# Army National Guard Readiness Center

## Technical Report 1

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**Computer files located at Y:\ijh5004\Thesis_Tech1_Comp_Files**

# Contents

# Executive Summary

The contents of Technical Report One are comprised of an evaluation of the lighting design and basic characteristics of the Army National Guard Readiness Center Addition. It is comprised of a 5 story tower atop 3 below grade levels. The building serves as an addition to an existing building but functions as a stand-alone structure. Its main purpose is to serve as an administrative office building to accommodate for the increase in the number of employees for the existing building. Open and private offices make up the majority of the square footage, with the exception of several special purpose areas including an auditorium, fitness center, and a library. Four specific spaces will be evaluated in detail in this report.

The spaces that will be studied are the 4$^{th}$ tower floor open office plan, auditorium, prefunction area, and outdoor plaza. Architectural features and existing lighting designs will be discussed in detail along with design criteria that should be incorporated within each space. At the end of each section, the space mentioned will be evaluated based on computer calculated data and/or qualitative analysis as well as energy code compliance.

Typical of an office building, the lighting design comprises of either recessed or pendant mounted fluorescent fixtures spaced out in even grids. This ensures uniform lighting at efficient energy costs. However there are a few special purpose spaces which break away from this mold in order to provide more architecturally aesthetic lighting. Most notably will be the auditorium discussed later on.

Despite the adequacy of the lighting designs within the spaces, there is still room for improvement. More efficiency in terms of power density can be acquired as well as additional architectural features can be highlighted. It is the intention of this report to provide an overview of the building features, design criteria, and the pros and cons of the lighting design in order to establish a basis for improvement.

# Open Office- Work Space

## *Existing Conditions:*

On almost every floor of the building there is a large open office, each very similar to the others. The one that will be evaluated in this report will be the open office area located on the fourth level of the tower portion of the building (level 4T) within the northeast section. This one was chosen because it appeared to be the most similar to the others. An exterior glass and aluminum curtain wall system makes up the entire north and east walls, allowing a large amount of natural light to enter the space. To the south and west of the office space are partition walls that separate the space from smaller, individual offices. The space will be comprised mostly of cubicles in sections of 6 to 8, each with its own desk and computer. Therefore, intensive VDT use is a design consideration within the space. Also, reading of various text sizes and styles will be a major task taking place within the space.

**Materials**

*Floor*- CPT-2: Modular Carpet Tile

- Description: Manufacturer- Constantine; Color- R252200; Pattern Name-Narrow
- Reflectance: 0.2

*Ceiling*- CLG1- Gypsum Wall Board

- Description: Bright White, Flat Sheen
- Reflectance: 0.76

ACT1- Acoustical Ceiling Tile and Grid

- Description: 2’ X 2’, White finish
- 0.8

*Base*- WB-1: Wood Wall Base

- Description: Color- Alabaster
- Reflectance: 0.3

*North Wall*- G6: Vision Glass

- Description: 3/4” Clear Glass (Specific glass type not chosen at this time)
- Reflectance: 0.25 (assumed)
- Transparency: 0.75 (assumed)

*East Wall*- G6: Vision Glass

- Description: 3/4" Clear Glass (Specific glass type not chosen at this time)
- Reflectance:  0.25 (assumed)
- Transparency: 0.75 (assumed)

*South Wall*- GWB1: Gypsum Wall Board

- Description: Eggshell Sheen
- Reflectance: 0.5

*West Wall*- GWB1: Gypsum Wall Board

- Description: Eggshell Sheen
- Reflectance: 0.5

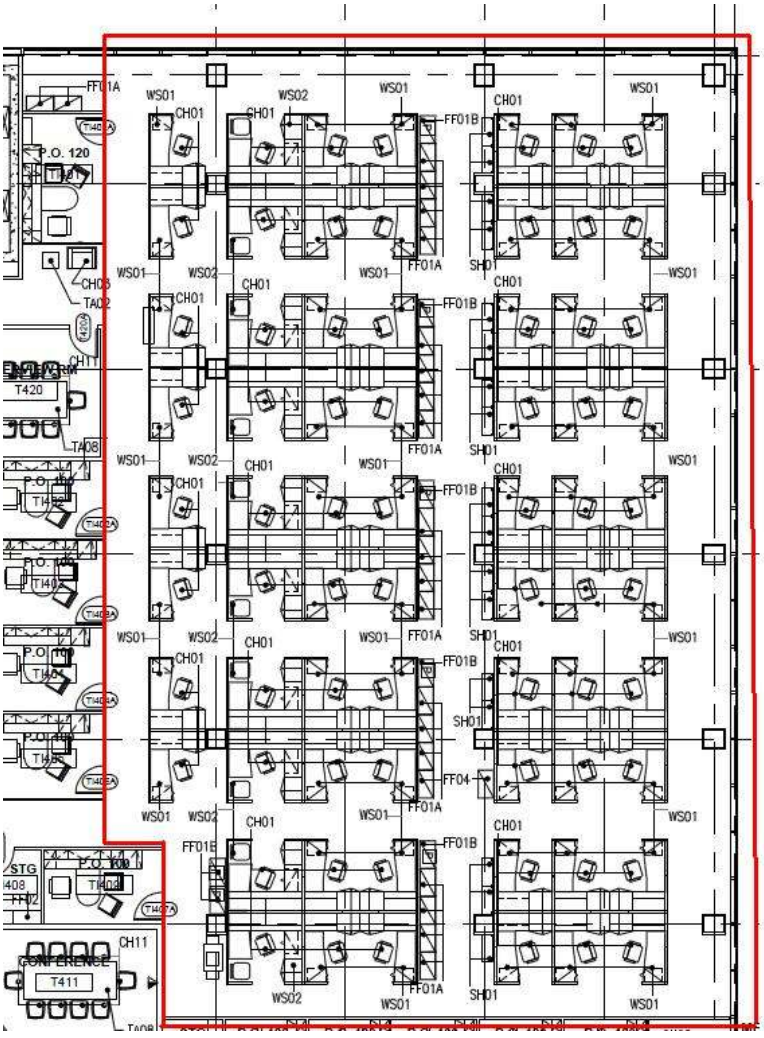


**Figure 1: Open Office Floor Plan**

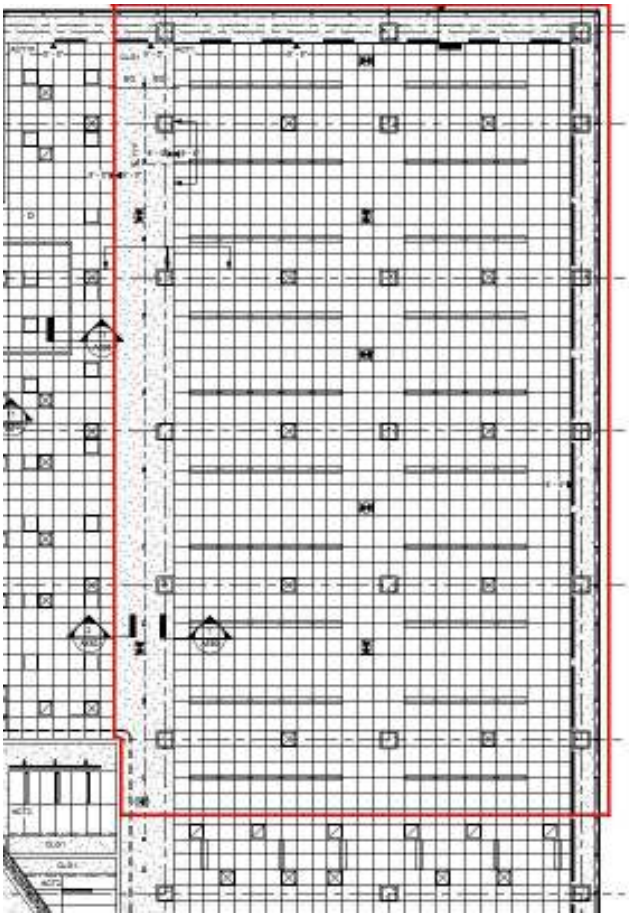

**Figure 2: Open Office Reflected Ceiling Plan**

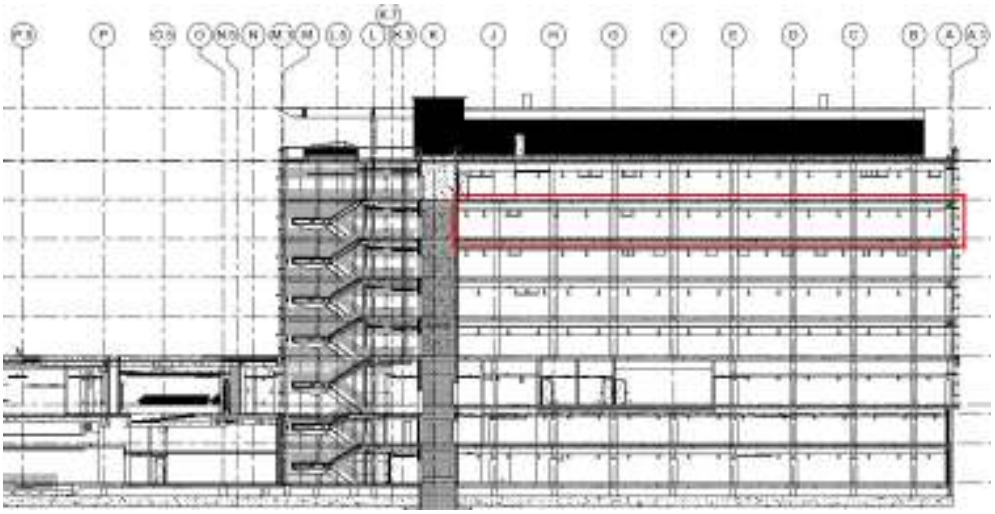

**Figure 3: Open Office Section**

## Lighting

The lighting system in the open office space is a combination of linear and compact fluorescent lamp fixtures. Rectilinear, indirect/direct pendant mounted luminaires hang over the cubicles while recessed down lights illuminate the walkway on the west side of the room. Luminaire placement is arranged within a grid-like pattern, which is ideal for uniform lighting. There appears to be a separation of space with not only the transition of ceiling material, but also the change from pendant mounted luminaires over the cubicles to recessed fixtures over the left aisle. All luminaires in the space are controlled via low voltage lighting control override switches and automatic control devices.

**Open Office Luminaire Schedule**

| Type | Description | Manufacturer | Catalog NO. | No. of Lamps | Lamp type | Watts Per Lamp | Voltage | Height |
|---|---|---|---|---|---|---|---|---|
| KA | Open Office Rectangular Pendant | Finelite | S16-WCB-SC-EP-Open-277-FA-EE With advance ballast # 1OP32-HL-SC 1.18 Ballast Factor | 1 | Sylvania F032/835PS/ECO-3100 Lumens CRI-85 T8-HO 3500k | 38W/4' | 277 | 8'-0" AFF |
| KB | 6" Square fluorescent recessed downlight horizontal lamp | Gotham | SQF-1/26TRT-6AR-LD-277 | 1 | CF26DT/E/IN/835 300K | 29W | 277 | 9’-0” |
| KC | 2' X 2' Direct recessed downlight | Ledalite | 9422-D2-ST-2TT5-S-1-277V | 1 | F40/30BX/SPX35 | 41W | 277 | 9’-0” |

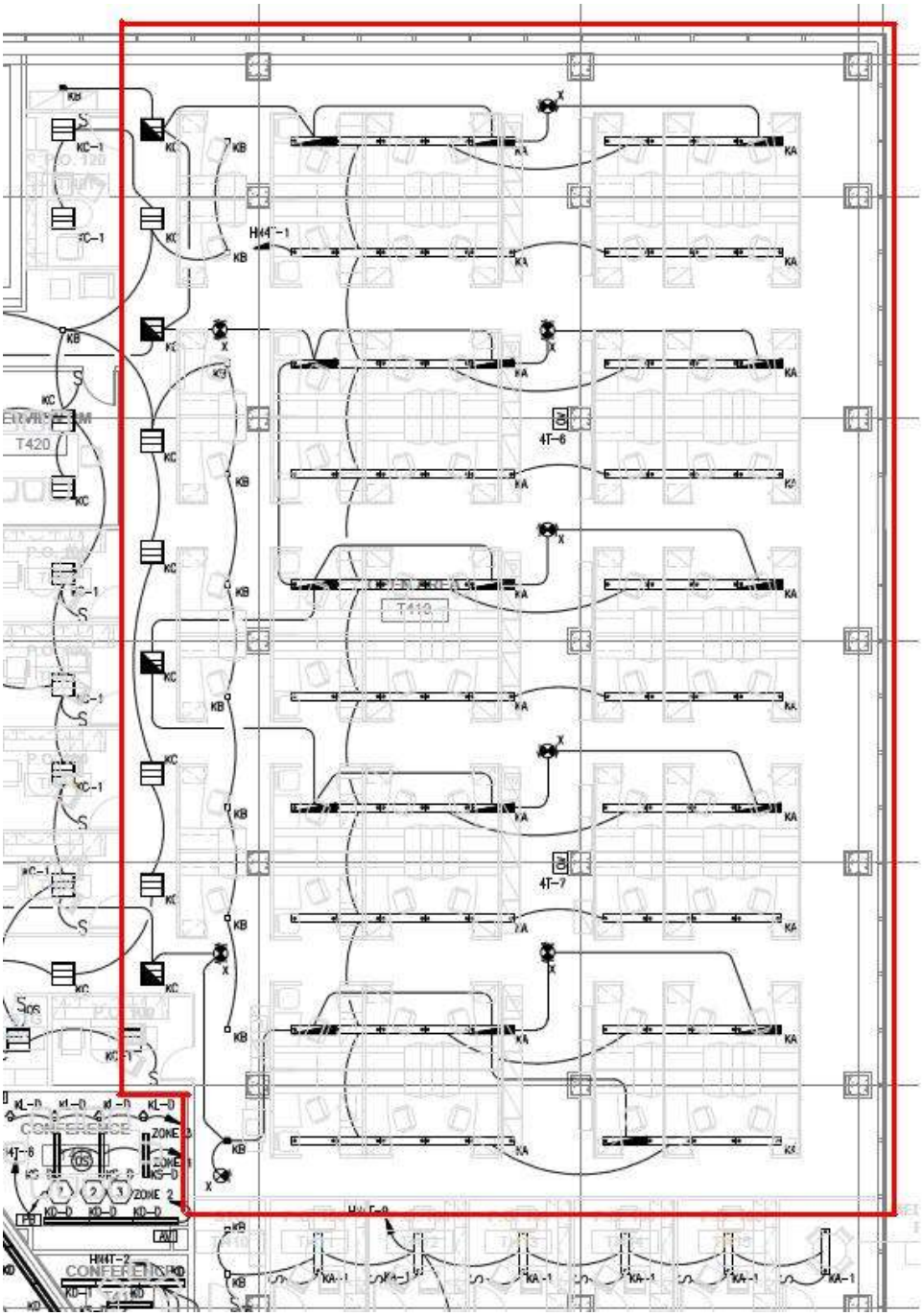


**Figure 4: Open Office Lighting Plan**

**Design Criteria:** Open plan office- Intensive VDT use; Reading- VDT screens, Handwritten tasks, Printed tasks

Illuminance Values

- Horizontal- 30 fc
- Vertical- 5 fc

Direct Glare- Very Important

- Direct glare can cause visual discomfort and interfere with visibility of the occupants. Its main causes are from luminaire placement and natural light coming in through windows. Because reading and writing will be two tasks being performed by the occupants, it is crucial to control this problem in order for work to be properly done. Considerations to prevent this lie in use of indirect instead of direct light sources, luminaire placement, and placement of seating around fenestrations.

Reflected Glare- Very Important

- Reflected glare can be caused by light refracting off of shiny or glossy surfaces such as magazines. Veiling reflections from such surfaces can cause visual discomfort and reduce contrast on the surface. It is very likely that the occupants will be reading text glossy paper so reflected glare should not be ignored. This problem can be solved in much the same way direct glare can.

Luminances of Surfaces- Very Important

- Luminance values should be uniform on all surfaces; including floor, wall, ceiling, and work plane in order to reduce visual clutter and distractions. However, a slightly higher luminance value may be desired on work surfaces in order to direct focus to the work of the occupants.

Light Distribution on Task Plane (Uniformity) - Very Important

- Uniformity on the task plane is important for visual clarity while performing tasks such as reading and writing. Any type of patterns is undesirable for they will be distracting to the occupants.

Source/ Task/ Eye Geometry- Very Important

- Luminaires should be kept away from the offending zone to reduce reflections. Indirect lighting and luminaires placed to the sides of the desks will help avoid these problems.

Appearance of Space and Luminaires- Important

- It is important that the space be bright and uniformly illuminated to avoid visual distractions and clutter. Areas of circulation should stand out in order to guide foot traffic.

Color Appearance (and Color Contrast) - Important

- Proper color rendering is crucial for producing a pleasant looking space and complementing the appearance of the occupants. Contrast is required for distinguishing text in reading applications.

Daylighting Integration and Controls- Important

- Daylighting integration is important for reduction of lighting load and to provide high quality light or light with exceptional color rendering. The space receives an ample amount of natural light due to the fact that about 50 percent of its walls are exterior glazing. However, measures need to be taken to control the amount of daylighting such as shading in order to reduce glare or excessive solar heat gain.

Modeling of Faces and or Objects- Important

- Within the work environment, it is often important for people to converse with one another and share ideas. Therefore, it is necessary that the occupants' faces are rendered in a pleasant manner in order to optimize social interaction.

**Power Allowances and Control Requirements (ASHRAE 90.1):**

ASHRAE 90.1 states that the maximum power density for an office space, using the Space-by-Space Method, is 1.1W/ft$^2$. As for lighting controls, because the building is over 5000 ft$^2$ "all interior lighting shall be controlled with an automatic control device to shut off building lighting in all spaces."

## *Evaluation:*

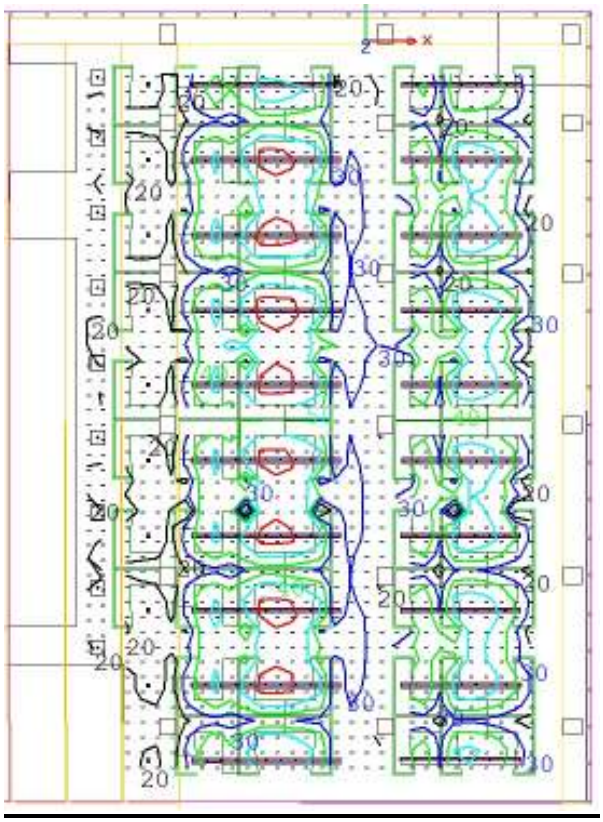


**Figure 5: Open Office Isoline**

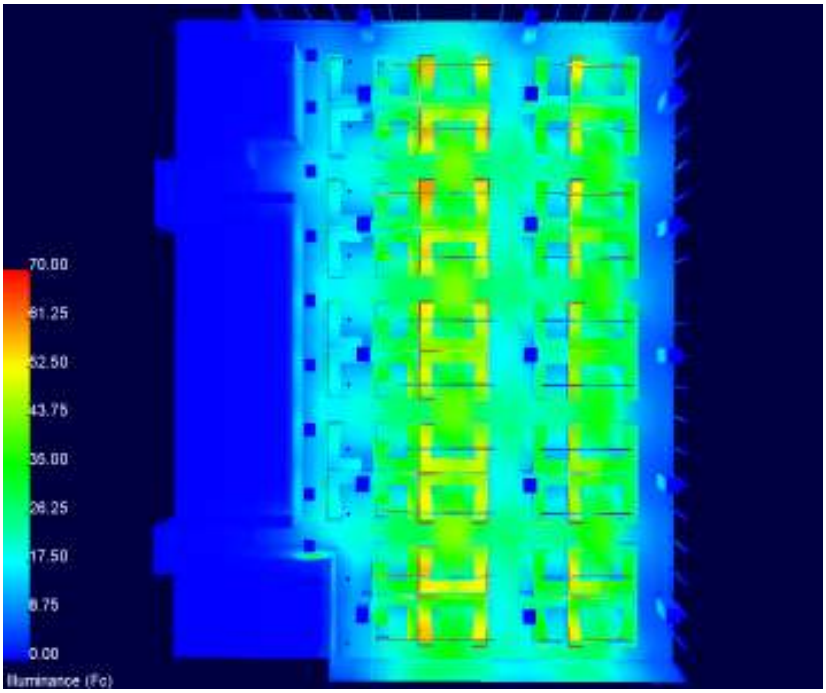


**Figure 6: Open Office Psudo Color Plan**

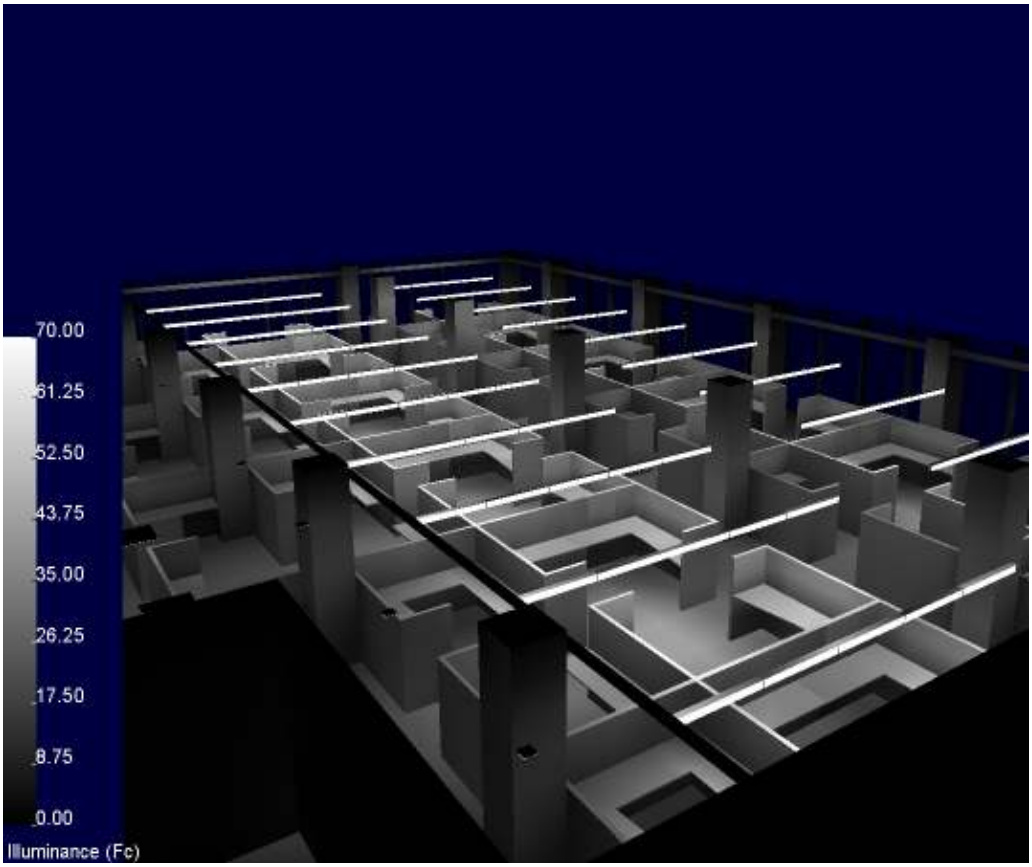


**Figure 7: Open Office Grey Scale Perspective**

| Light Loss Factors | | | |
|---|---|---|---|
| **Luminaire Type** | **LLD** | **LDD** | **BF** |
| KA | 0.95 | 0.95 | 1.18 |
| KB | 0.88 | 0.95 | 1.0 |
| KC | 0.9 | 0.95 | 1.0 |

| Power Density | | |
|---|---|---|
| **ASHRAE 90.1** | **Actual** | **Difference** |
| 1.1W/ft$^2$ | 0.31W/ft$^2$ | -0.79 W/ft$^2$ |

| Illuminance Values | | |
|---|---|---|
| | Workplane | Circulation |
| Average Illuminance | 37 | 19.6 |
| Maximum | 64 | 23 |
| Minimum | 20 | 17 |

According to the data, the existing lighting design meets both the IES recommended illuminance level on the work plane as well as the power density allowance stated in ASHRAE 90.1. For the most part, each cubicle receives the same amount of light with the exception of the last row on the left. There is a difference in illuminance values between the cubicles and areas of circulation, with the cubicles being of higher illuminance. This is a good feature of the design since more light is required on the task areas. The use of indirect/direct pendant luminaires is a good choice for the office space because the space utilizes more indirect, ambient light which will help reduce direct and reflected glare. Luminaire placement is also well done for many of them tend to stay out of the offending zone, eliminating direct glare and veiling reflections. Any problems with glare caused by daylighting can be avoided though the use of the roller window shades near the perimeter of the walls as specified in the building plans.

One of the problems with the design is the insufficient light levels on the end row cubicles. According to the analysis, most of those desks receive 20 fc which is under the recommended 30 fc. Ironically, the cubicles more towards the center receive an excess of 35 fc. Therefore, more care should be taken to make sure the light levels are distributed more evenly. Also, the use of direct lighting over the end cubicles may have the propensity to cause shadows on the work plane.

# Auditorium- Special Purpose Space

## *Existing Conditions*:

The auditorium is located on the first floor below grade (level 1P) in the southern portion of the building. It is surrounded by corridors on the east, west, and south side and a prefunction area to the north, therefore, no natural sunlight enters the space. At the southern end of the auditorium lies a stage and motorized projector screen for presentations.

Materials:

*Floor*- CPT-5: Modular Carpet Tile (Seating Area)

- Description: Broad Loom; Manufacturer- Constantine; Color- Custom R204850
- Reflectance: 0.08

WF-1: Wood Floor (Stage)

- Description: Wood Sports Floor Bio-Cushion Classic; Manufacturer- Robbins, Northern Hard Maple
- Reflectance: 0.08

*Ceiling*- CLG1- Gypsum Wall Board

- Description: Bright White, Flat Sheen
- Reflectance: 0.76

*North Wall*- WD1: Wood Veneer

- Description: Quartered Red Gum
- Reflectance: 0.16

UWP2: Upholstered Wall Panel

- Description: Color- 029 Tonic
- Reflectance: 0.54

*East Wall*- WD1: Wood Veneer

- Description: Quartered Red Gum
- Reflectance: 0.16

UWP2: Upholstered Wall Panel

- Description: Color- 029 Tonic
- Reflectance: 0.54

UWP3: Upholstered Wall Panels

- Description: Color- 116-11 White Shadow
- Reflectance: 0.54

P1- Paint

- Description: Color- Alabaster
- Reflectance: 0.5

PL1- Plastic Laminate

- Description: Color- New White
- Reflectance: 0.6

*West Wall*- WD1: Wood Veneer

- Description: Quartered Red Gum
- Reflectance: 0.16

UWP2: Upholstered Wall Panel

- Description: Color- 029 Tonic
- Reflectance: 0.54

P1- Paint

- Description: Color- Alabaster
- Reflectance: 0.5

PL1- Plastic Laminate

- Description: Color- New White
- Reflectance: 0.6

*South Wall*- WD1: Wood Veneer

- Description: Quartered Red Gum
- Reflectance: 0.16

UWP2: Upholstered Wall Panel

- Description: Color- 029 Tonic
- Reflectance: 0.54

UWP3: Upholstered Wall Panels

- Description: Color- 116-11 White Shadow
- Reflectance: 0.54

P1- Paint

- Description: Color- Alabaster
- Reflectance: 0.5

PL1- Plastic Laminate

- Description: Color- New White
- Reflectance: 0.6

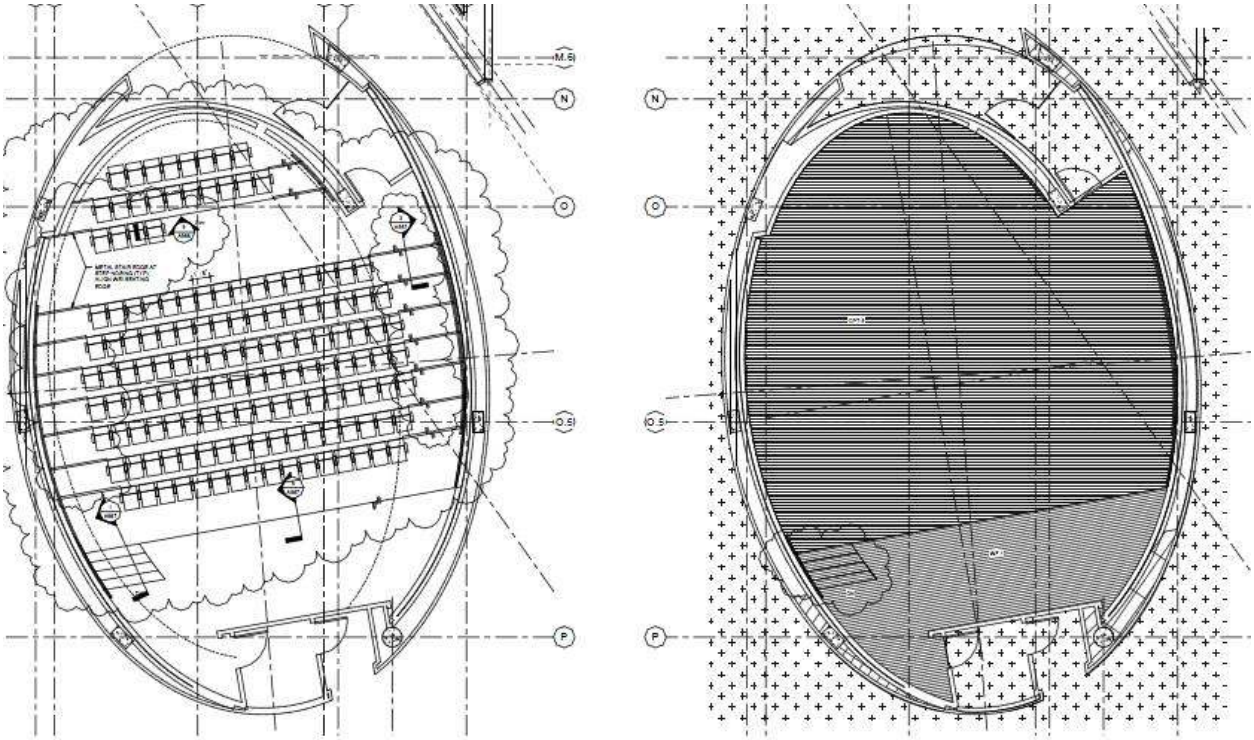

**Figure 8: Auditorium Furniture and Finish Plan**

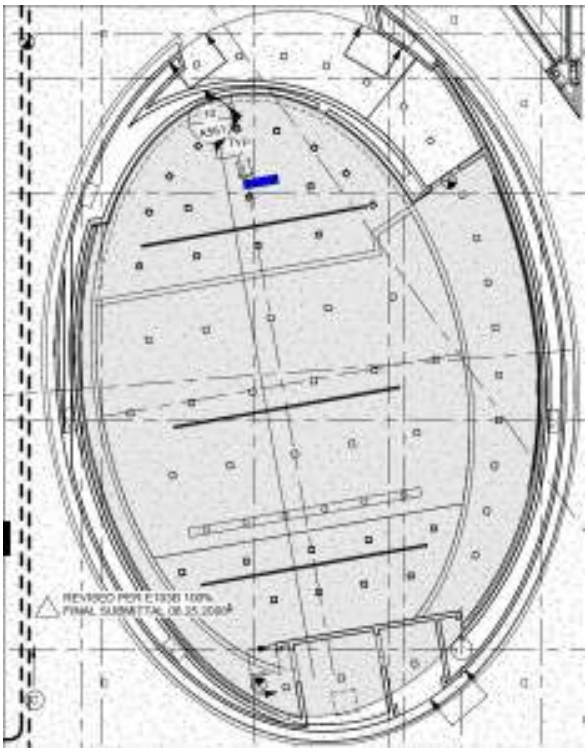

**Figure 9: Auditorium Reflected Ceiling Plan**

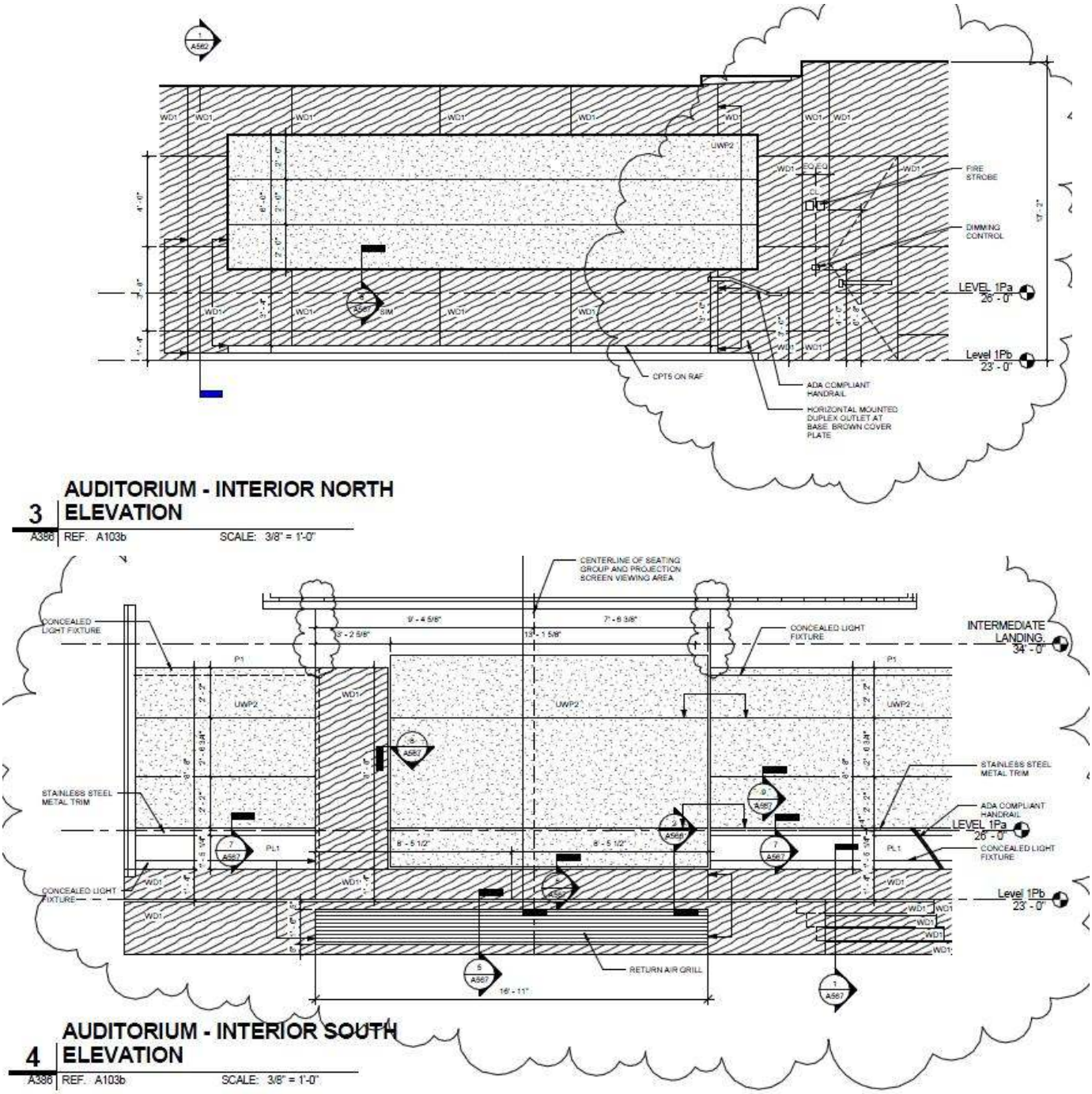


**Figure 10: Auditorium elevations**

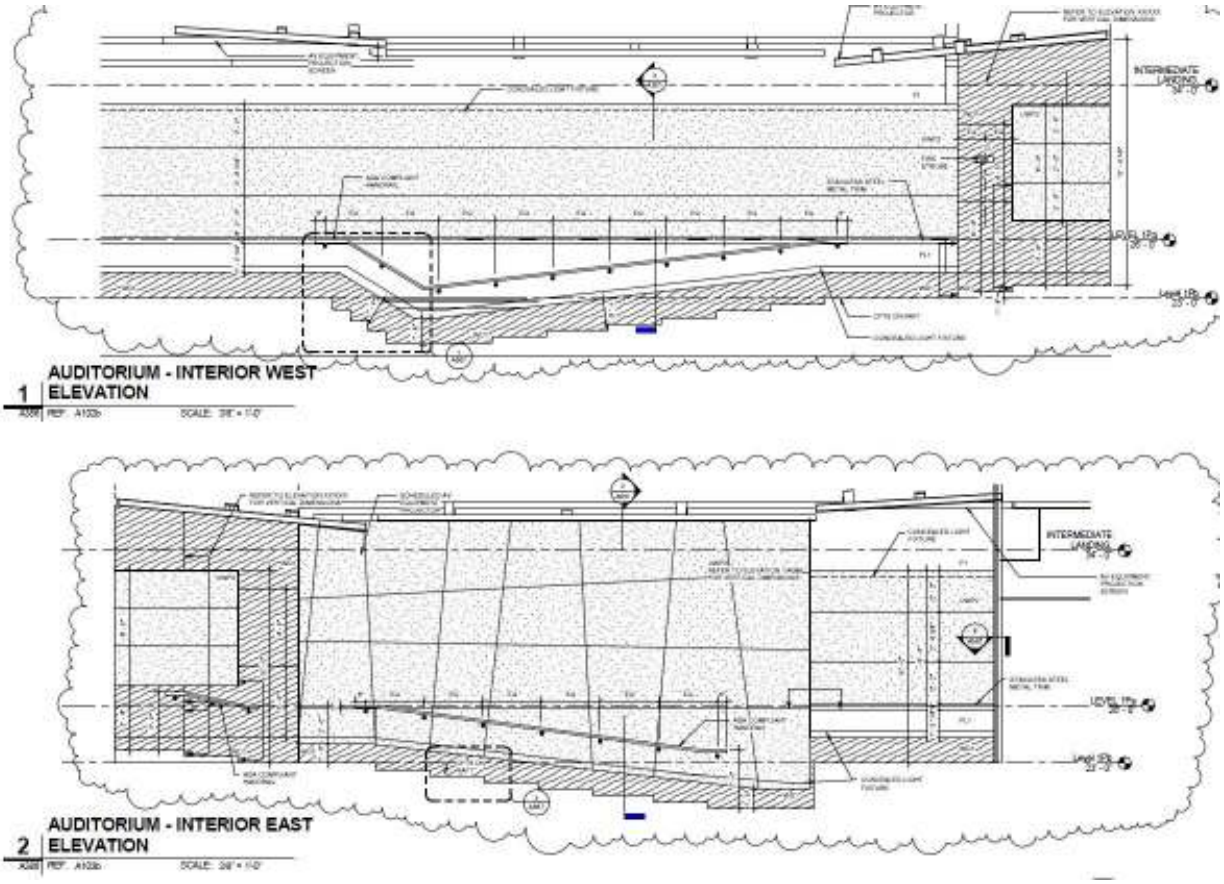


**Figure 11: Auditorium Elevations**

**Lighting:**

The auditorium is predominantly illuminated with incandescent downlights and track lighting, along with cold cathode accent lighting around the perimeter. The western and northern walkways are illuminated by 6" recessed, tungsten halogen wallwashers. Above the seating area and center aisles are recessed quartz downlights housing T4 frosted halogen lamps. In front of the stage is a track lighting system where PAR38 flood lights are mounted, which provides directional lighting on the stage. The center of the stage is illuminated by directional PAR38 downlights. One of the interesting aspects of the existing lighting system is the cold cathode cove lights concealed around the perimeter of the room. These are long, tubular, flexible light fixtures that can be adjusted to fit the contours of the curved walls. They are placed within a wall slot just under the hand rail and their main function is to help illuminate the walkways when overhead lighting is not desirable. All lighting systems in this space are connected to dimmable control systems.

| Auditorium Luminaire Schedule | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **Manufacturer** | **Catalog NO.** | **No. of Lamps** | **Lamp type** | **Watts Per Lamp** | **Voltage** | **Height** |
| KW | 6" Square parabolic quartz wall wass | Kurt Versen | H-8654-WT | 1 | Q150 T4 Mini Can-Frosted | 150 | 120 | |
| KX | Quartz Downlight | Kurt Versen | H-8604-150-WT | 1 | Q150 T4 Mini Can-Frosted | 150 | 120 | |
| KX-1 | Sloped Ceiling Quartz Downlight | Kurt Versen | H-8604-150-WT-W/ Sloped Ceiling Adapter | 1 | Q150 T4 Mini Can-Frosted | 150 | 120 | |
| KV-1 | Spot light for speaker MTD. To type KV track | Lightolier | 22OR8 White-AF7FR | 1 | Q 90 PAR 38/FL | 90 | 120 | |
| KU-D | Dimmable cold cathode cove curved on the inside of auditorium | Cathode LTG Systems | Flexible Cathode Light Strips- FCLS-C-277- 7.2 Lumens/Watt 30TC-3500K Dimmable | 1 | Flexible Cathode Light Strips FCLS-C-277 | 13.7W/ft | 277 | |

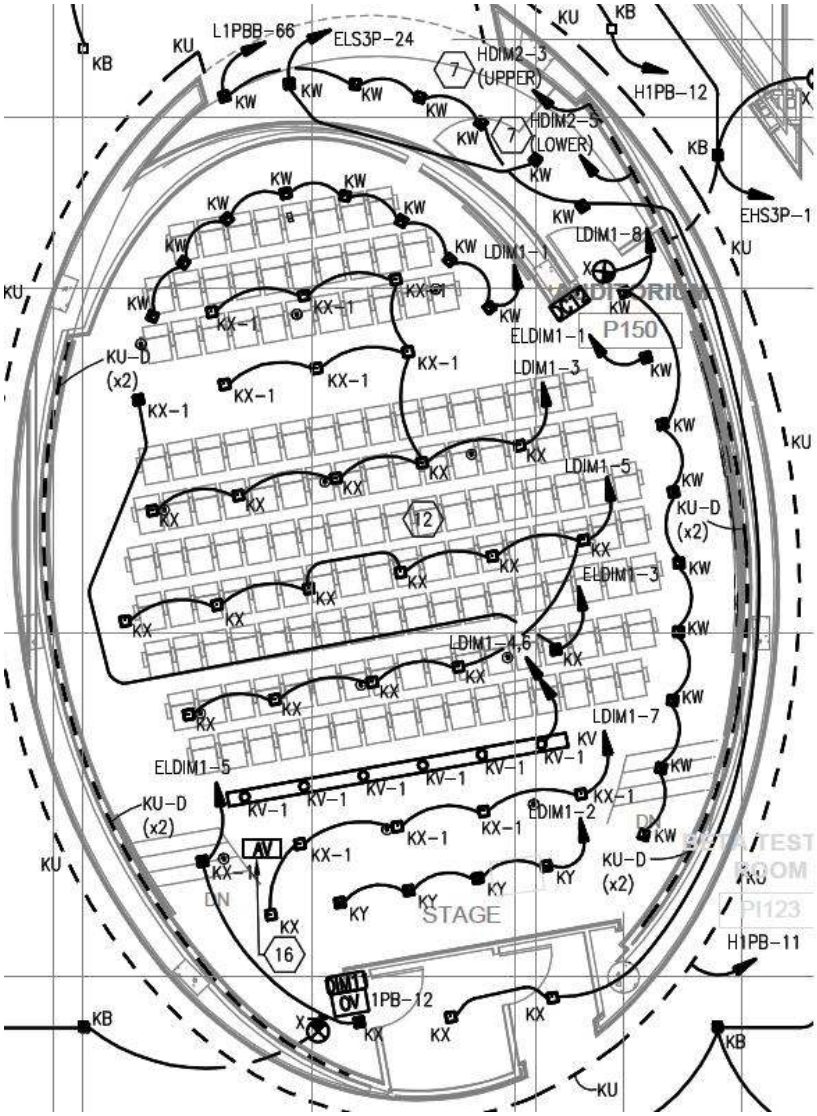


**Figure 12: Auditorium Lighting Plan**

## ***Design Criteria*:** Auditoriums-Assembly

Illuminance Values:

- Horizontal-50 fc
- Vertical- NA

System Control and Flexibility- Very Important

- Because this space can be used for different events and purposes, the lighting must be able to adjust for the specific tasks. For example, higher luminance values are necessary for reading or filing occupants to their seats but lower luminance values would be required for presentations on a projector. Also, the lighting must be able to highlight specific areas to draw attention such as the stage or a speaker at the podium.

Color Appearance (and Color Contrast) - Important

- Color appearance is important for rendering the furnishings in the space and making them appear more vibrant. Such finishes that would benefit from good color rendering characteristics would be the wood finishes of the stage and walls.

Modeling of Faces or Objects- Important

- Modeling of faces will be important in the space for on certain occasions there may be a speaker giving a presentation. It is therefore necessary to ensure that the speaker's facial expressions and characteristics are visible in order to enhance nonverbal communication. Excessive facial contrast should be avoided.

Points of Interest- Somewhat Important

- IESNA considers this design criterion to not be important for an auditorium, however, one may argue otherwise. The reason for this is because there are a couple areas that should draw the attention of the occupants and should therefore be brighter than the surrounding spaces. One of them being the stage area since it is where the most important activity will take place. The other is the side walkways because in times when the task in the space requires lower light levels (such as a presentation on the projection screen) occupants may have a hard time finding the exit unless the pathways are illuminated at a higher value.

Daylighting Integration and Control- Somewhat Important to Not Important

- Daylighting integration would be beneficial for such a large space in that it would help reduce the lighting load and help the space conform to ASHRAE 90.1 while providing continuous spectrum light. Contrary to what IESNA recommends, one could argue that that daylighting for this particular auditorium is not important at all. One reason is because it will be impossible to incorporate daylighting since the space is isolated from any natural light. Also, because most of the tasks in the space will require use of the projection screen, daylighting will not be necessary since it would not be beneficial.

**Power Allowances and Control Requirements (ASHRAE 90.1):**

For convenience, this space will be considered as a performing arts theatre while referencing ASHRAE 90.1. ASHRAE 90.1 states that the maximum lighting power density for a performing arts theater, if using the Space-by-Space method, is 2.6 W/ft$^2$. For the track lighting in front of the stage, the wattage shall be the specified wattage of the luminaires included in the system with a minimum of 30 W/lin ft as is stated in section 9.1.4.

In regards to controls, section 9.4.1.2 states that the space is required to have at least one control device to independently control thee general lighting within the space. Each control device shall be activated either manually bay an occupant or automatically by sensing an occupant.

## *Evaluation*:

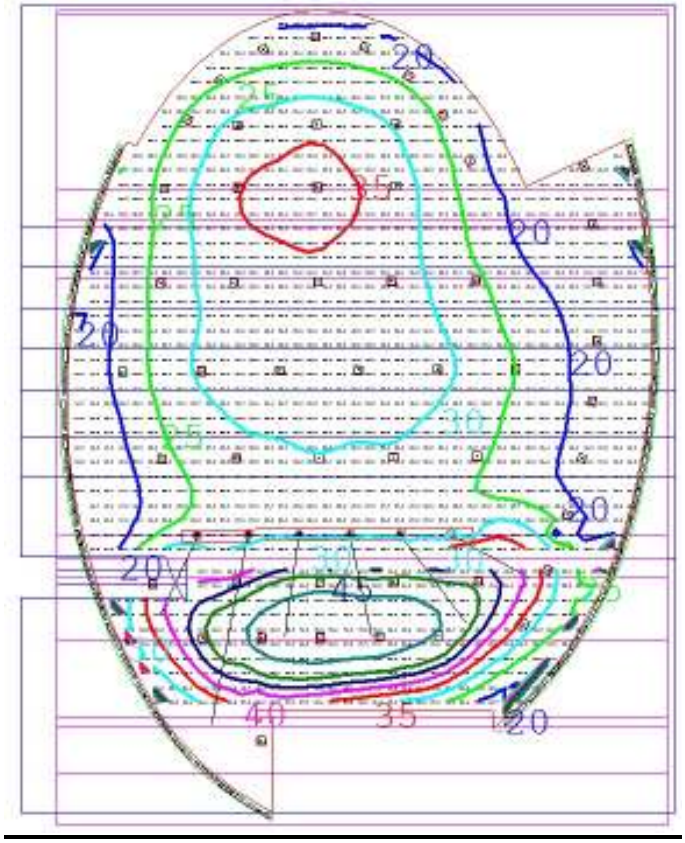


**Figure 13: Auditorium Isoline**

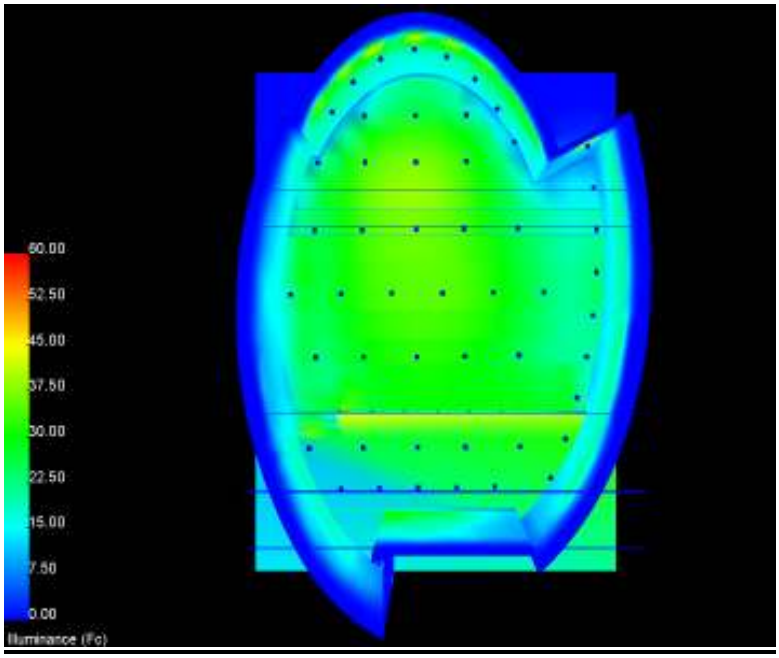


**Figure 14: Auditorium Psudo Color Plan View**

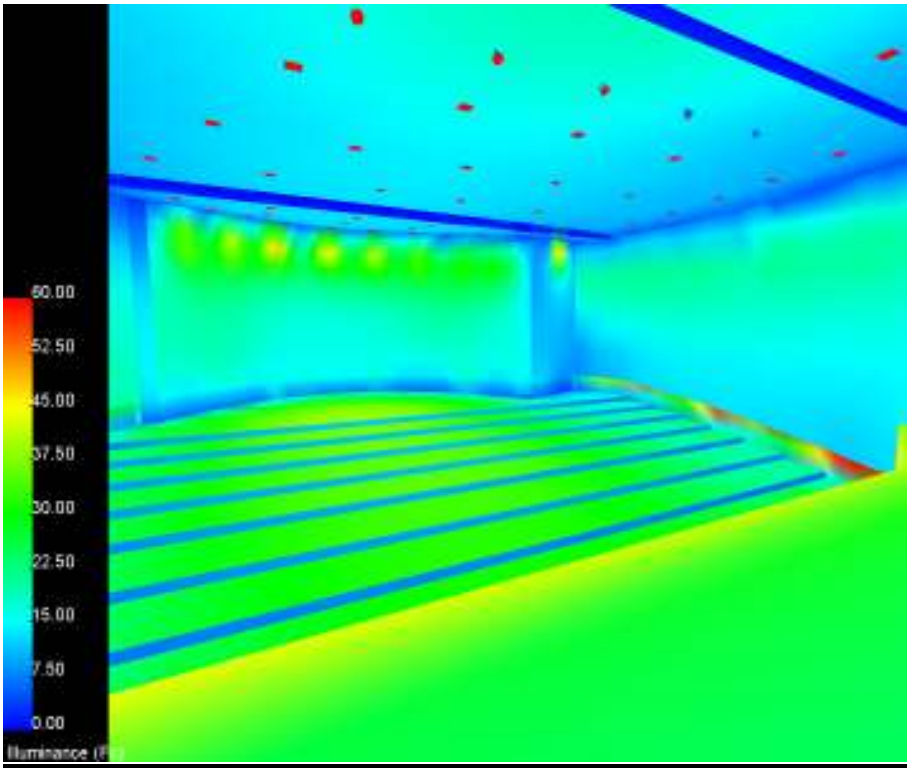


**Figure 15: Auditorium Perspective Psudo Color (from stage)**


**Figure 16: Auditorium Perspective Greyscale (from stage)**

| Light Loss Factors | | | |
|---|---|---|---|
| Luminaire Type | LLD | LDD | BF |
| KW | 0.7 | 0.95 | NA |
| KX | 0.7 | 0.95 | NA |
| KX-1 | 0.7 | 0.95 | NA |
| KY | 0.7 | 0.95 | NA |
| KU-D | - | 0.95 | NA |

| Power Density | | |
|---|---|---|
| **ASHRAE 90.1** | **Actual** | **Difference** |
| 2.6 $W/ft^2$ | 4.3 $W/ft^2$ | + 1.7 $W/ft^2$ |

| Illuminance Values | | |
|---|---|---|
| | Seating | Stage |
| Average Illuminance | 29 | 48 |
| Maximum | 40 | 75 |
| Minimum | 12 | 20 |

Based on the data, it appears that only the stage receives the IES recommended illuminance of about 50 fc while the seating area falls surprisingly short. However, it is beneficial that there is contrast between the two areas for it allows the stage to become the focal point within the space. Wall wash luminaires help to give the space a spacious psychological impression while guiding circulation to the exit. The use of dimming controls allows for flexible lighting schemes, important for accommodating change in usage.

The power density for the space is also well over that which is allowed by ASHRAE 90.1. This is due to the extensive use of incandescent and concealed cold cathode lighting around the perimeter. Although this space does not comply with the Space-by-Space method of determining power densities, its over usage of is most likely offset by the efficiency of the lighting in the open offices (refer to previous data).

# Prefunction Area- Circulation Space

## *Existing Conditions*:

The Prefunction area is located just outside the entrance to the auditorium and will serve as a gathering space for employees or guests who are about to participate in events taking place within the auditorium or large conference room. Surrounding the space are conference rooms, an auditorium, elevator lobby, and glass staircase. Because the staircase is transparent and has a skylight that leads to the roof of the building, there is a possibility that the space may receive some amount of daylighting. However, since this light must travel through 5 stories, its impact on the space should be minimal.

**Materials:**

*Floor*- ST-1: Stone Floor (Plank)

- Description: Limestone, Honed finish
- Reflectance: 0.2

*Ceiling*- CLG1- Gypsum Wall Board

- Description: Bright White, Flat Sheen
- Reflectance: 0.76

*Base*- WB-3: Wood Wall Base

- Description: Color- Alabaster
- Reflectance: 0.16

*North Wall*- Not enclosed, Material NA

*East Wall*- GL1: Vision Glass

- Description: Clear Glass
- Reflectance: 0.15

South Wall- SP1: Italian Plaster

- Reflectance: 0.5

GWB1: Gypsum Wall Board

- Description: Eggshell Sheen
- Reflectance: 0.5

*West Wall*- SP1: Italian Plaster

- Reflectance: 0.5

GWB1: Gypsum Wall Board

- Description: Eggshell Sheen
- Reflectance: 0.5

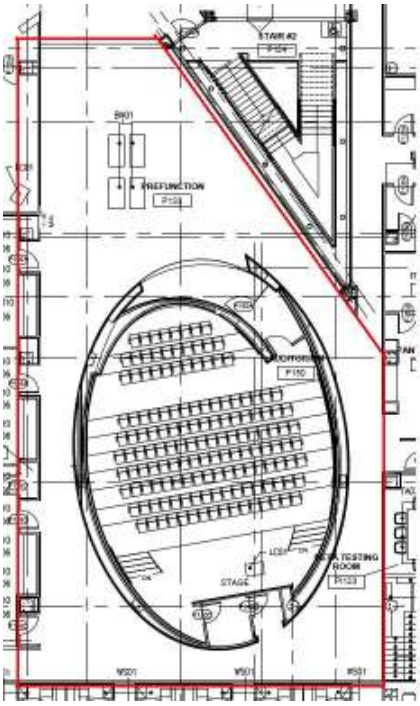


**Figure 17: Prefunction Floor Plan**

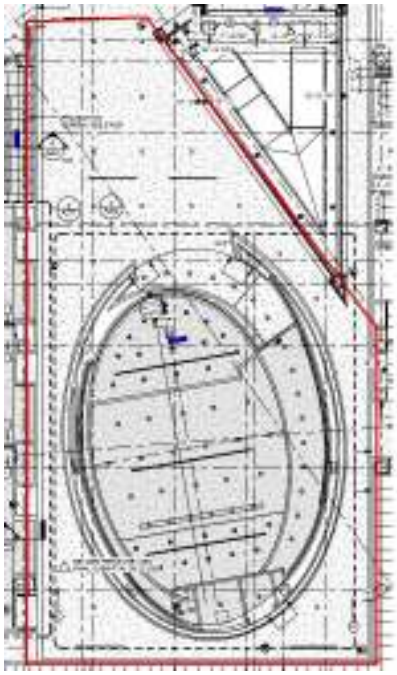

**Figure 18: Prefunction Reflected Ceiling Plan**

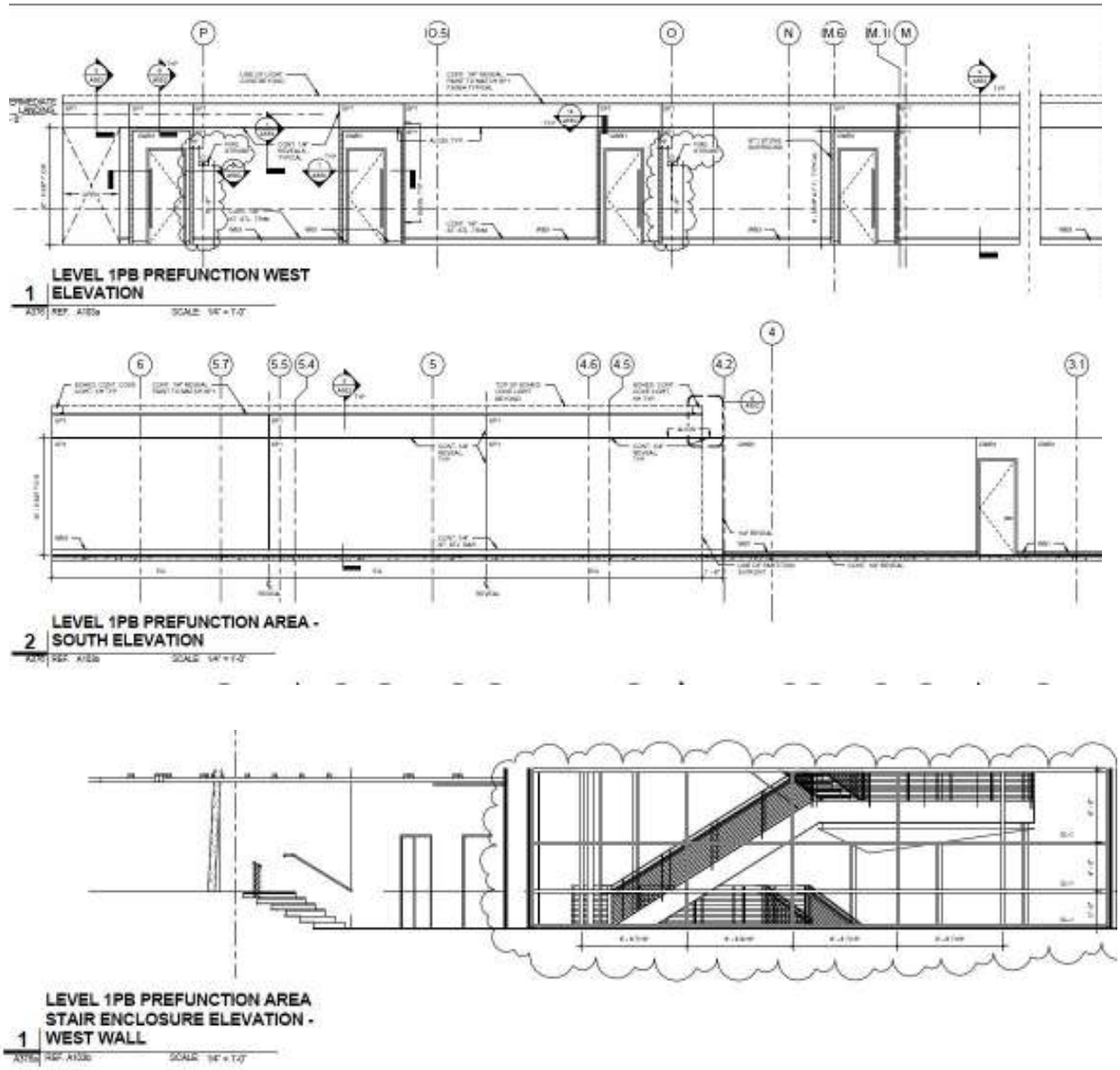


**Figure 19: Prefunction Elevations**

**Lighting:**

The majority of the lighting in the space is done with 6” recessed, compact fluorescent downlights spaced out in a grid-like pattern. These provide good uniformity throughout the space. Along the perimeter walls, with the exception of the staircase, are continuous, recessed, wall wash cove luminaires.

| Prefunction Area Luminaire Schedule | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **Manufacturer** | **Catalog NO.** | **No. of Lamps** | **Lamp type** | **Watts Per Lamp** | **Voltage** | **Height** |
| KB | 6" Square fluorescent recessed downlight horizontal lamp | Gotham | SQF-1/26TRT-6AR-LD-277 | 1 | CF26DT/E/IN/835 3000K | 29W | 277 | |
| KH | Continuous wall wash cove | Mark Lighting | PPl-WH-277-1T5HO-EB | 1 | F54 T5/835/Ho-3500K | 62W/4’ | 277 | |
| KU | Cold cathode cove curved on the outside of auditorium | Cathode lighting systems | FCLS-C-277 76.2 Lumens/Watt30TC-3500K Non-Dim | 1 | FCLS-C-27-50,000 Hour Life 76.2 Lumens/Watt 30TC-3500K | 13.7W/ft | 277 | |

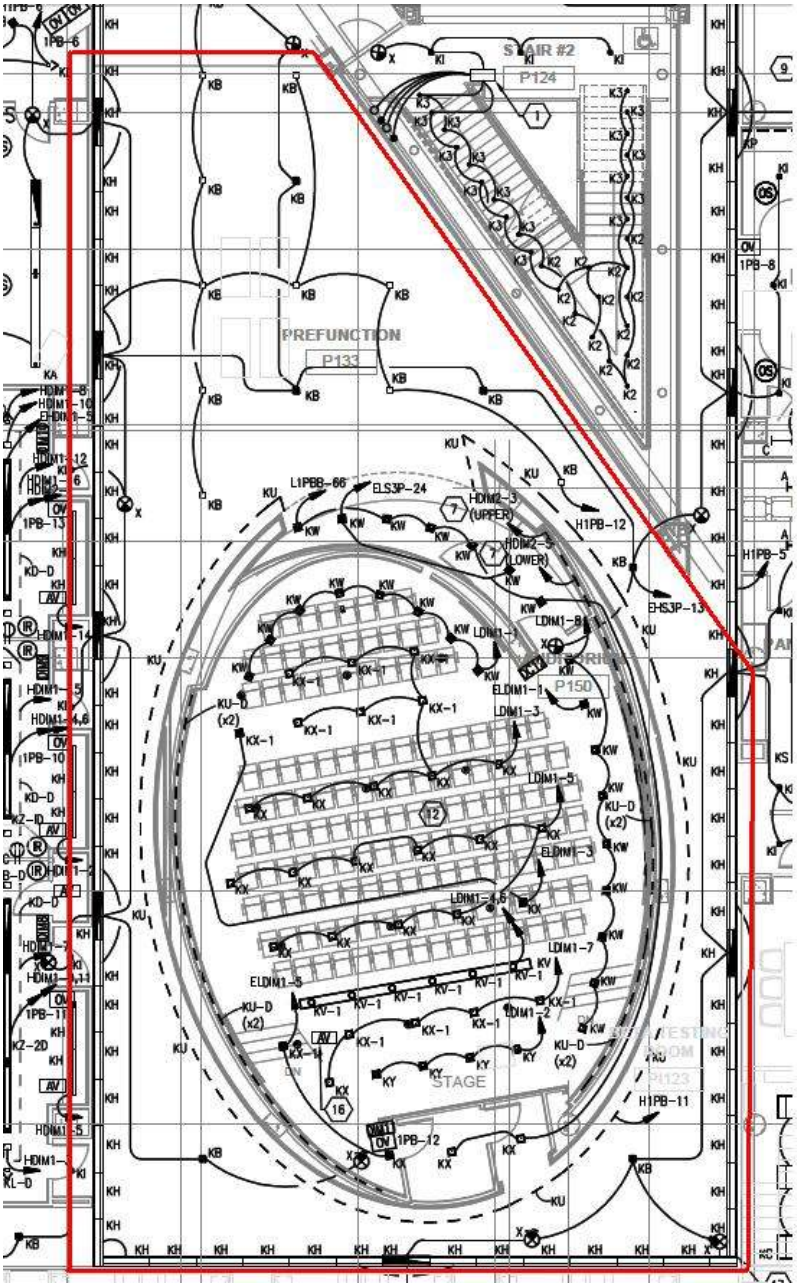


**Figure 20: Prefunction Lighting Plan**

***Design Criteria*:** Offices- Lobbies, lounges, and reception areas

Illuminance Values

- Horizontal Illuminance: 10 fc
- Vertical Illuminance: 3 fc

Psychological Reinforcement

- Two psychological impressions would be appropriate to incorporate through two different lighting schemes in the space. These impressions are that of spaciousness and enclosure. An impression of spacious ness is achieved by brightly illuminating the ceiling and walls. Enclosure is experienced through the use of over-head direct downlighting without any emphasis on lighting the ceiling or walls.

Appearance of Space and Luminaires- Very Important

- The prefunction area will often be used as a socializing area, possible including guests who do not work within the building. Therefore, appearance of the space is important in order to make a good impression and to set a proper mood for the event that is about to take place. The luminaires should also be located in a manner which helps guide occupants through the space to other areas it connects to.

Color Appearance- Important

- Food is often served in prefunction areas before an event and color appearance is crucial for determining how appetizing the food will appear. Color appearance is also important for the general rendering of people and to make socialization more pleasant.

Direct Glare- Important

- Direct glare can cause discomfort to the occupants and inhibit social interaction. Luminaires should not be placed in the direct line of sight of the occupants.

Modeling of Faces or Objects- Important

- Because this will be a space for social interaction, facial modeling is important for occupants to read other people's facial expressions. Luminaires should be aimed in a way that excessive facial contrast is avoided.

**Power Allowances and Control Requirements (ASHRAE 90.1):**

For convenience, this space will be considered as a lobby while referencing ASHRAE 90.1. ASHRAE 90.1 states that the maximum lighting power density for a lobby, if using the Space-by-Space Method, is 1.3 W/ft$^2$. As for lighting controls, because the building is over 5000 ft$^2$ "all interior lighting shall be controlled with an automatic control device to shut off building lighting in all spaces."

## *Evaluation*:

The lighting design is simple and straight forward with its use of one luminaire type spaced out in an even grid. This should provide good uniformity throughout the space, typical of any type of circulation space. The continuous wall wash cove should reinforce guided circulation to and around the connected spaces by drawing the attention of the occupants to the perimeter walls. Because this space will be used merely for circulation of employees for most of the time, the simple, uniform lighting scheme is appropriate. The wall wash cove adds a subtle change to and helps break up the common grid of downlights that is utilized throughout the bulk of the space.

One such feature that is not illustrated on the drawings, but should be included, is flexible lighting controls. An argument for this would be because the space will be used for different purposes depending whether or not an event or presentation will be going on in the auditorium or large conference room. Therefore, a solution would be to have multiple lighting controls to adjust luminance levels and create different psychological impressions.

In terms of power density, the prefunction area's comes out to be 1.79W/ft$^2$. This value is above the 1.1W/ft$^2$ allowed by ASHRAE 90.1. The main reason for this is due to the excessive, continuous cove lighting around the perimeter of the walls and outside the auditorium.

| **Power Density** | | |
|---|---|---|
| **ASHRAE 90.1** | **Actual** | **Net Difference** |
| 1.1W/ft$^2$ | 1.79W/ft$^2$ | + 0.69W/ft$^2$ |

# Outdoor Plaza- Exterior Space

## *Existing Conditions*:

The outdoor plaza is located where the three below grade levels transition into a five story triangular tower. Within the space will be features such as pedestrian walkways, seating areas, planters, and a roof monument pad. The purpose of this space will be for relaxation and circulation. An interesting fact about the plaza is that it also serves as a green roof for the lower floors, giving the building LEED credibility.

**Materials:**

*Grass*- Reflectance: 0.24

*Walkways*- Paver D: Pedestal Pavers

- Reflectance: 0.15

Paver B: Flagstone Paving

- Reflectance: 0.28

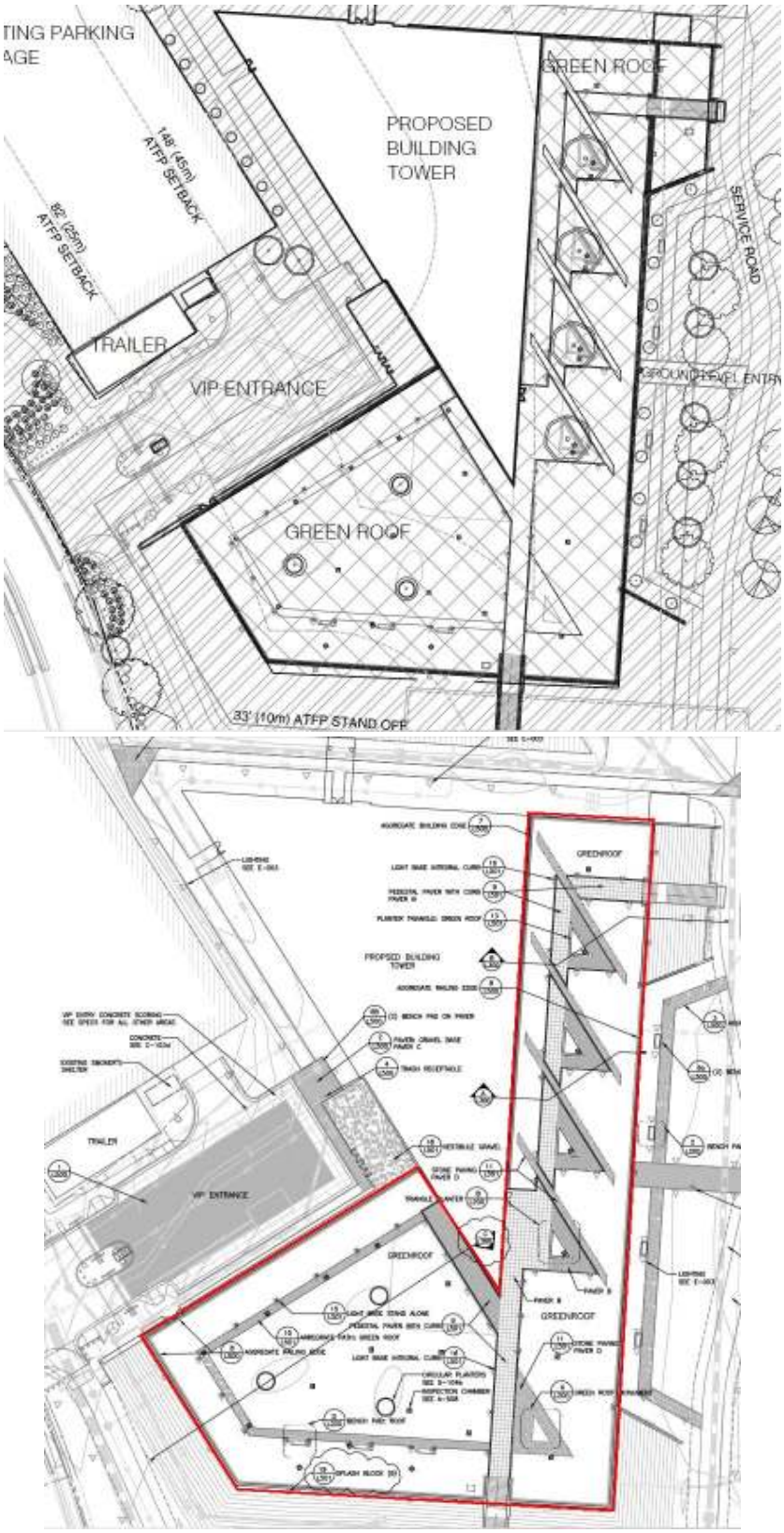


**Figure 21: Plaza Floor Plans**

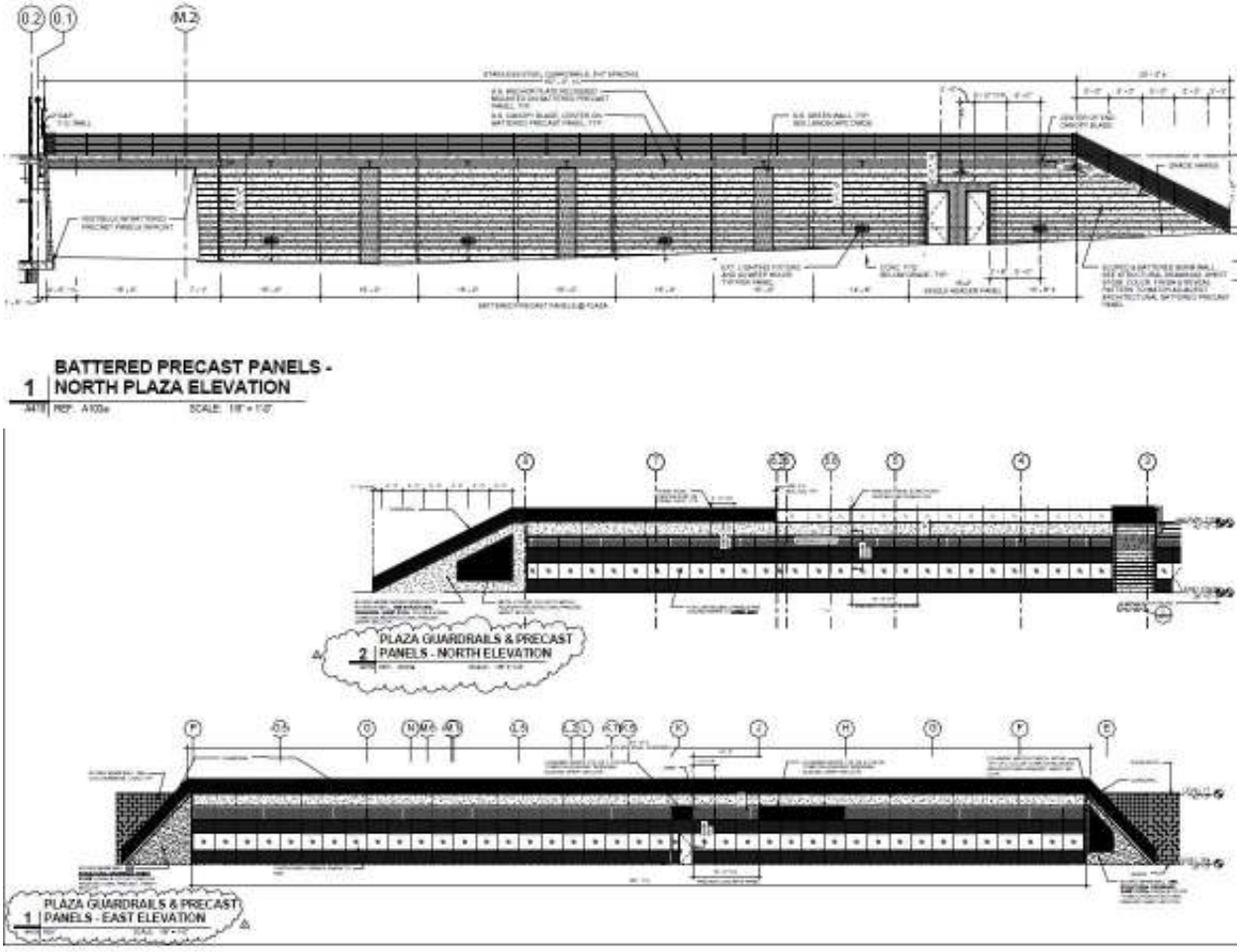


**Figure 22: Plaza Elevations**

**Lighting:**

All walkway lighting on the plaza is performed by squared incandescent fixtures flush with the curb. For the pathways around the building are either illuminated by triangle lightpoles or bollards housing 70 watt and 39 watt ceramic metal halide lamps. The lighting scheme focuses mainly on illuminating the walkways rather than the entire area of the plaza.

| Outdoor Plaza Luminaire Schedule | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **Manufacturer** | **Catalog NO.** | **No. of Lamps** | **Lamp type** | **Watts Per Lamp** | **Voltage** | **Mounting Height** |
| KEX-7 | Green roof square walkway lighting | Bega | 8612 with concrete backe box Finsh: Centria color XL9967 Pewter | 1 | 35W T4-Gy6.35 12V Lamp by Xelogen | 35 | 120 | Flush with curb |
| KEX-2 | Walkway Triangle Bollard | Selux | BTM-MTR Bollard Triangular 3'- H39-277-SP Finish: Centria Color XL9967 Pewter | 1 | CMH39/T/U/830/G12-300K | 56 | 277 | Surface Mounted pole 3' high |

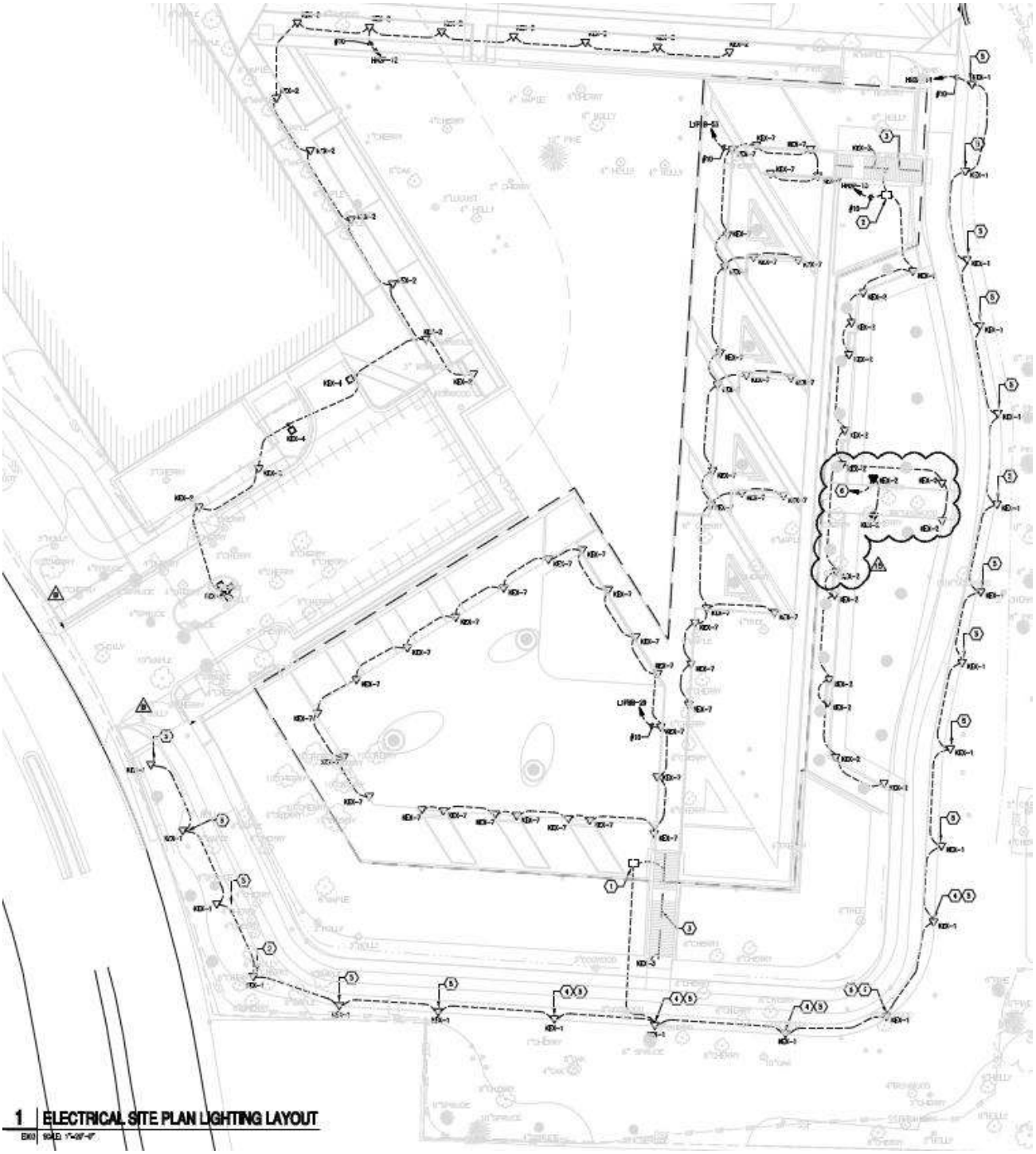


**Figure 23: Plaza Lighting Plan**

***Design Criteria*:** Parks, Plazas, and Pedestrian Malls

Color Appearance (and Color Contrast) - Very Important

- The plaza will contain vegetation in the form of trees and shrubbery and it is desirable to showcase these items to make the space seem lush and inviting at night. Lamps with CRI's of 80 or higher should be sufficient for rendering the vegetation.

Direct Glare- Very Important

- Direct glare can cause discomfort to pedestrians and inhibit their ability to navigate through the space. Considerations must be taken to avoid placing luminaires directly in the line of sight of occupants. Also, shielding can be incorporated on the luminaires.

Light Pollution/Trespass- Very Important

- Light pollution and trespass can cause discomfort to and affect the appearance of surrounding properties. Fixtures should have shielding or cutoffs and be placed as close to the pathways as possible. This is to ensure wasted light is kept to a minimum.

Modeling of Faces or Objects- Very Important

- Human interaction and socialization will be a very common experience within the space. Many co-workers within the office building will meet on a regular basis within the space, so modeling of faces is important for facial recognition. Luminaires should be aimed in a way that excessive facial contrast is avoided.

Shadows- Very Important

- Shadows can be distracting for occupants circulating through the space. They can also impair visual clarity on the pathways and make the space unpleasant. Lighting from multiple directions can help soften up shadows and make the pathways more uniformly light.

Source/Task/Eye Geometry- Very Important

- The space will be used for either circulation around the site or relaxation. It is important that the occupants circulating through the space are not affected by direct glare. All light sources should not be immediately visible which might cause glare.

Appearance of Space and Luminaires- Important

- The outdoor plaza is one of the first things visitors will notice about the building so it is crucial that the space be well displayed well. Lighting fixtures and layout should reflect the building and surround landscape style as best as possible.

Points of Interest- Important

- The plaza will contain both circular and triangular planters as well as a monument platform. These will be key features for the space and should be highlighted. Direct lighting on the trees and the proposed monument should provide contrast with the surrounding site and draw the attention of visitors.

**Power Allowances and Control Requirements (ASHRAE 90.1):**

According to ASHRAE 90.1, power densities for plaza areas shall not exceed 0.2 W/ft$^2$. Walkways less than 10 ft wide shall not exceed a power density of 1.0 W/linear foot. Walkways greater than 10 ft wide shall not have a power density exceeding 0.2 W/ft$^2$. Lighting for all exterior applications shall have automatic controls capable of turning off exterior lighting when sufficient daylight is available or when the lighting is not required during nighttime hours.

## *Evaluation*:

Without computer analysis it is difficult to evaluate whether or not the space is getting the required amount of Illuminance. However, judging by the lighting layout one would agree that the pathways are adequately illuminated, providing safe conditions for circulation at night. Although special care was taken to illuminate the walkways, it appears that that is the only feature the designer focused on. There is no attempt to highlight any of the shrubbery in the planters or the planned monument location. In order to improve the design, one might want to focus on highlighting these features as well as highlight and provide adequate illumination for the seating areas.

Certain design criteria such as glare, light pollution, and shadows are properly accounted for in the lighting design due to the low luminaire heights and cutoff angles. However, facial rendering is non-existing in the space because the majority of the luminaires are located at the occupants' feet. Taller pole mounted luminaires that would illuminate more of the surrounding areas, especially seating areas, would help satisfy these requirements. The triangular styles of the luminaires, however, are a good choice because they connect very well with the shape of the building. "Points of interest" is also a consideration not taken into account due to previously mentioned existing lighting conditions, such as lack of accent lighting on the shrubbery and other key features of the space.

For power density calculations, only the walkways will be taken into consideration since they are the only feature that is illuminated. The power density for the walkways over 10 ft comes out to be 0.15 $W/ft^2$, which is lower than the 0.2 $W/ft^2$ allowed by ASHRAE 90.1. The power density for the walkways less than 10 ft wide comes out to be 1.69W/linear ft, which is higher than the 1.0 W/linear foot allowed by ASHRAE 90.1.

| Power Density | | | |
|---|---|---|---|
| | ASHRAE 90.1 | Actual | Difference |
| Walkways < 10 ft | 1.0 W/linear foot | 1.69W/linear foot | + 0.69W/linear foot |
| Walkways ≥ 10ft | 0.2 $W/ft^2$ | 0.15$W/ft^2$ | - 0.05 $W/ft^2$ |