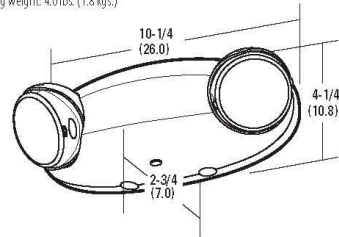
- Based on continuous operation.
- At 77°F (25°C).
- All life safety equipment, including emergency lighting path of egress, must be maintained, serviced and tested in accordance with all National Fire Protection Association and local codes. Failure to perform the required maintenance, service or testing could jeopardize the safety of occupants and will void all warranties.
- Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.

**REMOTE OUTPUT CAPACITY**

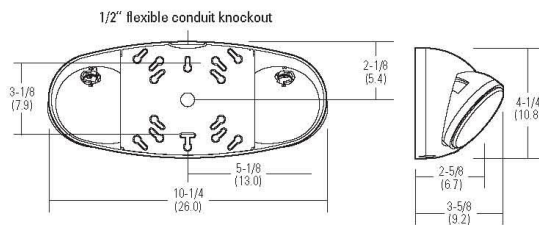
Standard unit	Unit\ high-output battery (HO)
NA	6W

**MOUNTING**

All dimensions are inches (centimeters).  
Shipping weight: 4.0 lbs. (1.8 kgs.)



**Mounting Plate**

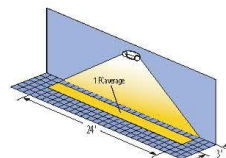


**LAMP PHOTOMETRICS**

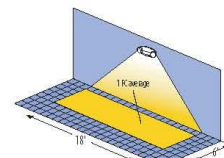
**QUANTUM LED SERIES – SINGLE COVERAGE**

3W Total White LEDs

Using a single unit at a typical 7.5' mounting height delivers an average illuminance of 1.0 FC over a distance of 24' on a 3' path of egress and 18' on a 6' path of egress.



Example of single ELM2 LED unit illuminating a 3' path of egress

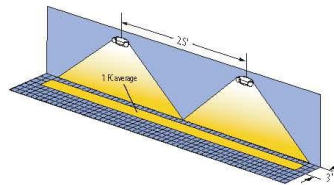


Example of single ELM2 LED unit illuminating a 6' path of egress

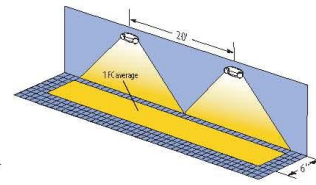
**QUANTUM LED SERIES – MULTIPLE COVERAGE**

3W Total White LEDs

Using multiple units at a typical 7.5' mounting height delivers 25' center-to-center spacing on a 3' path of egress and 20' center-to-center spacing on a 6' path of egress.



Example of multiple ELM2 LED units illuminating a 3' path of egress



Example of multiple ELM2 LED units illuminating a 6' path of egress

**EXTENDED RUN-TIME FOR HIGH-OUTPUT UNITS**

Product	Run time
ELM2 LED HO (no remotes)	3.9 hours

\* Meets Life Safety Code standard minimum illuminance of 0.1 FC and average illuminance of 1.0 FC. Assumes open space with no obstructions, mounting height: 7.5'; ceiling height: 9'; and reflectances: 80%/50%/20. Analysis based on independently tested photometrics.



ELM2\_LED

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