THESIS FINAL REPORT | SPRING 2015

UNIVERSITY OF MARYLAND – BALTIMORE
HEALTH SCIENCES FACILITY III

666 W. BALTIMORE ST. BALTIMORE, MD

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LIGHTING / ELECTRICAL
THESIS ADVISOR: SHAWN GOOD
Link to project AGI Files at Y: Moore

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EXECUTIVE SUMMARY

The following report details the various topics researched and developed throughout the fall and spring semester, as part of the Architectural Engineering Student Individual Thesis. The project is based on the University of Maryland – Baltimore Health Sciences Facility III building. Within, the lighting systems, and electrical systems of the existing project have been re-evaluated, and re-designed. The re-evaluated spaces include:

- CIRCULATION SPACE – ELEVATOR LOBBY
- LARGE WORK SPACE – NANOMEDICINE WORKSTATION
- SPECIAL PURPOSE SPACE – MEETING ROOM
- OUTDOOR SPACE – EXTERIOR PLAZA

In addition to the lighting and electrical depths of study, two breadth studies have been completed. First, the implementation of a rain screen system was evaluated against the existing exterior façade. This system would prove beneficial, but to confirm its effectiveness, a structural summary of the exterior façade has also been studied.

ACKNOWLEDGEMENTS

I would like to thank the following people for their advice, guidance, and support throughout the process of my thesis.

BARTON MALOW COMPANY

FOR PROVIDING PROJECT DOCUMENTS

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SECTION 1 | PROJECT OVERVIEW

PROJECT OVERVIEW | GENERAL BUILDING DATA

Building: Health Sciences Facility III

Location and Site: University of Maryland – Baltimore
666 W. Baltimore Street, Baltimore, MD 21201

Building Occupant: University Students and Staff

Occupancy Type: Business use Group B, Assembly use Group A-3, Storage use Group S

Size: Approximately 430,000 square feet

Number of Stories above Grade: 10

Total Number of Stories: 13 (Includes the upper and lower basement levels. The Mechanical Penthouse and Mechanical Mezzanine are considered an additional level because it encompasses the entire rooftop structure)

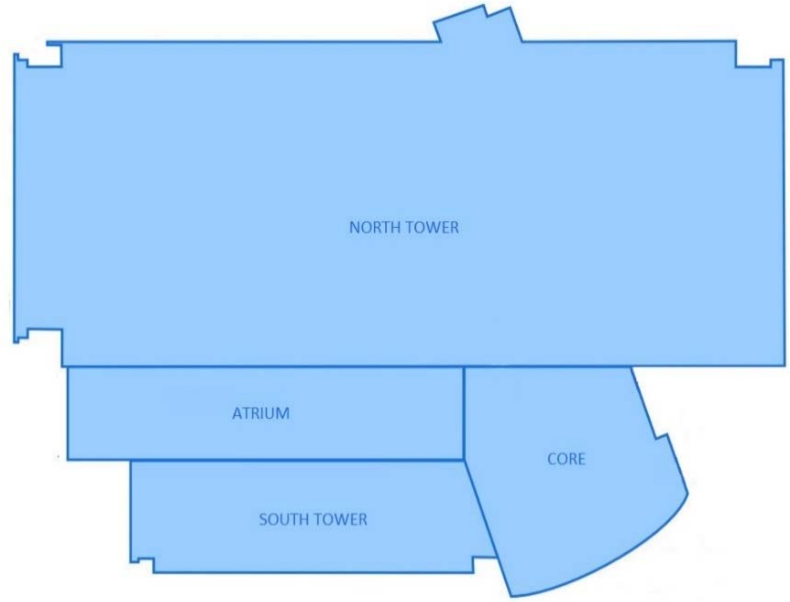
Dates of Construction: July 2013 - September 2017 (including Demo)

Cost Information: $216 million total building construction cost

Project Delivery Method: CM at Risk

Architect: Hellmuth, Obata, Kassabaum (HOK)
Construction Manager: Barton Malow Company
Associate Architect: Design Collective
Mechanical Engineer: AEI Engineers
Plumbing/FA/FP Engineer: WFT Engineers
Structural Engineer: Cagley & Associates
Civil Engineer/Landscape Architect: Site Resources
Lab Planning: Jacobs Consultancy
Interior Architects: Melville Thomas Architects, Inc.
Geotechnical Engineer: Kim Engineering, Inc.

PROJECT OVERVIEW | ARCHITECTURE



The new Health Sciences building for the University of Maryland campus will be a highly advanced research facility. It is designed to house research groups from the university's School of Medicine, Pharmacy, and Dentistry. The building is divided into 4 main sections. First, the 10 story tower (north) that serves as a wet lab for research and office space. A second, smaller tower (south) serves as a dry lab which also features offices and workstations for research. The third section is the main atrium. This 7 story atrium connects the two main towers with open bridges on the upper floors, allowing transference between both buildings. The final east tower (core) is the main connection between all 4 spaces mainly consisting of elevator lobbies, stairwells, and conference room space.

APPLICABLE CODES

- Maryland Building Performance Standards, COMAR 05.02.07 (2012 Edition) and State of Maryland Fire Prevention Code COMAR 29.06.01 (2013 Edition)
- International Building Code (IBC), 2012 Edition
- International Mechanical Code (IMC), 2012 Edition
- International Fire Code (IFC), 2012 Edition
- American with Disabilities Act, Titles II and III (ADA), 2010 Edition
- ASME A17.1, Safety Code for Elevators and Escalators
- NFPA 101 Life Safety Code (LSC), 2009 Edition
- NFPA 70, National Electrical Code (NEC), 2011 Edition
- NFPA 45, Standard for Fire Protection for Laboratories using chemicals, 2011 Edition
- NFPA 72, National Fire Alarm and Signaling Code, 2010 Edition
- NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2012 Edition
- NFPA 92B, Smoke Management Systems in Malls, Atriums and Large Spaces, 2009 Edition
- NFPA 1, Fire Code, 2012 Edition

ZONING

Not Applicable: On Campus Location

HISTORICAL REQUIREMENTS

None

PROJECT OVERVIEW | BUILDING ENCLOSURE

FAÇADE

The majority of the southern exterior façade is an insulated glass curtain wall. The north tower is mainly a precast wall with punch out windows. There is a curtain wall that juts out from the precast on the north façade adding an additional feature to the exterior. The rest of the north tower is a combination of 4” nominal brick veneer and composite aluminum metal panels on the penthouse floors. Below is an image of the curtain wall section. The laminated glass units are 9/16” thick with a fritted PVB interlayer.

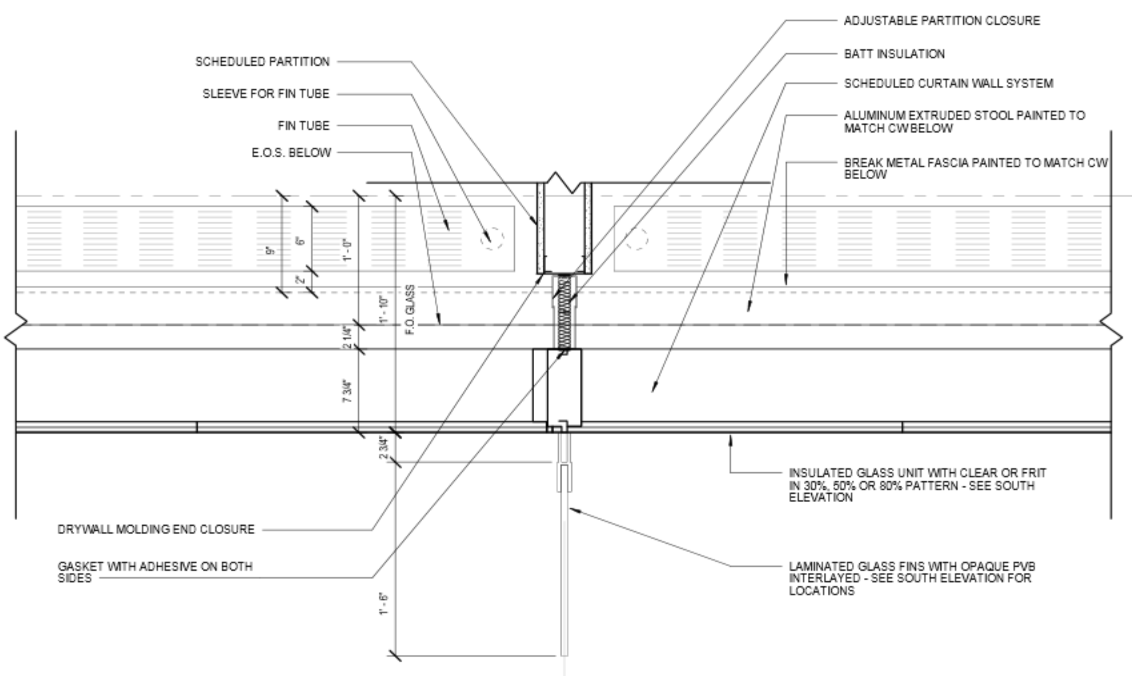


Figure 1: Section view of the southern exterior façade.

ROOFING

The roofing features sloped concrete slab sections for rainwater collection. The North tower is the only space not covered by green roof which consists mostly of exposed precast and hot fluid applied rubberized asphalt. Uncured neoprene flashing is embedded in the roofing membrane.

PROJECT OVERVIEW | SUSTAINABILITY FEATURES

The facility features a green roof on all building towers except for the North Tower. The 2nd floor of the north tower has a small exterior space which also functions as a green roof. Below is an image showing the standard depth of green roof.

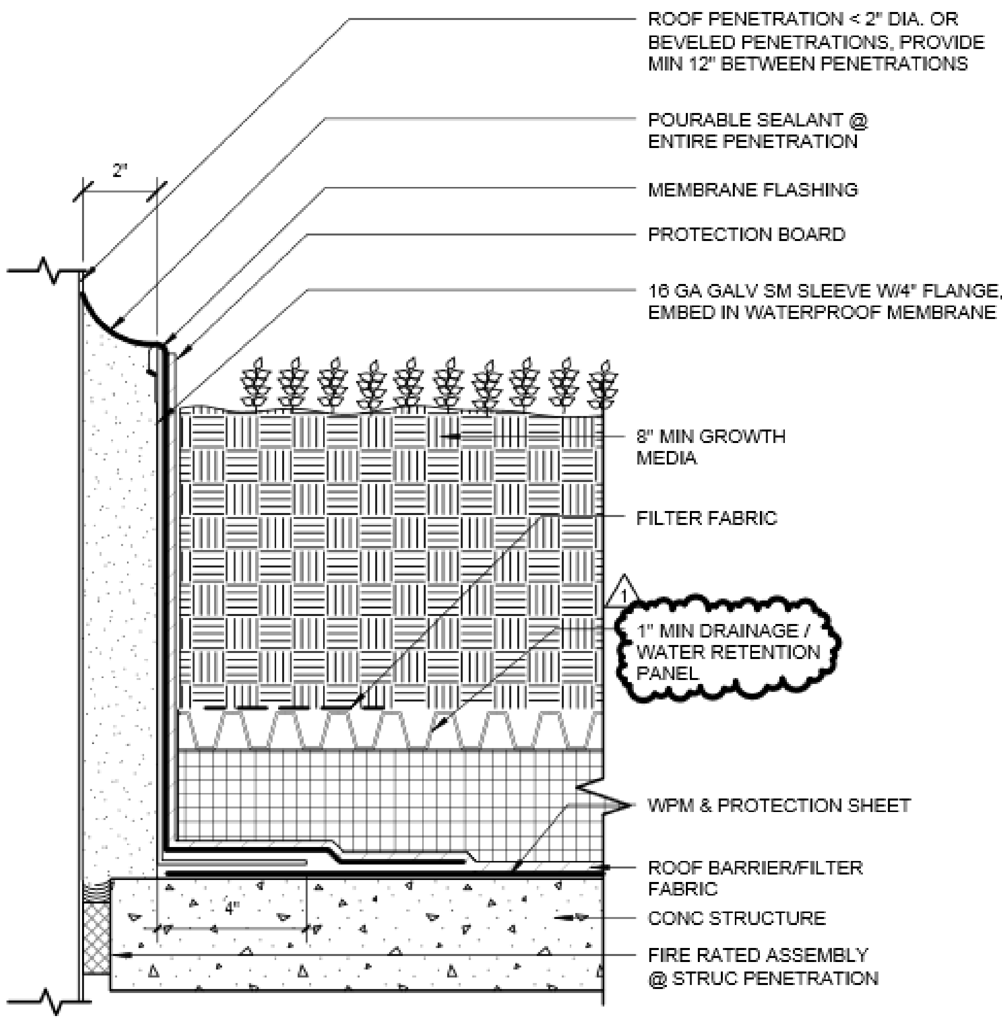


Figure 2: Section view of the north tower green roof.

LIGHTING

The lighting systems are comprised of fluorescent and LED sources. All fluorescent lamps use electronic ballasts, including continuous runs. These are predominantly used throughout the corridors and special offices. The majority of the building fixtures are recessed, and grid mounted. Lighting for railings is also provided in the atrium bridges, and exterior walkways. The exterior plaza fixtures are all LED.

ELECTRICAL

The building features multiple distribution panels to accommodate multiple receptacles, laboratory equipment, and emergency power. There are 2 distribution boards on the first level, and a total of 13 panel boards, one for each floor. Equipment panel board's voltages are 480/277V and 208/120V. General lighting is 120V and 277V. Receptacles are 120V. Emergency power is listed for a business group B, assembly group A-3 classification. The main electrical room is located in the basement. It receives power from the dual redundant 13.2 KV feeders. Of the four main switchgear, 2 serve as backup generators.

MECHANICAL

The building has a large amount of lab space, where research groups are using a myriad of chemicals and contaminants. Because of this, the nanomedicine centers house a series of fume hoods to prevent any contaminants leaving the space. There is also a chilled water system for the equipment in the labs space. The building contains four chilled water systems that service the air handling units. There are four air-handling units that service these labs with a 100% DOAS system at 63000 CFM. The additional two air-handling units service the office and conference spaces. They house a mixed air system with 35% outside air at 38000 CFM. These air handling units are located on the penthouse level.

STRUCTURAL

A geotechnical report was provided by the Kim Engineering subcontractor on the project. The report confirmed all foundations have been placed on undisturbed soil at elevations indicated that have been designed for a net allowable bearing pressure of 5000 PSF, and require placement of structural fill on portions of the site. The facility has a mat foundation due to the high water table location. The mat slab is poured into eight sections, where the form joints already fit together. The superstructure is cast in place concrete spanning an average of 21 ft. The core slabs are 10 in thick while the elevated slabs are 8 in. Shear walls are located at all stairwells and shafts within the building. All floors and roof decks are galvanized steel. Structural wide flange columns and beams provide the skeletal structure of the building.

The atrium curtain wall features a steel framing plan using HSS6X4X1/4 "mega column" connections. The HSS6X4 truss chords hold the steel column in place at the connection of the corner of the curtain walls. The atrium ceiling contains skylights with a W8X10 and W18X40 beams framework.

PROJECT OVERVIEW | ENGINEERING SUPPORT SYSTEMS

FIRE PROTECTION

All stairs, elevators, and shafts are given a two-hour fire rating. Electrical and mechanical room partitions receive a one-hour fire rating. The highest fire rating is for three-hours, only mandated for the oil tank room, as it is considered a hazardous space. According to NFPA 13, all laboratory spaces are considered an ordinary hazard, group 2, however the remaining spaces are considered group 1. The atrium space features a water curtain and sprinkler system in order to protect the storefront windows for each of the levels of the north tower. There are two connections for the fire department to access at the corners of the building. An incoming pipe is located in the basement with a double check backflow preventer.

TRANSPORTATION

There are four entrances to the building. The first is located at the east wall of the atrium with a vestibule connection. This can be considered the main entrance as it is the closest entrance to the drop-off circle. The second is located under the overhang of the south tower connecting to the atrium. A small third entrance is located closest to the exterior plaza on the west side of the building and is a means of egress from the elevator lobby. The final entrance is located at the north end of the central hallway directly connected to the elevator lobby. There is a small pedestrian wheelchair lift at the end of the hallway due to the small set of stairs located there. The elevator lobby features four main elevators and a service elevator for the upper and lower basements. The four main elevators service floors one through nine however only two continue to the tenth floor, and one to the interstitial tenth floor. The penthouse levels, as well as the basements can be accessed via the service elevators that run throughout all the floors of the building. In addition to the elevators, there are 5 main stairwells throughout the building, while only one extends to the roof. These stairwells separate the means of egress from the basements and the upper floors, which is ideal for a building of this size.

TELECOMMUNICATIONS

The facility features a series of projection rooms. The projection systems are low voltage and ceiling mounted. Most rooms feature standard wall outlets, junction boxes, and floor boxes to provide for students and staff. All data connections are routed and serviced at the two IT rooms found on each floor. The building is implemented with an electronic security system. The system is featured on every floor in addition to the exterior. It includes access control intercommunications, and video systems. A card access system is also included for building staff outside of normal business hours.

SPECIAL SYSTEMS

There are no special systems required other than listed above.

SECTION 2 | LIGHTING DEPTH

DESIGN CONCEPT

This research facility is a brand new addition to university and, as such, must reflect a new and innovative design. I was intrigued by the simplicity and scale of the interior architecture, particularly lobby and meeting room space. The building needed a creative lighting design that would extenuate its existing structure. After brainstorming, I decided to apply the concept of bioluminescence, in that I would be showcasing the building's form through internal light.

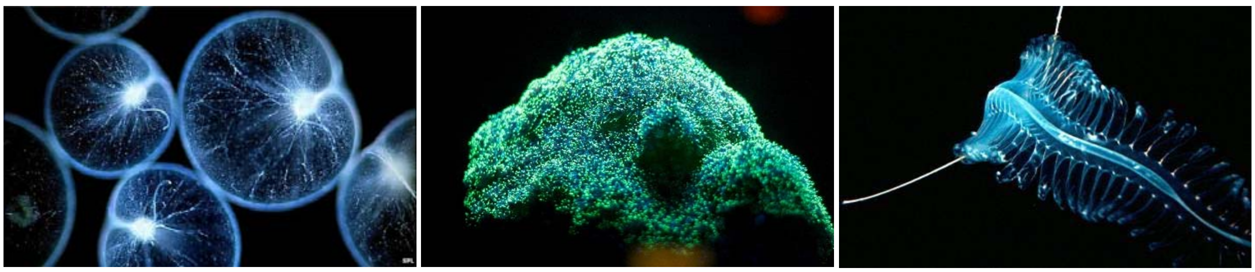


Figure 3: Concept images of bioluminescent plants and animals.

In nature, bioluminescent plants and animals produce their own light in order to function or deter prey. Their bodies form the skeletal structure, and the light emitting chemicals take the form of the structure. Therefore, the concept is that the building is the skeletal structure, and the light is emitting from within forming the body. When applied, the lighting scheme should be simple, unseen (recessed), and should create texture throughout the spaces.

Throughout my design process, I attempted to build off the idea of bioluminescence. I was encouraged by professional designers to address the concept from a more creative standpoint. While my concept was brilliant and creative in thought, it became more and more difficult to encompass the idea when addressing practical solutions to the lighting design. In the end, in order to meet my lighting criteria, I had to implement my practical design in lieu of the creative schematic designs.

SECTION A | ELEVATOR LOBBY

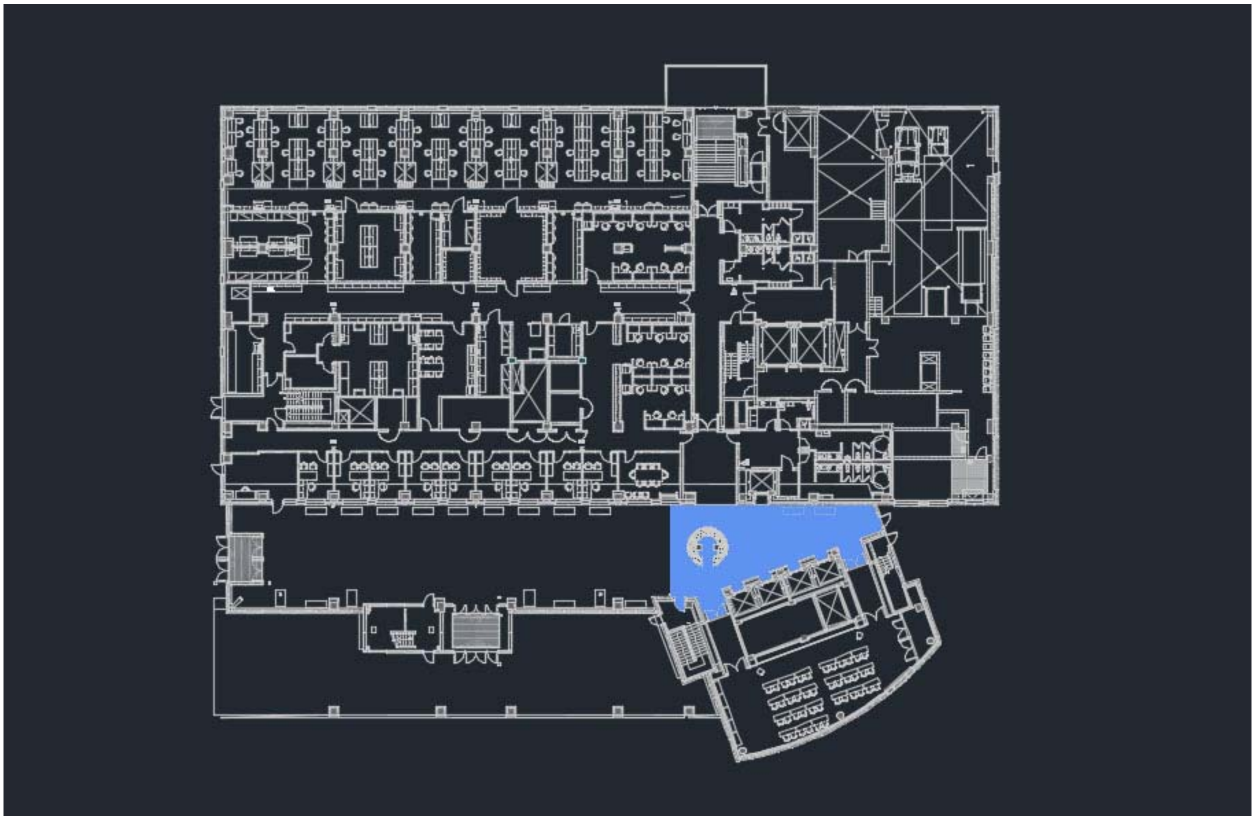


Figure 4: Plan view of the elevator lobby – First level

DETAILED SUMMARY

Space Designation: Elevator Lobby – 1003
Area: 1,206 sq. ft.
Floor Finishes: Terrazzo Tile
Wall Finishes: Painted Gypsum Wall Board, (North Wall Only) Granite, Brick
Ceiling Finishes: Acoustic Panel Ceiling and Gypsum Board Ceiling

The Elevator lobby is connected to the building's main atrium. A central information and check-in desk is situated below the 2nd floor overhang which separates the lobby's ceiling height and the atrium's ceiling height. A total of 4 pedestrian elevators are available to the public, while a 5th staff elevator is located at the north wall of the elevator lobby. This lobby also connects to the meeting room space located on the first floor.

I chose to implement John Flynn's psychological system of Spaciousness within the lobby space. Because of its smaller size in comparison to the atrium, the space it will feel congested. To counteract this psychological experience, I implemented uniform lighting that contours to the architecture, thus expanding the visual environment. Students and staff members should have a sense of openness when greeted with the sight of uniform, vibrantly illuminated walls.

The elevator lobby has a centrally located administration desk. The original design goal was to include LED tape-light underneath the varied exterior shelves. However, it was found to be unnecessary when considering the target average, and was not used in the later design. Below is a sketch to provide greater detail.

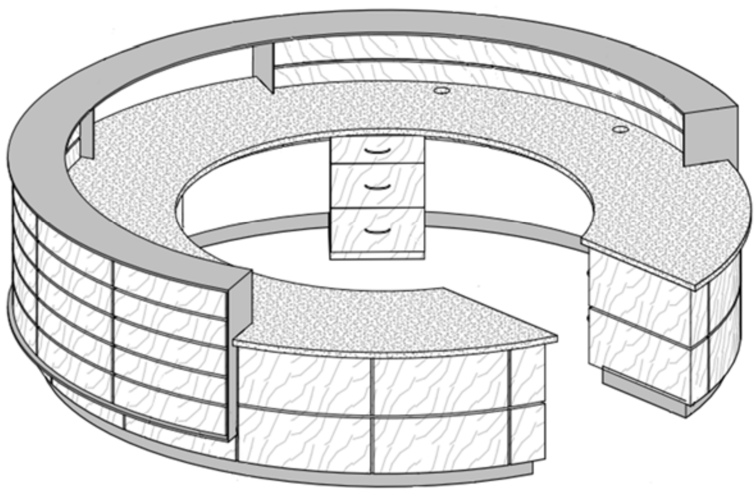


Figure 4: A sketch of the elevator lobby desk.

DESIGN CRITERIA

The elevator lobby is considered a high pedestrian activity area, as this is a research facility on a college campus. It is the central location of the building's circulation. I recommended illuminance targets for both elevator lobbies (during daytime and nighttime hours), and reception lobbies that have been included in the lighting criteria.

Table 22.2 Common Applications Illuminance Recommendations

IES Lighting Handbook, 10th Edition

Circulation, Elevator Lobbies	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
Day	100	30	4:1
Night	50	20	4:1
Distant from Entries	100	30	4:1

E_h @floor; E_v @ 5' AFF. Close proximity to exterior.

Lighting should be designed to assist with adaptation when passing to/from exterior.

Reception Lobbies	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
Desk Top	150	50	4:1

E_h @3'6" AFF; E_v @ 5'AFF

In addition, the reception desk at the junction of the atrium space and the elevator lobby must have adequate lighting to ensure a productive reception workplace, and to provide enough light for patron facial recognition.

Table 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method

ANSI/ASHRAE/IES Standard 90.1-2013

Common Space Types	LPD (W/ft^2)
Elevator Lobby	0.64
General Lobby Space	0.90

The elevator lobby is a continuation of the atrium space and thus, part of the general lobby space. Therefore I assumed the target LPD would be .9 rather than .64.

LIGHT-LOSS FACTORS

Assumed LED Light Loss Factor	
Description	Factor
Lamp Lumen Depreciation	.80
Luminaire Dirt Depreciation	.95
Total Light Loss Factor	.76

REFLECTED CEILING PLAN

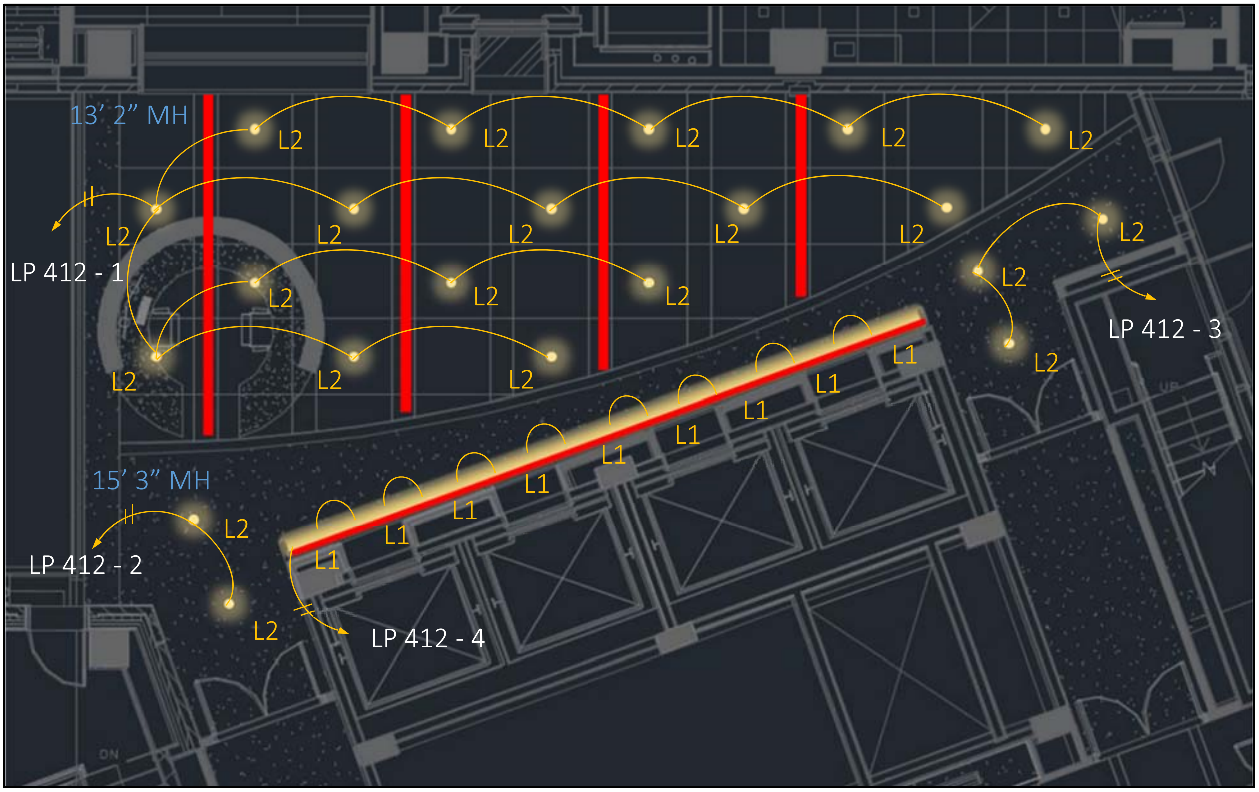
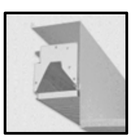


Figure 5: A reflected ceiling plan of the elevator lobby.

Objects in RED are ventilation systems.
Ceiling is 4 X 4 grid.



LUMINAIRE: L1
DESCRIPTION: RECESSED PERIMETER COVE LINEAR FLUORESCENT WALL GRAZER
MANUFACTURER: FOCAL POINT

LUMINAIRE: L2
DESCRIPTION: RECESSED ROUND TRIMLESS DOWNLIGHT
MANUFACTURER: USAI

It was important to avoid the ventilation systems in this space because I knew that the mechanical systems could not be changed. In my research I found that the spacing between the first and second floor was without room to place the ducts in a different position. Therefore, I designed around the systems.

PERFORMANCE DATA

The following calculations were performed in AGI-32 Software.

0 Fc	10 Fc	20 Fc	30 Fc	40 Fc	50Fc

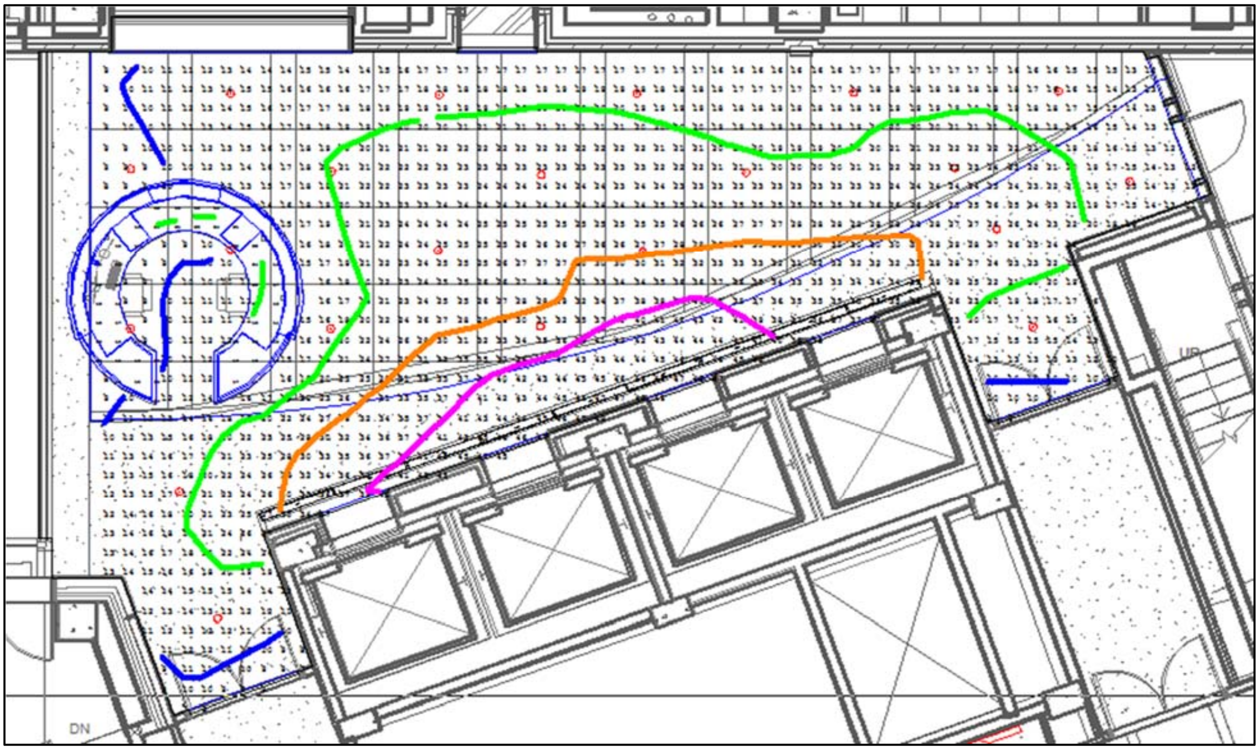


Figure 6: AGI-32 Calculation showing targeted illuminances (fc).

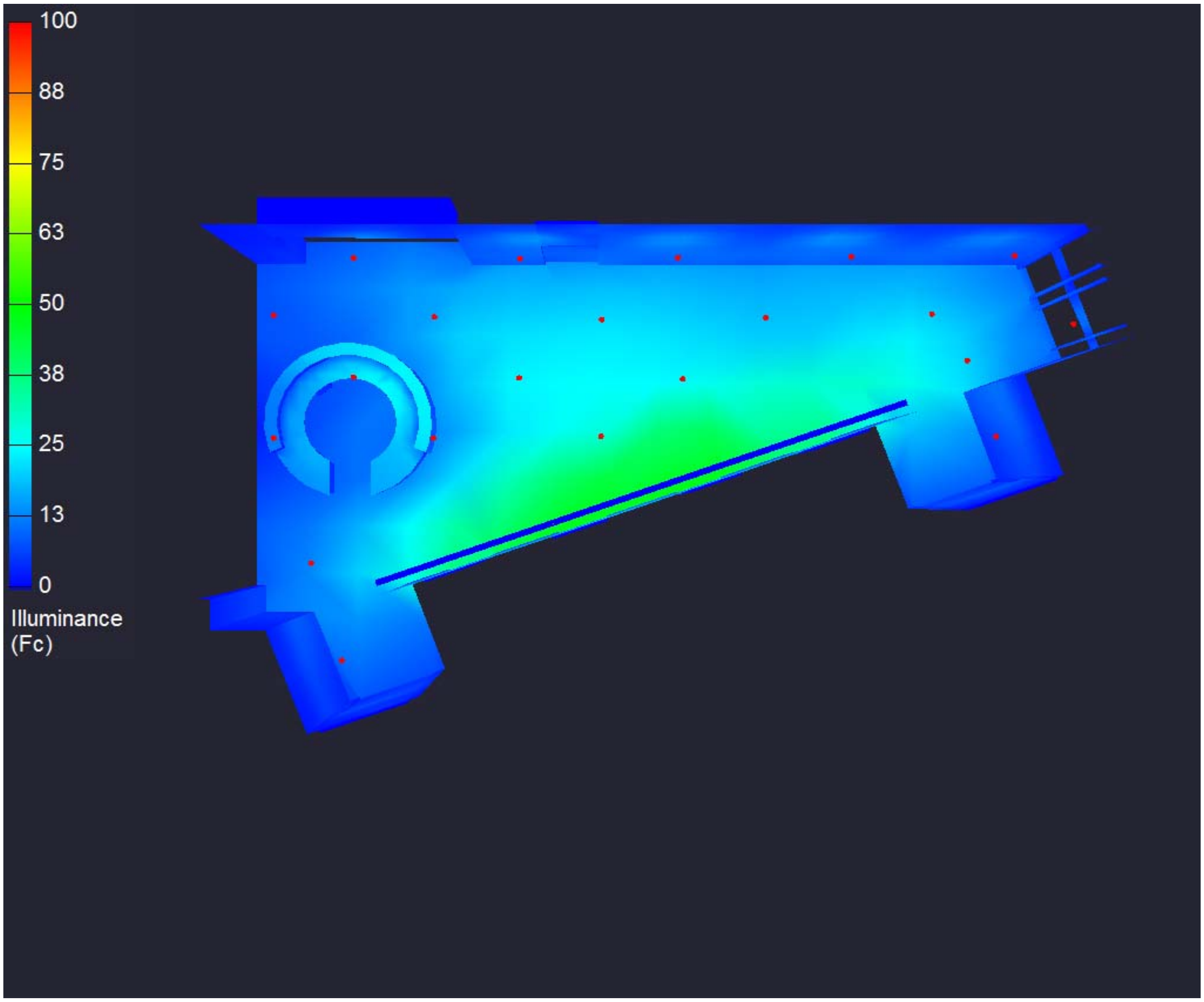
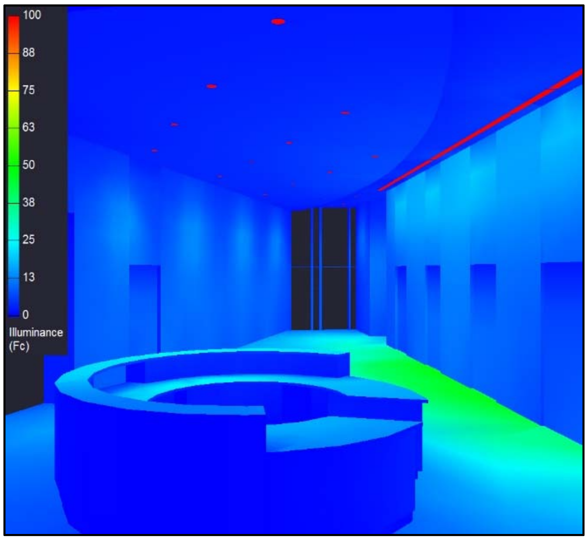


Figure 7: Pseudo rendering of the meeting room from above.

DESIGN SUMMARY

Lighting Criterion	Recommended Value	Achieved Value	Criteria Met
LPD Area Summary	< 0.9 W/ft²	0.843 W/ft²	Yes
Average Target Illuminance	≥ 10 fc	22.3 fc	Yes
Desk Surface Illuminance	15 fc	16.8 fc	Yes



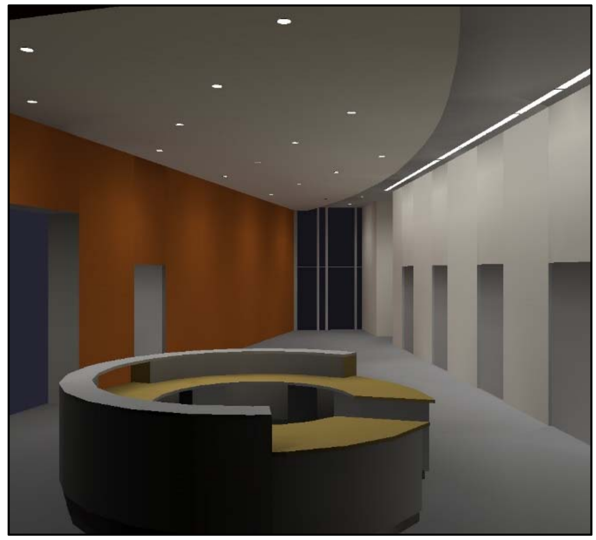


Figure 8: Pseudo rendering of the elevator lobby looking east.

Figure 9: Perspective rendering of the elevator lobby looking east.

The elevator lobby is meant to be the accent of the lobby space. Clearly the addition of the linear wall grazer above the elevators draws the attention of pedestrians to that part of the room. The reception desk is illuminated by the pattern of recessed downlights above, providing it with enough light to meet the criteria I specified. Without the issue of avoiding the ventilation ducts within the space, perhaps I could have implemented a more decorative design. In the end, I am pleased with the results as both the LPD and average target illuminance values were met.

SECTION B | NANOMEDICINE WORKSTAION

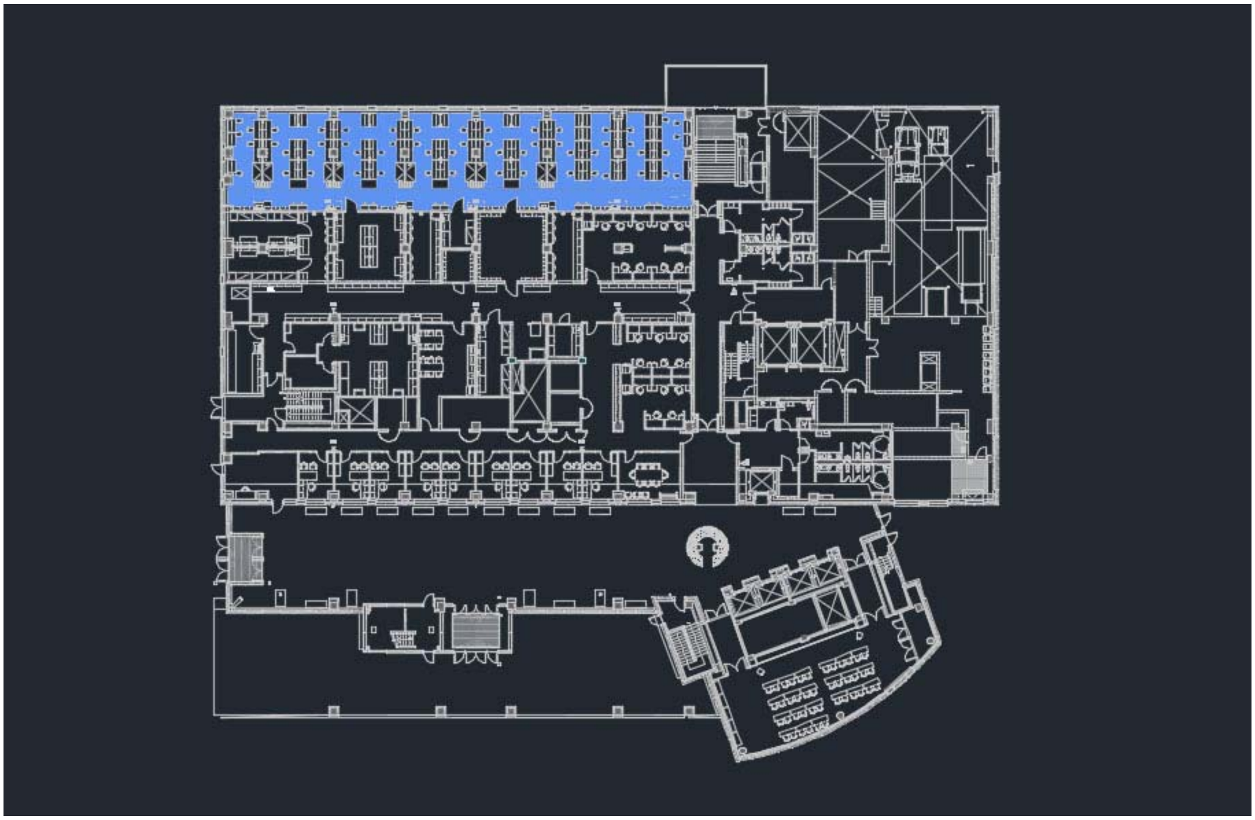


Figure 10: Plan view of nanomedicine workstation – First level

DETAILED SUMMARY

Space Designation: Nanomedicine PDoc/GS/Tech Workstation – 1130, 1140
Area: 4026.3 sq. ft.
Floor Finishes: Vinyl Composition Tile
Wall Finishes: Painted Gypsum Wall Board
Ceiling Finishes: Acoustic Panel Ceiling

The nanomedicine workstation is one of a number of research and development labs within the building. It is expected to be a laboratory where a myriad of chemicals and compounds are synthesized, while also serving as presentation and educational space. The lab is predominantly filled with casework, sinks, benches, and shelving units. The shelving units are attached to the partition of the benches, above the table workspace. These units can be seen in section detail in figure 8. These shelving units can reduce the amount of light hitting the surface of the desk, depending on the placement of the overhead fixture. There are also ten fume hoods within the lab, small ventilation devices that limit human exposure to hazardous materials or fumes. The hoods can be seen in detail in figure 12.

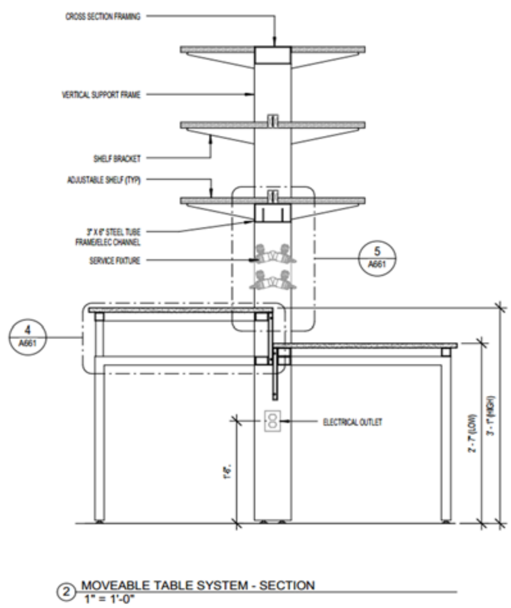


Figure 11: A section view of the workspace shelving and table system.

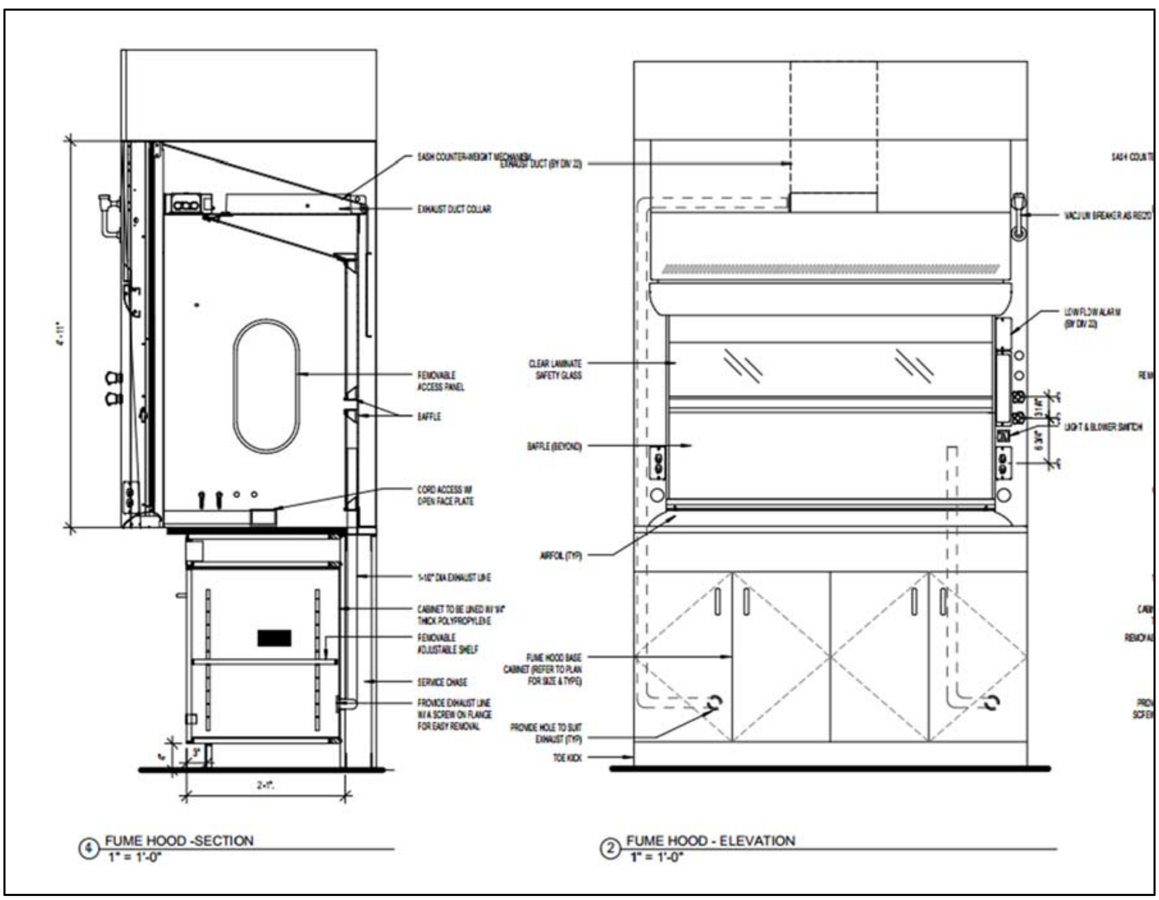


Figure 12: A section view of one of the ten workstation fume hoods.

DESIGN CRITERIA

Table 24.2 Educational Facilities Illuminance Recommendations

IES Lighting Handbook, 10th Edition

Applications and Tasks	Recommended Maintained Illuminance Targets (lux)		
Classrooms: Science Labs	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
Bench	500	300	1.5:1

E_h @3'; E_v @ 4'6" AFF. Ave:Min based on Table 12.6 Default Illuminance Ratio Recommendations.

Classrooms: Science Labs	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
Demonstration Area	1000	500	3:1

E_h @3' AFF; E_v @ 4'6" AFF

The majority of the workstation space is casework, lab tables, and shelving. Since it is part of an educational facility, the illuminance recommendations for science labs are appropriate. The lighting criteria are such that all of the workstation benches, desks, and demonstration areas have adequate lighting for the staff and students should be able to see what they are doing. The safety of certain projects may be determined by reading and understanding what chemical compounds they are using. Thus, the target illuminance at the desk height must match the criteria. It was my assumption that the workstation space would be considered a workshop space, and thus I selected the following lighting power density.

Table 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method

ANSI/ASHRAE/IES Standard 90.1-2013

Common Space Types	LPD (W/ft^2)
Workshop	1.59

LIGHT-LOSS FACTORS

Assumed Fluorescent Light Loss Factor	
Description	Factor
Lamp Lumen Depreciation	.90
Luminaire Dirt Depreciation	.95
Ballast Factor	1.15
Total Light Loss Factor	.983

Assumed LED Light Loss Factor	
Description	Factor
Lamp Lumen Depreciation	.80
Luminaire Dirt Depreciation	.95
Total Light Loss Factor	.76

REFLECTED CEILING PLAN

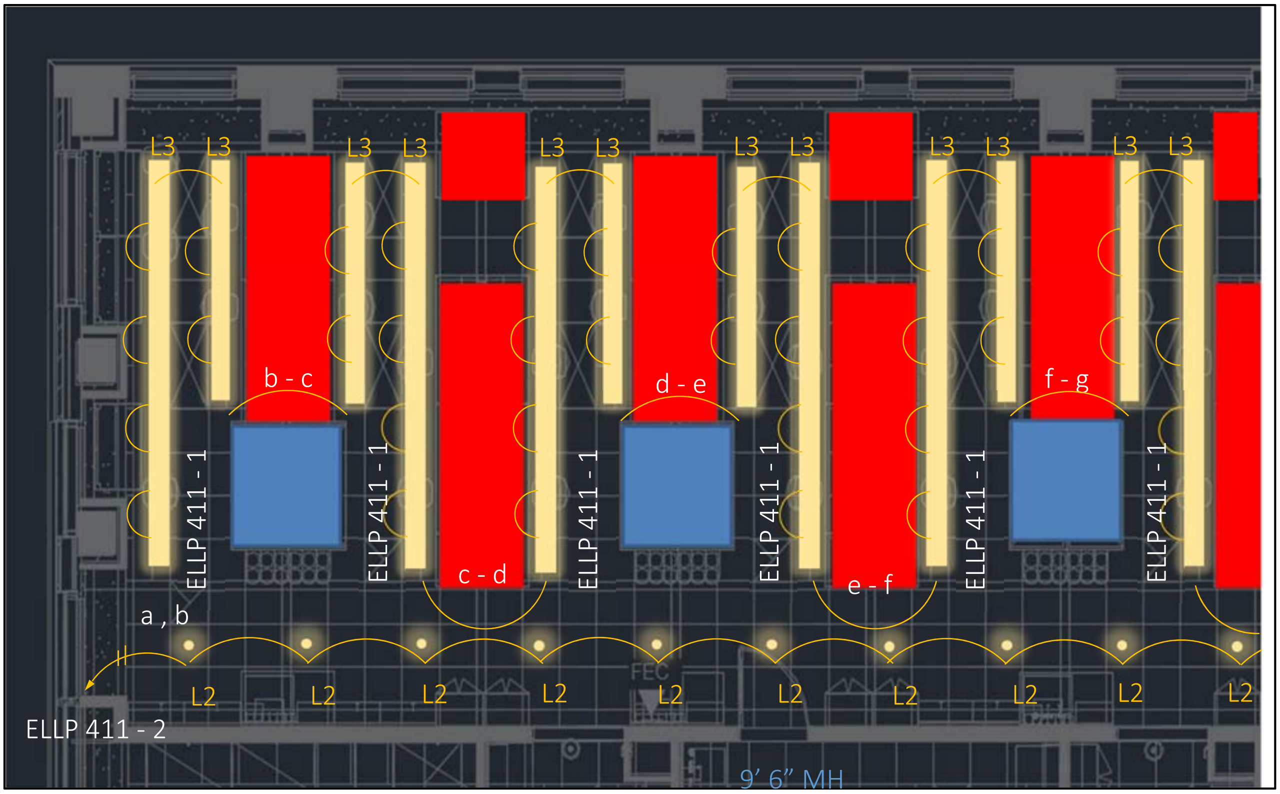


Figure 13: A reflected ceiling plan of the nanomedicine workstation.

Objects in RED are shelving and casework. Objects in BLUE are the fume hoods.
Ceiling is 2 X 2 grid.

LUMINAIRE: L3
DESCRIPTION: 1' x 4' RECESSED VOLUMETRIC DISTRIBUTION LUMINAIRE
MANUFACTURER: LITHONIA

LUMINAIRE: L2
DESCRIPTION: RECESSED ROUND TRIMLESS DOWNLIGHT
MANUFACTURER: USAI

This space proved difficult, as I had to design not only around the ceiling ventilation, but also the fume hoods which encompassed a large portion of the vertical space. The target was the task plane on the desks beneath the shelving units.

PERFORMANCE DATA

The following calculations were performed in AGI-32 Software.

20 Fc	30 Fc	40 Fc	50 Fc	60 Fc	70Fc

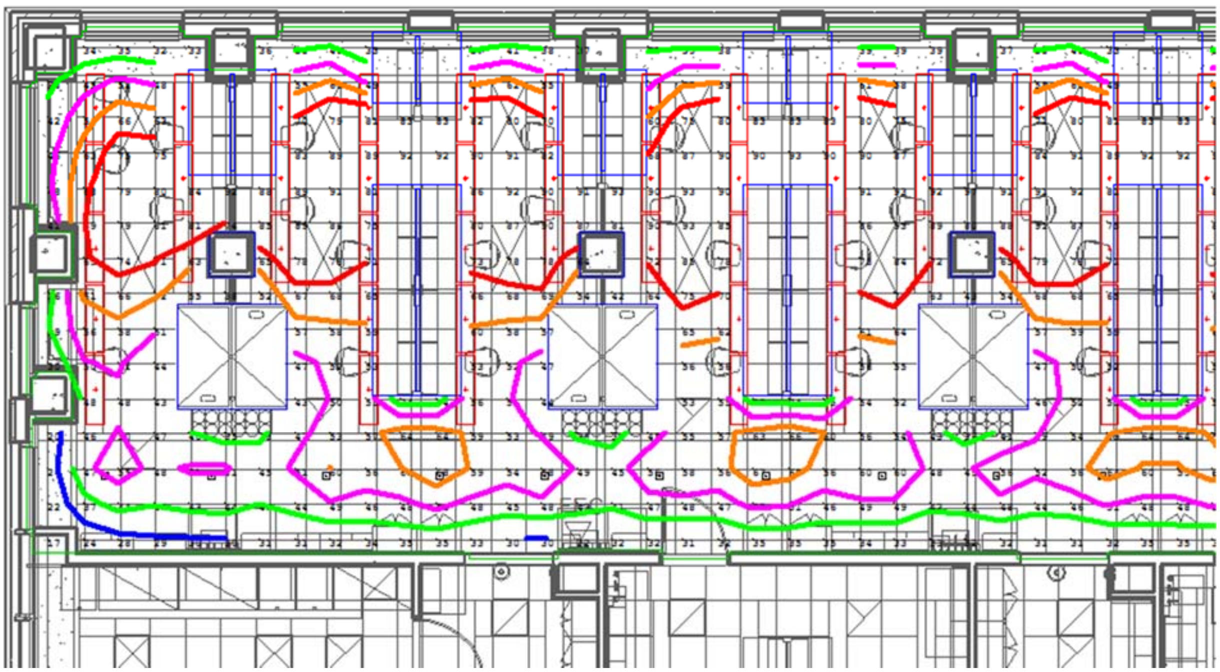


Figure 14: AGI-32 Calculation showing targeted illuminances (fc).

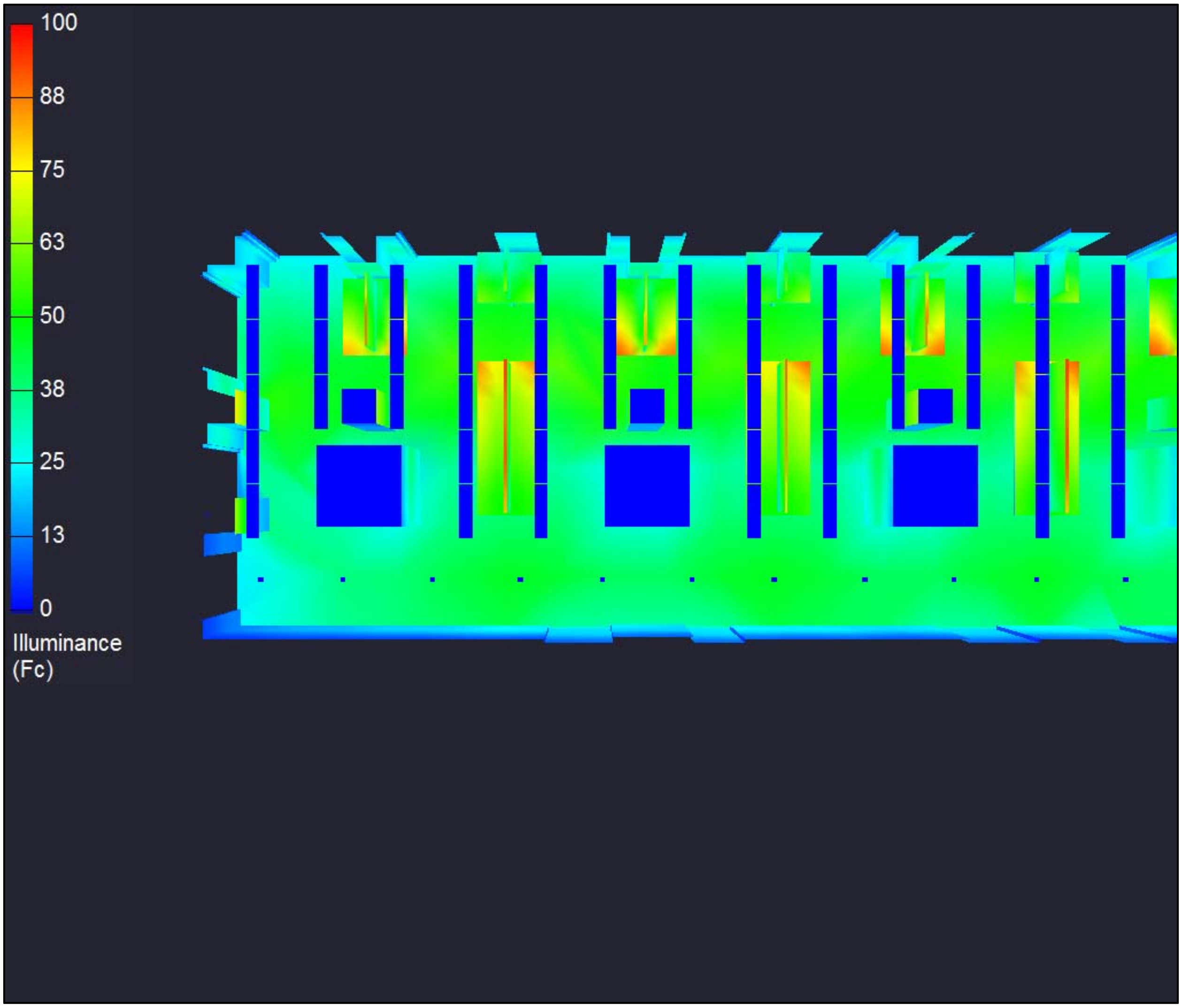


Figure 15: Pseudo rendering of the workstation from above.

DESIGN SUMMARY

Lighting Criterion	Recommended Value	Achieved Value	Criteria Met
LPD Area Summary	< 1.59 W/ft^2	0.973 W/ft^2	Yes
Average Target Illuminance	≥ 50 fc	62.8 fc	Yes

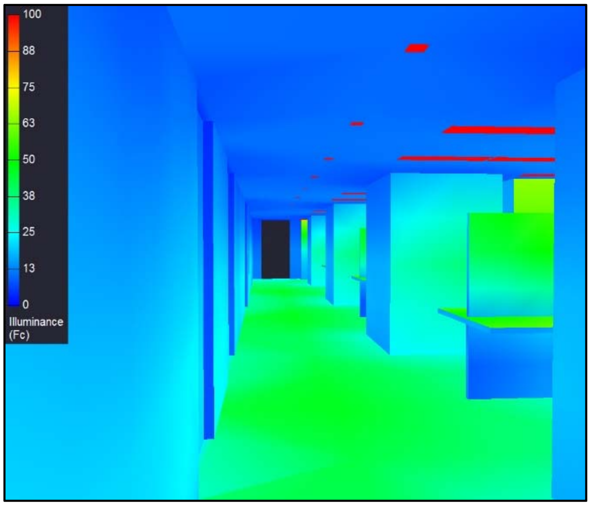


Figure 16: Pseudo rendering of the workstation looking west.

Figure 17: Perspective rendering of the workstation looking west

Both the LPD and the average target illuminance values met the established criterion. The desk and shelving space has enough light in order to perform any task within the laboratory space. In addition, the lighting does not interfere with the fume hoods that are taking up the majority of the vertical space. While it is not the most aesthetically pleasing lighting design, it makes up for its appearance with functionality.

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SECTION C | MEETING ROOM

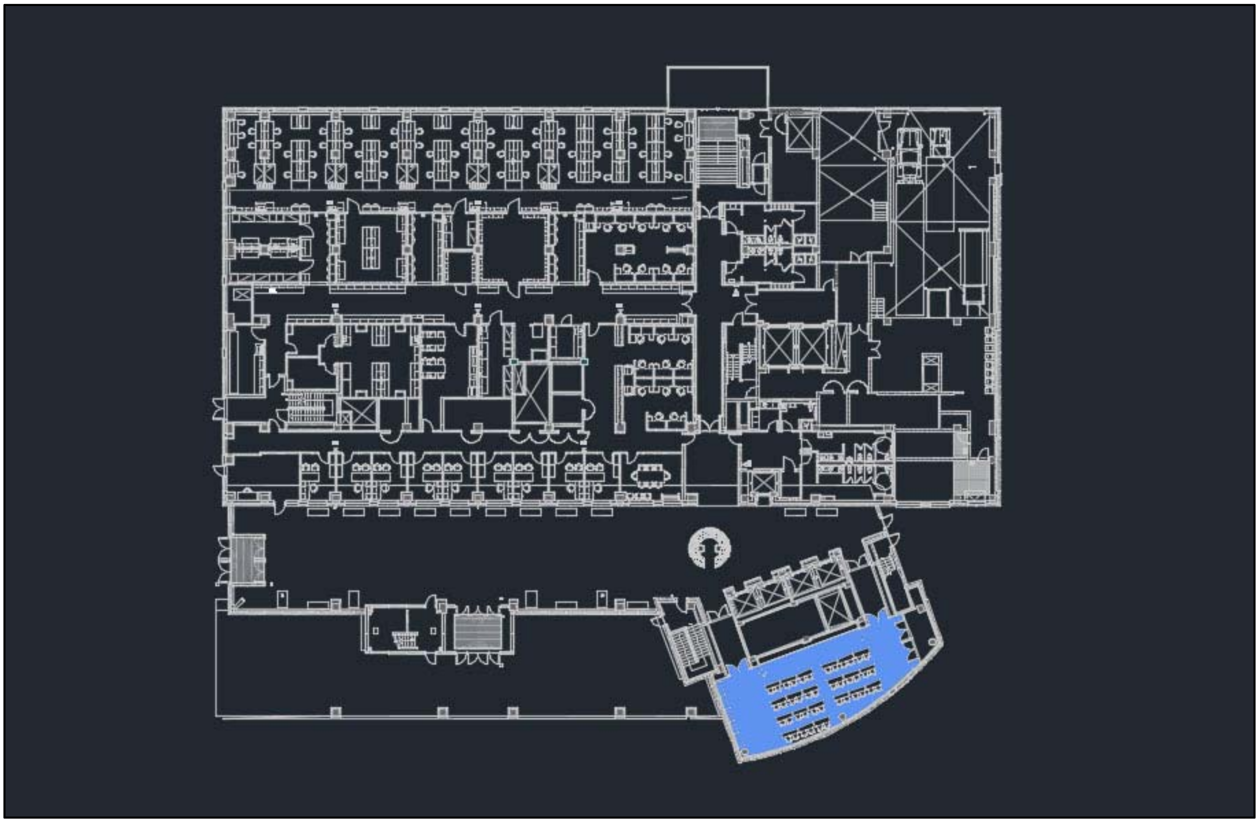


Figure 18: Plan view of the meeting room – First level

DETAILED SUMMARY

Space Designation: Meeting Room – 1010
Area: 1,421 sq. ft.
Floor Finishes: Carpet Tile
Wall Finishes: Veneered Acoustic Panel and Painted Gypsum Wall Board
Ceiling Finishes: Acoustic Panel Ceiling
(Note: Ceiling is Armstrong Techzone Lay-in)

The meeting room is a moderately sized conference room space. Here office staff and building patrons can meet for video conferencing, audiovisual presentations, and lectures. The majority of seating is assumed to be temporary, and can be moved as needed to fit the conferencing event. The north wall of the meeting room features two presentation boards mounted between the structural columns.

DESIGN CRITERIA

Table 22.2 Common Applications Illuminance Recommendations

IES Lighting Handbook, 10th Edition

Applications and Tasks	Recommended Maintained Illuminance Targets (lux)		
Conferencing: Meeting	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
Discourse	300	100	1.5:1

E_h @2'6"; E_v @ 4'AFF maintained for presentation surfaces (vertical poster boards, presentation boards, task surfaces).
Ave:Min based on Table 12.6 Default Illuminance Ratio Recommendations.

Conferencing: Presentation	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
AV	30	30	-

E_h @2'6"; E_v @4' AFF.

The meeting room should maintain a 300lux average so that presenters and listeners alike can see each other, be able to recognize the space, and be able to read and write within the space. Because of the addition of the audio visual equipment at the north wall, the horizontal and vertical targets must also be considered. The general LPD for a conference room is listed below.

Table 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method

ANSI/ASHRAE/IES Standard 90.1-2013

Common Space Types	LPD (W/ft^2)
Conference/Meeting/Multipurpose	1.23

LIGHT-LOSS FACTORS

Assumed LED Light Loss Factor	
Description	Factor
Lamp Lumen Depreciation	.80
Luminaire Dirt Depreciation	.95
Total Light Loss Factor	.76

REFLECTED CEILING PLAN

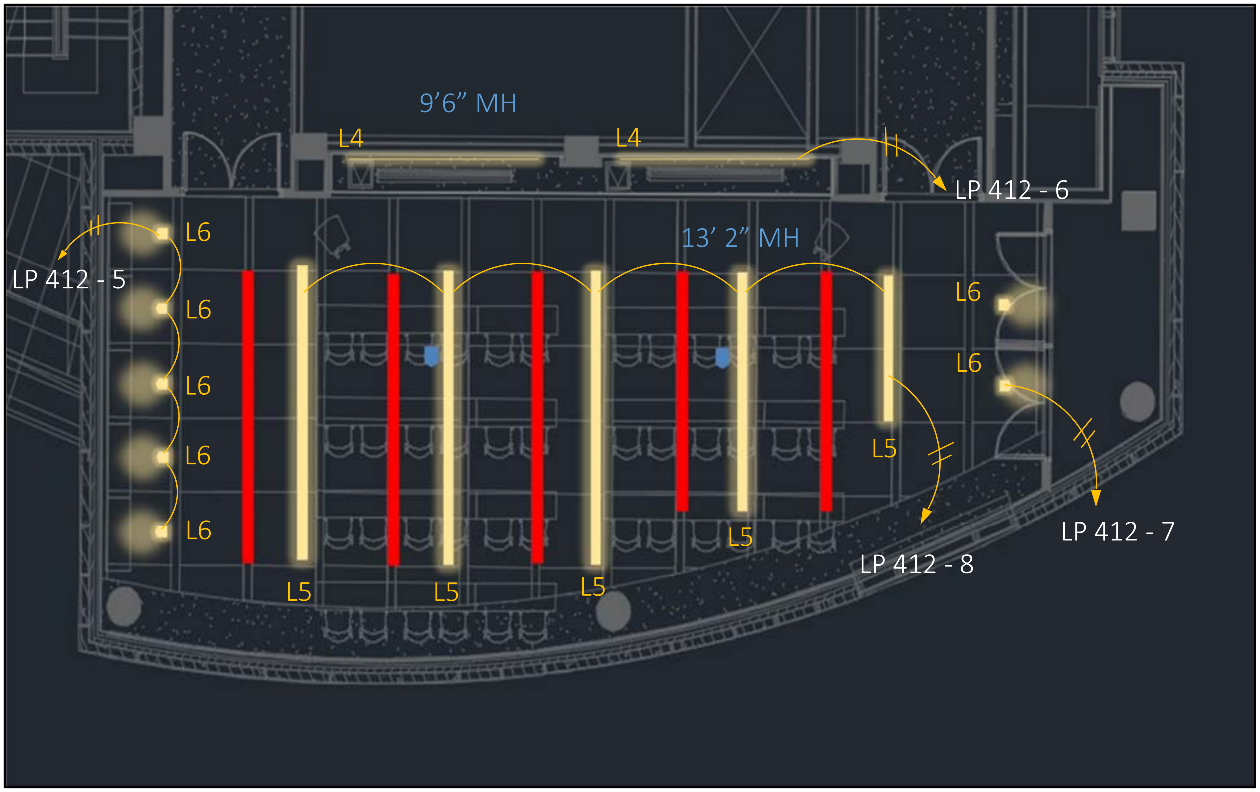
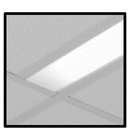


Figure 19: A reflected ceiling plan of the elevator lobby.

Objects in RED are ventilation systems. Objects in BLUE are ceiling mounted projectors. Ceiling is 4 X 4 grid.

LUMINAIRE: L4
DESCRIPTION: LOW WATTAGE LINEAR LED SLOT LUMINAIRE
CONTINUOUS RUN – 4’ LENGTHS
MANUFACTURER: FOCAL POINT



LUMINAIRE: L5
DESCRIPTION: RECESSED LED LINEAR DOWNLIGHT FLUSH LENS
CONTINUOUS RUN – 4’ LENGTHS
MANUFACTURER: FOCAL POINT

LUMINAIRE: L6
DESCRIPTION: RECESSED ROUND TRIMLESS DOWNLIGHT
MANUFACTURER: USAI

PERFORMANCE DATA

The following calculations were performed in AGI-32 Software.

20 Fc	30 Fc	40 Fc	50 Fc	60 Fc	70Fc

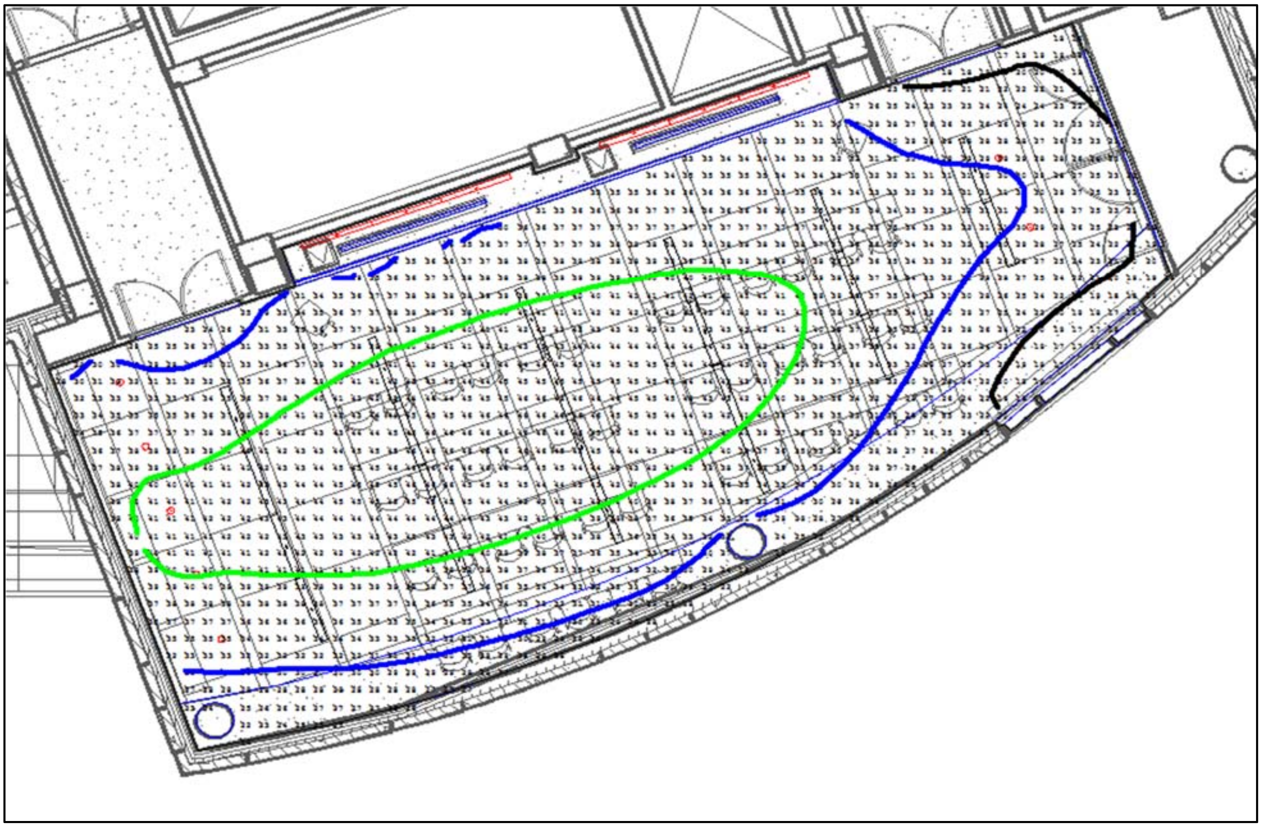


Figure 20: AGI-32 Calculation showing targeted illuminances (fc).

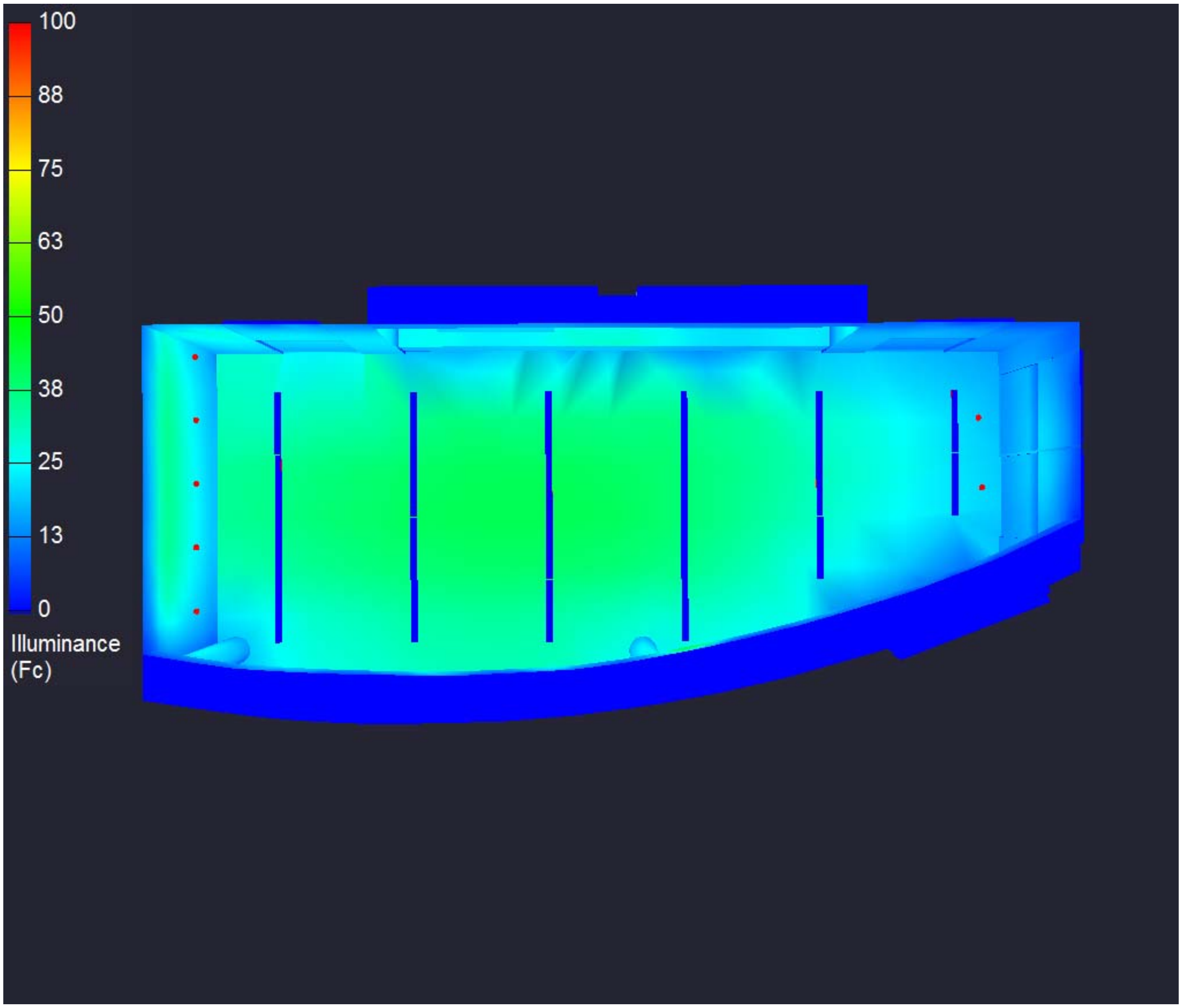


Figure 21: Pseudo rendering of the meeting room from above.

DESIGN SUMMARY

Lighting Criterion	Recommended Value	Achieved Value	Criteria Met
LPD Area Summary	< 1.23 W/ft²	0.685 W/ft²	Yes
Average Target Illuminance	≥ 30 fc	34.9 fc	Yes

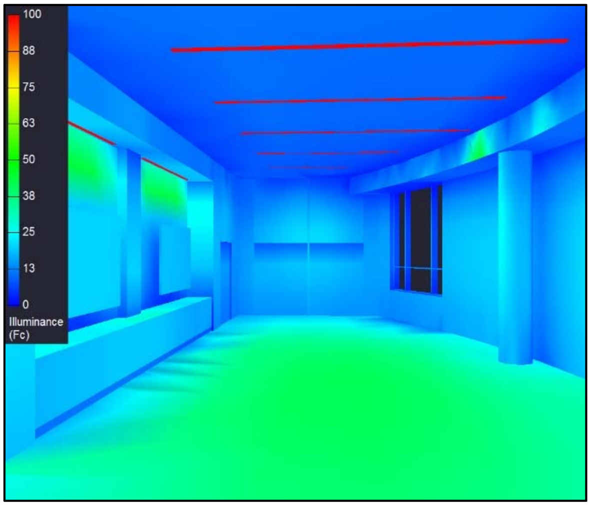


Figure 22: Pseudo rendering of the meeting room looking west.

Figure 23: Perspective rendering of the meeting room looking west

The target illuminance of the meeting room was calculated above the recommended value. In addition, the recommended LPD was also less than that the recommended maximum. Thus, the simple lighting scheme worked well within the small conference space. The Trace fixtures behind the projector screens add a nice balance of illumination in what would have been a dark section of the north wall. The added light adds more to the feeling of spaciousness within the room.

SECTION D | EXTERIOR PLAZA

DETAILED SUMMARY

Area: Approximately 32,704 sq. ft.

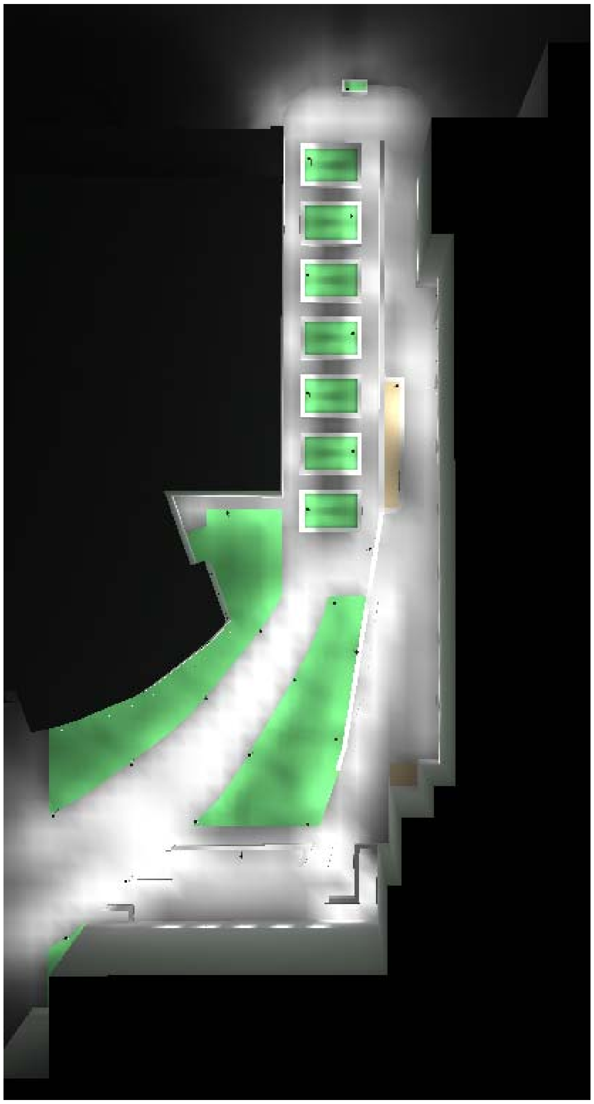


Figure 24: An aerial view of the exterior plaza.

The Health Sciences Facility site is within a block radius of the Schools of Pharmacy and Medicine, and adjacent to the School of Dentistry building. The exterior space is mostly paved walkways. There is a large courtyard space near the south entrance which connects to a pathway that functions as a pedestrian channel through the HSF3 site and the School of Dentistry building. This pathway's slope declines walking from north to south, thus there are a series of stairs and ramps between the paved paths. This heavily trafficked space will need to provide an adequate amount of illumination for pedestrians to travel safely through the campus either during the day, or at night. Up lighting and pathway grazing will be a key element of the exterior space, applying the concept of unseen but powerful light throughout the plaza.

DESIGN CRITERIA

Table 26.4 Nighttime Outdoor Lighting Zone Definitions

IES Lighting Handbook, 10th Edition

Zone	Outdoor Lighting Situation	Definition
LZ3	Moderately High Ambient Lighting	Areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security, and/or convenience and it is often uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

The building site is within one block of the Schools of Pharmacy, Medicine, and Dentistry. Therefore it is safe to assume that the site will be exposed to heavy pedestrian traffic throughout the day. I accounted for high activity when setting my outdoor lighting criteria.

Table 34.2 Retail Illuminance Recommendations

IES Lighting Handbook, 10th Edition

Applications and Tasks	Recommended Maintained Illuminance Targets (lux)		
Plazas and Town Squares: High Activity	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
LZ3	6	2	5:1 (10:1)
(curfew)	4	2	5:1 (10:1)

E_h @pavement; E_v @ 5’ AFG in at least the two primary directions of circulation. Coordinate lighting with security cameras.

Ramps, Stairs, and Steps: High Activity	Horizontal (E_h) Targets	Vertical (E_v) Targets	Avg:Min
LZ3	8	4	5:1 (10:1)
(curfew)	6	2	5:1 (10:1)

E_h @treads/landings; E_v @ 5’ AFG in at least the two primary directions of circulation. Coordinate lighting with security cameras.
Lighting should address the area of the ramps, steps, and landings. Alternatively, draw attention to the elevation changes with contrast lighting.

The recommended horizontal illuminance at the pavement will be the target illuminance factor for the path of egress. There is a portion of the paved space that inclines north along the path. In addition, there are small stairs located at various positions and must be accounted for based on a separate standard.

Table 9.4.2-2 Individual Lighting Power Allowances for Building Exteriors

ANSI/ASHRAE/IES Standard 90.1-2013

Building Grounds (Zone 3)	LPD (W/ft^2)
Walkways less than 10ft wide	0.8
Plaza Areas	0.16
Stairways	1.00
Landscaping	0.05

The exterior lighting power density must remain within the allowances set in the above criteria. Some of the exterior pathways are greater than 10’ wide, while others are less than that width. Thus, I will account for both when considering LPD. In addition, the stairways and landscaping allowances are considered due to the large amount of landscaping space and several small stairwells.

LIGHT-LOSS FACTORS

Assumed LED Light Loss Factor	
Description	Factor
Lamp Lumen Depreciation	.80
Luminaire Dirt Depreciation	.95
Total Light Loss Factor	.76

EXTERIOR SITE PLAN

LUMINAIRE: S1
DESCRIPTION: LED AREA LUMINAIRE
MANUFACTURER: LITHONIA

LUMINAIRE: S2
DESCRIPTION: LED LIGHTING INTEGRATED WITHIN HANDRAIL
MANUFACTURER: LUXRAIL

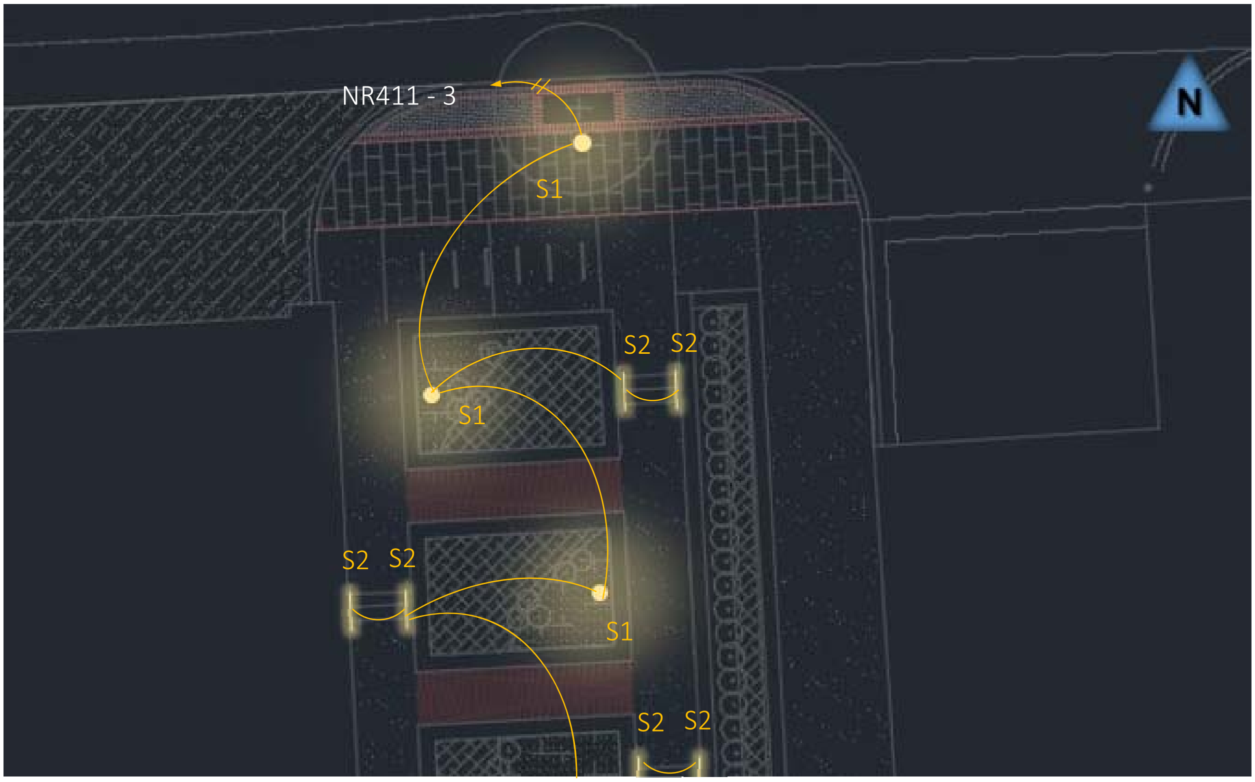


Figure 25: An aerial site plan of the upper exterior plaza.

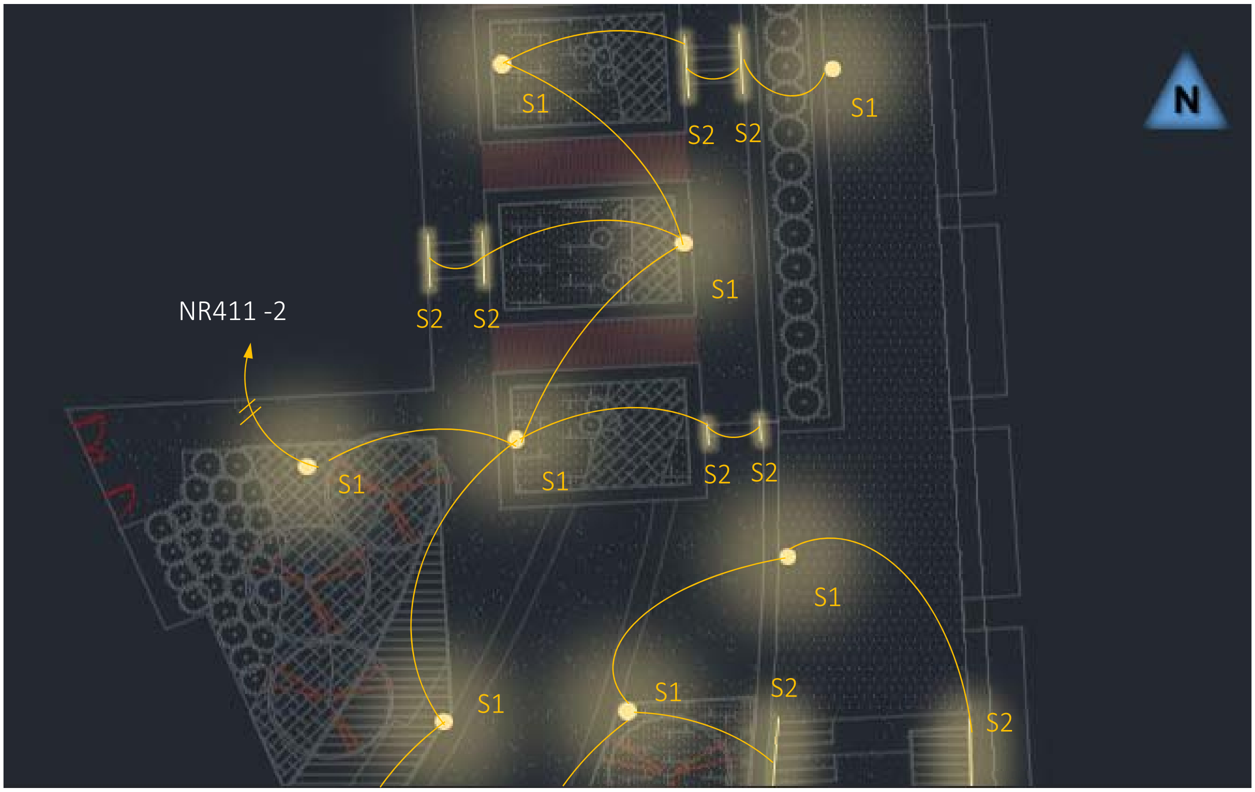


Figure 26: An aerial site plan of the central exterior plaza.

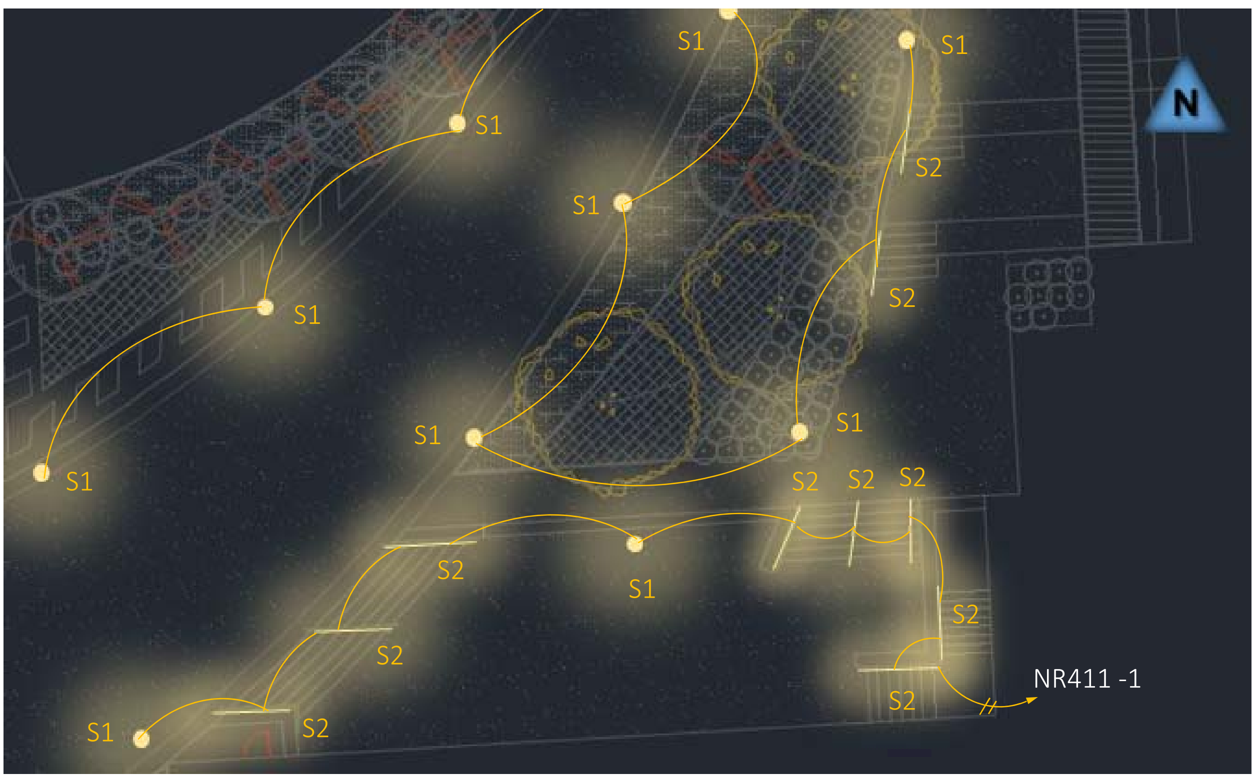


Figure 27: An aerial site plan of the lower exterior plaza.

PERFORMANCE DATA

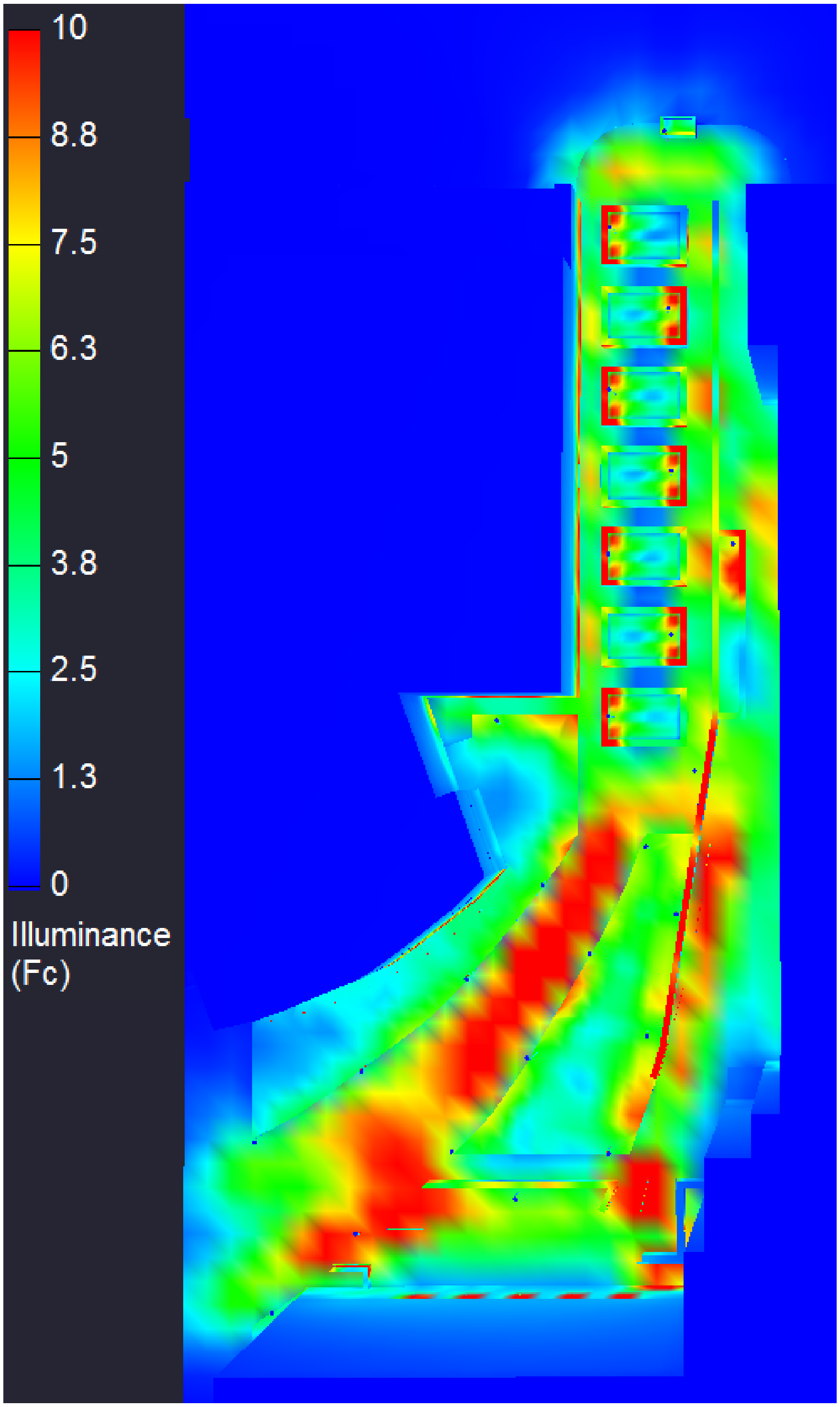


Figure 28: An aerial site pseudo rendering of the exterior plaza.

DESIGN SUMMARY

Lighting Criterion	Recommended Value	Achieved Value	Criteria Met
LPD Area Summary	< 0.8 W/ft²	0.181 W/ft²	Yes
Average Target Illuminance	≥ 6 fc	6.35 fc	Yes

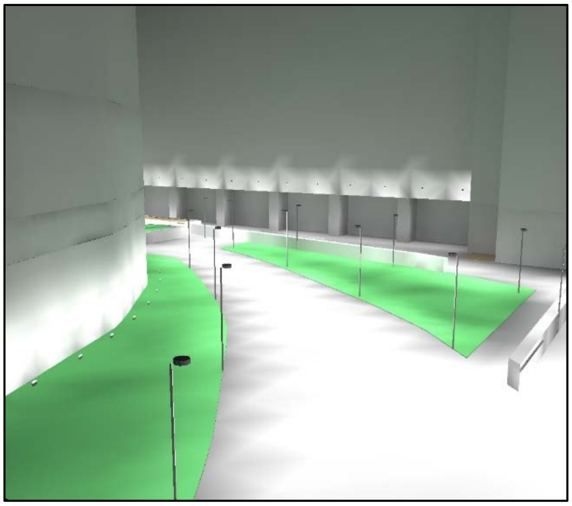


Figure 29: Perspective rendering of the plaza looking north. .

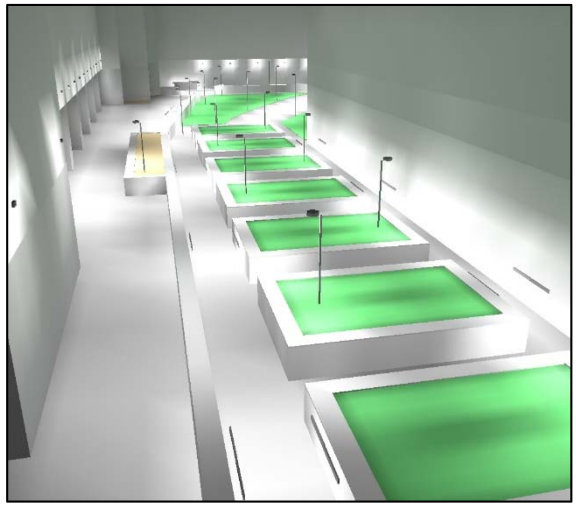


Figure 30: Perspective rendering of the plaza looking south.

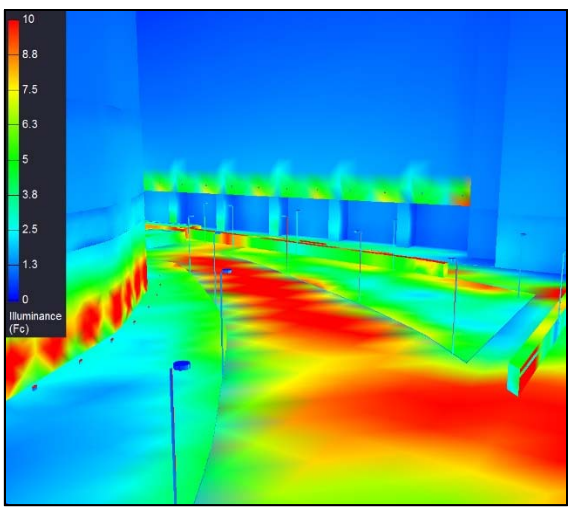


Figure 31: Pseudo rendering of the plaza looking north.

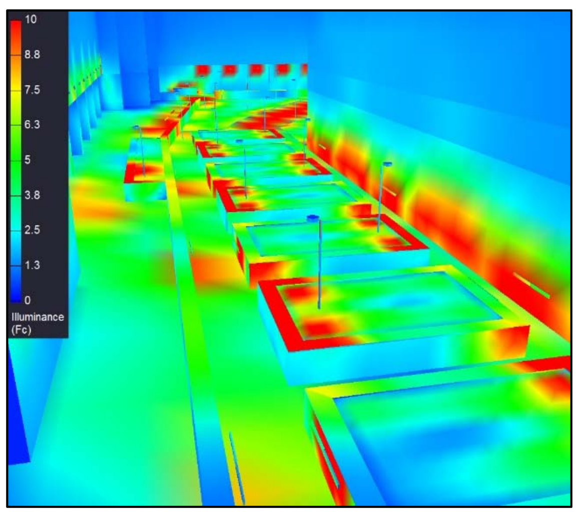


Figure 32: Pseudo rendering of the plaza looking south.

As you can see, the pathway clearly meets the 1 fc average illuminance as specified in the criteria. This will provide enough for safe night-time pedestrian travel.

SECTION 3 | ELECTRICAL DEPTH

The building is projected to receive a LEED Gold rating. The minimum energy performance must exceed ASHRAE 90.1 – 2007 by 10%. The MEP will confirm roughly 25% savings when energy model is completed.

BUILDING UTILIZATION VOLTAGES

Lighting: 120V and 277V | 1 ϕ
Receptacles: 120V | 1 ϕ
Mechanical Equipment: 208/120V and 480/277V | 3 ϕ
Special Equipment: Elevators 120V | 1ϕ

ELECTRICAL SYSTEMS PERCENTAGE

The majority of the building's electrical storage space is in the basement and penthouse levels. In addition, there are IT and electrical rooms at the east and west ends on each floor. The building's IT and electrical rooms are located in the same area of each subsequent floor and are therefore identical in area.

Lower Basement Level = 5376 sq ft.
Upper Basement Level = 5267 sq ft.
Level 1 = 752 sq ft.
Level 2 = 752 sq ft.
Level 3 = 752 sq ft.
Level 4 = 752 sq ft.
Level 5 = 752 sq ft.
Level 6 = 752 sq ft.
Level 7 = 752 sq ft.
Level 8 = 752 sq ft.
Level 9 = 752 sq ft.
Lower Penthouse Level = 5280 sq ft.

Electrical Combined Floor Area = 22,691 sq ft.
Building Total Area = 428,970 sq ft.

22,691 / 428,970 = .05 (5% of the building floor area)

BUILDING LOAD CALCULATION

The Health Science Facility III is classified as Occupancy Business use Group B, Assembly use Group A-3, Storage use Group S by the IBC 2009 Ed. Load calculations provided by the NEC 2011 Ed.

LIGHTING

3.5 VA/SF × 428,970 SF = 1501 kVA
DEMAND FACTOR: 100%

RECEPTACLE

3.5 VA/SF × 428,970 SF = 1501 kVA
10 kVA + (.5 × 1491 kVA) = 755 kVA
DEMAND FACTOR: 100% for first 10kVA, 50% for remainder

MECHANICAL

7 VA/SF × 428,970 SF = 2402 kVA
DEMAND FACTOR: 80%

SPECIAL EQUIPMENT – ELEVATORS

1.1 VA/SF × 428,970 SF = 472 kVA
DEMAND FACTOR: 100%

TOTAL BUILDING LOAD = 5130 kVA

POWER COMPANY RATE SCHEDULE

Baltimore Gas and Electric Company provides the following monthly net rates:
Utility Voltage is 480V | 3ϕ

CUSTOMER CHARGE = $88.00 per month
DEMAND CHARGE = $3.17/kW
DELIVERY SERVICE CHARGE = 0.01584 $/kWh
GL SCHEDULE – TYPE II SOS

GENERATION RATE = 14.909 c/kWh
TRANSMISSION RATE = 0.549 c/kWh
TOTAL SUPPLY RATE = 15.458 c/kWh

BACK-UP POWER LOADS

GENERATOR (LONG – TERM)

Emergency Lighting = 7.51kVA
Elevator Systems
IT Equipment

UNINTERRUPTIBLE POWER SUPPLY (SHORT – TERM)

Video Surveillance
Security Access

COMMUNICATION SYSTEMS

Telephone / Data
Fire Alarm
CATV
Access Control – Card Access
Security / Video Surveillance

MAJOR EQUIPMENT

Switchboards
Panel boards
Generators
Transformers
Elevator Motors
Uninterruptible Power Supply (UPS)

CONNECTED BUILDING LOADS

See Appendix C.

EMERGENCY POWER

See Appendix C.

MAIN SERVICE AND DISTRIBUTION EQUIPMENT

Switchgear E/NG5B1 | 13200V
Switchgear NS5B1 | 480Y/277, 3 ϕ, 4 wire
Switchgear ES5B1 | 480Y/277, 3 ϕ, 4 wire
Switchgear ES5B2 | 480Y/277, 3 ϕ, 4 wire
Switchgear ES5P1 | 480Y/277, 3 ϕ, 4 wire
Switchgear ES5P2 | 480Y/277, 3 ϕ, 4 wire
Switchgear ELG4P1 | 480Y/277, 3 ϕ, 4 wire

MAIN SERVICE EQUIPMENT

Single Ended equipment, indoor location.

MAIN SERVICE TRANSFORMER

Typical Dry Type Insulated transformer 480V Delta Primary, 208Y/120V Secondary

STEP DOWN TRANSFORMERS

With exception to the basement and penthouse levels, all floors have either 4 or 5 transformers located in the electrical rooms. Below is a listing of the transformers.

DESIGNATION	VOLTAGE (kVA)
TXB1	112.5
ETXB1	112.5
ELTXB1	45
ETXB2	112.5
ELTXB2	112.5
TX11	112.5
ETX11	75
ETX12	75
TX12	112.5
ELTX11	75
TX21	112.5
ETX21	75
ETX22	75
TX22	112.5
TX31	112.5
ETX31	75
ETX32	75
TX32	112.5
TX41	112.5

ETX41	75
ET432	75
TX42	122.5
ELTX41	15
TX51	112.5
ETX51	75
ET452	75
TX52	112.5
TX61	112.5
ETX61	75
ET462	75
TX62	`112.5
TX71	112.5
ETX71	75
ET472	75
TX72	112.5
ELTX71	15
TX81	112.5
ETX81	75
ET482	75
TX82	112.5
TX91	112.5
ETX91	75
ET492	75
TX92	112.5
TX101	112.5
ETX101	112.5
ET4102	112.5
TX102	112.5
ELTX101	15
ELTXP1	15
ELTXP2	112.5
ETXP1	112.5

PANEL BOARDS
Wall - Mounted with galvanized steel channels.

MAIN RISERS AND FEEDERS
The busses are copper, with bolted feeders.

CONDUCTORS
Copper Conductors throughout the building circuitry.

CONDUIT
General PVC Conduit, insulation 6 inch.

RECEPTACLES
Specification Grade.

SWITCH AND RECEPTACLE FACEPLATES
Switch cast weatherproof cover. Watertight compression used for receptacle box. Additional sealant requirements in architectural drawings.

MOTOR STARTERS
The building's motor starters are individual and non-reversing.

UPS

The UPS sub-division panel is located in the basement of the building. This 208/120V 1 ϕ system operates for the security surveillance and IT components in the building.

The addition of a new lighting system had a minimal effect on the building loads on the first floor. Below is a portion of the panel board schedule found in Appendix C. Here, the lighting panel used for the elevator lobby and meeting room are shown.

DESIGNATION	LEVEL	FED FROM	VOLTAGE	CONNECTED LOAD (kVA)	DEMAND (kVA)	TYPE
LP412	LV 1	BUSWAY	480Y/277, 3 PHASE, 4 WIRE	13.31	16.64	LIGHTING PANEL

LP412 – New Connected Load = 13.42 kVA

The new connected load was slightly higher. Most likely due to the addition of the trace fixtures in the cove space within the meeting room.

Next is the lighting panel that the nanomedicine workstation connects to. Notice that this is a life safety panel rather than a generic lighting panel.

DESIGNATION	LEVEL	FED FROM	VOLTAGE	CONNECTED LOAD (kVA)	DEMAND (kVA)	TYPE
ELLP411	LV 1	ELDP451	480Y/277, 3 PHASE, 4 WIRE	7.51	9.38	LIFE SAFETY LIGHTING PANEL

ELLP411 – New Connected Load = 7.48 kVA

The new connected load was found to be relatively the same as the previous design. This is because the design utilized mainly the same placement of luminaires within the space.

PRODUCT: WATTSTOPPER Isole IDP – 3050 Power Strip with Personal Sensor

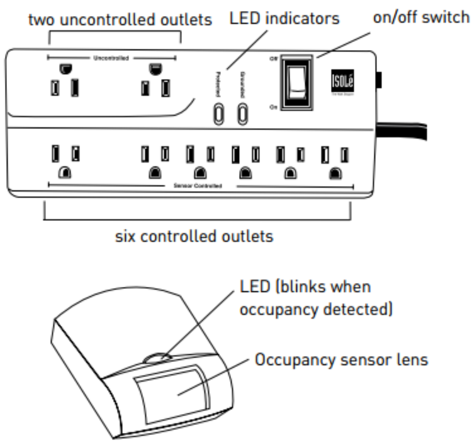


Figure 33: View of the IDP power strip.

The Isole IDP – 3050 is a control system for desktop plug load equipment that can provide additional energy savings within the facility's office and conference spaces.

The power strip features eight outlets. Six are controlleg by the occupancy sensor, while the remaining two are basic uncontrolled outlets.

The personal sensor uses infared (PIR) technology in order to detect occupancy. This sensor can be adjusted by the user to assume a 30 sec to 30 min time delay. With a 120° sensing range (nearly 300 sq. ft. of coverage) this is an ideal system for small office space.

Baltimore Gas and Electric Company provides the following monthly net rates:
Utility Voltage is 480V | 3ϕ

CUSTOMER CHARGE = $88.00 per month
DEMAND CHARGE = $3.17/kW
DELIVERY SERVICE CHARGE = 0.01584 $/kWh
GL SCHEDULE – TYPE II SOS

GENERATION RATE = 14.909 c/kWh
TRANSMISSION RATE = 0.549 c/kWh
TOTAL SUPPLY RATE = 15.458 c/kWh

TOTAL SUPPLY RATE OF THE BUILDING = 15.458 C/KWH

INITIAL STUDY SHOWS NEW SUPPLY RATE = 13.912 C/KWH

SAVING ROUGHLY 10%

The following Economic analysis is performed with the assumption that there is a warranty of 5 years.

Cost per unit = roughly $97.50
Cost of Installation/Labor = roughly $5000.00
Number of Offices = 835
One unit per office = $81412.50 total unit cost

Delivery Service charge) = 0.01584 c/KWh
Electrical Combined Floor Area = 22,691 sq ft. / 300 = 75.6367

Savings per unit = $97.50 - $75.6367 = $21.8633

Initial Cost: ($81412.50) + $5000.00) = $864112.2
(Unit Cost + Labor Cost)

Savings percentage = 10%

Subsequent savings per year: (22,691/13.912) = $1631.04

($1631.04 x 5 year warranty) = $8155.12 saved over 5 years.

The installation of this system is definitely worth the investment as it will provide for at least $8155 worth of energy savings.

SECTION 4 | ARCHITECTURAL BREADTH

ARCHITECTURAL BREADTH | FAÇADE DESIGN STUDY

STUDY: Will the addition of a rain screen prove useful in the new construction?

PRODUCT: Kalzip FC Rain Screen System

This system incorporates non-penetrative and lightweight flat rain screen panels that are suitable for both new construction and refurbishment projects.

Panels have the benefit of being able to be mounted either vertically or horizontally, making them easier and faster to install compared to conventional rain screen panel systems.

SPECIFICATIONS FROM CUTSHEETS

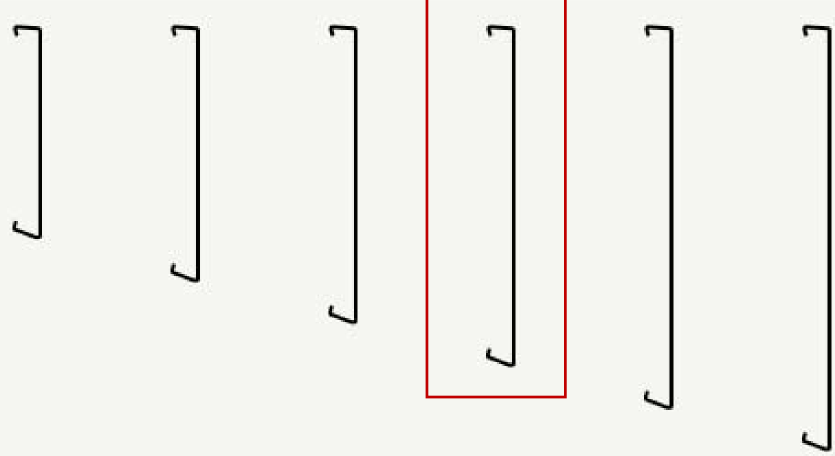
- Contemporary, visually stunning aesthetics
- Several different profile widths provide flexibility and scope for design
- Highly cost-effective through simple and fast installation techniques
- Optimized panel geometry means low inherent weight and reduced use of materials
- Variable acoustic and thermal insulation options
- A wide range of color and surface finishes with edge folding as standard
- Fully integrated corner panels (optional)
- High structural performance
- Creation of fixed point without the use of screws and rivets

The rain screen façade system not only prevents water penetration in a façade, but also increases the thermal efficiency of the building. By implementing this on both the east and west elevations, the Health Science Facility III

Figure 34: HSF III West Elevation.

Figure 35: HSF III East Elevation.

Profile type:	Kalzip FC 30/250	Kalzip FC 30/300	Kalzip FC 30/350	Kalzip FC 30/400	Kalzip FC 30/450	Kalzip FC 30/500
Profile thickness	1.0 mm 1.2 mm	1.0 mm 1.2 mm	1.0 mm 1.2 mm	1.0 mm 1.2 mm	– 1.2 mm	– 1.2 mm
Micro-ribbed	no	no	no	yes	no	no



Based on the brick veneer façade of the east and west elevations it would be beneficial to implement a micro-ribbed Kalzip panel. They can also specify with edge return (a design standard). Because the facades are relatively narrow and combed with windows, this would be the appropriate choice.

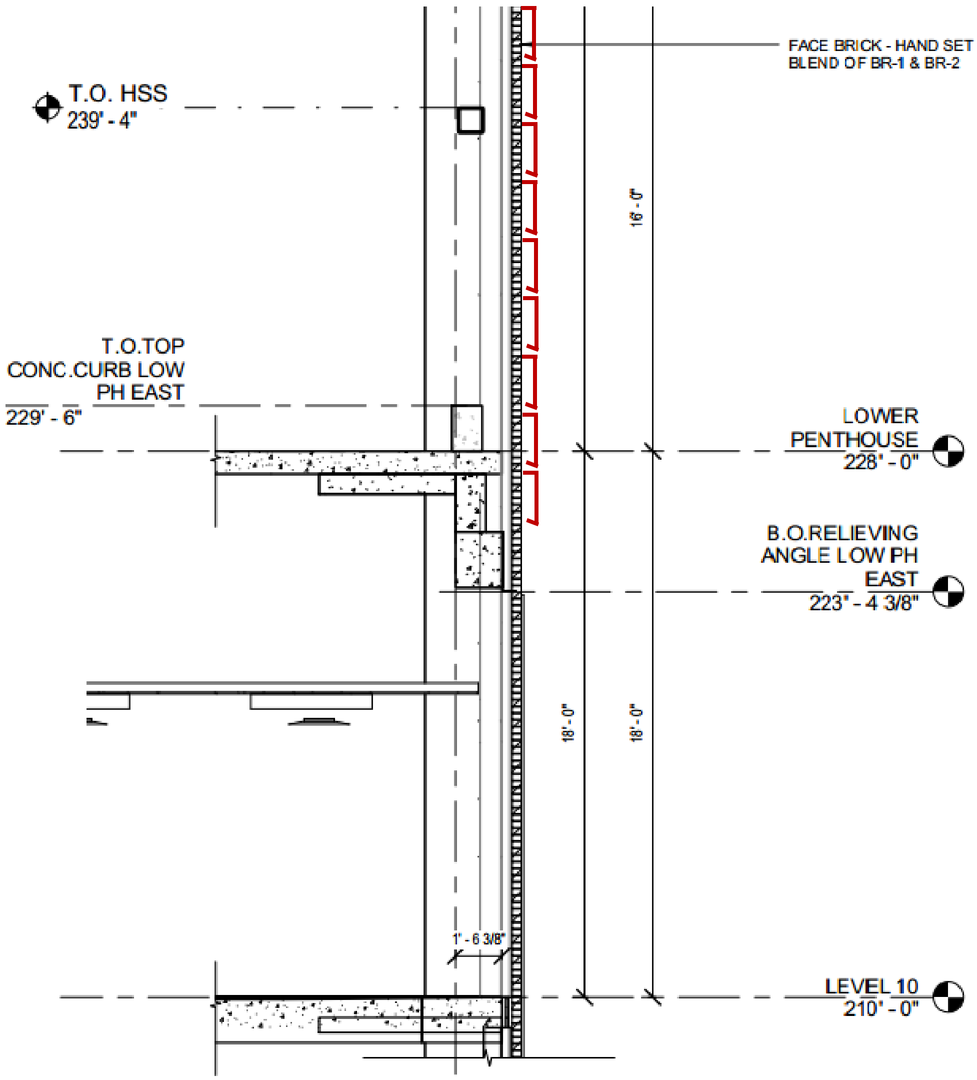


Figure 36: HSF III East Elevation.

RAIN SCREEN COST

For every 1500 sqft of surface area the average rain screen costs roughly $2000.00 - $3000.00. For this study, I will assume $2500.00.

The East exterior surface area = 14395.43 sq ft / 1500 = appx. 8.7
Therefore the total cost for the east exterior will be **$21930.71**

The West exterior surface area = 13158.43 sq ft / 1500 = appx. 9.6
Therefore the total cost for the west exterior will be **$23992.38**

The rain screen system can improve the thermal efficiency of the Health Science Facility. Given the high initial cost, it would be up to the university whether they thought the energy savings would be worth the higher initial cost.

SECTION 5 | STRUCTURAL BREADTH

STRUCTURAL BREADTH| NEW LOAD SUMMARY

The following study is to prove whether or not the proposed rain screen will affect the structural load on the building.

Due to the low structural weight of the rain screen, it can be surmised that the advanced weight and placement of the Kalzip façade will not create many issues. Below are some assumed loads for building load calculations.

ASSUMED LOADS

AREA	LIVE LOAD	PARTITIONS
BALCONIES - EXTERIOR	100 PSF	N/A
CATWALKS (MAINTENANCE)	40 PSF	N/A
CLASSROOMS	40 PSF	15 PSF
CORRIDORS	100 PSF	N/A
CORRIDORS - ABOVE 1ST FLOOR	80 PSF	N/A
LAB SPACE	125 PSF	N/A
LIBRARY - READING ROOMS	60 PSF	15 PSF
LIBRARY - STACK ROOMS	150 PSF	N/A
MARQUEES	75 PSF	N/A
MECHANICAL ROOMS	150 PSF	N/A
OFFICES	80 PSF	15 PSF
STAIRS & EXITWAYS	100 PSF	N/A
STORAGE - LIGHT	125 PSF	N/A
STORAGE - HEAVY	250 PSF	N/A
TRUCKING - LOADING DOCK	250 PSF	N/A

AREA	SD LOAD
FLOORS	10 PSF
ROOF	30 PSF
ABOVE MECH. ROOF	20 PSF

Figure 37: Load Spreadsheets provided by contract documents.

Exterior Column Load:

Fc (Lower Basement level – Penthouse) = 5000 PSI

5000 X 13 = 65000 PSI at base of exterior column.

Kalzip = 3psf – panel self weight.

Total area = 14395.43sf + 13158.43sf = 27553.86sf

27553.86 sf x 3psf = 82661.58

The Kalzip structure will be placed along the exterior edge of the east and west façade. The façade weight will not be subjected to any extreme changes in applied weight.

REPORT SUMMARY

The previous report was a brief summary of the upcoming Health Science Facility III. This highly advanced research facility will house groups from the majority of the health science campus including the School of Pharmacy, Dentistry, and medicine. This new lab space will provide ample opportunity in the University of Baltimore's already thriving campus.

The implementation of the new lighting systems proved to be a worthy endeavor. The lighting schemes for all four spaces, including the elevator lobby, the nanomedicine workstation, and the exterior plaza, all met the predetermined criteria that was specified in the schematic design. With the use of less luminaires as the original design, energy savings were potentially made, however, this came at a cost of less illuminance in each space. The requirements were met, however I wish I had been able to implement more of my design concept throughout the spaces.

The electrical study proved that the sizing of the new panel boards was relatively unnecessary, in that the lighting scheme did not change the required load enough to show improvement. Instead, the research into implementing an occupancy sensor controlled office scheme proved to have rewarding energy savings.

The rain screen study was an interesting glimpse into the additional benefits to using sustainable design. While it does have many energy savings benefits, the rain screen may prove too costly for the university to implement.

The structural summary yielded no significant weight change in the exterior façade, therefore the system is worth implementing.

REFERENCES

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