

A E 481 THESIS TECHNICAL REPORT ONE

# Shepherd University Wellness Center | AE 481 Thesis Lighting Technical Report 1

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Lighting/ Electrical Option  
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Models can be found at T:\lab5097

## Executive Summary

The Shepherd University Wellness Center is a multi-function facility that provides a balanced recreational program for the students, faculty, and staff of the University. The Technical Report One is a detailed analysis of the existing lighting design of the Shepherd University Wellness Center.

Four spaces will be considered: the fitness room, as a large work space; the multi-purpose room, as a special purpose space; the rotunda, as a circulation space; and the outdoor entry, as the outdoor space. Each space will contain a description of its use and materials, drawings, the specified lighting equipment, design considerations, and an evaluation of the lighting design.

Overall, the existing lighting design adequately provides light for the desired activities within each space. The fitness room uses light to distinguish sub spaces of different workout tasks, while the multi-purpose room allows for flexibility of the use of light for each type of aerobic activity. The rotunda enhances the architecture of the building entrance. The outdoor entry relates the building to the University campus.

## Fitness Room | Large Work Space

### Existing Conditions

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 is about 7,500 square feet and consists of free weights, resistance machines, and cardio equipment. The space also contains nine flat screen televisions.

Materials:

MATERIAL	OBJECT	COLOR	REFLECTANCE
Glass	Windows	N/A	0.40
Athletic Flooring	Floor	Marine Blue G786, Grey G707	0.03, 0.23
Paint	Walls	Elmira White HC-84	0.70
Acoustical Ceiling Tile	Ceiling	N/A	0.78

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

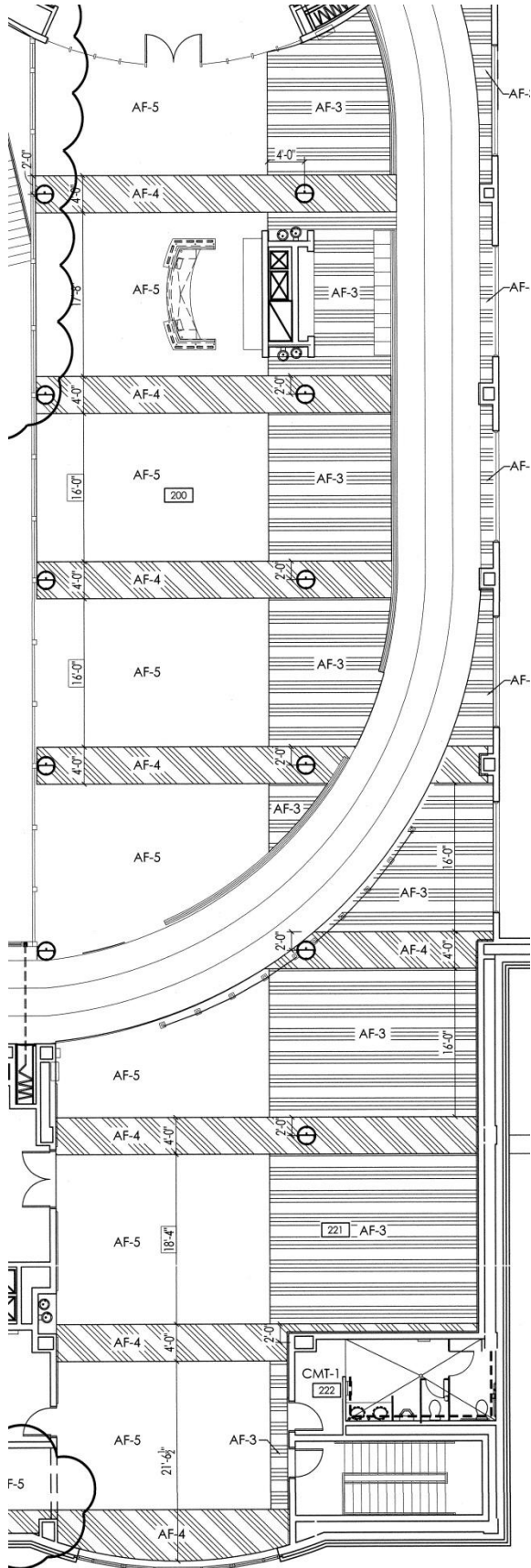


Figure 1: Finish floor plan of the fitness room.

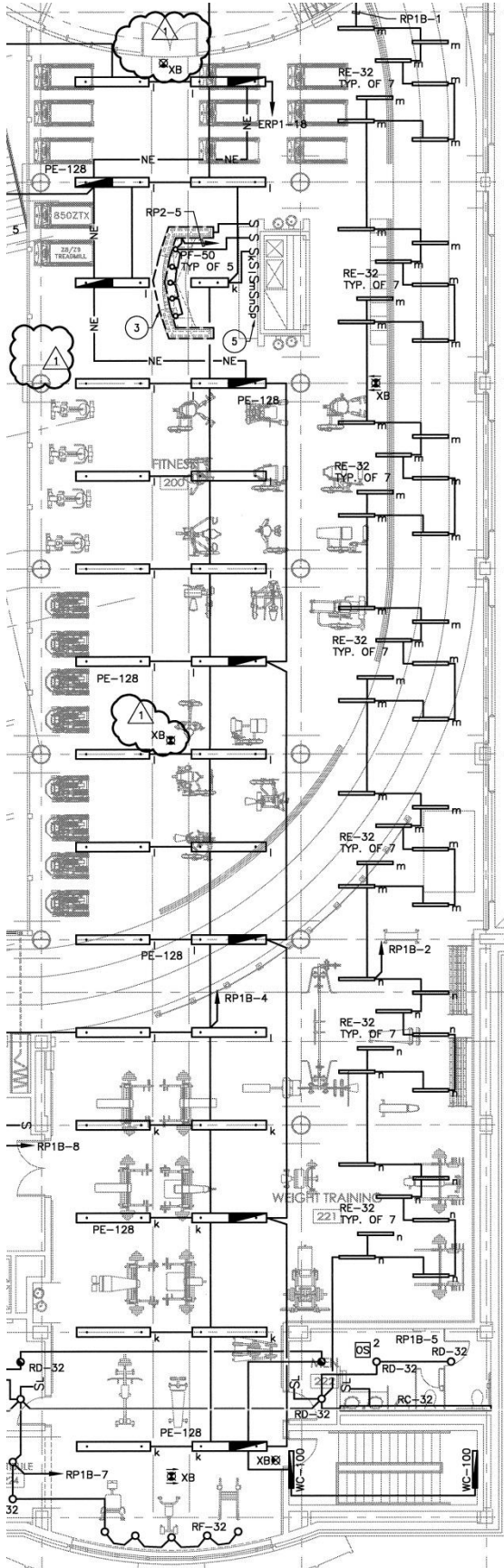


Figure 2: Existing lighting plan of the fitness room.





Figure 3: Sketch of the fitness room.

## Lighting Equipment

Description: The fitness room uses two types of fluorescent luminaires for the overall ambient lighting. Low voltage halogen lamps provide task lighting above the main desk. Compact fluorescent downlights accent the space by the window.

LUMINAIRE SCHEDULE					
TYPE	MANUFACTURER/ CATALOG NUMBER	LAMP	MOUNTING LOCATION	VOLTAGE	DESCRIPTION
PE-128	Litecontrol #PI54-48/T8-XXX-XXX-ECSS	32 Watt T8 Fluorescent	Pendant	277V	8', 2 lamps in cross section, crescent profile, linear indirect fluorescent pendent with a "shelf style" end cap. Luminaire is nominal 3" high by 9" wide.
PF-50	Tech Lighting #700FJ-IFS-21 Pendant #700FJSFV-S Transformer	50 Watt Bi-Pin Halogen	Pendant	120V	Frosted glass low voltage decorative pendant with a cone shaped canopy holding a 75 Watt, 12 Volt transformer. All exposed trim in satin nickel.
RE-32	Selux #MIRI-1T8-SD-XX-004-WH-XXX	32 Watt T8 Fluorescent	Recessed	277V	6" wide, 4" deep slot style luminaire with satin lens and single lamp. Luminaire depth may not exceed 4".
RF-32	Gotham #AFV-32TRT-6ARLD-MVOLT	32 Watt TRT Compact Fluorescent	Recessed	120/277V	6" diameter aperture, vertical lamp compact fluorescent open downlight with a semi-diffuse low iridescent alzak reflector and overlapping flange.
XB	Pathway Lighting #XR	LED	Universal	120/277V	White polycarbonate tapered face panel, LED exit sign that features a pivoting head for any type of mounting.

## Lighting Design Criteria

*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.
- Reflected Glare
  - 60 percent reflectance for ceiling and 30 to 60 percent reflectance for walls is recommended.
- Illuminance
  - General uniform and diffuse lighting of 30 footcandles is recommended.



*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.

## Evaluation and Critique

The existing lighting design provides a unique layout of luminaires to compliment the space. The fitness room is divided into two large halves, and then subdivided on one side through the use of different ceiling heights. The left half of the room shows a uniform layout of two foot by eight foot fluorescent pendants hanging from a 14 foot high ceiling. The right half of the room shows a recessed fluorescent luminaire layout on at 15 foot, 8 inch high ceiling with a slightly lower illuminance value on average. Thus, the lighting clearly distinguishes the two spaces.

The average horizontal illuminance of about 27 footcandles is sufficient for the recommended 30 footcandles by the *IESNA Lighting Handbook*. More light is generated over the left side of the room where most of the fitness machines are located, which meets the safety criteria for the space. Also, spot lights are directed above the main desk for task lighting.

Looking inside the space from the exterior of the building, the compact fluorescent accent lighting along the window provides interest to the space. The accent lighting breaks up the long uniform layout; however, it is hidden to most viewers. This feature could be mirrored within the space to divide the left side of the room further.

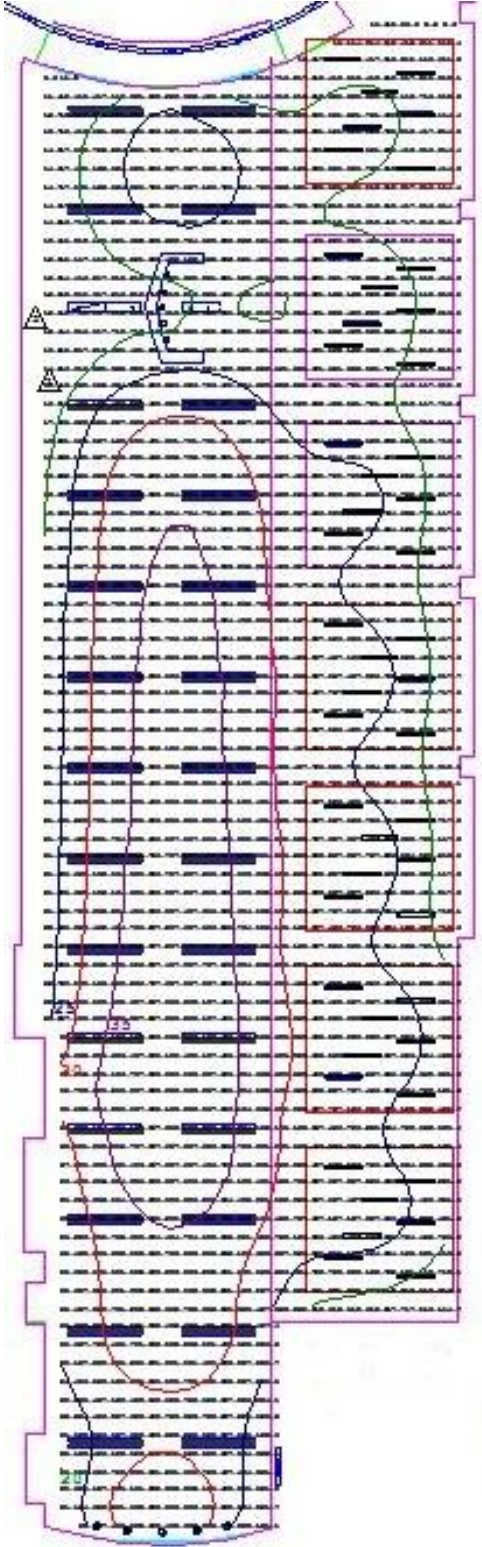


Figure 4: Existing illuminance levels of the fitness room. The purple, red, blue, and green lines represent 35, 30, 25, and 20 footcandles respectively.



Figure 5: Existing lighting design of the fitness room.

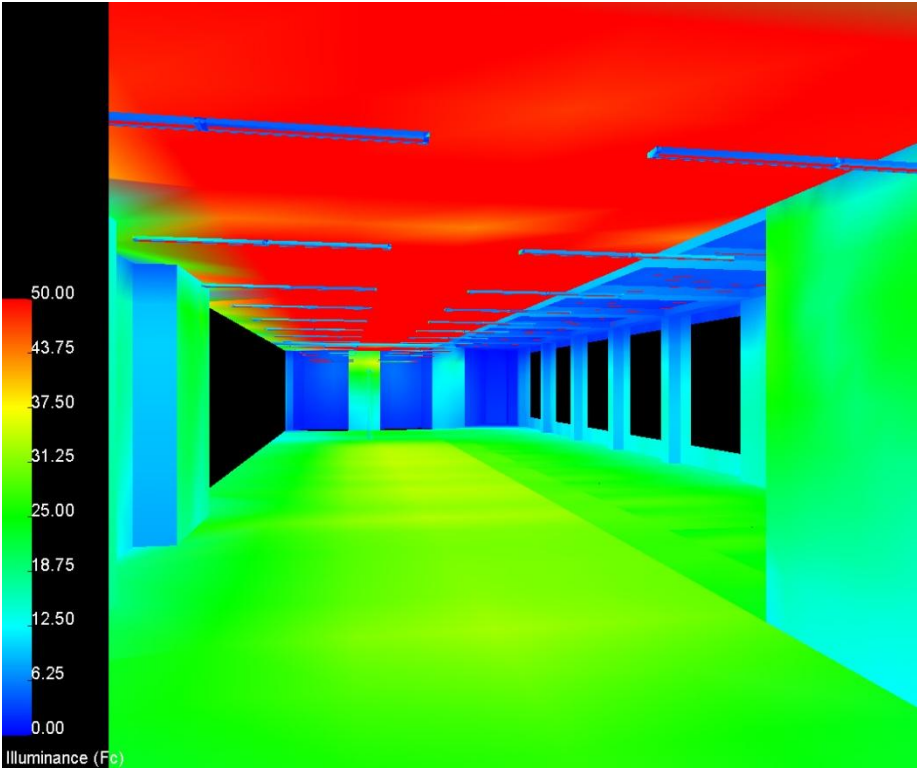


Figure 6: Illuminance pseudo-color diagram of the fitness room. Illuminance scale shown in footcandles

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Model Calculation Output: at a work plane of 2.5 feet

	Horizontal Illuminance (fc)	Vertical Illuminance (fc)
Average	26.67	11.46
Max/ Min	4.48	38.20

Light Loss Factors: *IESNA Lighting Handbook 9<sup>th</sup> Edition*

Luminaire Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor
PE-128	0.95	0.93	0.88	0.78
PF-50	0.94	0.93	N/A	0.87
RE-32	0.95	0.93	0.88	0.78
RF-32	0.95	0.93	0.88	0.78

Model Assumptions

- Window height of 12 feet and 2 feet above floor
- Clean environment with 12 month cleaning interval
- Use GE Electronic Dimming Ballast

## Multi-Purpose Room | Special Purpose Space

### Existing Conditions

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. This space does not contain furniture or any permanent layout. The room is equipped for dance, aerobic, and wellness classes.

Materials:

MATERIAL	OBJECT	COLOR	REFLECTANCE
Wood Athletic Flooring	Flooring	N/A	0.55
Windows	Wall	N/A	0.50
Paint	Walls	Elmira White HC-84	0.70
Acoustical Ceiling Tile	Ceiling	N/A	0.78

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



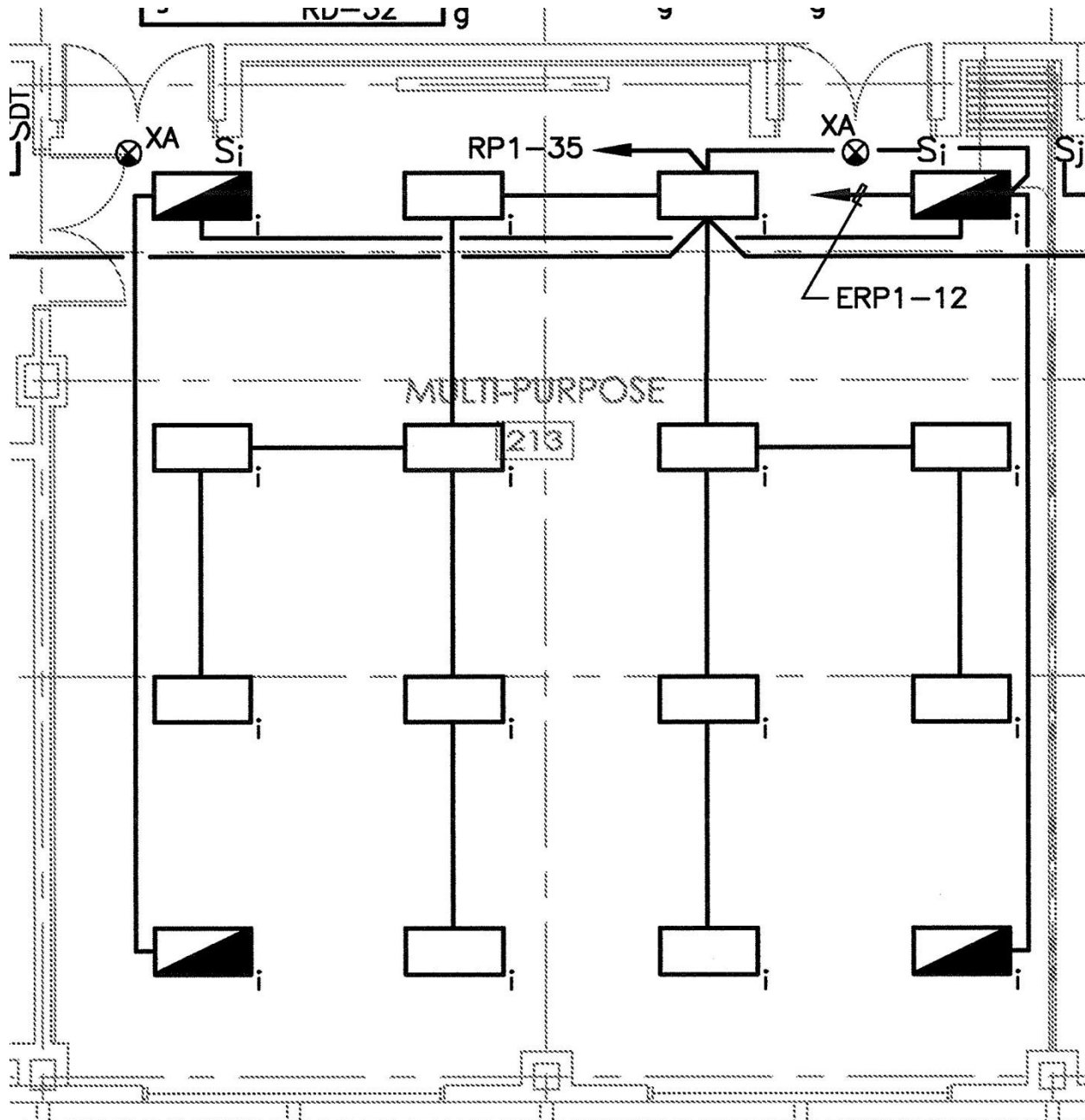


Figure 7: Existing lighting plan of the fitness room.

### Lighting Equipment

Description: This space uses a uniform layout of 16 troffers, each two foot by four foot, with three T8 fluorescent lamps. The lighting plan allows for switch and dimming control.

LUMINAIRE SCHEDULE					
TYPE	MANUFACTURER/ CATALOG NUMBER	LAMP	MOUNTING LOCATION	VOLTAGE	DESCRIPTION
RA-96	HE Williams #HE3X-D24-332-36S-X-XX- XXX	32 Watt T8 Fluorescent	Recessed	277V	2' x 4' 3 lamp recessed troffer with 3" deep semi-diffuse low iridescent 18 cell parabolic louvers.
XA	Lithonia #LRP-1RC-X-120/277-X	LED	Ceiling	120/277V	Single face, edge-lit LED exit sign with brushed aluminum trim.

## Lighting Design Criteria

*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 (3000 K) 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.
- Daylighting Integration and Control: Important
  - This space has two large windows that may need blinds to control the amount of direct sunlight penetration into the space. Shadows cast by daylight may cause risk of injury to the participants' visual limitation. Daylight may not be desirable for more somber activities such as yoga.
- 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 classes that will utilize the space. Occupancy sensors would be advisable to maximize the lighting system's efficiency.

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- 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 may be used.
- Vertical Illuminance: Somewhat Important
  - 3 footcandles is recommended for orientation and simple visual tasks.

*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 somber and festive impressions.

## Evaluation and Critique

The existing two foot by four foot troffer layout works well for the multi-purpose room. The system control allows the space to accommodate the different types of aerobic classes offered. The use of daylight in this space is an excellent feature that aids in the color appearance and modeling of people and objects. Daylight control, however, is a design consideration that should be addressed through the use of a shading mechanism.

While the *IESNA Lighting Handbook* recommends five footcandles horizontally for simple visual tasks, this space needs more illuminance to accommodate the aerobic tasks. The existing lighting design produced an average horizontal illuminance of about 60 footcandles with all luminaires fully turned on. This value is rather high and should be reduced to about 40 footcandles at full light output by using an energy saving lamp.

The existing lighting layout does not provide aesthetic appeal to the space, but it does compliment the simple geometry of the space using squares. Overall, the lighting design for this space provides visual clarity for the occupancy and is appropriate for the space functionality.



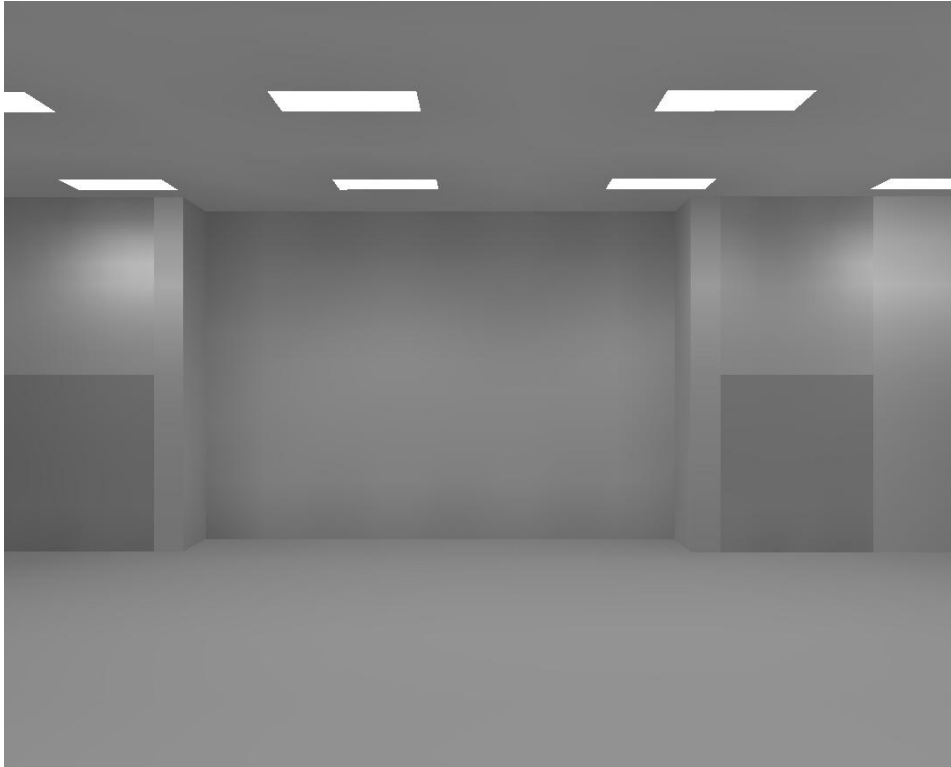


Figure 9: Existing lighting design of the multi-purpose room.

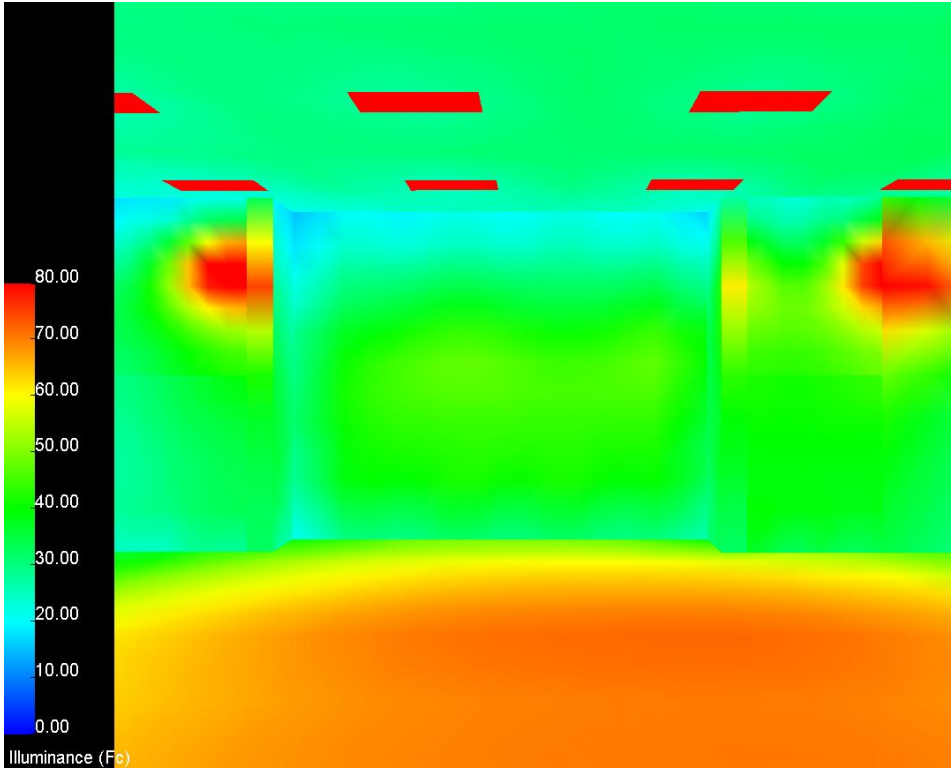


Figure 10: Illuminance pseudo-color diagram of the multi-purpose room. Illuminance scale shown in footcandles



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Model Calculation Output: at a work plane of 2.5 feet

	Horizontal Illuminance (fc)	Vertical Illuminance (fc)
Average	61.87	34.56
Max/ Min	2.18	2.49

Light Loss Factors: *IESNA Lighting Handbook 9<sup>th</sup> Edition*

Luminaire Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor
RA-96	0.95	0.93	0.88	0.78

Model Assumptions

- Door height of 7 feet
- Window height of 9 feet and 2 feet above floor
- Clean environment with 12 month cleaning interval
- Use GE Ecolux T8 lamp with GE Electronic Dimming Ballast

## Rotunda | Circulation Space

### Existing Conditions

Description: This two-story 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. A circular walking path with a bisecting arc shaped walking path breaks up the openness of the space on the second level. This space's main purpose serves for circulation and egress.

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.



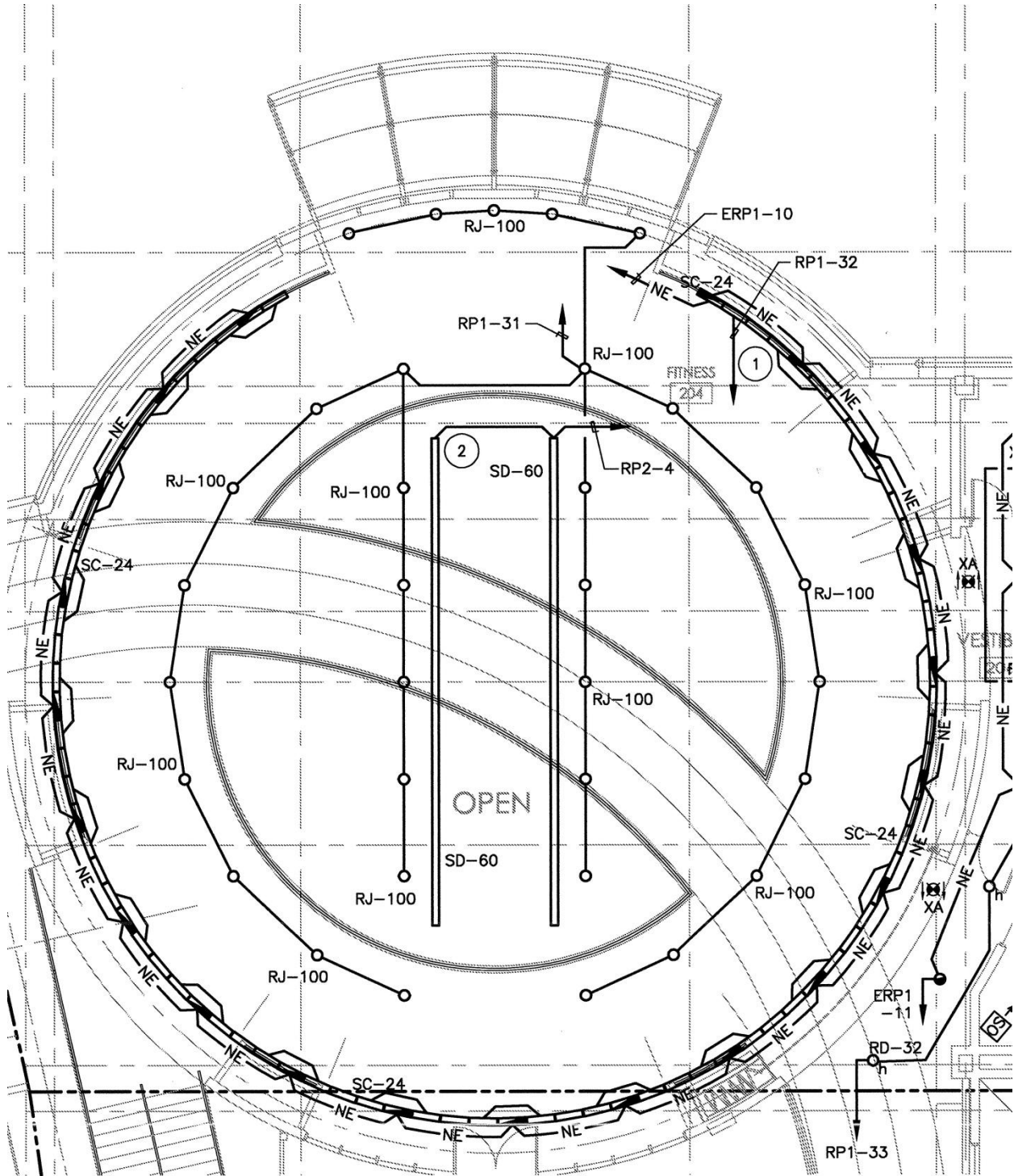


Figure 12: Existing lighting plan of the second floor rotunda.

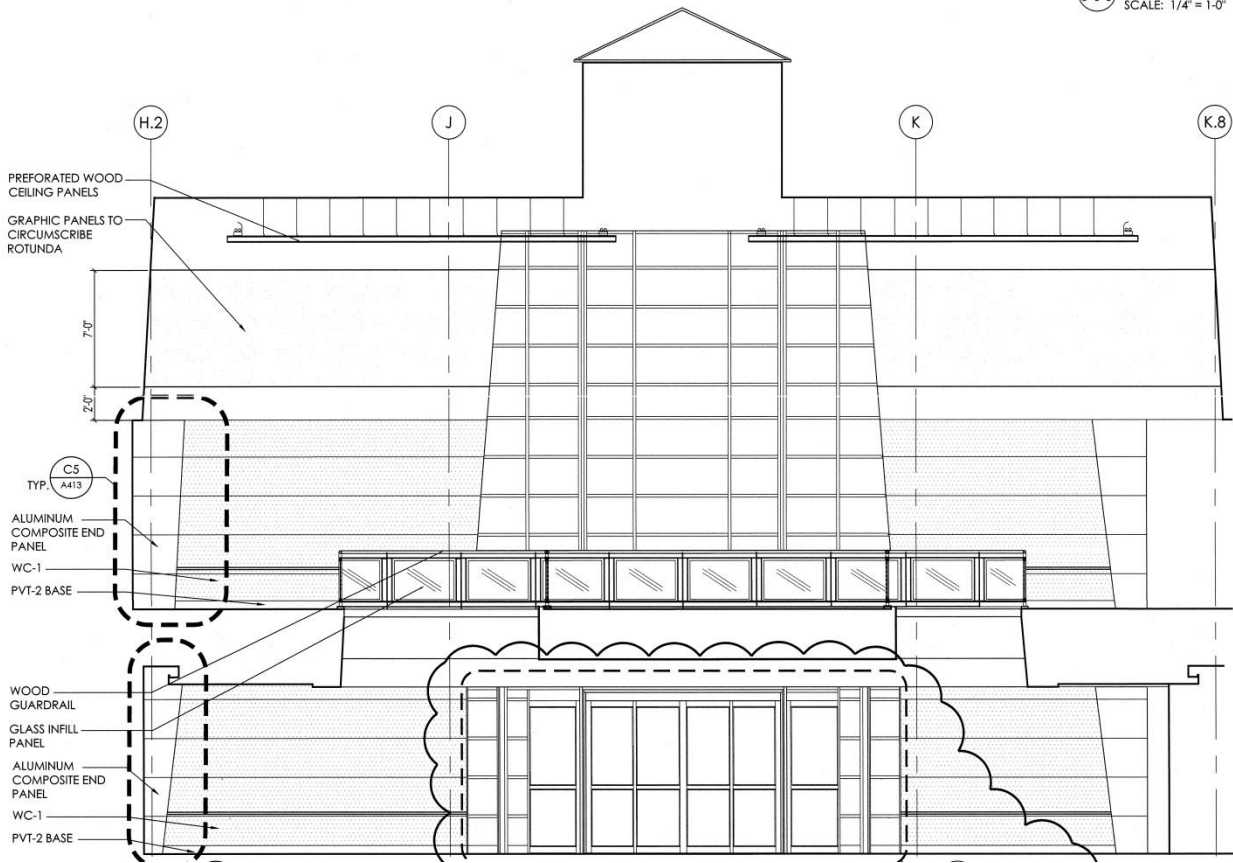


Figure 13: North elevation of the rotunda.



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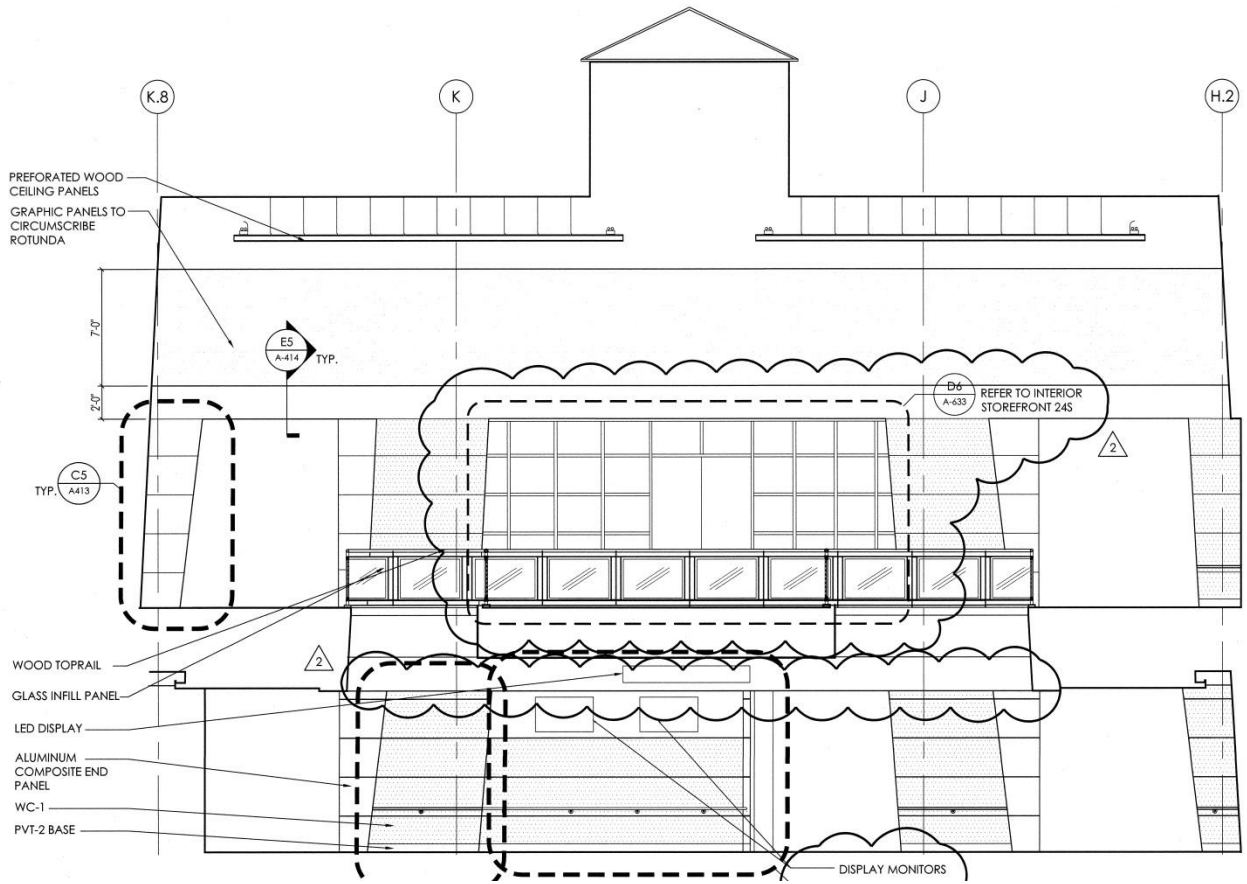


Figure 14: South elevation of the rotunda.

## Lighting Equipment

Description: Incandescent, fluorescent, metal halide, and xenon lamp sources are found in this space. Cove lighting on the first and second floor surround the perimeter of the space.

LUMINAIRE SCHEDULE					
TYPE	MANUFACTURER/ CATALOG NUMBER	LAMP	MOUNTING LOCATION	VOLTAGE	DESCRIPTION
RD-32	Gotham #AFV-32TRT-8ARLD- MVOLT	32 Watt TRT Compact Fluorescent	Recessed	120/277V	8" diameter aperture single lamp compact fluorescent open downlight with a semi-diffuse low iridescent alzak reflector and overlapping flange.
RE-32	Selux #MIRI-1T8-SD-XX-004-WH- XXX	32 Watt T8 Fluorescent	Recessed	277V	6" wide, 4" deep slot style luminaire with satin lens and single lamp. Luminaire depth may not exceed 4".
RI-50	Gotham #DLV-DWN-MR16-4AC-LD- XXX	50 Watt MR16	Recessed	277V	4" diameter aperture, downlight with a clear, semi-diffuse low iridescent alzak reflector and overlapping flange.
RJ-100	Gotham #AH100MHC-8ARLD-XXX	100 Watt Color Corrected Coated Metal Halide	Recessed	277V	8" diameter aperture, metal halide downlight with a clear, semi-diffuse, low iridescent alzak reflector and overlapping flange.
SC-24	Elliptipar #F306-T124-S-00-X-000	24 Watt T5HO Fluorescent	Surface	277V	2' single lamp T5HO fluorescent cove luminaire with a single scoop shaped reflector.
SD-60	Celestial Lighting #COR-1-RL-24-10-2.4-AR- XX	10 Watt Xenon Rigid Loop, 24 Volt, 2800K, 20000 HR	Surface	120V	Fully flexible low voltage linear light that can bend both vertically and horizontally. The Xenon lamps shall be held 2.4 inches apart. System shall be capable of handling up to 25 Amps. Lengths shall be field cuttable. Fixture to have an integral asymmetric reflector.
SH-24	Lithonia MS5-1-24T5HO-MVOLT- GEB10PS	24 Watt T5HO Fluorescent	Surface	120V	2' single lamp low profile striplight. Luminaire is to be integrated with signage and casework.
XA	Lithonia #LRP-1RC-X-120/277-X	LED	Ceiling	120/277V	Single face, edge-lit LED exit sign with brushed aluminum trim.

## Lighting Design Criteria

### *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.

## Evaluation and Critique

The overall existing lighting design within the rotunda uses perimeter lighting to reinforce the psychological aspect of spaciousness. The two rings of luminaires one the first floor that is then mirrored on the second floor compliments the circular architectural features of this space. This ring of light guides visitors throughout the space towards the corridors located off of this main building entrance. Additionally, metal halide spot lights on the second floor ceiling visually guide visitors from the door entrance to the reception desk located directly across the circular space.

The design combines incandescent, fluorescent, metal halide, and xenon lamps. The combination of lamp sources allows for flexibility of the space, yet may appear as a chaotic scheme of color when mixed with the daylight from the front glass façade. A cooler color temperature for the metal halide and incandescent light sources may be used to blend in more with the daylight.

## Outdoor Entry | Outdoor Space

### Existing Conditions

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. This space’s main purpose serves for circulation and egress.

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.

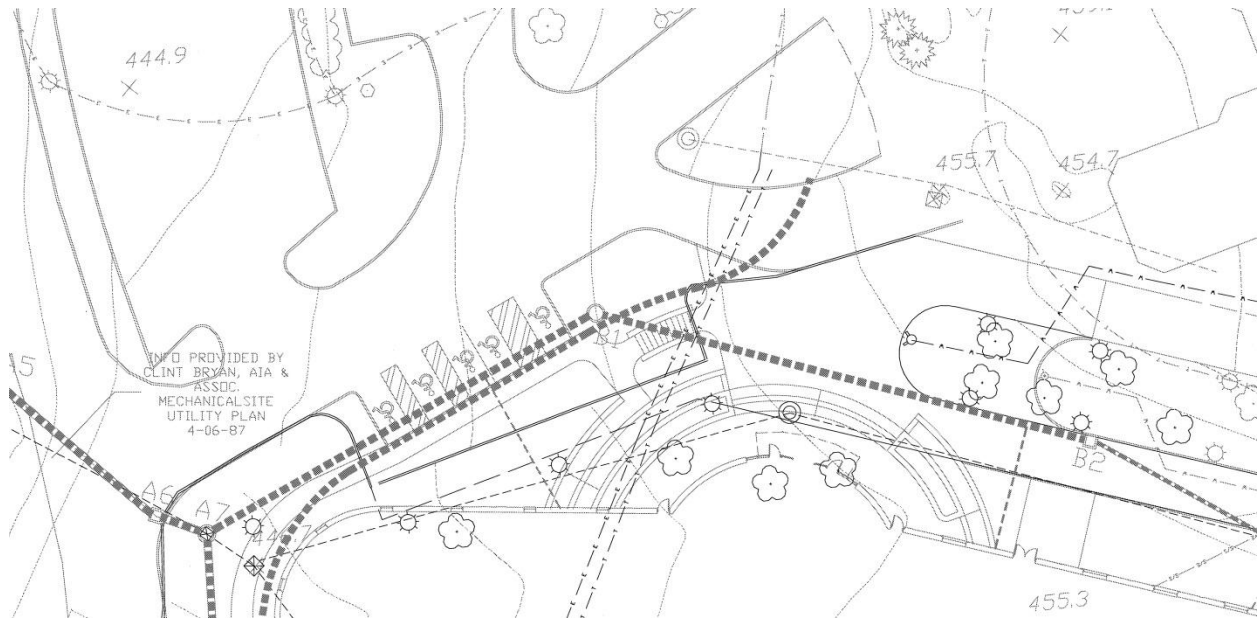


Figure 15: Electrical plan of the outdoor entry.

## Lighting Equipment

Description: University standard metal halide poles and luminaires are used throughout this space. Compact fluorescent steplights are added for safety in areas that do not receive enough light.

LUMINAIRE SCHEDULE					
TYPE	MANUFACTURER/ CATALOG NUMBER	LAMP	MOUNTING LOCATION	VOLTAGE	DESCRIPTION
OB-32	Lightech, Inc. #SL8120 Series	32 Watt Triple Tube Compact Fluorescent	Wall	277V	Horizontal mount, compact fluorescent “brick” steplight fixture with a cast aluminum housing and cast aluminum recessed horizontal louver faceplate.
OD-300	Site Pole and Fixture Hadco #C2452-DWG02 Floodlight #1 Stern #PLG-100MH-RM-XXX-C- YK-SF-BK Floodlight #2 Stern #PLG-100MH-RN-XXX-C-YK- SF-BK	100 Watt Metal Halide	Pole/Yoke	277V	Decorative pedestrian sealed site pole with historic style fixture. Pole shall have an arm bracket on each side with a 2” pipe tenon that is 4” long and centered 10” from the edge of the pole. One flood light shall be mounted on each side of the pole such that the fixtures are parallel to the building entrance. The site pole/luminaire is a University standard. The 24x81 degree and 12x81 degree 50% beam spreads of the flood lights are critical to this design.

## Lighting Design Criteria

*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.



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- 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
  - Uncovered Parking Areas: Tradable Surfaces
    - Parking lots and drives: 0.15 W/ square feet
  - Building Grounds: Tradable Surfaces
    - Walkways less than 10 feet wide: 1.0 W/ linear foot
    - Plaza areas: 0.2 W/ square feet
  - Building Entrances and Exits: Tradable Surfaces
    - Main entry: 30 W/ linear foot of door width
  - Building Facades: Nontradable Surfaces
    - 0.2 W/ square feet for each illuminated wall or surface or 5.0 W/ linear foot for each illuminated wall or surface length

*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.

## Evaluation and Critique

The existing lighting design for the outdoor entry addresses the University's concern for uniformity throughout their campus. The decorative pole and luminaire blends the new building into the older campus setting. The steplights allow for additional light along the pathways to provide an adequate illuminance level to meet the safety of the space's visitors. The existing design does not address the building's parking lot or façade. Light within the parking lot should be provided for the safety for vehicular and pedestrian traffic, while light on the building façade should be provided for aesthetic appeal. The University standard pole and luminaire addressed light pollution issues and should be used throughout the parking lot as well.