ALYSON LARIMER

SENIOR THESIS FINAL REPORT
SPRING 2011

LIGHTING | ELECTRIAL

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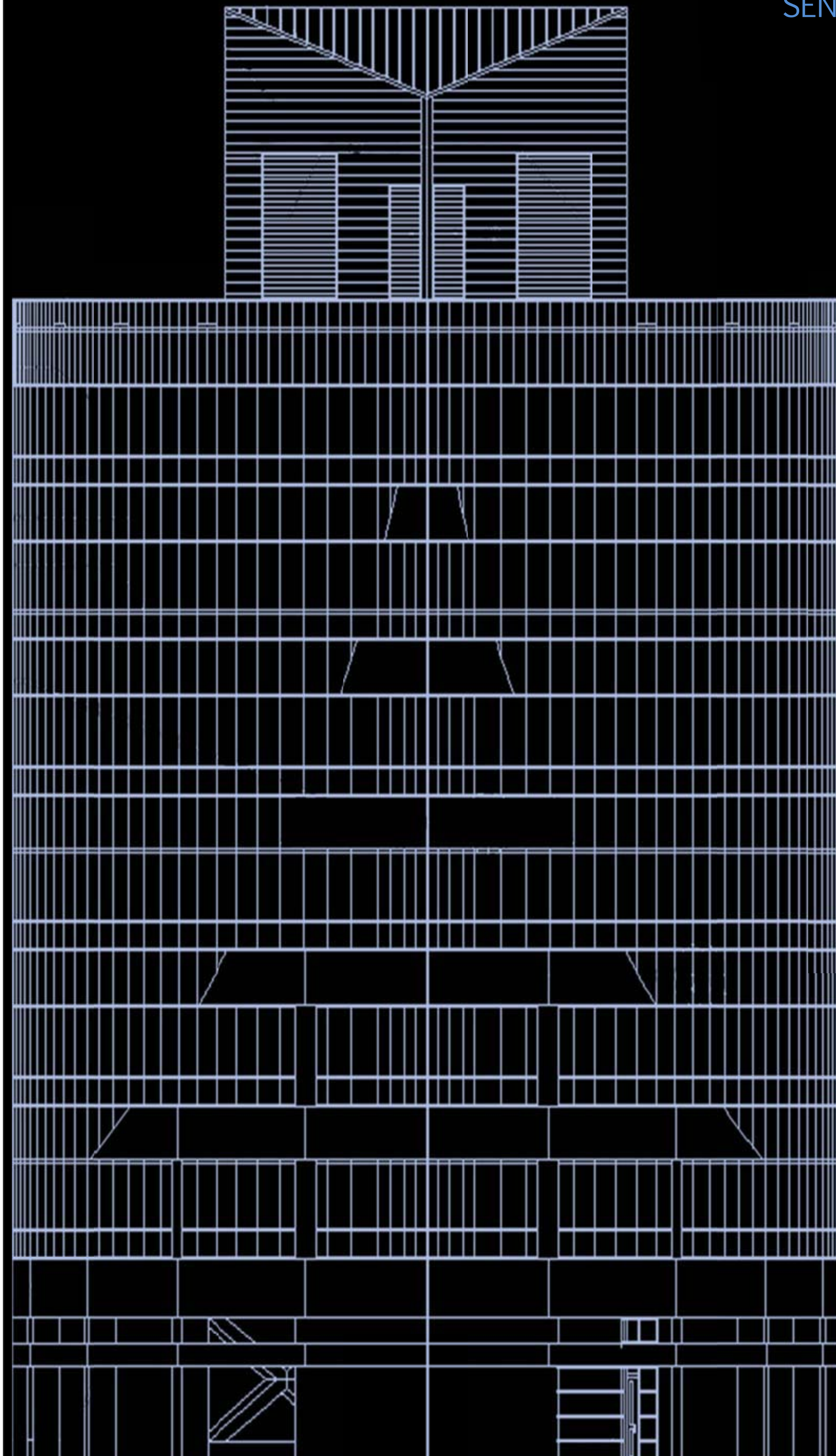
PROF. TED DANNERTH



VIRGINIA ADVANCED SHIPBUILDING AND CARRIER INTEGRATION CENTER

Virginia Advanced Shipbuilding and Carrier Integration Center

Newport News, Virginia

Project Team

A/E/M/S: Clark Nexsen

Architecture and Engineering

Building Statistics

Occupancy: Shipbuilding/Office
Size: 241000 sqft
Levels: 8 Max
Construction: 1999-2002
Delivery: Design-Bid-Build
Cost: $58 Million

Alyson Larimer

Lighting / Electrical

www.engr.psu.edu/ae/thesis/portfolios/2011/azl5017

Architecture

The VASCIC Facility consists of two main building components; the laboratory with integrated parking garage, and the office Tower. The laboratory forms the backbone for the VASCIC facility, which was designed to house assembly and integration of electronics and power systems for aircraft carriers.

Mechanical

The primary air provided to the Laboratory is served from 4 VAV roof top air handling units and the Office is conditioned from the Tower Penthouse. The Penthouse contains 3 VAV air handling units utiliizing oval and rectangular duct.

Structural

The entire facility was built with a precast, prestressed concrete foundation system. The framing system utilizes precast concrete load bearing wall panels and interior columns, or a wide-flange structural steel system integrating braced frames and shear walls.

Electrical

Virginia Power provided four 5MVA pad mounted transformers with secondary voltage of 13800V. Electrical service to the facility enters at the Laboratory wing and is then connected to the Office Tower. The service entrance consists of four seperate switchgear set in main-tie-main configuration. Three 5MVA transformers suppy power to the Laboratory Power Lab and one 5MVA transformer supplies the rest of the VASCIC facility. Normally the tie breaker will be open but may need to be closed to perform laboratory experiments requiring over 15MVA. The fifth 5MVA transformer is designated specifically for the fire pump station.

Lighting

Within the Facilities' buildings, there are multiple functions in a single building. The Office Tower utilizes a task/ambient lighting system. In the conference rooms and display areas, recessed and accent lighting is used. The Laboratory wing contains an auditorium which also utilizes a task/ambient lighting design along with adjustable accent lighting.

Throughout the main laboratory space, a high bay metal halide system is used. Daylighting was alos a consideration in the design process due to the facade materials chosen.

EXECUTIVE SUMMARY

The Virginia Advanced Shipbuilding and Carrier Integration Center is the leading researcher in nuclear-powered aircraft carriers and obtains a well-deserved signature structure that is visible from the distance. The Technology Tower stands approximately 135 feet in the air. The VASCIC Facility is architecturally influenced by water, most importantly, the ship industry. The façade is mainly a curtain wall system with detailing of horizontal precast concrete bands.

This report is a final documentation of the facility primarily focusing on lighting and electrical redesign of four spaces located either in the Technology Tower of the Laboratory Wing. In addition to these two main depths of study, two other breadths of study outside of lighting and electrical design were performed to further enhance the design of the facility. These breadths include an architectural landscape design of an exterior space as well as an acoustical study performed in response to a ceiling material change in the auditorium space.

The lighting depth comprises a redesign of the lighting systems. Prior to finalizing designs, preliminary design concepts and criteria were compiled in order to properly design the lighting for each individual space. Furthermore, surface materials were accounted for when determining where and how to place light throughout the facility. Luminaire layouts, mounting details, performance summaries, and final renderings of each new design are included. The four spaces that were considered for these redesigns are the main lobby, the open office located on the fourth floor of the Technology Tower, the auditorium located on the second floor of the Laboratory Wing, and finally an exterior gathering space that was first designed architecturally.

In response to the lighting design changes, the electrical depth considers the lighting load changes on each panelboard. These changes directly affect the sizing of branch circuits, panelboards, feeders, and protective devices. In addition, voltage drop calculations, short circuit calculations, and a protective device coordination study were conducted to confirm equipment and feeders were properly sized. Furthermore, two electrical breadths were conducted. A motor control center was designed for the laboratory main electrical room to easily compile all the motors of the space in one location for maintenance purposes, as well as a cost analysis of busducts verses conduit and feeders for the Laboratory Wing.

This report is intended to demonstrate an integrative approach to building design process and analysis providing a more comprehensive understanding of the architectural engineering design process.

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PROJECT BACKGROUND

The Virginia Advanced Shipbuilding and Carrier Integration Center is a state-of-the-art facility designed to enhance and promote the quality and competitiveness of the ship building industry. Teams of experts including Northrop Grumman Shipbuilding, electronic system suppliers, software suppliers, U.S. Navy laboratories and program representatives, and many other advanced shipbuilding programs conjure within the VASCIC facility to explore and research new technologies. This facility is the leading researcher in nuclear-powered aircraft carriers, being responsible for the design of Nimitz – and – Ford class aircraft carriers, Virginia – Class attack submarines, U.S Coast Guard Security Cutters along with many others.

There are two main building components of the facility; center stage is a seven-story Technology Tower and adjoining is a three-story Laboratory Wing, which is all situated between 23rd Street and the James River of Newport News. Within the Technology Tower, 400 personnel are situated here primarily for coordination and support of new technologies implemented into aircraft carriers. On each end of the tower there are conference rooms, small meeting rooms, as well as technology displays. The Laboratory wing contains a three-story parking garage, a 180-seat auditorium, a few small offices that overlook the ship building process, modeling and simulation rooms, as well as a few secure video and teleconference rooms. The rest of the space is open laboratory reserved for the ship building process.

BUILDING STATISTICS:

BUILDING NAME: The Virginia Advanced Shipbuilding and Carrier Integration Center

LOCATION AND SITE: 2401 West Avenue, Newport News, Virginia

BUILDING OCCUPANT: Northrop Grumman Newport News Shipbuilding

BUILDING FUNCTION: Commercial Office/Research and Design

SIZE: 241,000 sq. ft.

NUMBER OF STOR IES: 7 story Office Tower

3 story Laboratory Wing

PRIMARY PROJECT TEAM:

OWNER: Clark Nexsen Architecture and Engineering

http://www.vascic.com/

ARCHITECTS: Clark Nexsen Architecture and Engineering

http://clarknexsen.com/

STRUCTURAL ENGINEER: Clark Nexsen Architecture and Engineering

http://clarknexsen.com/

MEP/FIRE PROTECTION: Clark Nexsen Architecture and Engineering

http://clarknexsen.com/

CIVIL ENGINEER: Clark Nexsen Architecture and Engineering

http://clarknexsen.com/

CONSTRUCTION/GENERAL CONTRACTOR: W.M Jordan Company

http://www.wmjordan.com/

DATES OF CONSTRUCTION: December 1999 – February 2002

ACTUAL COST: $58 million building cost

PROJECT DELIVERY METHOD: Design – Bid – Build

ARCHITECTURE:

Design:

The VASCIC facility consists of two main building components; the Technology Tower and the Laboratory Wing. The laboratory forms the backbone for the VASCIC facility, which was designed to enhance the competitiveness of the shipbuilding industry. The VASCIC facility is the leading researcher in nuclear-powered aircraft carriers and therefore deserves to obtain unique architecture style. From an elevation standpoint, the Technology Tower appears to be a ship sailing through water. Reflecting pools surround the ground floor and extend past the building edge to further enhance the appearance of a ship in water. Additionally, precast concrete bands are placed horizontally up the building in a rhythm that imitates the contours water would possess as a ship sails through water.

Codes:

BOCA National Building Code, International Mechanical Code, International Plumbing Code, NFPA 70 National Electric Code, ASME A17.1-93 Safety Code for Elevators and Escalators.

Historical Requirements: Not Applicable

Building Envelope:

Through the utilization of different façade materials, there is a distinct visual separation between the two main functions of the building. The office tower is enclosed primarily of curved reflective glass panels of two main glass types (below), IG-2 and IG-3. Type IG-2, the larger glass panels, are reflective insulated glass manufactured by Viracon with visible light transmittance of 12%, a winter u-value of 0.40, a summer day u-value of 0.46, a solar gain coefficient of 0.17, and an outdoor visible reflectance of 32%. Type IG-3, the smaller bands of glass panels, are ceramic-coated spandrel insulating glass with a medium gray frit pattern. Also integrated into the front façade of the building are sections of pre-cast concrete that are lightly sand blasted for texture.

The research and laboratory wing connected to the office wing has a façade primarily made of tilt-in-place insulated concrete wall panels that are lightly sand blasted with recessed pre-cast concrete panels that are heavily sand blasted. The view shown above is a typical east or west bay that contains glazing and pre-cast concrete sections. The glazing, like the office tower, consists of two different types of CSG-1 and IG-3. Type CSG-1 is a low emissive insulating glass also manufactured by Viracon. Its visual light transmittance is not less than 70%, winter night u-value of not more than 0.29, summer day u-value not more than 0.28, solar heat gain coefficient of not more than 0.37, and outdoor visible reflectance of 11%. Type IG-3 is the same ceramic-coated spandrel insulating glass as used for the office tower façade.

The roofing of the two building sections is rather simple and less complex as the façade. The office tower utilizes EPMD on the roof while the research laboratory is a painted sloping metal roof deck. All exposed metal is required to be painted with color fluoropolymer or a polyester finish.

ELECTRICAL:

Power to the Virginia Advanced Shipbuilding and Carrier Integration Center is provided directly from Virginia Power at 23,000 volts in plastic conduit encased in concrete. At the service entrance, five transformers are present. Virginia Power is responsible for all five transformers, two Square D Powerlogic metering equipment, and one switchgear. Four transformers are utilized for facility power each pad mounted and rated at 5 MVA, 23.0/12.2 KV, Y primary, and 13.8/7.9 KV, Y secondary. The fifth transformer is designated for the fire pump which is also pad mounted and rated at 23.0/13.2 KV, Y primary, and 480Y/277 secondary.

The service entrance is located outside of the Laboratory/Parking Building in the South East section of the building. The main switchgear SGA is located here and is connected to the secondary switchgear SGB inside the Laboratory/Parking Building in the Electrical Integration Lab. Switchgear SGA is a metal clad type with draw out vacuum circuit breakers rated at 15 KV, 500 MVA, 1200 A continuous current and switchgear SGB has draw-out type DS power circuit breakers. These two switchgears are connected through underground conduits utilizing four sets of 15 KV cables that are plastic conduit encased in concrete. Switchgear SGB is in main-tie-main configuration which is left open for the majority of the time. It is only closed when specialty testing in the Laboratory is being conducted to provide a common 10 MVA to the facility. Switchgear SGB distributes power to switchboards SBPA, SBPB, and SBPC. Switchboard SBPA distributes power to another smaller switchboard TSB in the Office Tower. Switchboard TSB distributes power to the left hand side of the Office Tower while switchboard SBPB distributes power to the right hand side via distribution panel PDP. It also distributes power to the main mechanical equipment located on the rooftop penthouse of the Office Tower. Switchboard SBPC distributes power to all lighting and receptacle loads utilizing a bus duct riser system in the Electronic Integration Lab.

LIGHTING:

The lighting utilizes lamp types of linear fluorescent, compact fluorescent, incandescent, halogen, metal halide, and high intensity discharge. Linear fluorescent ballasts are multi-lamp electronic type with total harmonic distortion rating less than 20%. Compact fluorescent ballasts are electronic type with power factor greater than 90%. High intensity discharge ballasts are constant wattage autotransformer single-lamp type with starting temperature at a minimum of -22 degrees Fahrenheit.

The Auditorium contains an extensive dimming control system to cater to the needs of the occupant. The dimming system contains three lighting scene controllers, two dimming panels, and three entry controllers.

The lighting scene controllers contain a four scene preset module and a separate four scene accessory control allowing for a total of eight scene presets. The preset module has eight control zones with a raise/lower switch to control each zone separately. These modules are Grafik Eye 4000 Series manufactured by Lutron.

Each dimming panel has main lugs for incoming power, a 20 A single-pole circuit breaker for each zone, plug-in dimmer cards, and filter chokes. The dimming cards are capable of dimming electronic fluorescent ballasts and incandescent loads.

The three entry controllers are two-button, single scene ("on"/"off"), that are Grafik Eye NTGRX-2S series manufactured by Lutron.

MECHANICAL:

The Office Tower primary air is provided by the penthouse mechanical room located on the roof that houses 3 VAV AHU's. The required primary air is provided through round or oval duct utilizing a vertical chase.
The Laboratory/Parking Building primary air is provided by 4 VAV AHU's located in the center of this building. The required primary air is provided through galvanized, round straight runs of duct to each end of the Laboratory.

The estimated cooling load for the entire facility is 1000 tons provided by high efficiency water cooled centrifugal chillers. The design consists of one 350 ton chiller and one 650 ton chiller with a 12 degrees temperature difference.

The estimated heating load for the entire facility is 7,500,000 btu/hr. A gas hot water system is utilized with gas fired boilers that are high efficiency condensing type to generate hot water. This hot water is distributed throughout the facility by two way valves at heating coils and perimeter hydronic heat at glass wall locations.

STRUCTURAL:

The foundation system for both the Technology Tower and the Laboratory Wing is a deep foundation system consisting of precast, pre-stressed concrete driven piles. The sizes and lengths of the piles are based on the required load capacities. The piles support a concrete pile cap and grade beam system that supports each building superstructure. The material of the concrete piles and foundation is 5000 psi minimum compressive strength concrete.

The flooring system of the Laboratory Wing is constructed of precast, pre-stressed concrete double “tees” spanning (+/-) 60 feet, supported by precast, pre-stressed concrete beams. The load capacity of the floor system is 300 psf, based on criteria provided by Newport News Shipbuilding. A concrete topping slab is placed over the double “tees”. The flooring system of the Technology Tower is a composite system consisting of a formed steel deck with a concrete infill supported by structural steel beams. Each beam as steel studs welded to the top flange as required to achieve the composite action with the concrete deck. The double “tee” material is 6000 psi minimum compressive concrete and the structural slab is 5000 psi minimum compressive strength concrete.

FIRE PROTECTION:

The sprinkler system is based on the height of the Technology Tower and is required to have a fire pump station. The fire pump is electric motor driven and includes a controller that is a power transfer switch for connection to the facility generation in emergency situations. The sprinklers throughout the facility are pendant heads where suspended ceilings are utilized and upright sprinkler heads where exposed ceilings are utilized.

The fire alarm system is an automated detection system including smoke detectors, duct smoke detectors, and a sprinkler system. In spaces of assembly type occupancies, voice automated fire alarm systems are utilized.

COMMUNICATION SYSTEMS:

Access Control:

Access to the facility is controlled by a card access system. Car readers are either swipe or proximity type and are located on the entrance side of all exterior doors. Exit monitoring is not required in the facility. Access to the parking facility is controlled by card readers and motorized gates. This entire security system is placed on uninterruptible power supply.

Another component of the access control system is video imaging system integration. This integration system provides a single database on the main host computer of every cardholder data and image fields; including photo, fingerprint, and signature.

CCTV:

A closed circuit television system is provided to monitor the parking facility and entrance doors. Monitors are located in the reception/security desk on the ground floor of the Office Tower. Both the CCTV System and Access Control System are part of the main security system of the facility.

CCTV equipment include video cameras, camera outlets and controls, monitors, signal-processing equipment, control stations, distribution components, and videotape recorders to generate video images for processing and distribution.

Telecommunications:

The main telecommunications room is located in the Facility Support Wing of the Office Tower. Each floor of the Office Tower contains a telecommunications room on either end of the floor. Each room has a 19: rack with modular patch panels housing multiple connections. In these rooms are 20 amp emergency disconnects and voice/data outlets designated for administrative LAN lines. There are also separate outlets for voice only. Horizontal wiring connected to each work station is installed in cable trays above the lay-in ceiling tile system. Cable extends from the ceilings down the columns to connect system furniture to power.

LIGHTING DEPTH

INTRODUCTION:

The Virginia Advanced Shipbuilding and Carrier Integration Center is situated along one of the most influential components of the architecture and lighting design of the facility, water. Being the leading researcher in nuclear powered aircraft carriers, the state-of-the-art facility must obtain visual authority not only through the architecture, but also through lighting. It is important to have interesting, yet practical design in this situation because the buildings are not accessible to the public.

The lighting design throughout the facility will follow the concept of water, from a literal and design stand point. Situated along the James River, the Technology Tower appears as a sailing ship cutting through water, being reinforced by reflecting pools surrounding the main entrance to the lobby on the ground floor. Because there are multiple visual components reflecting the concept of water, the objective is to reflect the characteristics of water through the lighting design. By understanding how water actually benefits, or controls us rather, is how the schematic design process was approached. Recognizing that a human can only walk where water is not, and a ship can only sail where it is present represents the big picture of where to place lights throughout the four design spaces. The lighting is designed to control you in the exact way that water controls humans and sailing ships. It is designed such that the user can easily define where to go or what to focus on in that particular space. Different elements and designs were utilized in each space in order to easily execute the task at hand. In addition, different materials and surfaces were emphasized, disregarded, or changed in order to create contrast allowing for key elements to stand out among the rest of the surroundings.

The four spaces to be analyzed and redesigned will include:

1. Circulation Space | Lobby and Main Staircase
2. Large Work Space | Open Office
3. Multi-Purpose Space | Auditorium
4. Exterior Space | Gathering Space Design

Each space will include a space description, preliminary design concepts, surface materials, design criteria and considerations, luminaire equipment schedule, light loss factor classifications, luminaire mounting details where applicable, performance and calculation summary, renderings, concluding with a final evaluation of the space.

The architectural lighting for these spaces must be designed to meet the established design criteria, both quantitatively and qualitatively. This will encompass guidelines from IESNA Handbook 9th Edition and ASHRAE Standard 90.1. The lighting analysis for each space will include a summary of the space, design criteria and considerations, a luminaire equipment schedule, light loss factors, lighting plans, pertinent details, performance data, and renderings.

CIRCULATION SPACE | LOBBY AND MAIN STAIRECASE

SPACE DESCRIPTION:

The main lobby to the facility is located on the ground floor of the Technology Tower. It is the only asset to the building placed on the ground floor due to the high water table of the area. Located within the lobby are one main entrance, two side entrances, and main staircase and elevator column that runs vertically through the building. It occupies approximately 2,981 square feet with a ceiling height of 13' 6" as the main staircase extends through the ceiling up into the second floor where a technology display is located.

Influencing the accessibility into the lobby, reflecting pools surround the lobby to contribute to the design influence of the facility. As you walk between the reflecting pools along the east side of the building to the entrance, you are greeted by the reception desk as well as the over-sized main staircase.

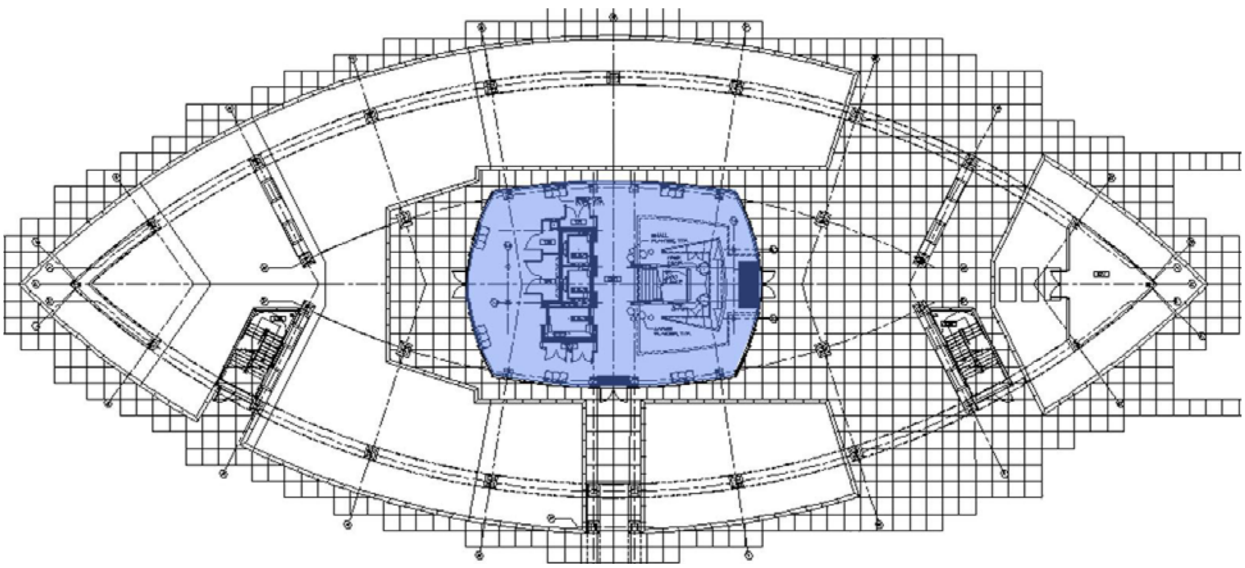


Figure 1.1: Lobby Floor Plan

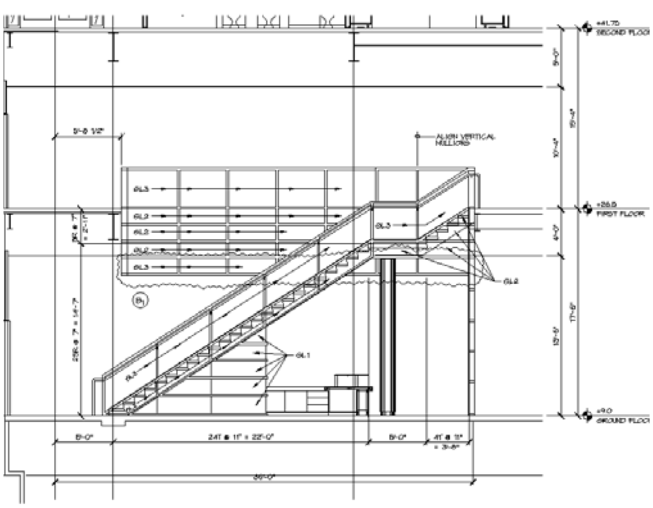


Figure 1.2: Lobby Stair Section

SCHEMATIC DESIGN:

Beginning the schematic design phase, recognizing the task of the space is focused on. By highlighting the two circulation elements, the grand staircase and elevator column, within the space would provide the user with a highly recognizable path to traverse vertically through the building. Also, generally highlighting the receptionist desk is important. However, since more employees will enter compared to visitors, no special lighting was addressed.

In order to create a visual circulation path, washing vertical surfaces opposed to illuminating the horizontal surfaces demonstrated this concept. Washing frosted glass surrounding the staircase, washing columns around the perimeter, and washing four walls enveloping the elevator creates a sense of height and direction. Washing frosted glass also occurs around the opening in the ceiling to the second floor. Both instances of washing the perimeter columns and elevator bank are intended to appear as though they are piercing through the ceiling into the floor above. This is done by creating openings surrounding the elements at the ceiling level to recess luminaires while concealing them from the observer's eye. Additional downlighting throughout the space is utilized for safe circulation while in the space as well as security purposes.

Figure 1.3: Lobby Preliminary Schematic

SURFACE MATERIALS:

MATERIAL SCHEDULE		
SURFACE	DESCRIPTION	PROPERTIES
Exterior Wall	Clear, insulated curtain wall glass	τ=0.85
Interior Walls	Grey paint, matte finish	ρ=0.78
Stair riser/tread	Marble	ρ=0.19
Stair Railing	Aluminum	ρ=0.21
Stair Glass Infill	Translucent glass	ρ=0.43
Floor	Marble	ρ=0.19
Desk	Marble	ρ=0.19
Desk Glass Infill	Translucent Grey Glass	ρ=0.43
Ceiling	2 x 4 ACT	ρ=0.64

DESIGN CRITERIA + CONSIDERATIONS:

Task Considerations

Throughout the lobby space, there are many tasks that must be considered, and therefore properly illuminated. Since it is classified as a circulation space, the primary task planes that must be illuminated include the main flooring as well as the staircase. Additionally, a reception desk is present within the space and, too, must have the task plane illuminated accordingly. There are three entrances from the exterior into the lobby. One entrance is treated as the main entrance; however the other two entrances need to be illuminated in order to be noticed as well.

Because the entire lobby of the Technology Tower is enclosed in a curtain wall system of clear insulated glass, it is important to be sure there is no glare or reflections present on the glossy marble floor. Although the upper six floors of the Technology tower overhang the lobby exterior walls by 26'9", it is still important that daylighting does not affect the user's ability to see their pathway.

Quantitative visual Performance

General Lobby:

- Horizontal: 10 fc
- Vertical: 3 fc

General Stairs/Corridor:

- Horizontal: 5 fc

Overall Room Brightness

Considering the design concepts of the lobby space, contrast throughout the lobby is desired. The lobby will have an overall illumination to it; however the key elements of the space will appear to stand out more. In addition, the overall feel of the lobby is cool and appearing crisp and modern. Materials and surfaces throughout the lobby are very smooth, some being dull to the eye; therefore utilizing higher color temperatures emphasizing white or light colored elements to achieve the desired feel.

Lighting Controls

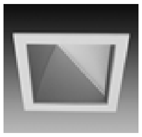
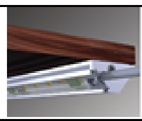
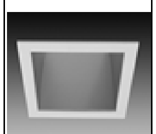
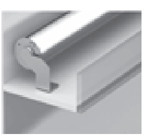
The Technology Tower is only in operation from 8am until 5pm. During times of occupancy, the lighting in the lobby will remain on. When the building is generally not in use, only mandatory lighting will be utilized to reduce energy costs. Multiple switches for the space will be located at the reception desk for easy controllability.

ASHRAE 90.1 | Power Density Allowance

The lighting power density required by ASHRAE 90.1-2007 Section 9.6: Space-By-Space Method for lobby areas is 1.3W/ft^2.

TYPE	FIXTURE QUANTITY	FIXTURE WATTAGE	TOTAL WATTAGE	UNITS
DN	24	21.6	518.4	WATTS
HR	18	11	198	WATTS
TS	8	19.8	158.4	WATTS
CW	21	64	1344	WATTS
EC	14	42.1	589.4	WATTS
		TOTAL SQ. FT.	2981	SQ.FT.
	TOTAL LPD ALLOWABLE		1.3	W/FT^2
		TOTAL LPD	0.37	W/FT^2

LUMINAIRE EQUIPMENT SCHEDULE:

TYPE		MANUFACTURER	CATALOGUE NUMBER	DESCRIPTION
DN		Focal Point	FL44-13LED-L30-120-SO-T L44-S0-DN-TD-TS	4.5" X 4.5" downlight LED module with remote phosphor technology, powered by Philips' Fortimo LED and AdvanceXitanium LED driver, aluminum heat sink incorporated into die-cast aluminum housing, clear acrylic reflector cone for superior brightness control and 55 degree cutoff, easy replacement, 70% luminaire efficiency.
HR		iO by Cooper Lighting	0.06.SSS.2.PM.NR.65.3K.GB3.120	Handrail integrated LED chips delivers functional outputs effectively illuminating paths of egress, available in two rail diameters and three beam spread angles, constructed of steel and aluminum, practical for indoor and outdoor applications, ADA and ANSI compliant, proper LED thermal management in accordance with LED manufacture specifications, generally provided in
TS		iO by Cooper Lighting	0.09.I.3K.NG.1.6.1.1	1.39" W X .66" D X 36" L shelf integrated task light, LEDge is a part of the iO linear LED-based family, low voltage, neoprene gasketed, housing made of extruded aluminum, finished in anodized
CW		Focal Point	FL44-13LED-L30-120-SO-T L44-S0-TD-TS	4.5" X 4.5" wall washing LED module with remote phosphor technology generating high system efficacy, luminaire design maintains form factors, lumen output, and thermal management for module and driver components, intelligent driver technology, flicker free. Housing made of die-cast aluminum incorporated with an angled MicroGlow lens redirecting light delivering asymmetric
EC		The Lighting Quotient	S301-R06G-S-00-1-00-0-30-00	Cove LED system of extruded aluminum integrated with proper heat sinks, impact-resistant extruded acrylic lens and holographic diffuser, rotating/locking hinges to allow for proper alignment, Philips Lumiled LUXEON LEDs, remote driver in aluminum enclosure, mounting L-brackets can be interlocked for continuous acting luminaire, luminaire provides uniform asymmetric distribution utilizing reflection and inter-

*See Appendix A | Lighting for full luminaire fixture schedule.

LIGHT LOSS FACTORS:

CALCULATIONS					**TOTAL LLF**
TYPE	MAINTENANCE CATEGORY	BALLAST FACTOR	LUMINAIRE DIRT DEPRECIATION	LAMP LUMEN DEPRECIATION	
DN	Clean	1.0	0.93	0.70	0.651
HR	Clean	1.0	0.93	0.70	0.651
TS	Clean	1.0	0.93	0.70	0.651
CW	Clean	1.0	0.93	0.70	0.651
EC	Clean	1.0	0.93	0.70	0.651

*Assumptions: Clean environment with 18 month cleaning cycle, calculations performed using IESNA 10th Edition 2011.

LIGHTING PLAN:

*See Appendix A for Lighting Plan.

DETAILS:

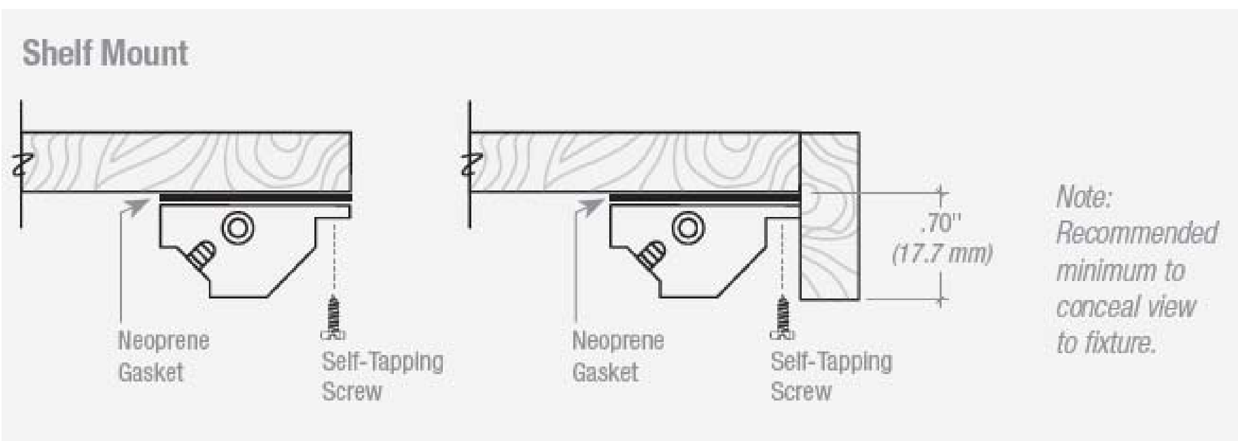


Figure 1.4: Lobby Desk Task Light Mounting Detail

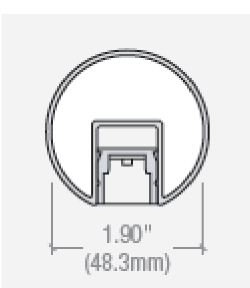
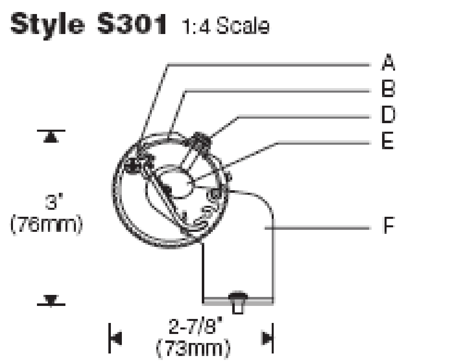


Figure 1.5: Lobby Handrail Detail



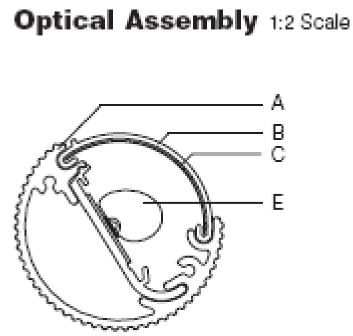
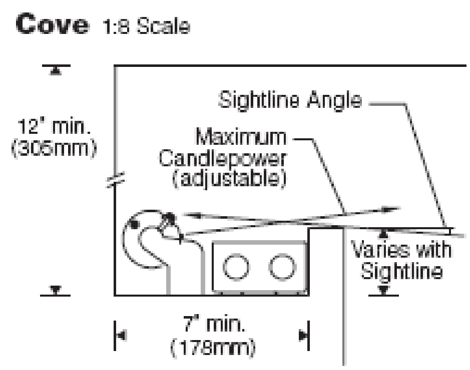


Figure 1.6: Lobby Elevator Optical Assembly Detail



Specifications

- **A** Extruded aluminum exterior, heat sink/ housing
- **B** Impact-resistant extruded lens
- **C** Holographic diffuser
- **D** Rotation locking tab/ screw
- **E** Removable light engine assembly with fraqtir™ acrylic refractor
- **F** L-shaped mounting feet, one pair per optical assembly (fasteners by others)
- **G** Remote driver in aluminum enclosure

Figure 1.7: Lobby Elevator Cove Detail

PERFORMANCE DATA:

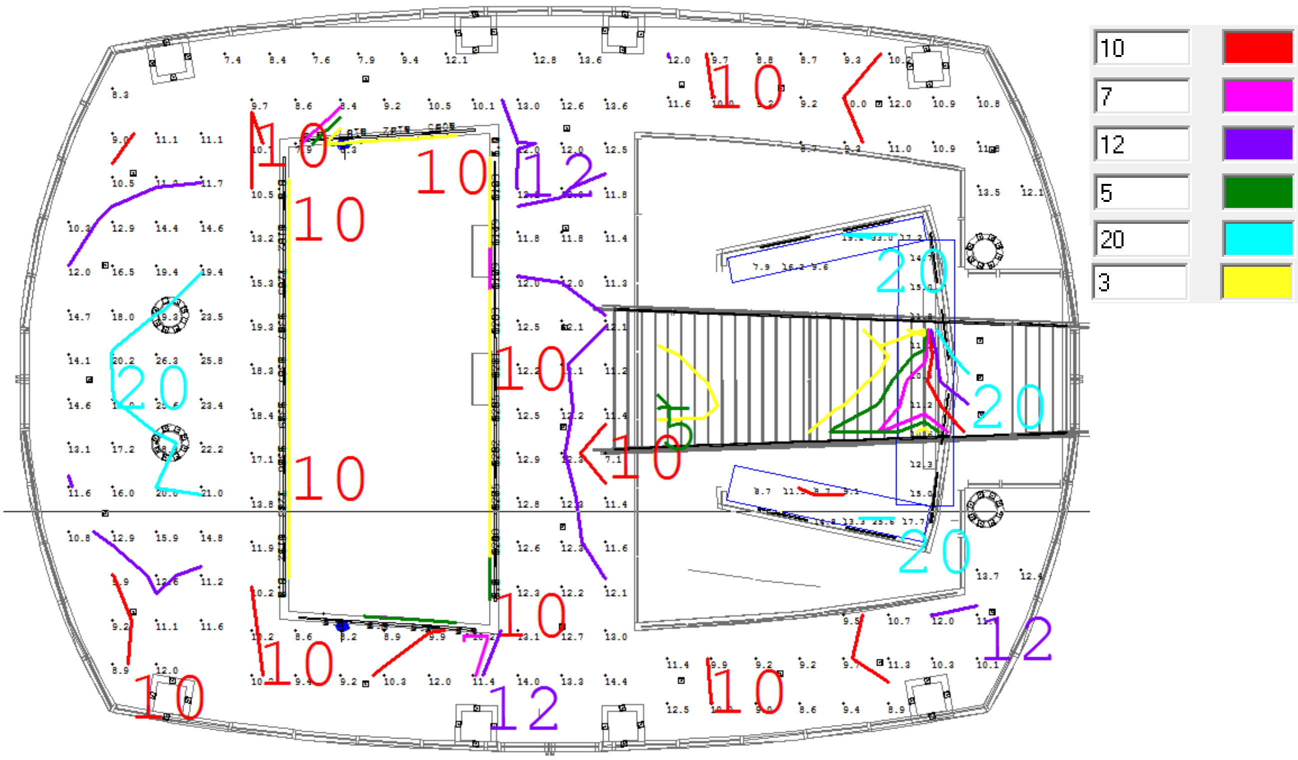


Figure 1.8: Lobby Floor Plan Isometric Contour Lines

Figure 1.9: Lobby Exterior RGB AGi32 Render

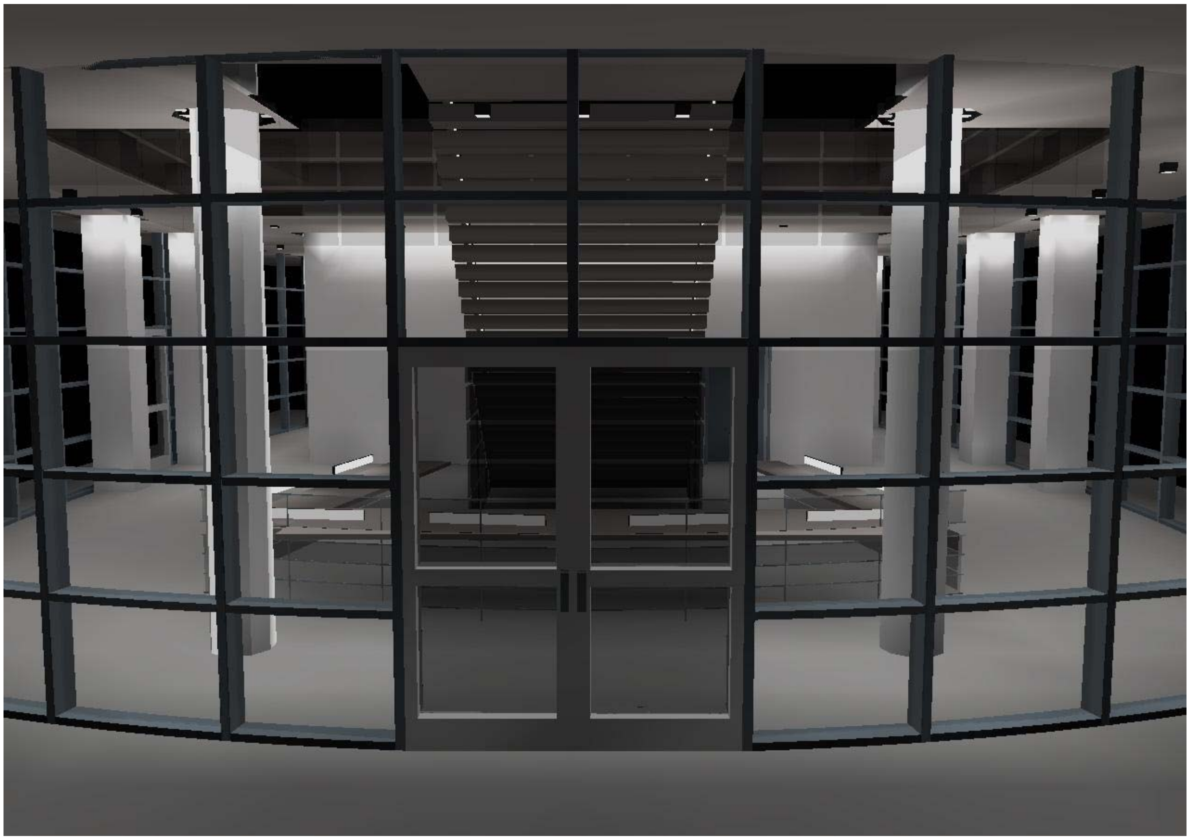


Figure 1.10 Lobby Main Entrance RGB AGi32 Render

Figure 1.11: Lobby Horizontal Exterior RGB AGi32 Render

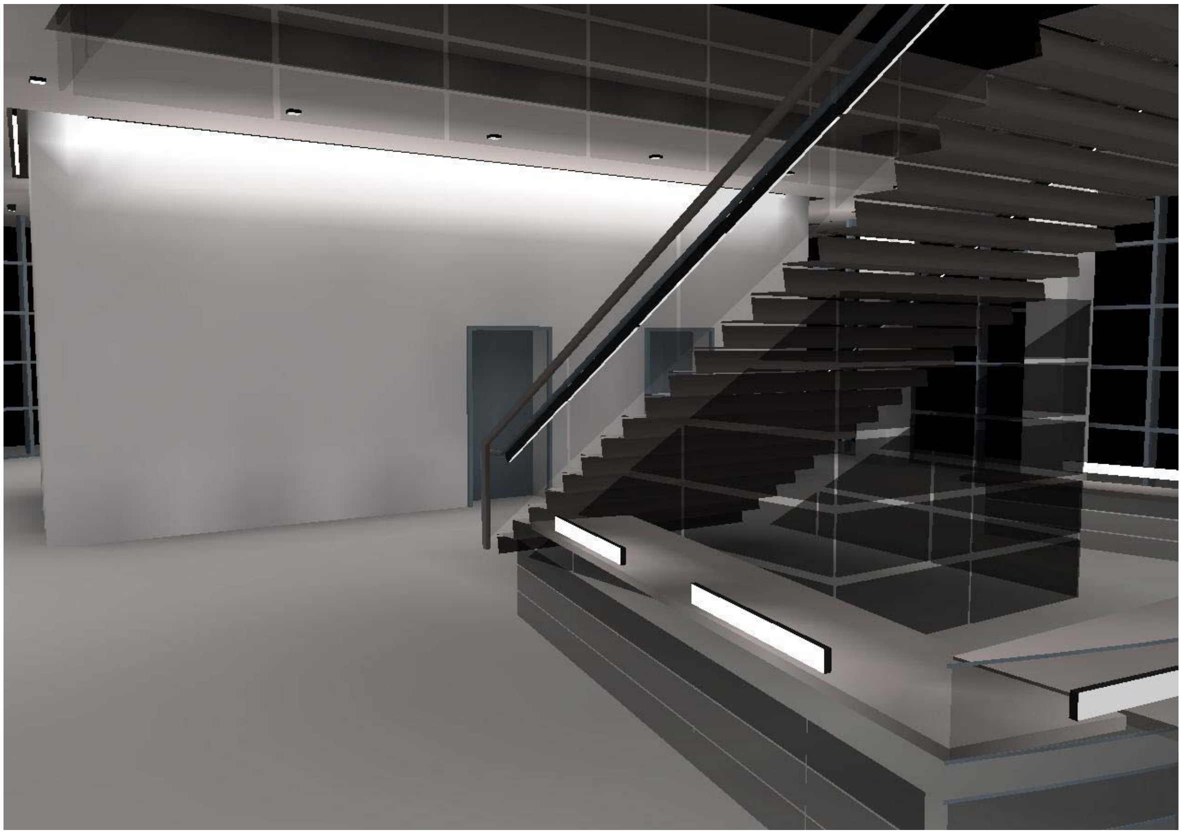


Figure 1.12: Lobby Interior Stair/Elevator RGB AGi32 Render

Figure 1.13: Lobby Elevator Column RGB AGi 32 Render

Figure 1.14: Lobby Exterior RGB AGi32 Render

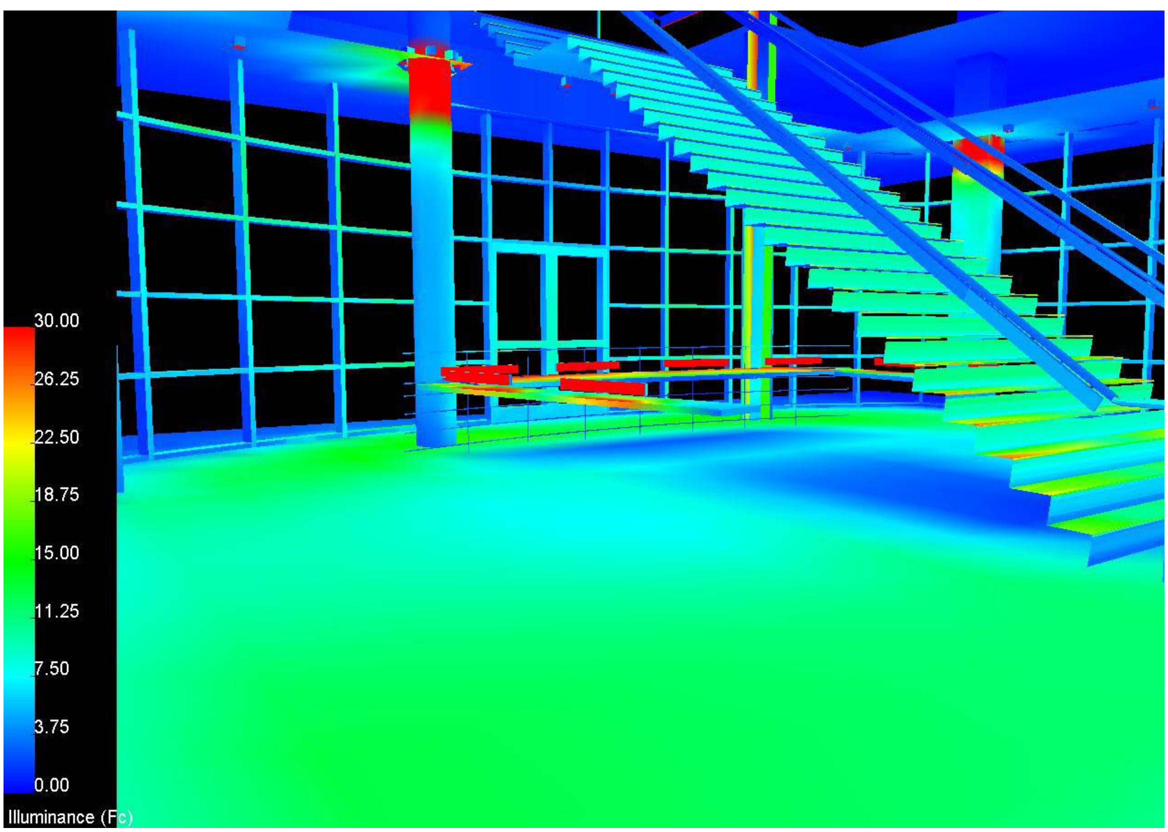


Figure 1.15: Lobby Pseudo Color AGi32 Render

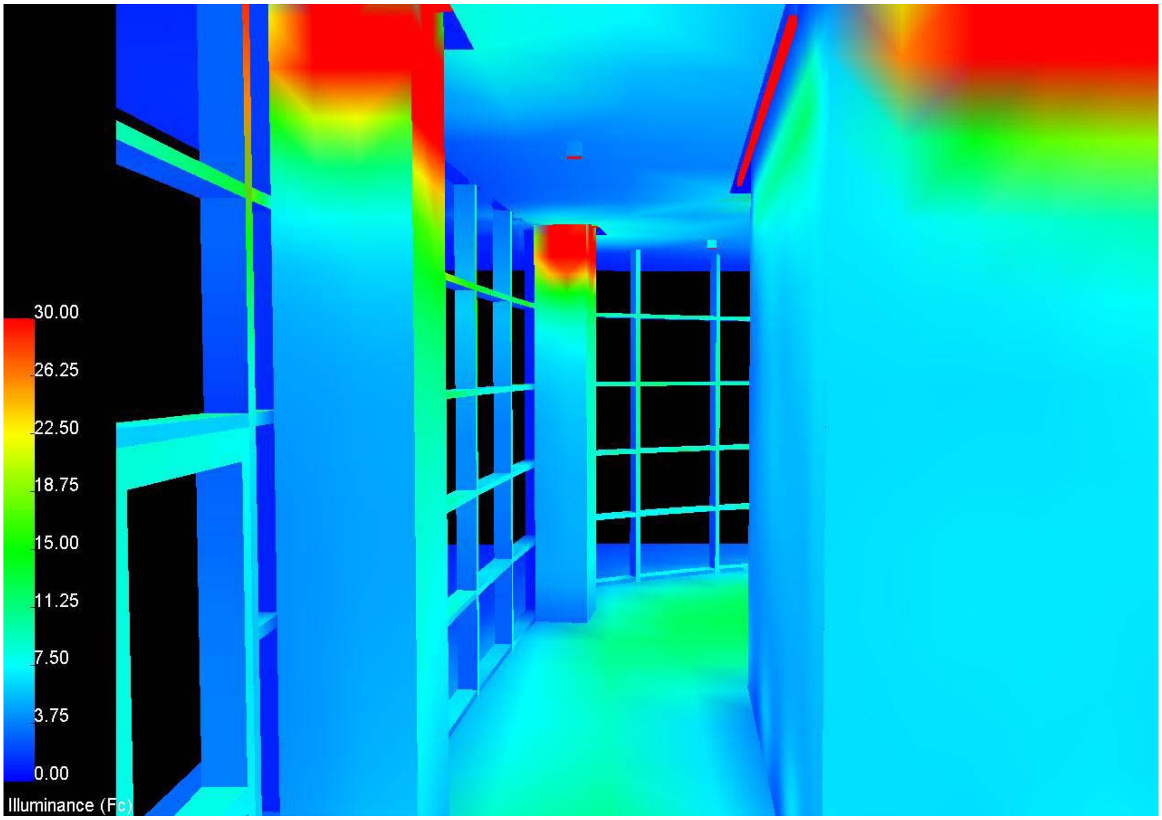


Figure 1.16: Lobby Side Pseudo Color AGi32 Render

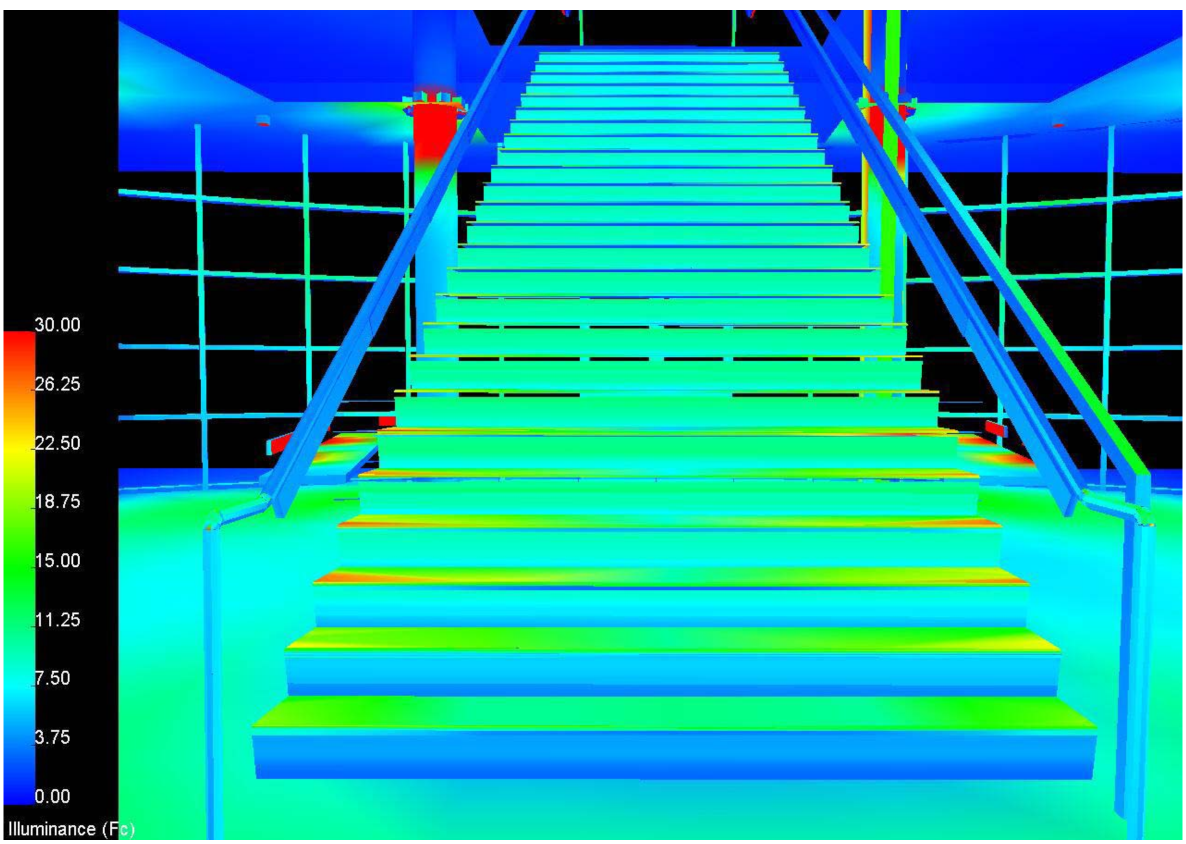


Figure 1.17: Lobby Interior Pseudo Color Render

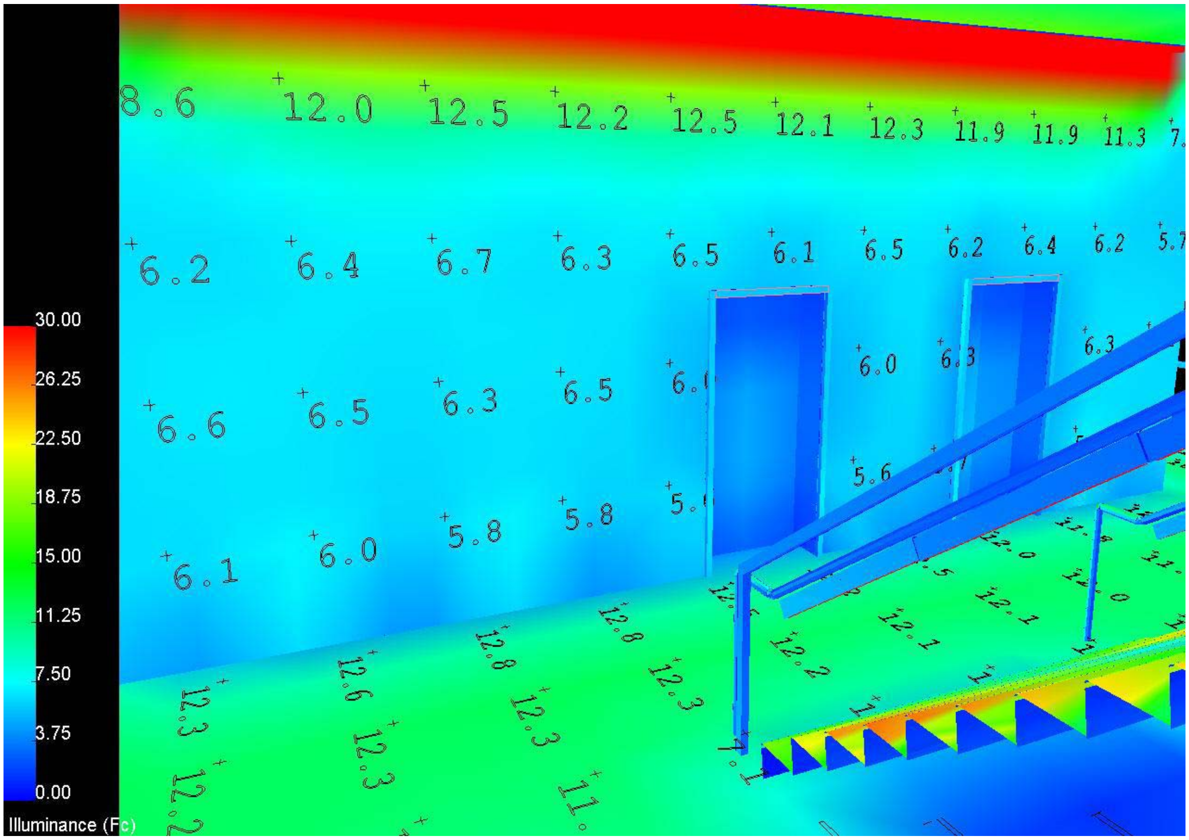


Figure 1.18: Lobby Interior Pseudo Color Render

FINAL RENDERINGS:

Figure 1.19: Lobby Exterior Final 3ds Max Render

Figure 1.20: Lobby Interior Final 3ds Max Render

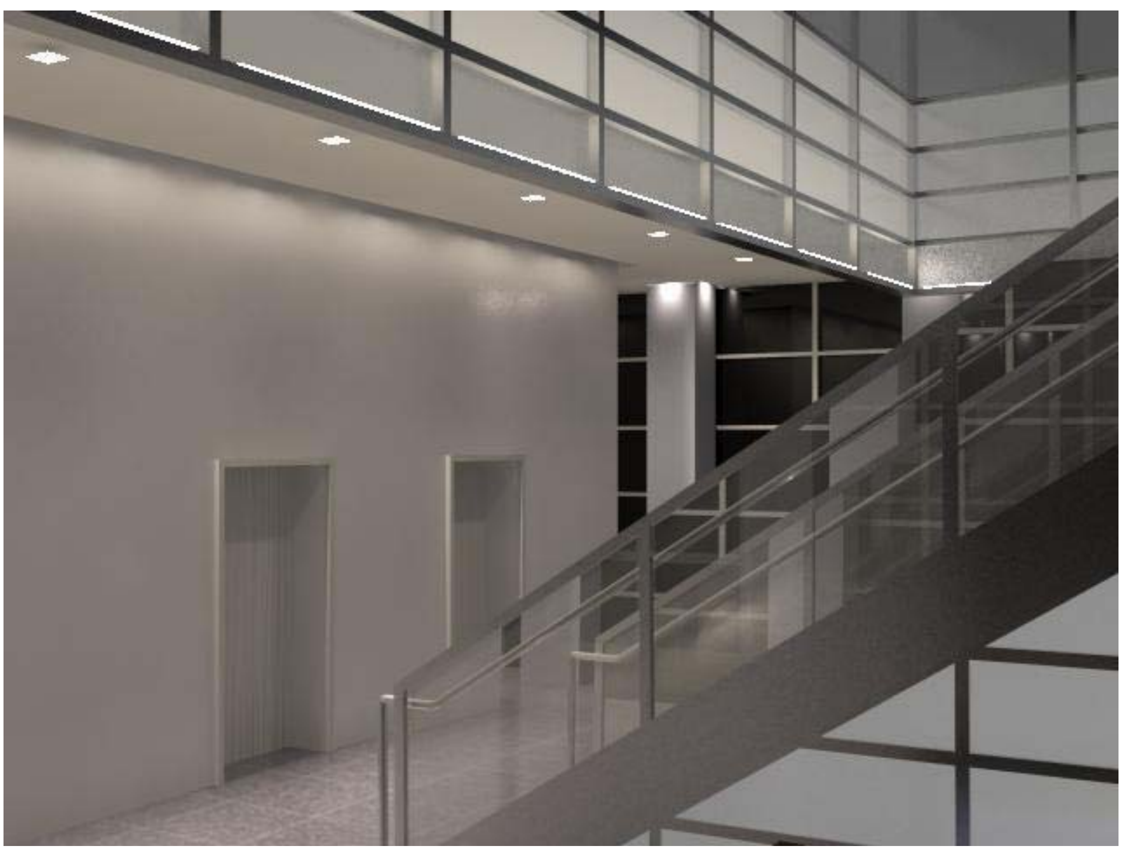


Figure 1.21: Lobby Stairs and Elevator Column Final 3ds Max

CALCULATION SUMMARY:

Lobby Calculation Summary					
	Desk	**Stairs**	**Floor**	**Elevator**	**Columns**
Avg. Illuminance	14.4	6.0	11.68	5.94	6.3
Avg/Min	1.64	6.67	3.50	4.43	12.8
CRITERIA	10.0	5.0	10.0	3.0	3.0
COMPLIANCE?	YES	YES	YES	YES	YES

EVALUATION:

Utilizing all LED sources, the lobby redesign adequately illuminaites all important features. In addition, hierarchy of light was addressed creating contrast within the space to achieve the design goals. Light was strategically placed throughout the lobby in order to direct occupants attention, mainly the staircase and elevator column. By illuminating each of these elements correctly, visitors are able to identify where to go from the exterior due to the lobby envelope consisting of a clear glass façade. Once you have entered the space, large columns are washed with light downlight wall washers recessed in a cove system to conceal the luminaire. This technique of washing highlights the vertical component of the space and demonstrates contrast between itself and the glass façade it sits adjacent to. As you approach the reception desk, self-illuminating panels outline the contours of the desk. Also, integrated LED task lighting is mounted on the underside of the top tier countertop illuminating the desk top. As you approach the center of the lobby, the elevator column is washed with a cove system and the stairs are illuminated utilizing an integrated LED handrail system. Throughout the rest of the lobby, square downlights are utilized providing general illumination on the floor.

After performing calculations, the lighting design provides adequate illuminance values for safe circulation complying with IESNA recommendations. In addition, lighting power densities provided by ASHRAE Standard 90.1-2007 requirements were met. The space provides an good first impression to visitors while maintaining a practical lighting design.

LARGE WORK SPACE | OPEN OFFICE

SPACE DESCRIPTION:

The open office spaces are located within the Technology Tower on floors three through six. Each floor houses 80 cubicle work stations occupying 12,752 square feet total with a ceiling height of 9'4". The open office space is separated by two interior column lines allowing 40 cubicle work stations in 6,376 square feet on each side. Directly in the center of each floor is the center column of movement with two elevators and a main staircase led up through the building from the lobby. Two additional staircases are located on either side of the open office.

The entire Office Tower is enclosed in a glass curtain wall system that contains two different glass types manufactured by Virakon. Originally, the curtain wall system obtained mirrored insulating glass in the middle pane with a grey fritted glass above and below of smaller panes. Because the transmittance value was only 12% for both curtain wall components, new low-e insulated fritted glass was chosen with the same solar heat gain coefficient with a higher transmittance value of 39% for the top and bottom portions and 30% for the middle glass section.

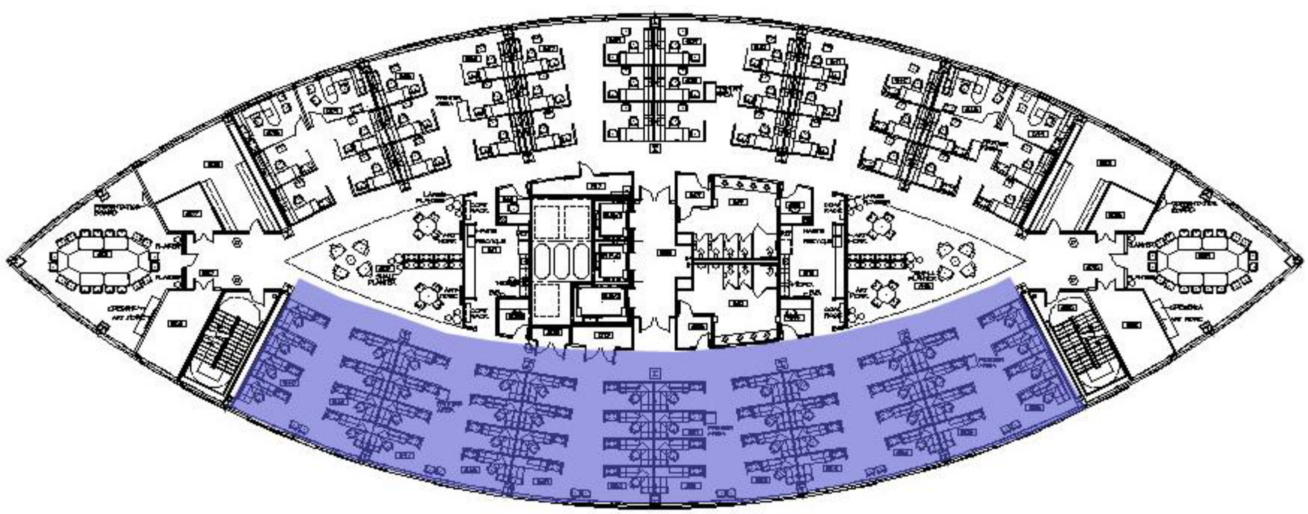


Figure 2.1: Open Office Floor Plan

SCHEMATIC DESIGN:

Preliminary designs began with utilizing a task-ambient lighting system. In addition, illuminating vertical surfaces as well as the ceiling creates an open and comfortable environment for the occupants. Because the entire Technology Tower envelope is a curtain wall façade system, daylight infiltration of the space is a large concern not only for control purposes, but also in regards to the occupant. It is important to be sure there is not irritating glare or veiling reflections to the occupant.

The open office space was originally designed to utilize indirect pendant fixtures with a small component of direct light along with integrated task lighting along the cubicle walls. In addition, sconces were placed on opposite sides of the interior column lines surrounding the central column of travel.

The final lighting design of the space uses the Tambient system from The Lighting Quotient with integrated daylight harvesting for cubicles located along with curtain wall. Also, shading devices will be necessary to reduce unwanted glare throughout the year. Like the preliminary design, sconces are placed on the interior columns. Because the design intent of the space is to create an open and spacious work environment, a cubicle redesign lowered the height while implementing a 3’ glass element along walls with adjoining cubicles.

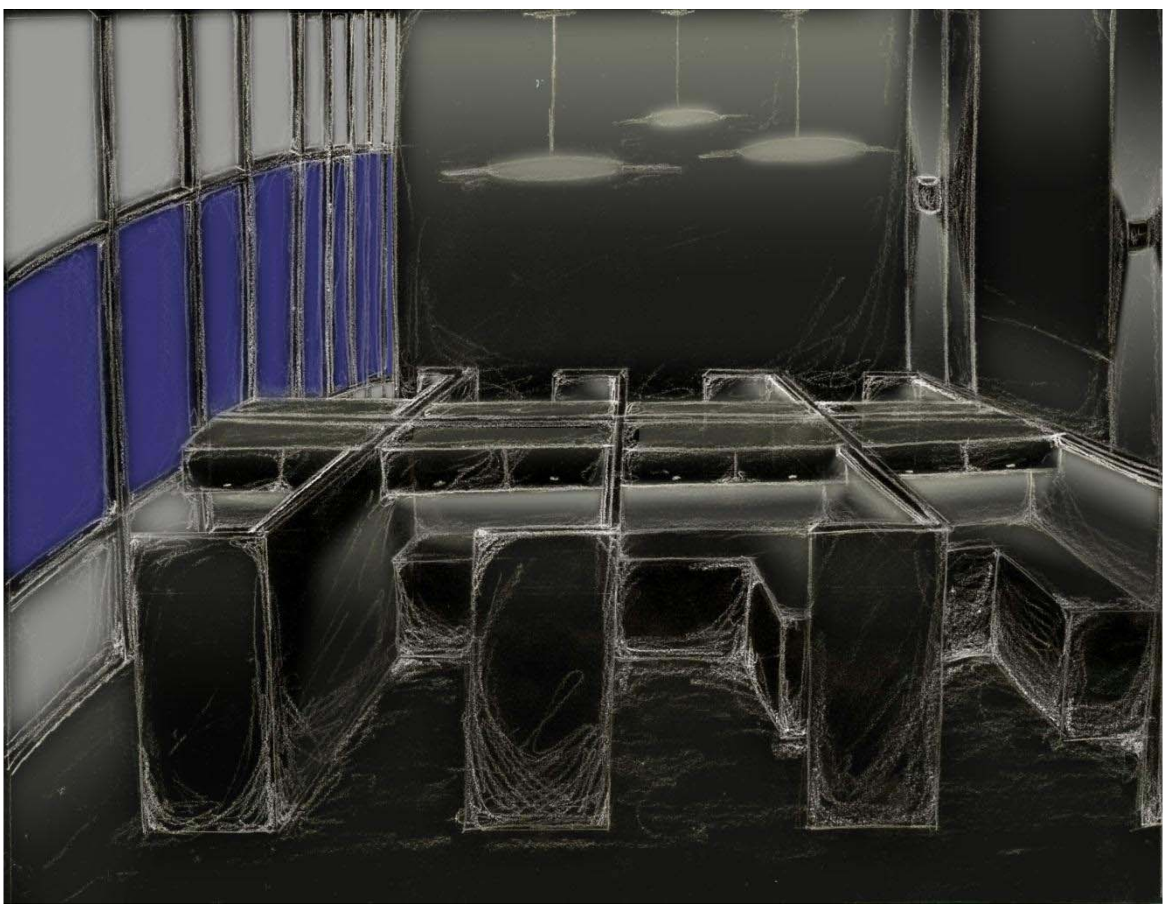


Figure 2.2: Open Office Preliminary Lighting Design

SURFACE MATERIALS:

MATERIAL SCHEDULE		
SURFACE	DESCRIPTION	PROPERTIES
Floor	Navy carpet	ρ=0.12
Lower Cubicle Partition	Medium Green Paint	ρ=0.60
Upper Cubicle Partition	Frosted glass	ρ=0.75
Desk Top	Medium grey desk top	ρ=0.67
Upper/Lower Curtain Wall Panel	Low-e insulating fritted glass	ρ=0.39
Middle Curtain Wall Panel	Low-e insulating fritted glass	ρ=0.30
Ceiling	2'x4' ACT	ρ=0.73

DESIGN CRITERIA + CONSIDERATIONS:

Task Considerations

There are many factors to consider in a lighting design for a task-oriented space such as an office. Uniformity on the task plane is most important in order to not cause unwanted shadows. Patterns of light can affect visibility, comfort, and perception of the task plane. Reflected glare and veiling reflections are also are a large contributor to decreased task visibility. In addition to uniformity, the task plane should have a higher illuminance than surrounding surfaces; however, too much illuminance can cause visual fatigue. When workstation task planes are illuminated higher than their surroundings, occupants are drawn to their work and experience fewer distractions. Other lighting design issues include direct glare, vertical illuminance, and room surface luminances.

Quantitative Visual Performance

- Horizontal | 40 FC
- Vertical | 5 FC
- Uniformity | 1:4

Overall Room Brightness

Highlighting vertical surfaces as well as the ceiling can create an environment with an open feeling contributing to a pleasant and functional work space for the occupant. Utilizing a direct/indirect luminaire can contribute to the overall brightness of the room by highlighting the ceiling while illuminating the task surface at the same time. However, it is important to consider hot spots on the ceiling generated by the indirect component. The direct component should provide diffuse lighting and adequate shielding for good visual comfort while avoiding glare.

Lighting Controls

Because the Office Tower is completely enclosed in a curtain wall system, it is important to consider solutions preventing discomfort to the occupant. Two types of fritted glass are used with differing transmittance values to accommodate for glare that may occur on the task plane. The top and bottom glass is a grey fritted low-e glass with a transmittance value of 39%. The middle portion of the curtain wall is a low-e insulating glass with transmittance value of 30%. In addition to the fritted glass, photosensors and occupancy sensors will be incorporated with the luminaires throughout the open office. Shading devices will also be necessary because of the building's west facing orientation.

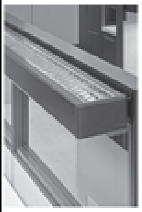
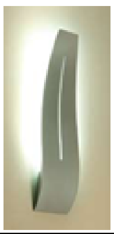
The Tambient system from The Lighting Quotient offers a control hub called the Tambient Control Hub that mounts to the underside of workstations. This control hub can control up to 50 dimming ballasts through five ports on the backside of the hub. Each zone of luminaires is controlled in unison, however all the control hubs can be networked together to be controlled as one uniform zone. Each hub is plug-and-play with the luminaires that are connected to it. The Tambient Control Hub communicates with the photosensors and occupancy sensors wirelessly utilizing the EnOcean wireless protocol. The sensors themselves are wireless modules with dual solar cells and utilize self-sustaining power capabilities by operating off the energy generated from a click of a light switch. One photosensor and occupancy sensor is able to communicate with more than one control hub. Each sensor has a 98.5' range typical for indoors and each control hub can control up to a range of 150'; through doors, partitions, ceilings, and furniture. Further information, such as specification sheets and photosensor coverage and placement diagrams are located in Appendix A | Lighting.

ASHRAE 90.1 | Power Density Allowance

The lighting power density required by ASHRAE 90.1-2007 Section 9.6: Space-By-Space Method for open office areas is 1.1W/ft^2.

TYPE	FIXTURE QUANTITY	FIXTURE WATTAGE	TOTAL WATTAGE	UNITS
TA	240	25	6000	WATTS
SC	12	5	60	WATTS
		TOTAL SQ. FT.	6376	SQ.FT.
	TOTAL LPD ALLOWABLE		1.1	W/FT^2
		TOTAL LPD	0.95	W/FT^2

LUMINAIRE EQUIPMENT SCHEDULE:

TYPE		MANUFACTURER	CATALOGUE NUMBER	DESCRIPTION
TA		The Lighting Quotient	L201-36S3-M-EL15-T-30	Task ambient luminaire 34.75" long with integral hang-on mounting, 1 21W T5 luminaire, high performance louver on top for maximum uplight coverage and minimal glare at eye height, clear prismatic acrylic task lens reducing veiling reflections,housed in extruded aluminum with downlight reflector.
SC		Ivalo Lighting Inc. by Lutron	LNN-27SNL-2WNUMT	27" interior decorative sconce, direct/indirect, ADA compliant (3-7/8" off of wall), white LED strings, incorporated reflector within housing of luminaire, finished in case aluminium, mounts on wall from base bracket with locking screws.

*See Appendix A | Lighting for full luminaire fixture schedule.

LIGHT LOSS FACTORS:

CALCULATIONS					TOTAL LLF
TYPE	MAINTENANCE CATEGORY	BALLAST FACTOR	LUMINAIRE DIRT DEPRECIATION	LAMP LUMEN DEPRECIATION	
TA	Clean	1.0	0.93	0.92	0.86
SC	Clean	1.0	0.93	0.70	0.65

*Assumptions: Clean environment with 18 month cleaning cycle, calculations performed using IESNA 10th Edition 2011.

LIGHTING PLAN:
*See Appendix A for Lighting Plan.

DETAILS:

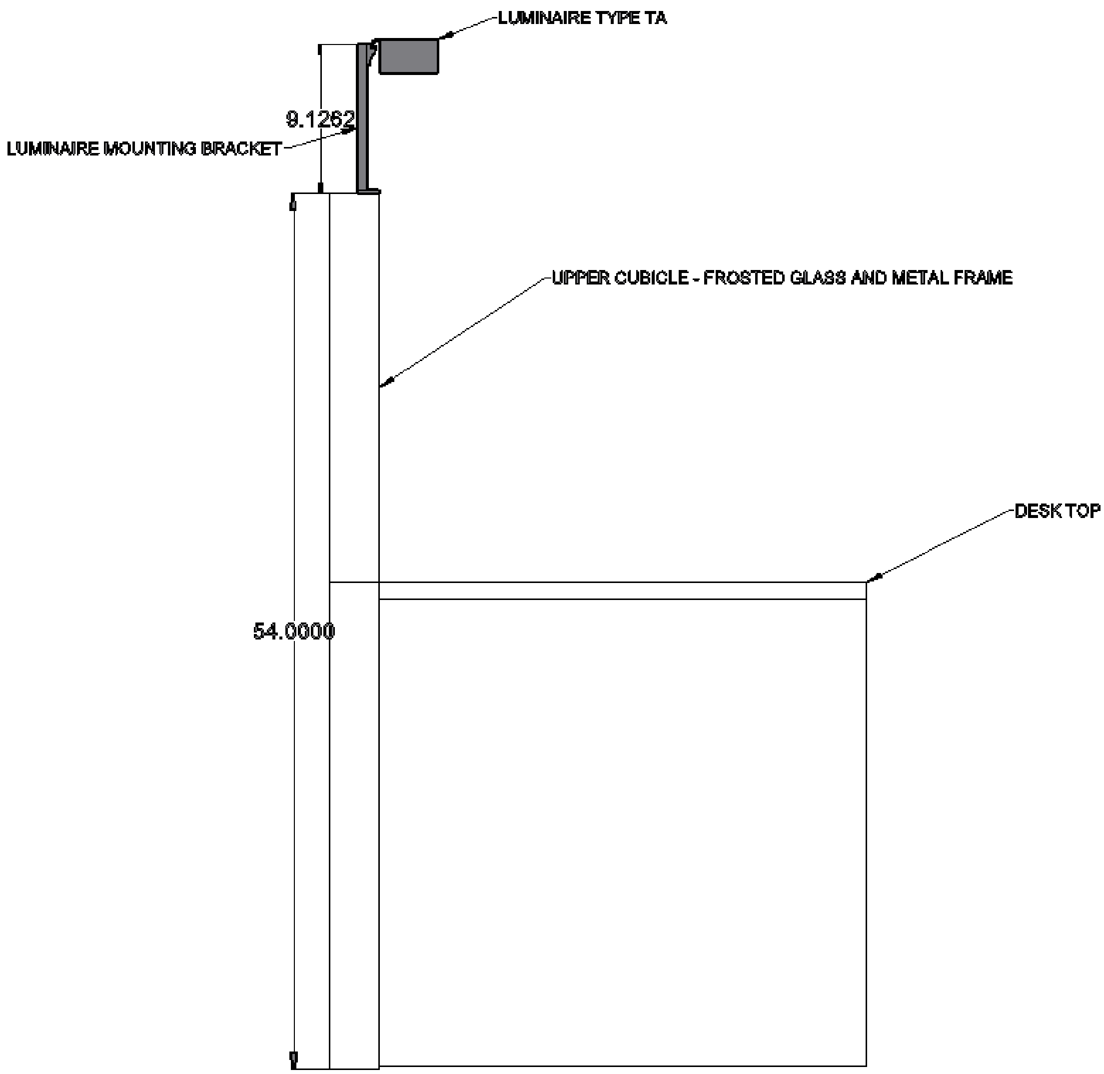


Figure 2.3: Cubicle Luminaire Mounting Detail

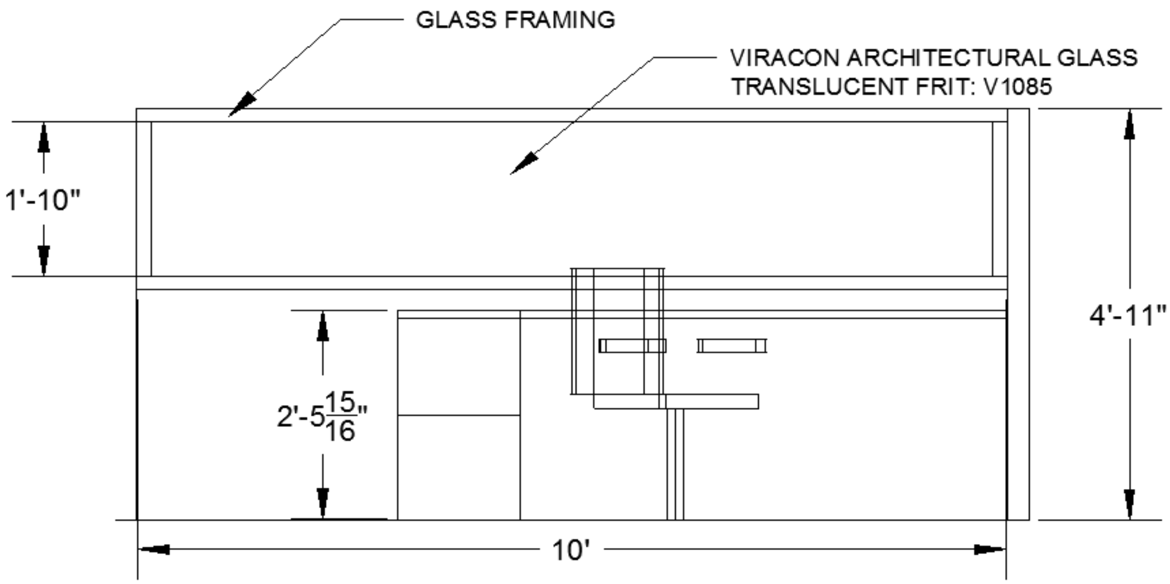


Figure 2.4: Cubicle Material Detail

PERFORMANCE DATA:

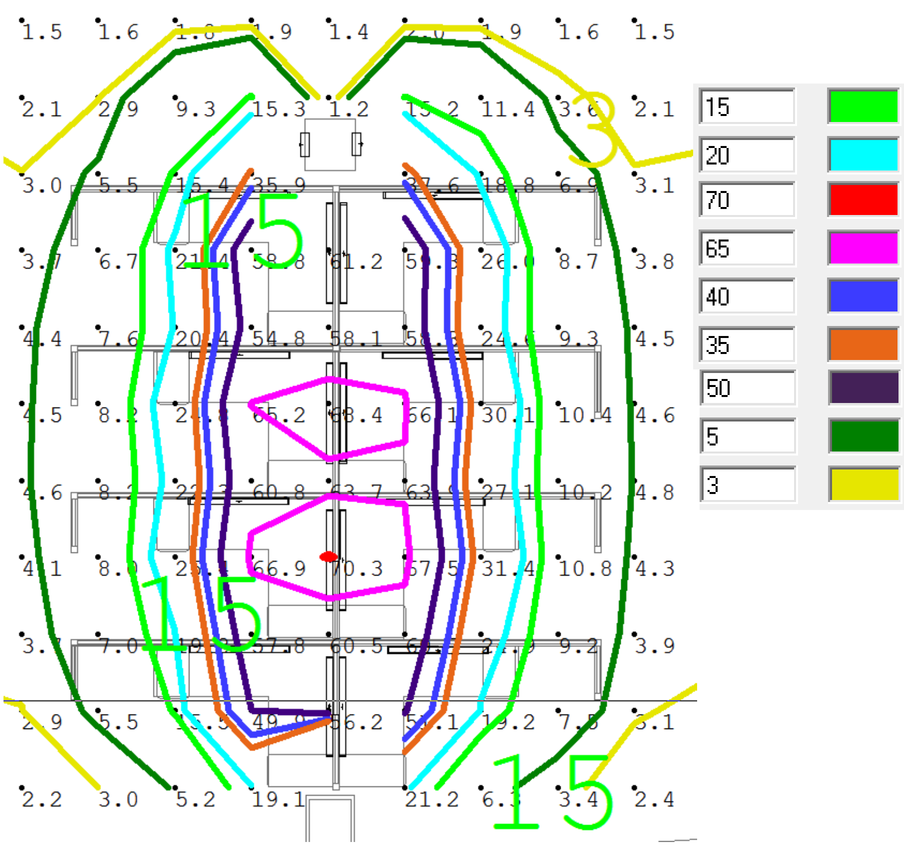


Figure 2.5: Office Ceiling Isometric Contour Lines

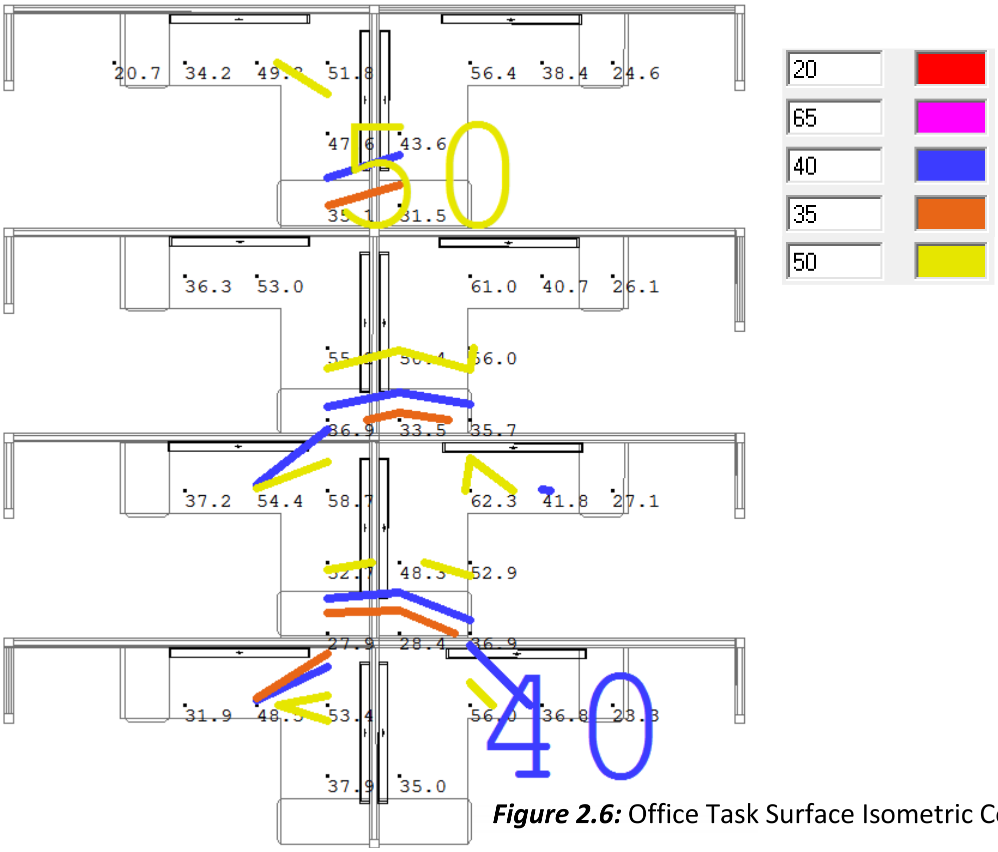


Figure 2.6: Office Task Surface Isometric Contour Lines

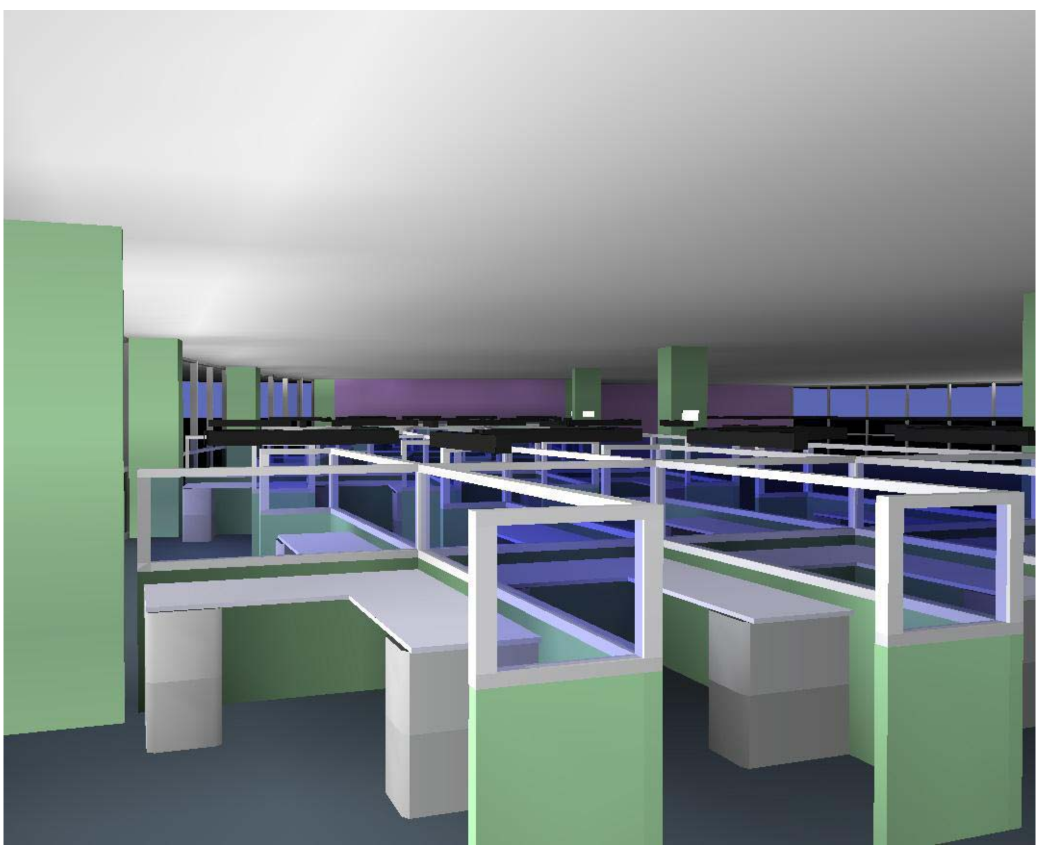


Figure 2.7:Office Daylight |June 21, 1:46 pm

Figure 2.8: Office Daylight |December 22, 11:46 am

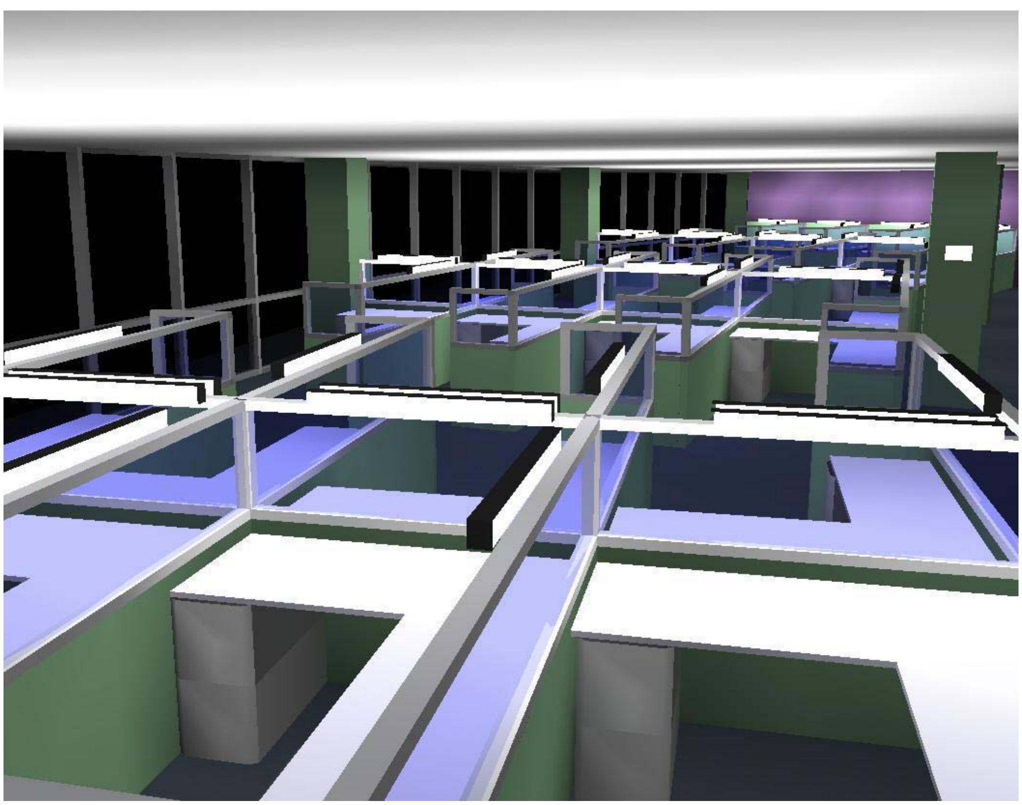


Figure 2.9: Office Daylight |December 22, 11:46 am

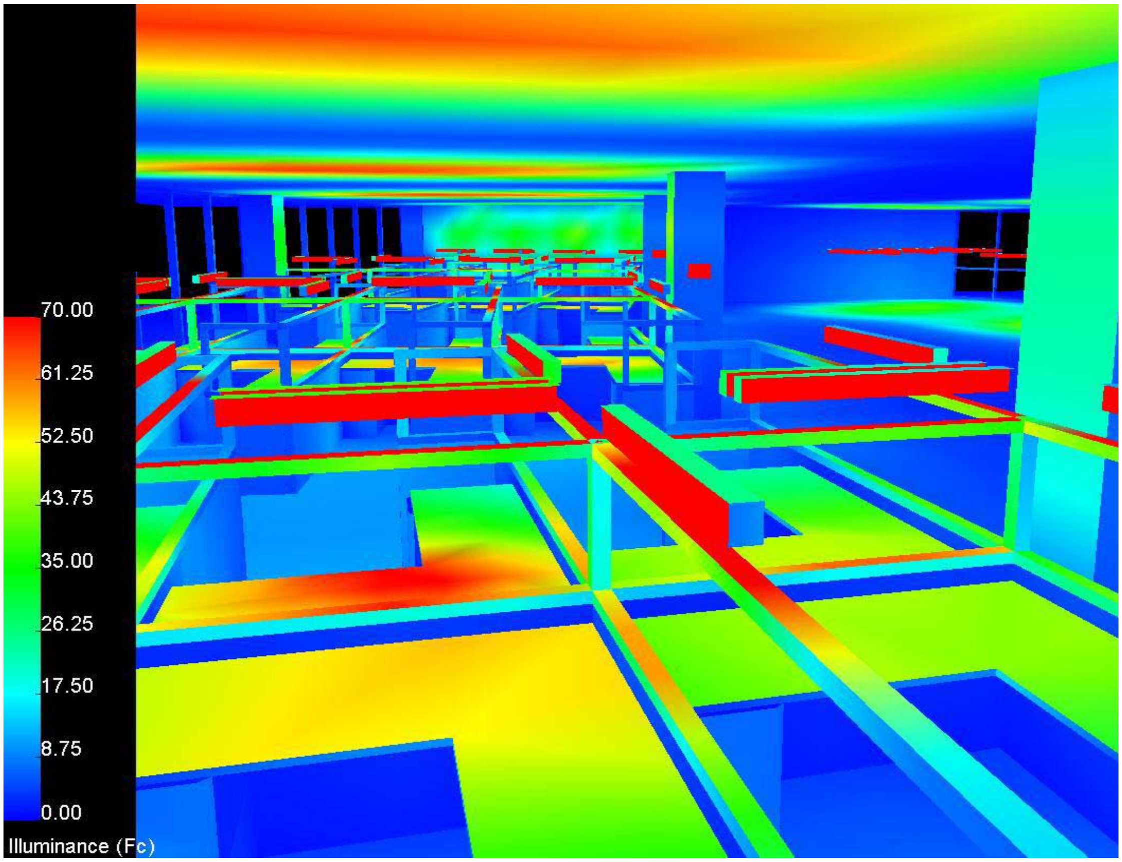


Figure 2.10: Office Electric Lighting Pseudo Color AGi32 Render

CALCULATION SUMMARY:

Open Office Calculation Summary				
	Electric Lighting		Daylighting	
	Task Plane	Ceiling	21-Jun	22-Dec
			Task/Ceiling	Task/Ceiling
Avg. Illuminance	40.62	20.57	110.85/98.87	350.23/138.47
Avg/Min	4.00	17.14	4.66/4.21	17.51/8.34
CRITERIA	30-50	15-25	-	-
COMPLIANCE?	YES	YES	-	-

EVALUATION:

The lighting design of the office adequately provides a stimulating work environment. By illuminating the space using a task ambient approach, a more comfortable space is created. Tambient luminaires manufactured by The Lighting Quotient uses a single T5 linear fluorescent with louvers to shield direct glare from the source. Originally, cubicle heights were standard at 66" high. With the new lighting design, there also was a cubicle design change. Firstly, the cubicle height was reduced to 54" high. Secondly, the upper 18" of cubicle wall was changed to a frosted glass. This change was implemented to create a more open feeling while still providing privacy between cubicles. The Tambient fixtures are mounted 6” above the top of the cubicle wall on mounting brackets. All three walls of the cubicle are now designed with frosted glass, but only two adjacent walls have luminaire mountings, over the desk areas.

In addition to the new lighting design, daylighting was also considered in the space. Daylight studies proved to be an issue; however it can be beneficial to daylight harvest. Daylight harvesting controls are integrated into the fixtures using a Tambient Control Hub controlling one grouping of cubicle luminaires within the daylight zone closest to the window. Shading devices are also necessary for low angled daylight that potential could cause high glare on the work surface. Occupancy sensors were also installed in the space to help increase energy savings.

Along the interior corridor of the office, LED wall sconces are mounted on either side of the columns for illumination of this space. These luminaires are utilized to emphasize the vertical components of the space and create and open atmosphere for the occupants.

After performing calculations, the lighting design provides adequate illuminance values for the work space as well as adequate ceiling illuminances providing to open the space up. IESNA recommendations were met for task illuminances, and a reasonable ceiling illuminance was assumed. Additionally, lighting power densities provided by ASHRAE Standard 90.1-2007 requirements were met.

MULTI-PURPOSE SPACE | AUDITORIUM

SPACE DESCRIPTION:

The auditorium is located on the second floor of the Laboratory Wing and seats 180 people in twelve rows occupying 7500 sq. ft. This space is mainly used for meeting situations utilizing a podium speaker and projection screen environment. Located on the long dimension of the west wall are a series of 14' high windows looking out to a patio. Another interesting feature to note is the exterior walls of the auditorium curve slightly until terminating at the back wall. Originally the ceiling was a drop ceiling with 2'x4' acoustical ceiling tiles at 25' 8". Part of the redesign of this space includes a new ceiling that is curved imitating a smooth water wave with a mean ceiling height still of 25' 8".

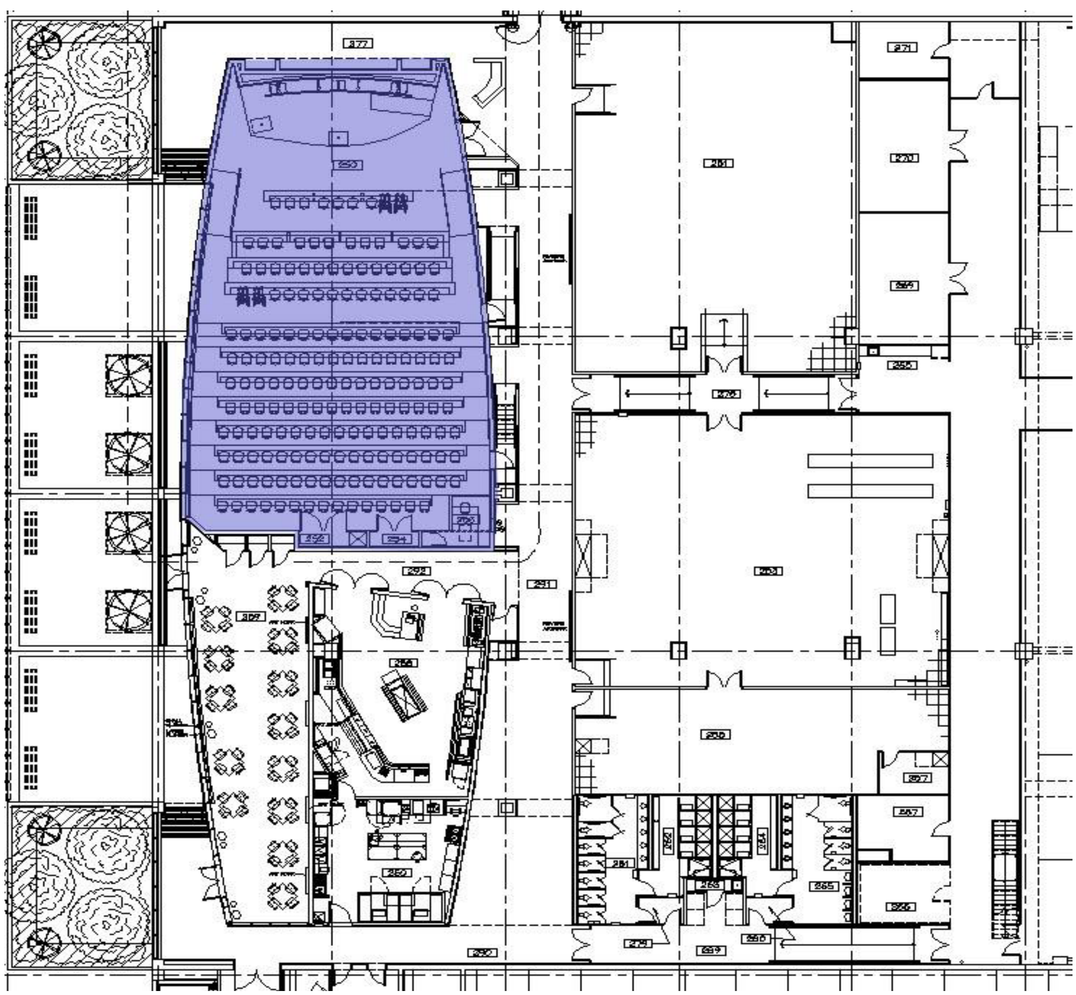


Figure 3.1: Auditorium Floor Plan

SCHEMATIC DEISIGN:

Because the auditorium is considered a multi-purpose space, many activities could potentially take place here. It is important to consider each of these activities to properly design the lighting. The preliminary design process began with assessing each of these situations and deciding an adequate level of illuminaition needed. The largest design change within the space was the ceiling contour and material. Originally, the ceiling was designed with a 2'x4' acoustical ceiling type system. A redesign implemented a curved acrylic system that is back lit with linear fluorescent industrial luminaires. This ceiling system is intended to act as an architectural element while contributing to the overall ambient lighting within the space. The luminaires are mounted 18" above the ceiling system. The mounting height and spacing of each row of luminaires behind the acrylic causes the ceiling to be non-uniformly lit creating shadows within the ceiling system itself. Because this element is intended to imitate a wave, the shadowed portions against the higher illuminated portions give the ceiling a sense of depth and motion just as a wave possesses.

In addition to the ceiling illuminance, other lighting systems are located throughout the space. The objective was to conceal the luminaires and show off the architecture of the space. Recessed LED step lights are placed in each riser. Integrated LED task lights are mounted on the underside of the counters of each pew. Compact fluorescent wall mounted cylinders are located above each door. Recessed LED downlights are located at the stage behind the speaker for general stage lighting. LED spot lights highlight the speaker at either of the podium locations.

Below is a section view of the preliminary design for the auditorium.

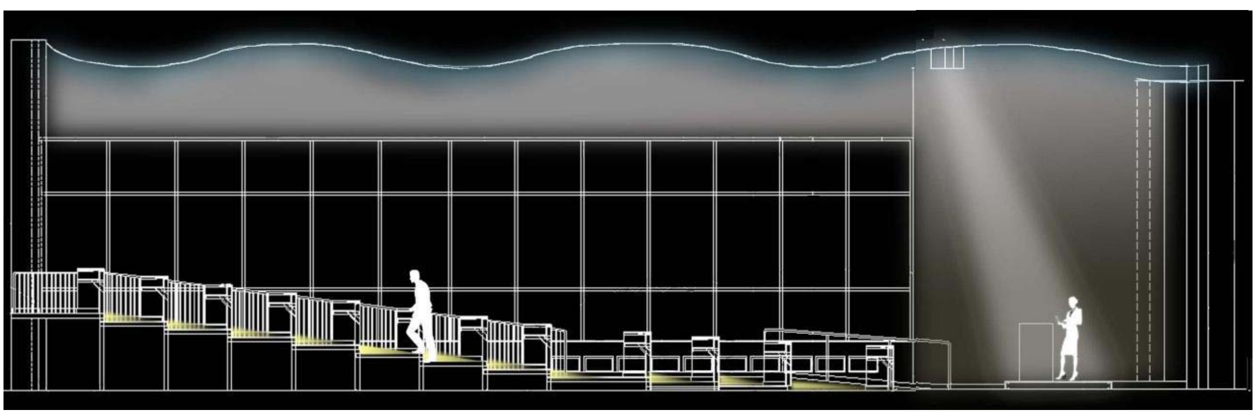


Figure 3.2: Auditorium Preliminary Schematic Design

SURFACE MATERIALS:

MATERIAL SCHEDULE		
SURFACE	DESCRIPTION	PROPERTIES
Floor	Blue/Yellow pattern carpet	ρ= 0.3
Stage	Dark blue carpet	ρ= 0.2
South Wall	Light Tan Paint	ρ= 0.85
North Wall	Light Tan Paint	ρ= 0.85
East Wall	Light Tan Paint	ρ= 0.85
West Wall	Light Tan Paint	ρ= 0.85
Glass 1	Grey Frit	ρ= 0.5, τ= 0.12
Glass 2	Blue Frit	ρ= 0.3, τ= 0.17
Projection Screen	–	ρ=
Doors	Oak	ρ= 0.22
Desk/Podium(s)	Oak	ρ= 0.22
Countertop	Linoeum Blue	ρ= 0.3
Door Frame/Mullions	Metal	ρ= 0.08
Ceiling	Acrylic	ρ= 0.5

DESIGN CRITERIA + CONSIDERATIONS

Task Considerations

There is no set task for this space; however, reading material and watching presentations will take place most often. It is therefore important to properly illuminate the task surface as well as vertical illuminance to render the speaker's face well. In addition, it is crucial there is no glare generated on the projection screen during a presentation as well as adequate shading devices on the west wall glazing. Surrounding spaces also require illuminance, such as the steps, ceiling, and exit doors for ease of egress.

Quantitative Visual Performance

- Assembly | Horizontal: 10 fc
- Social Activity | Horizontal: 5 fc

Stated in the IESNA Lighting Design handbook, task plane illumination is not considered important; however, the versatility of the space may require appropriate lighting for such tasks. Therefore, task plane illumination will be considered and targeted between 20-30 fc being controlled using scene controllers in the space.

Lighting Controls

Controllability of this space is considered a driving factor for luminaire placement and selection. Selecting proper zones must be catered to the use of the space as well as integrating shading devices for privacy and irritation from daylighting.

The auditorium is controlled by two scene controllers; one located adjacent to the lower entrance and the second located at the top of the auditorium adjacent to the sound booth. Each scene controller is a *Grafik Eye 4000* manufactured by Lutron with integrated shade controls as well as an added architectural wall station for general lighting switched on and off. The *Grafik Eye* is specified with four individual scenes comprised of different intensity values from each of the five zones. Below is a table representing the intensity percentage contributed from each zone.

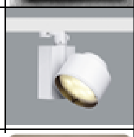
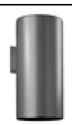
SCENE	STEPS	TASK	DOOR	STAGE SPOT	STAGE DOWNLIGHTS	CEILING
1	50%	60%	50%	FULL	FULL	OFF
2	50%	60%	50%	FULL	FULL	50%
3	FULL	30%	FULL	OFF	OFF	FULL
4	50%	60%	50%	FULL	OFF	OFF

ASHRAE 90.1 | Power Density Allowance

The lighting power density required by ASHRAE 90.1-2007 Section 9.6: Space-By-Space Method for auditorium and seating areas is 0.9W/ft^2.

TYPE	FIXTURE QUANTITY	FIXTURE WATTAGE	TOTAL WATTAGE	UNITS
ST	40	8	320	WATTS
SP	5	43	215	WATTS
SB	12	11.9	142.8	WATTS
TL	89	19	1691	WATTS
C	20	117	2340	WATTS
DS	5	17	85	WATTS
		TOTAL SQ. FT.	7500	SQ.FT.
	TOTAL LPD ALLOWABLE		0.900	W/FT^2
		TOTAL LPD	0.639	W/FT^2

LUMINAIRE EQUIPMENT SCHEDULE:

TYPE		MANUFACTURER	CATALOGUE NUMBER	DESCRIPTION
ST		iO LED-Cooper	0.01.SL.3K.N.100.3.0	5.9"x5.9" square LED step light for interior or exterior applications, UL listed for wet/damp locations, gasketed and corrosion resistant metal casting, polycarbonate lens, LED replaceable.
SP		ERCO	EN-1-ERCO-72086-000	4.9" track spot light, powder coated cast aluminium with 180˚ tilt capabilities,able to connect with a DALI track system, LED module replaceable
SB		CREE LED LIGHTING	LR6C-DR1000	6" recessed architectural downlight, Cree True White Technology LED, delivers 80 lumens/W, CRI 90
TS		iO by Cooper Lighting	0.09.I.3K.NG.1.6.1.1	1.39" W X .66" D X 36" L shelf integrated task light, LEDge is a part of the iO linear LED-based family, low voltage, neoprene gasketed, housing made of extruded aluminum, finished in anodized aluminum.
C		METALUX-COOPER LIGHTING	MBF-2-54T5FB	4' (2)T5 industrial fixture die formed channel from 20 gauge rolled steel with pretreated iron phosphate for rust inhibitor, reflector minimum 95% total reflectivity, mounted with suspension cables or surface mounted, integral occupancy sensor available.
DS		PRESCOLITE-HUBBELL LIGHTING	CF8W26QEB	8" wall mounted sylinder, 26W CFL, quad tube, electronic ballast

*See Appendix A | Lighting for full luminaire fixture schedule.

LIGHT LOSS FACTORS:

CALCULATIONS					**TOTAL LLF**
TYPE	MAINTENANCE CATEGORY	BALLAST FACTOR	LUMINAIRE DIRT DEPRECIATION	LAMP LUMEN DEPRECIATION	
ST	Clean	1.0	0.93	0.70	0.65
SP	Clean	1.0	0.93	0.70	0.65
SB	Clean	1.0	0.93	0.70	0.65
TL	Clean	1.0	0.93	0.70	0.65
C	Clean	1.1	0.93	0.92	0.94
DS	Clean	1.0	0.93	0.85	0.80

*Assumptions: Clean environment with 18 month cleaning cycle, calculations performed using IESNA 10th Edition 2011.

LIGHTING PLAN:

*See Appendix A for Lighting Plan.

DETAILS:

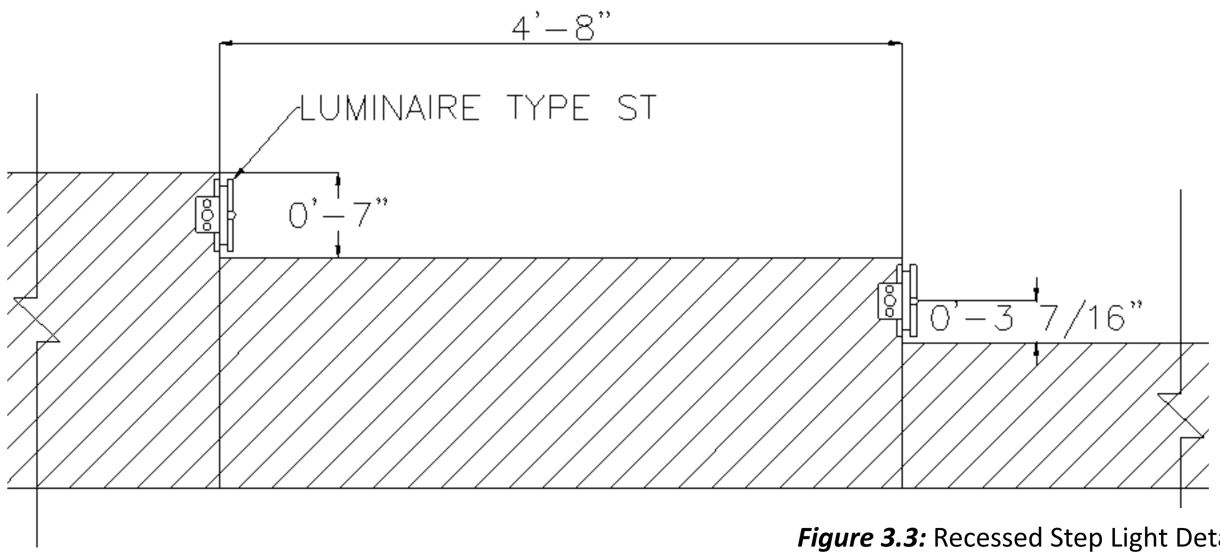


Figure 3.3: Recessed Step Light Detail

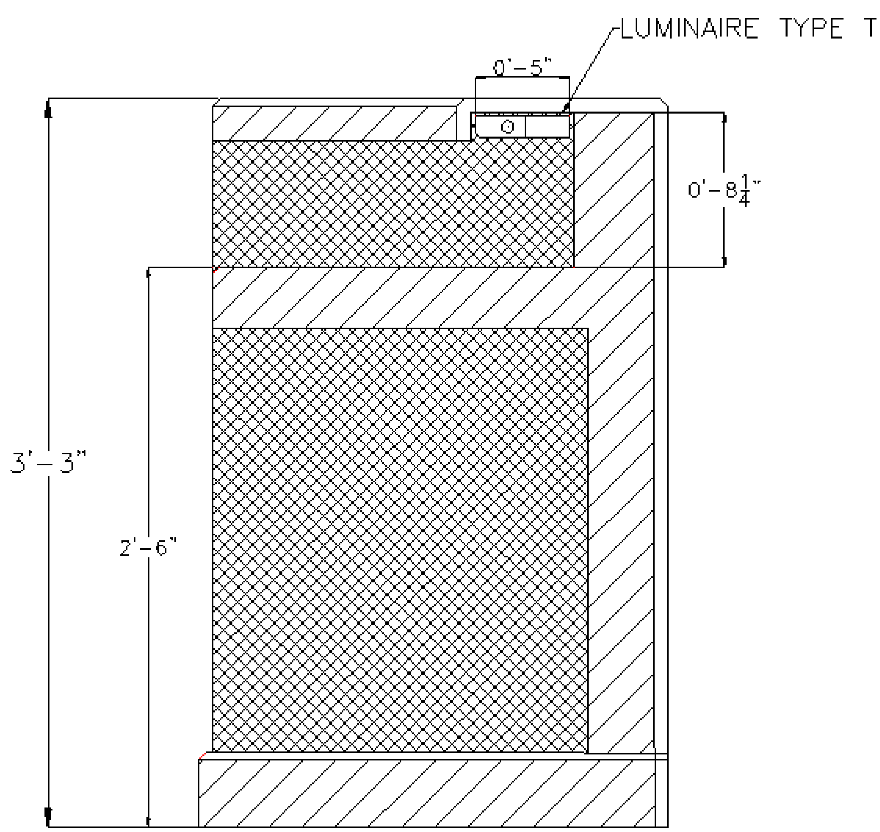


Figure 3.4: Integrated Task Light Detail

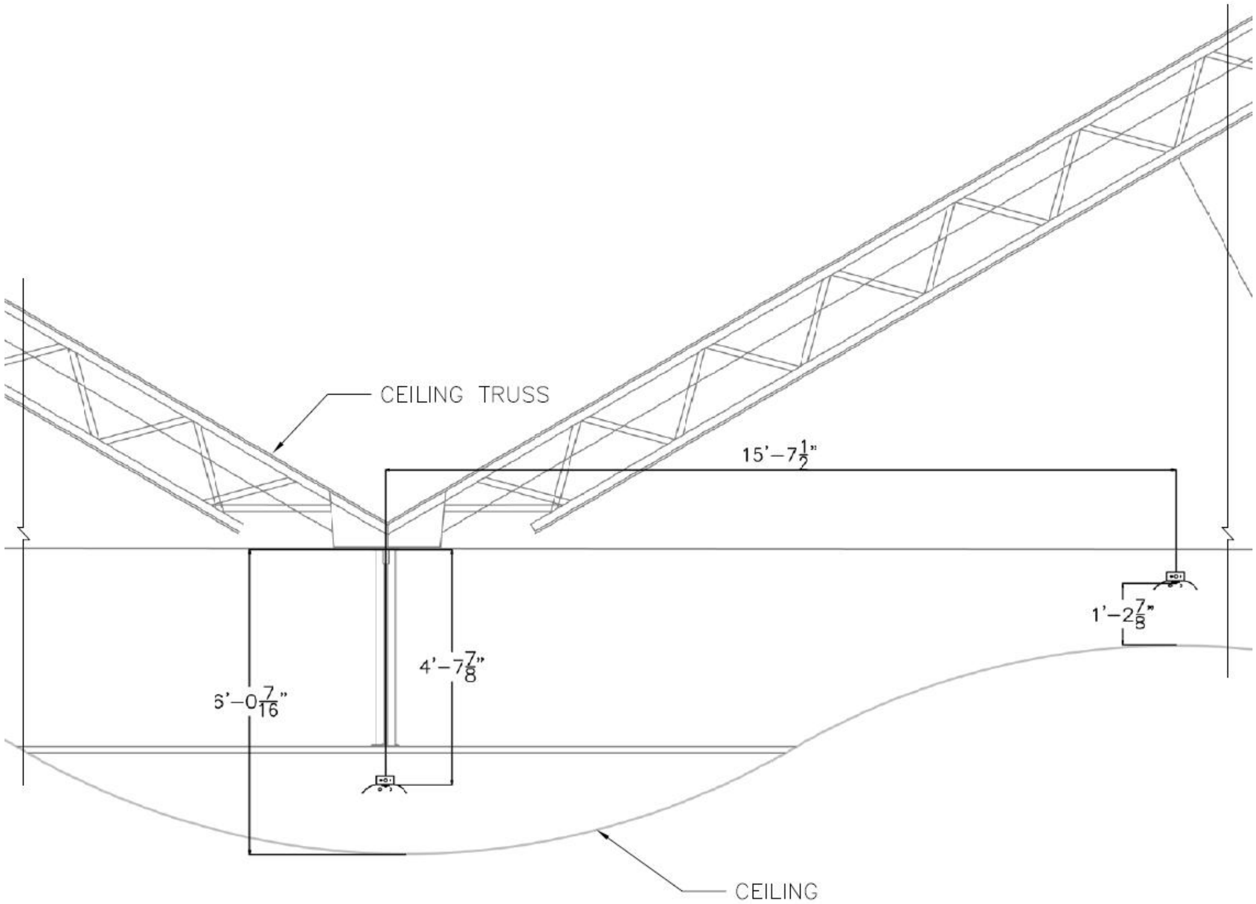


Figure 3.5: Auditorium Ceiling Luminaire Mounting Detail

*NOTE: Full specification sheets of ceiling system and translucent infill panels are located in Appendix A | Lighting

PERFORMANCE DATA:

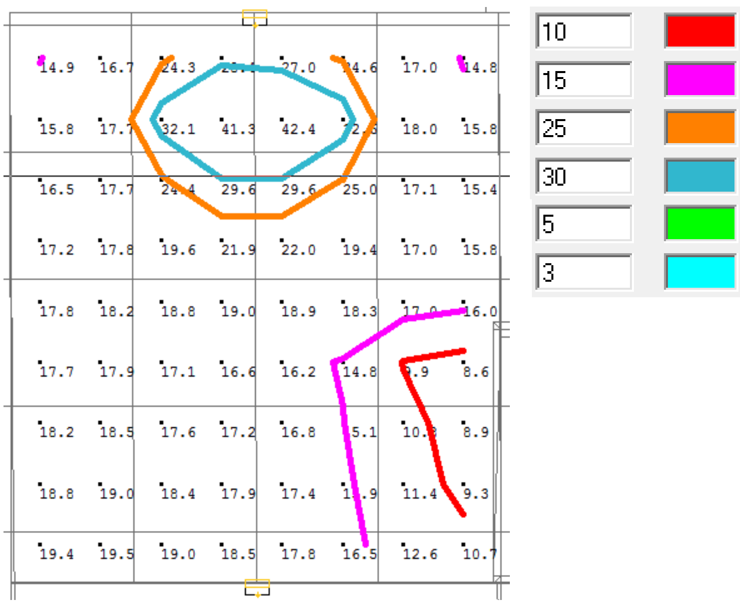


Figure3.6: Auditorium Step Calculation Isometric Contour

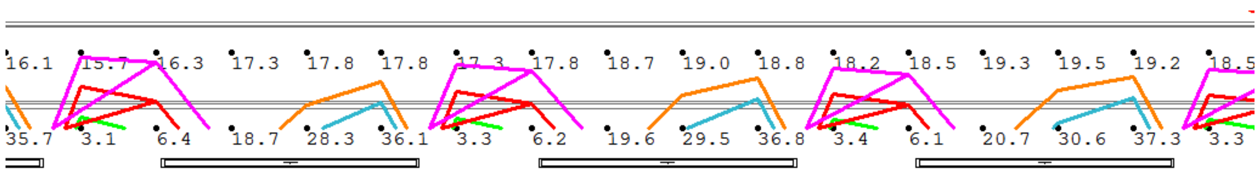


Figure 3.7: Auditorium Desk Calculation Isometric Contour Lines

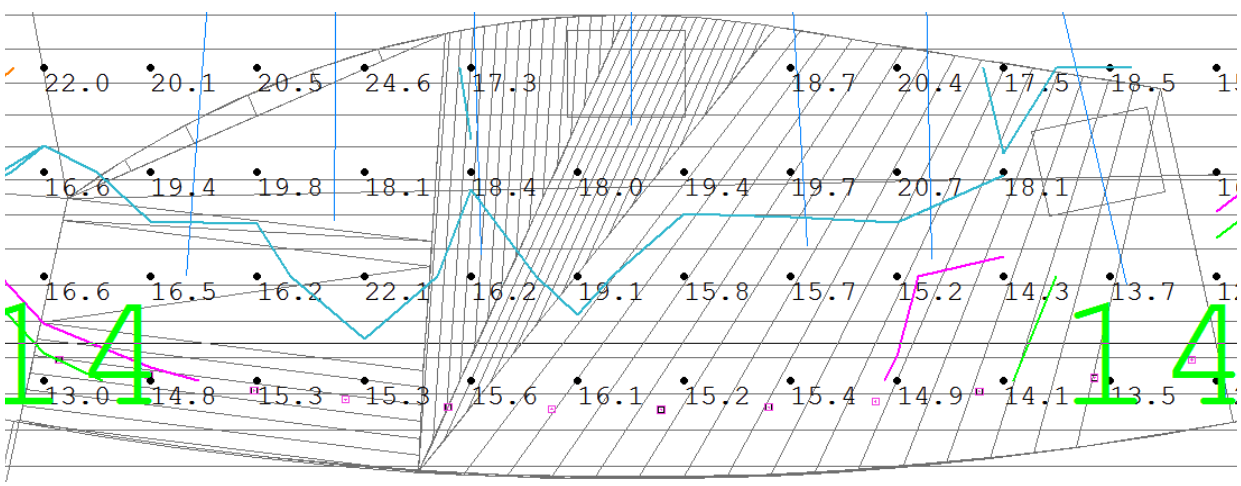
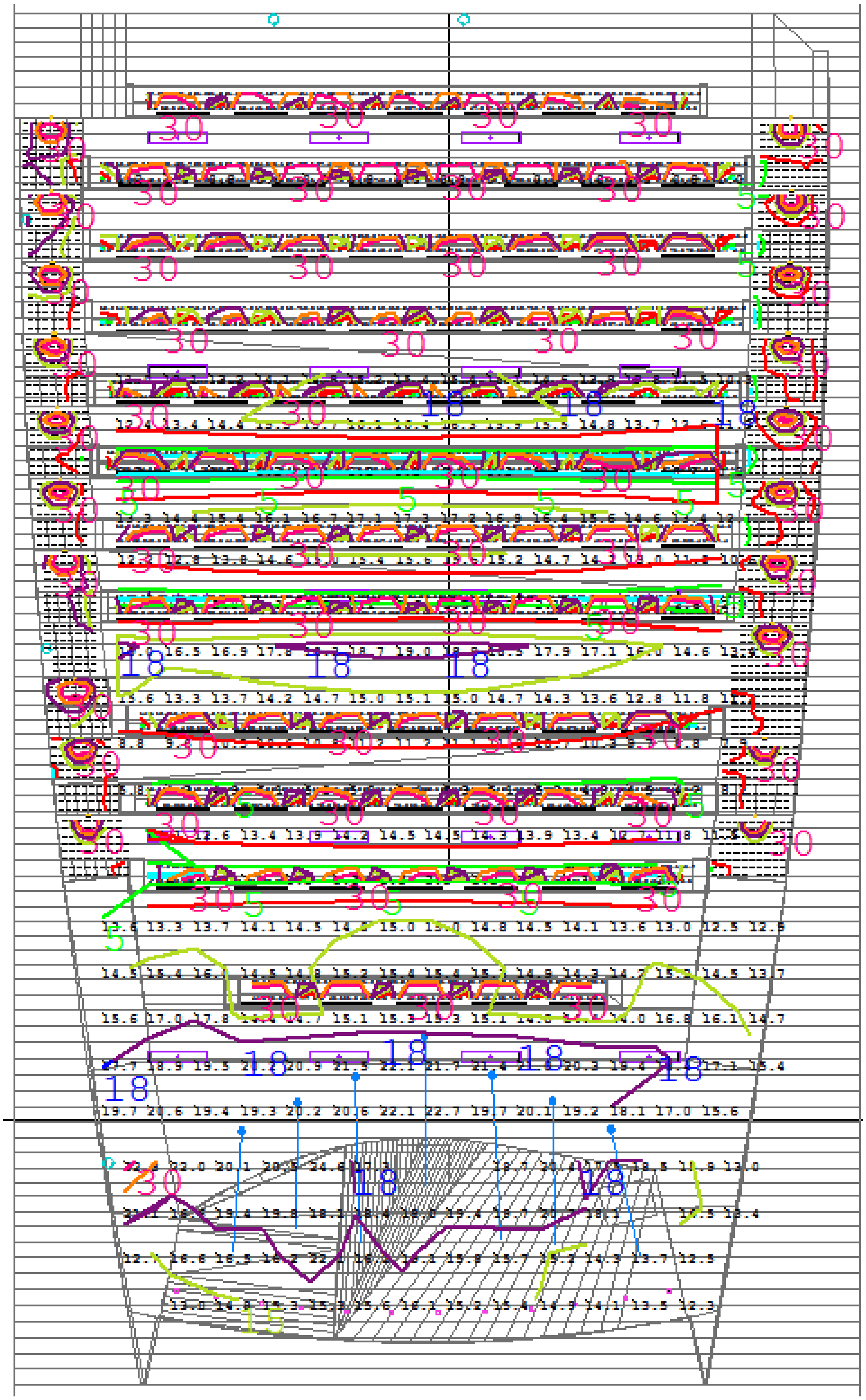


Figure 3.8: Auditorium Stage Calculation Isometric Contour Lines



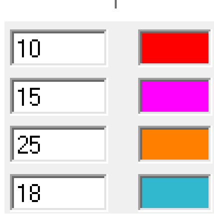


Figure 3.9: Auditorium Calculation Isometric Contour Lines

Figure 3.10: Auditorium RGB AGi32 Render

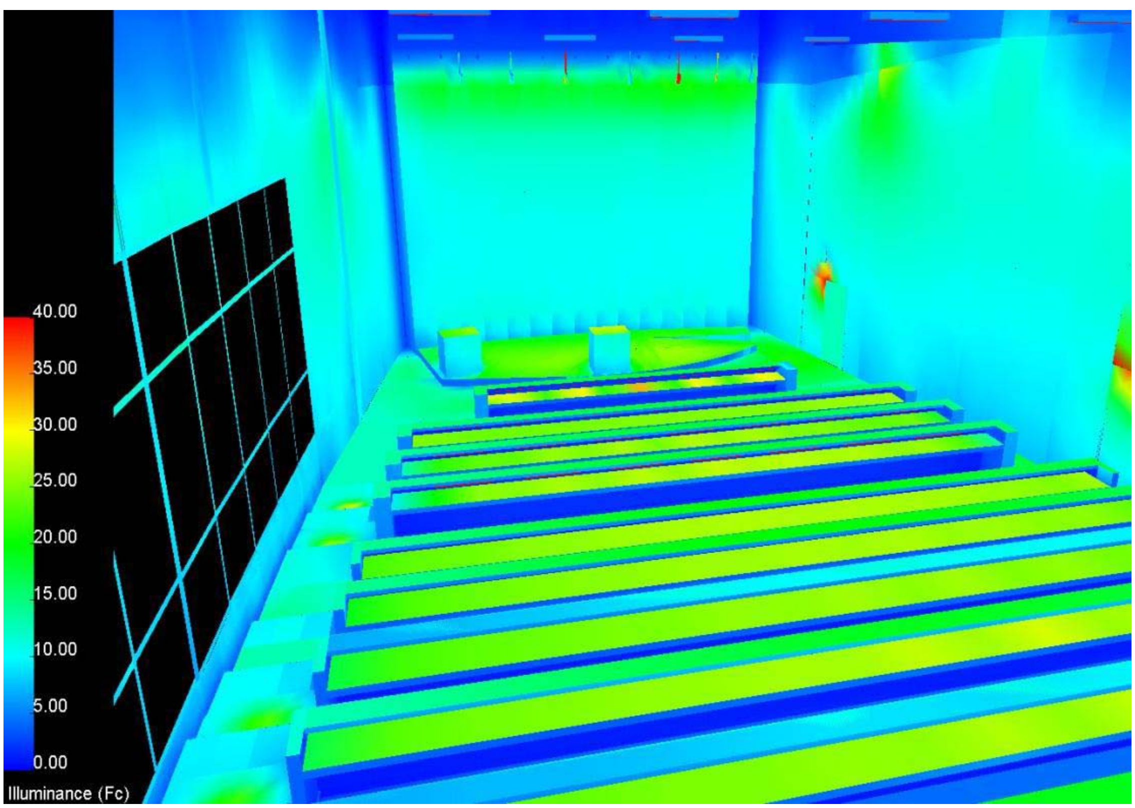


Figure 3.11: Auditorium Pseudo AGi32 Render

DAYLIGHT RENDERINGS:

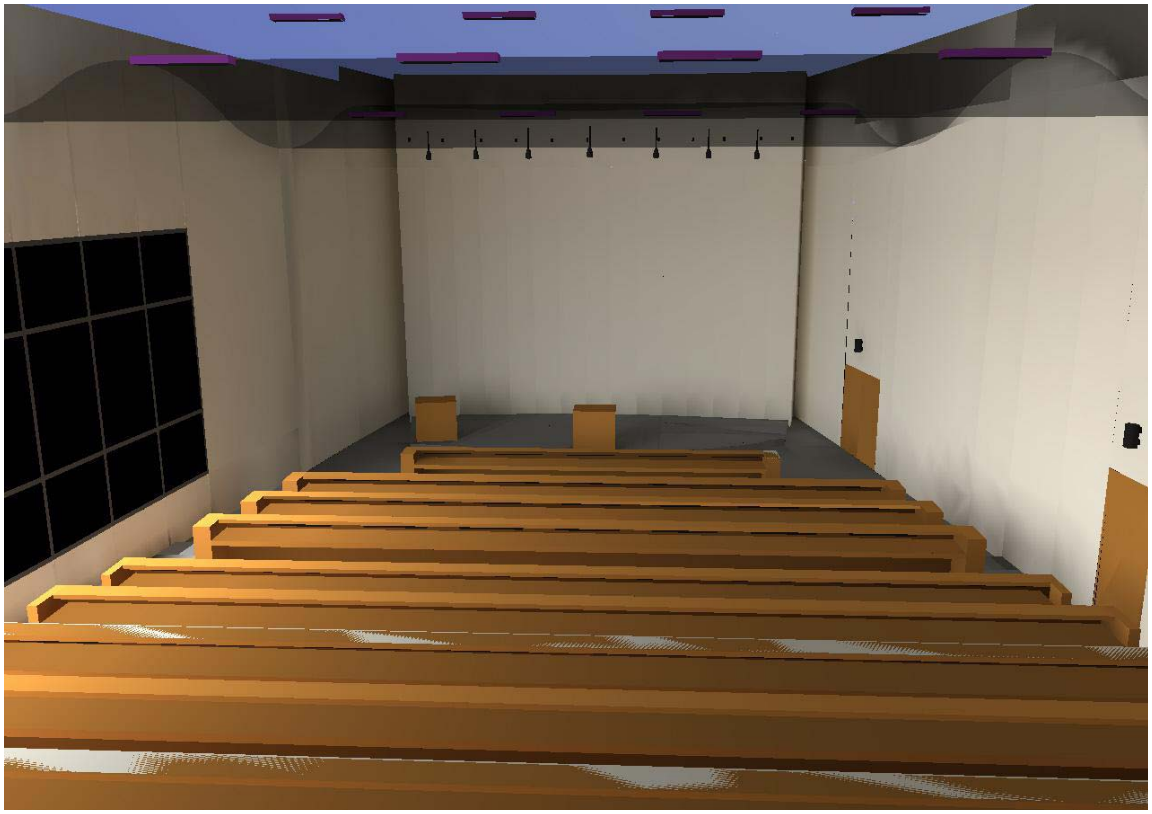


Figure 3.12: Auditorium Daylight June 21st RGB AGi21 Render

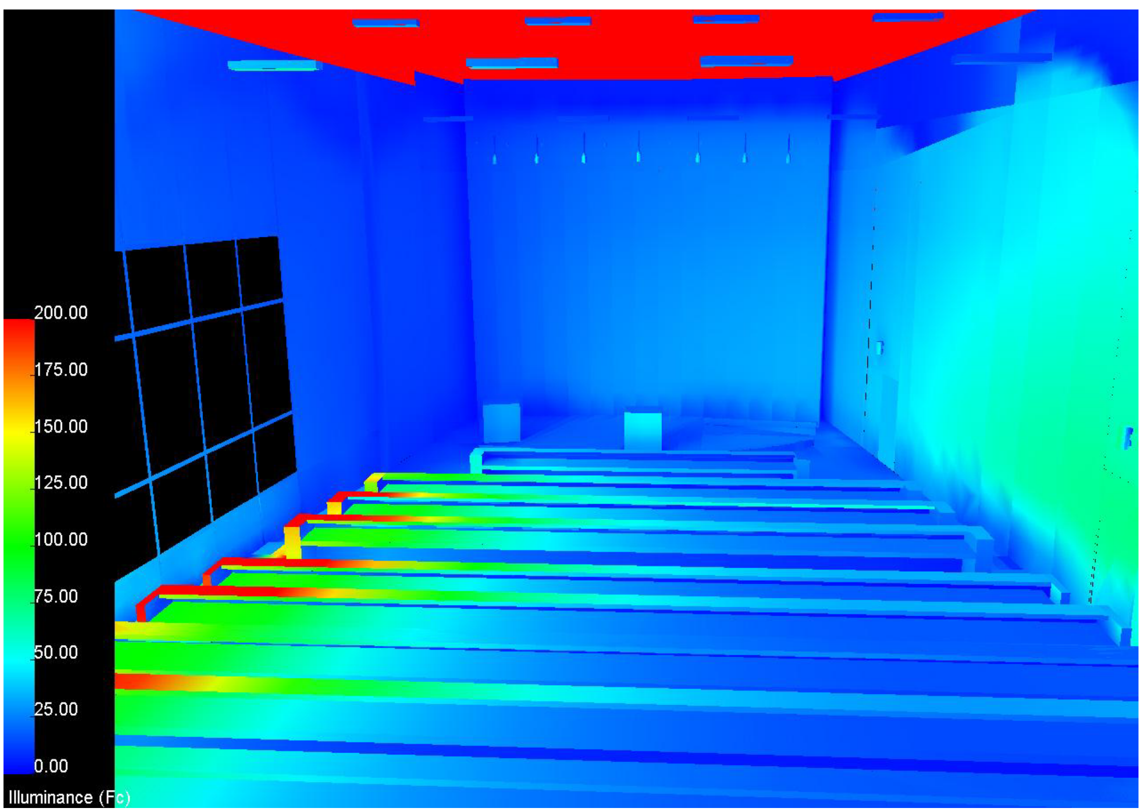


Figure 3.13: Auditorium Daylight June 21st Pseudo Color AGi32 Render

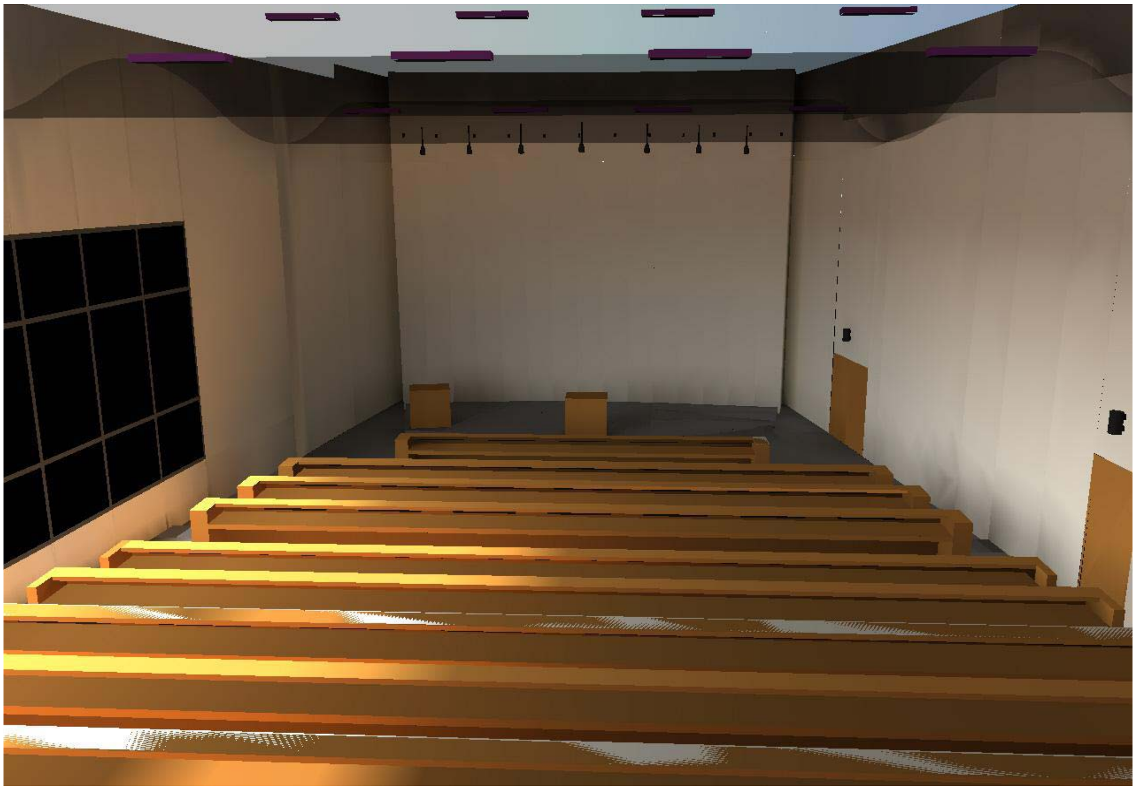


Figure 3.14: Auditorium Daylight Dec 22nd RGB AGi32 Render

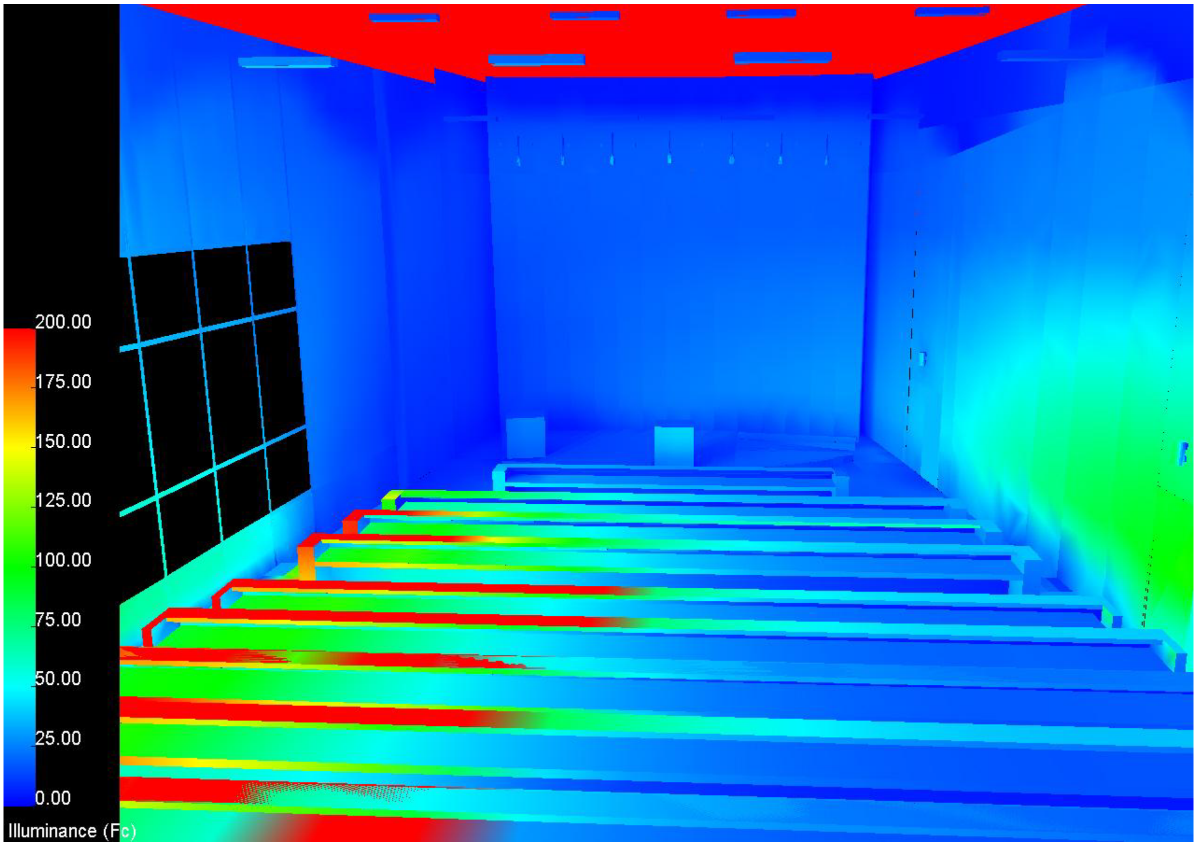


Figure 3.15: Auditorium Daylight Dec 22nd Pseudo Color AGi32 Render

SCENE CONTROL RENDERS:

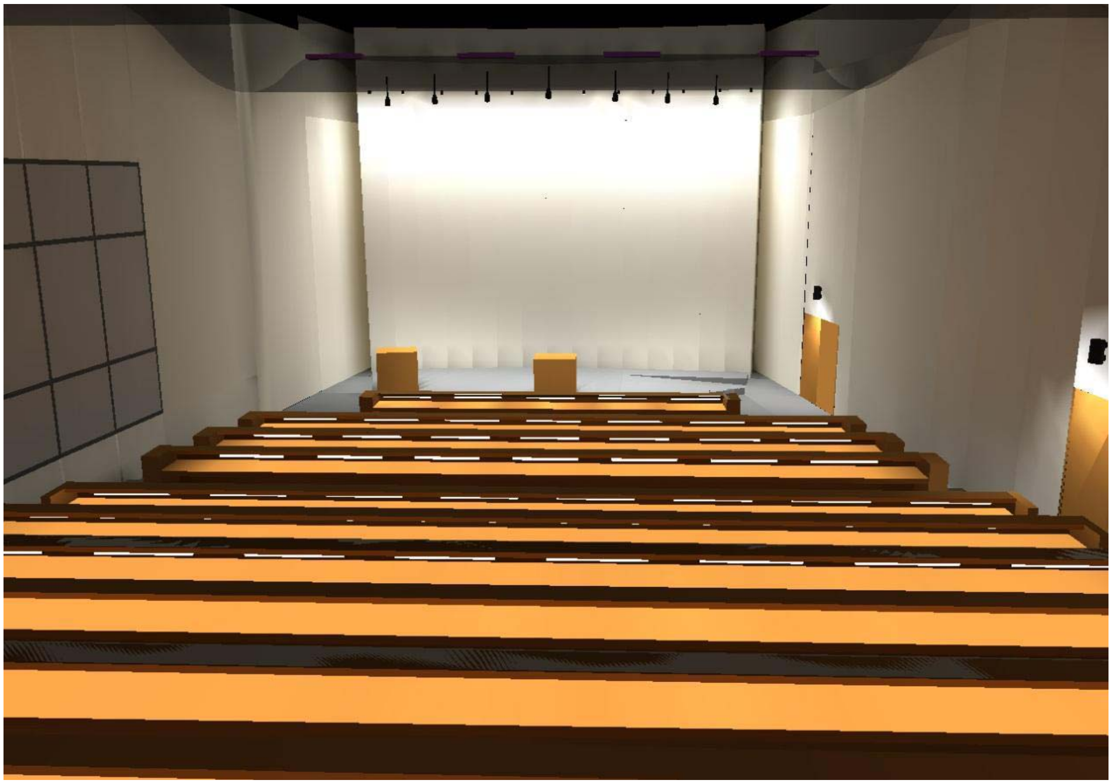


Figure 3.16: Scene 1 | Formal Presentation RGB AGi32 Render

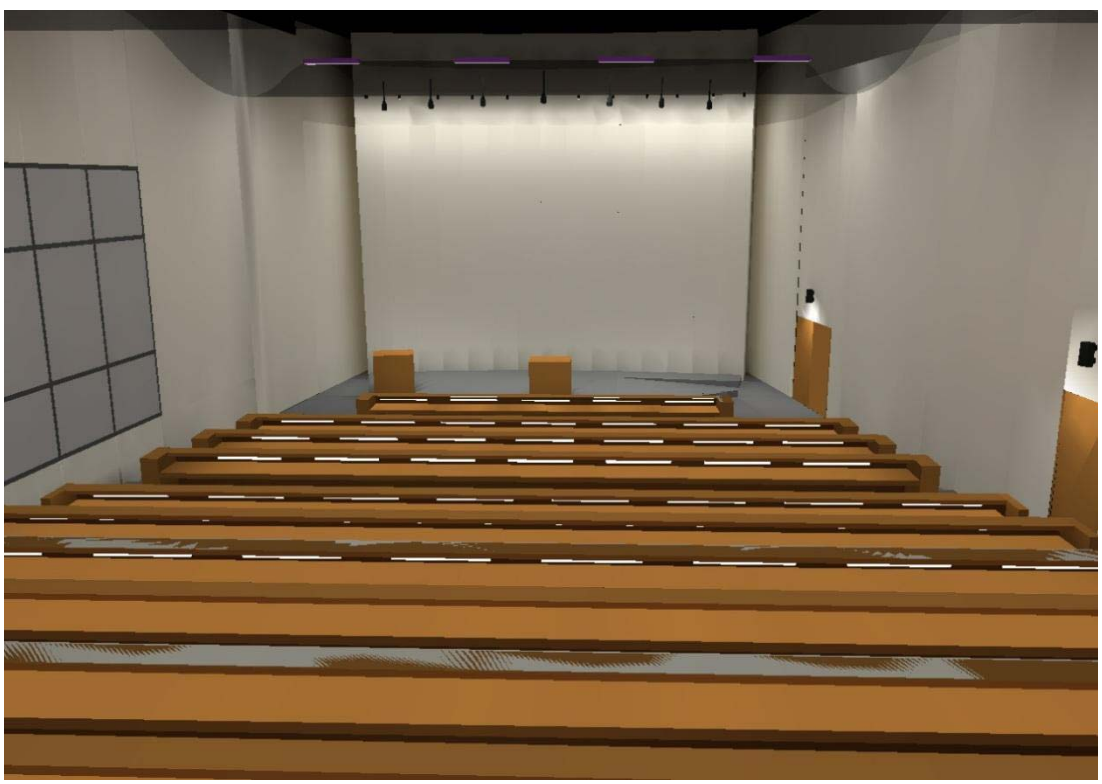


Figure 3.17: Scene 2 | Informal Presentation RGB AGi32 Render

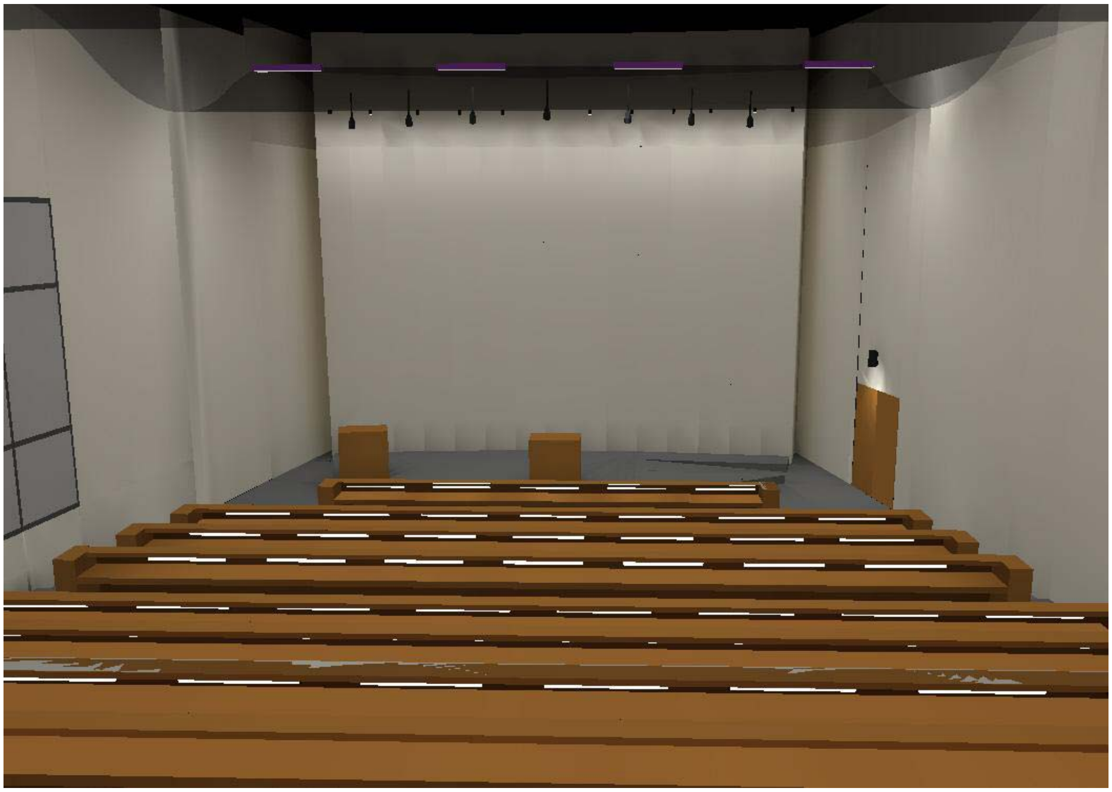


Figure 3.18: Scene 3 | Pre Presentation RGB AGi32 Render

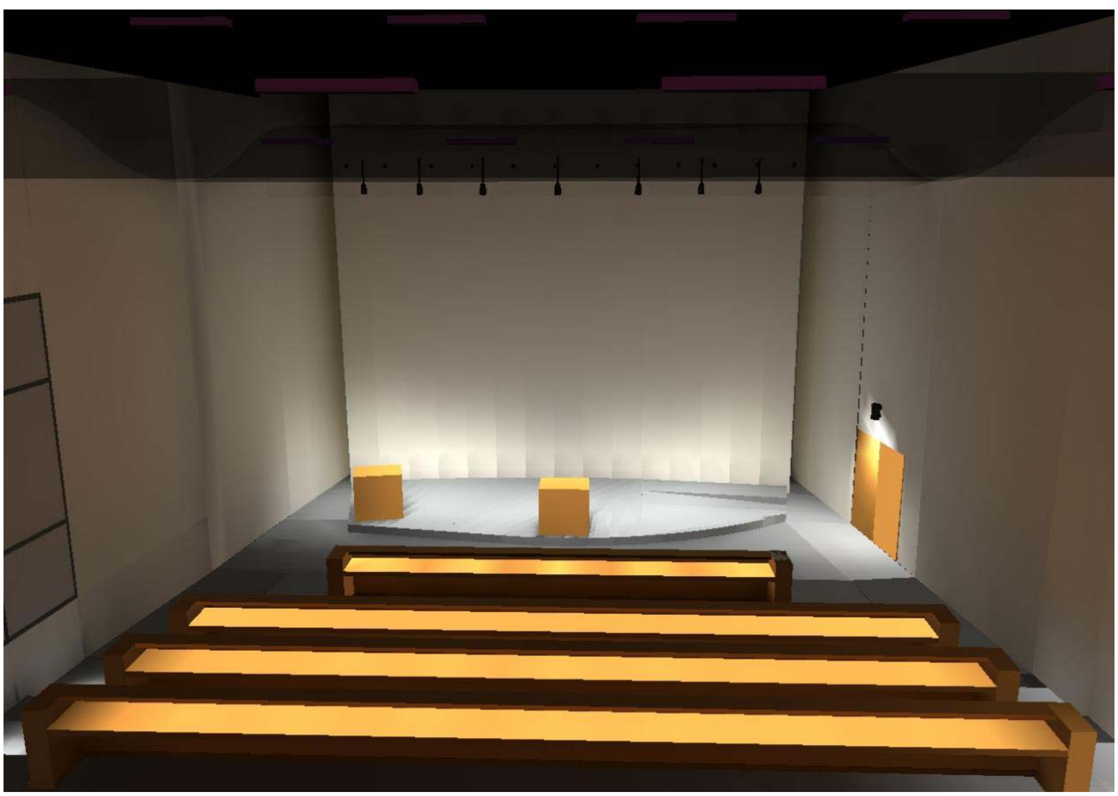


Figure 3.19: Scene 3 | Podium Speaker RGB AGi32 Render

CALCULATION SUMMARY:

Auditorium Calculation Summary				
	Stage	**Steps**	**Desk**	**Floor**
Avg. Illuminance	17.3	14.4	24.8	11.17
Avg/Min	1.4	2.9	5.3	4.25
CRITERIA	15.0	10.0	15.0	10.0
COMPLIANCE?	YES	YES	YES	YES

	DESK		FLOOR		STAGE		STEP	
	Avg	Avg/Min	Avg	Avg/Min	Avg	Avg/Min	Avg	Avg/Min
Scene 1- Formal Presentation	17.6	7.6	4.8	2.7	9.5	1.4	14.7	3.1
Scene 2- Informal Presentation	14.9	8.5	6.8	2.1	12.9	1.6	7.3	2.6
Scene 3- Pre Presentation	24.7	8.3	8.8	4.1	9.5	1.9	14.2	2.7
Scene 4/5- Podium Speaker and Projection	6.6	15.1	1	0.1	10.8	2.9	2.9	5.8

FINAL RENDERINGS:

Figure 3.20: Auditorium Side Podium 3ds Max Render

Figure 3.21: Auditorium Front Stage 3ds Max Render

EVALUATION:

The lighting design for the auditorium adequately addresses the multiple activities performed within the space while considering daylight. Within the space, 4 lighting scenes are available with separate screen controls. To further enhance the experience of the occupant, a curved back-lit ceiling was designed. It is illuminated with linear fluorescent strip fixtures 18” above the ceiling material. The mounting height and spacing both contribute to the appearance of a water wave by creating areas of shadows and highlight to illustrate the depth and movement of a wave. The entire auditorium instills a mix of LEDs and fluorescent sources primarily for their output and low power consumption qualities. Although LED sources are known not to be well dimmable, dimming to low levels is where the characteristics of LEDs tend to go astray. When the wattage and lighting scenes were designed, it was purposefully designed so the LED sources within the space would not be affected by dimming to low levels. LED sources within the space include all stage lighting, recessed step lighting, and integrated task lighting at each desk area. Compact fluorescent luminaires are wall mounted above each door.

The lighting design for the space adequately complies with IESNA recommendations in addition to lighting power densities from ASHRAE Standard 90.1-2007. It properly tailors to the needs of the space as well as providing a visually interesting environment for the occupant.

EXTERIOR | LANDSCAPE ARCHITECTURE BREADTH AND LIGHTING DESIGN

LANDSCAPE ARCHITECTURE BREADTH

INTRODUCTION:

Currently at the VASCIC facility, there is no exterior gathering space present. In 1993, the City Council adopted a code called the "*Framework for the Future 2030*". This comprehensive document was created in order to properly manage a vastly growing community such as Newport News, Virginia. It addresses issues of physical growth and planning, goals and policies, and specific plans of action to address different aspects of the City's development. Every five years, the code calls upon a citizen task force to re-evaluate how the city is coordinating economic, physical, and social development of the Newport News area.

Figure 4.1: Victory Landing Park Promenade

Newport News, and the VASCIC facility, is situated along 47 miles of the James River shoreline running parallel to Hampton Roads. Decided by the City Council and citizen task force, provided public access to the waterfront is the most essential change they could implement providing a Segway for future waterfront developments. When the VASCIC facility was being designed, the City Council required Northrop Grumman of Newport News Shipbuilding to redesign their bulkhead in order to contribute to the new code and begin providing the community a means of accessing the waterfront. Because Northrop Grumman was not responsible for designing an exterior gathering space, the City Council was therefore taking charge to instill a park along the waterfront behind the facility. However, with the economic downfall, the design was never executed and remains vacant. Another major issue the City Council has been having for years is of the 47 miles of shoreline, the city only owns 1.3 miles, or 2.6%. The rest of the shoreline is privately owned and creates a problem for docking boats at the various marinas along the coast. In addition to providing for the community, the new code also is trying to generate more attraction to the area by being able to accommodate tour boats along this promenade. In 2004, Victory Landing Park was designed alongside the VASCIC facility also making a connection to the main street and the historical arch commemorating veterans of all types.

PROBLEM:

Figure 4.2: Proposed Gathering Area

Because this promenade has become such a public attraction, designing a functional space for the employees of the VASCIC facility as well as the public would provide a more enjoyable atmosphere and, too, would generate more attraction to the area. In addition, implementing this space would in turn promote a higher quality of residential life, increase property values, and begin to build up areas of the city that have been vacant for some time. As a result, the community would begin to learn more about the shipbuilding industry, what this state-of-the-art facility does, and how it contributes to the industry. This makeover would generate a balance between the traditional amenities of the area while providing an attractive and unique experience in the center of an active industrial waterfront.

ARCHITECTURAL SCHEMATIC DESIGN:

The design of the exterior gathering space encompasses influences from many aspects of the facility. It pulls elements from the facility and what it does, design considerations of the water element throughout the lighting design, and the physical element of water surrounding the lobby space.

Figure 4.3: Docked ships

Facility influence on the design considered what the actually facility complex is designed for; it's all about water vessels. When designing the exterior area, four elements were drawn. Along the Victory Landing Park pathway, the entrance to the gathering space begins with a seating area that resembles a docked aircraft carrier. Also placed surrounding the majority of this space is a reflecting pool designed to resemble the stagnant water along the other side of a socked ship.

As you continue along the pathway, it widens and obtains different paver patterns. From an aerial view, this widened section is actually the floor plan of the USS Dwight D. Eisenhower aircraft carrier and the different patterned pavers are the individual markings of runways on the deck of the ship.

Figure 4.4: Fleet of ships

Surrounding the implementation of the aircraft carrier walkway are three additional smaller seating areas. When doing preliminary research, most all photographs of large aircraft carriers were pictured with a handful of smaller ships surrounding. Assuming this is the case all the time, designing a small fleet of ships was the idea. The smaller seating areas are more secluded than the other seating areas; however they themselves also resemble a portion of a ship. Almost identical to the footprint of the Technology Tower, the seating area resembles the bow of a ship with reflecting pools surrounding this shape to imitate the bow cutting through water as the ship sails.

Lastly, as you navigate through the walkway of ships, you end your journey along the section of Victory Landing Park waterfront promenade. At this point there is another large seating area. Originally when the city was created, the first ship to be built was a small boat named Dorthy. The city still has this boat and is very proud of this historic element. Because it is the icon of the city, original designs of this space had plans to incorporate this structure. This seating area structure is designed to be an iconic structure. For future ships entering the marina, looking head on at this structure, it obtains a profile of a ship sailing through water. Since the city has future plans to coordinate tour boats along the coast, this could direct the boats into the marina and onto land.

Figure 4.5: "Dorthy"

LANDSCAPE DESIGN:

Reinforcing the space designed architecturally, landscape elements are placed throughout to create more of an exterior environment. Coniferous trees of two different heights along with small shrubbery surround the small, enclosed seating areas to reinforce the private feeling without completely enclosing the user. Also in the middle of the connecting pathways are two rows of trees imitating the pattern of a wake behind a ship.

LANDSCAPE ARCHITECTURE LAYOUT:

*See Appendix C for plans and details of space.

LIGHTING DESIGN:

SCHEMATIC DESIGN:

The design intent of the space is to create and enhance the new architecture and landscaping. Creating private and public environments is not only created with the physical elements but also through lighting. At the same time, these public and private areas are treated as "destinations" along the pathway to the water. Choosing luminaires that do not appear to be luminaires and integrate with the landscaping or act as its own element is the main idea of the space. Illuminating the environment around the user and not necessarily directly down on them is a key design concept for this space. By highlighting trees and other landscaping around the seating areas as well as using glowing orbs sitting on the reflecting pools illuminates the environment around the seating but is still able to provide adequate levels for safety purposes.

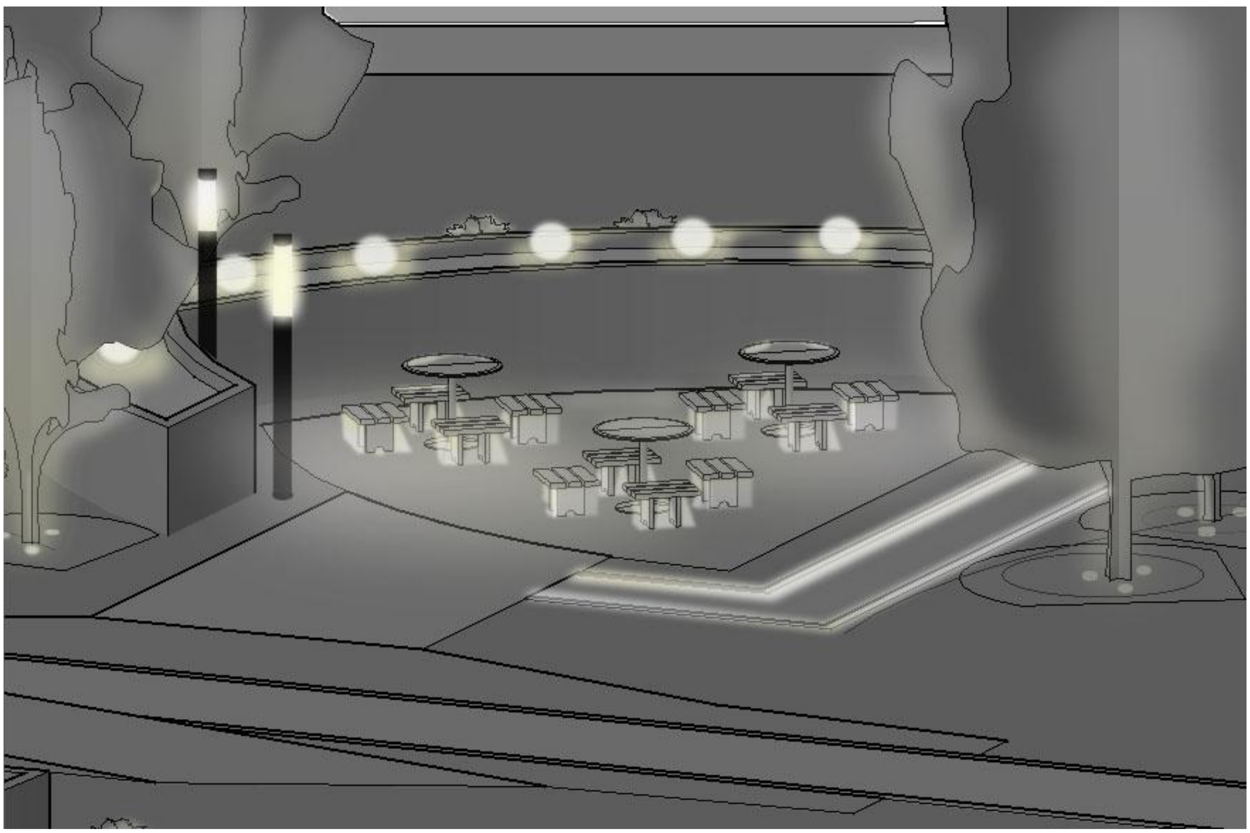


Figure 4.6: Exterior Gathering Schematic Design

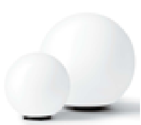
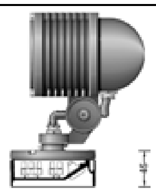
SURFACE MATERIALS:

MATERIAL SCHEDULE		
SURFACE	DESCRIPTION	PROPERTIES
Hardscape 1-Main pathways	Houndstooth Brick	ρ=0.10
Hardscape 2- Cross pathway	Granite Stone	ρ=0.32
Hardscape 3- Pathway Outline	Dirty Sandstone	ρ=0.28
Hardscape 4- Aircraft Carrier Outline	Running Brick	ρ=0.26
Small Seating Area	Dirty Sandstone	ρ=0.28
Large Seating Area	Sandstone	ρ=0.32
Round Seating Area	Sandstone	ρ=0.32
Pool Walls	Granite Stone	ρ=0.32
Ground	Grass	ρ=0.09
Water	Liquid	ρ=0.12
Round Seating Bench (concrete structure)	Brown Exposed Aggregate	ρ=0.26
Straight Benches	Brown Exposed Aggregate	ρ=0.26

DESIGN CRITERIA + CONSIDERATION:

TYPE	FIXTURE QUANTITY	FIXTURE WATTAGE	TOTAL WATTAGE	UNITS
GG	33	7	231	WATTS
PS	45	40	1800	WATTS
TT	55	17	935	WATTS
		TOTAL SQ. FT.	29888	SQ.FT.
	TOTAL LPD ALLOWABLE		0.2	W/FT^2
		TOTAL LPD	0.10	W/FT^2

LUMINAIRE EQUIPMENT SCHEDULE:

TYPE		MANUFACTURER	CATALOGUE NUMBER	DESCRIPTION
GG		Bega	5014	17.7" in diameter, portable garden luminaire with stainless steel base plate, white synthetic safety glass sphere housing one lamp, sphere distributes light siftly and uniformly over surface.
PS		Bega	7785MH	1.3' W x 1.3' L x 1.5 H, two piece die-cast aluminum construction providing a symmetrical distribution, construction robust enough for human weight, spun aluminum lamp housing location inside lower top covering shielded, anchored with secured plates to lower casting with four stainless steel rods, finished in black, UL listed for wet locations.
TT		Bega	7502	1.3"W x 1.5"L x 8.85" H LED floorlight, housed in aluminum alloy, stainless steel, and clear safety glass, silicone gasketed, inner reflector made of anodised pure aluminum, mounting bos with 2 fixing holes for permanent locking, UL label for wet locations

LIGHT LOSS FACTORS:

CALCULATIONS					**TOTAL LLF**
TYPE	MAINTENANCE CATEGORY	BALLAST FACTOR	LUMINAIRE DIRT DEPRECIATION	LAMP LUMEN DEPRECIATION	
GG	Clean	1.0	0.93	0.89	0.83
PS	Clean	1.0	0.93	0.81	0.75
TT	Clean	1.0	0.93	0.70	0.65

LIGHTING PLAN:

*See Appendix A for Lighting Plan.

PERFORMANCE DATA:

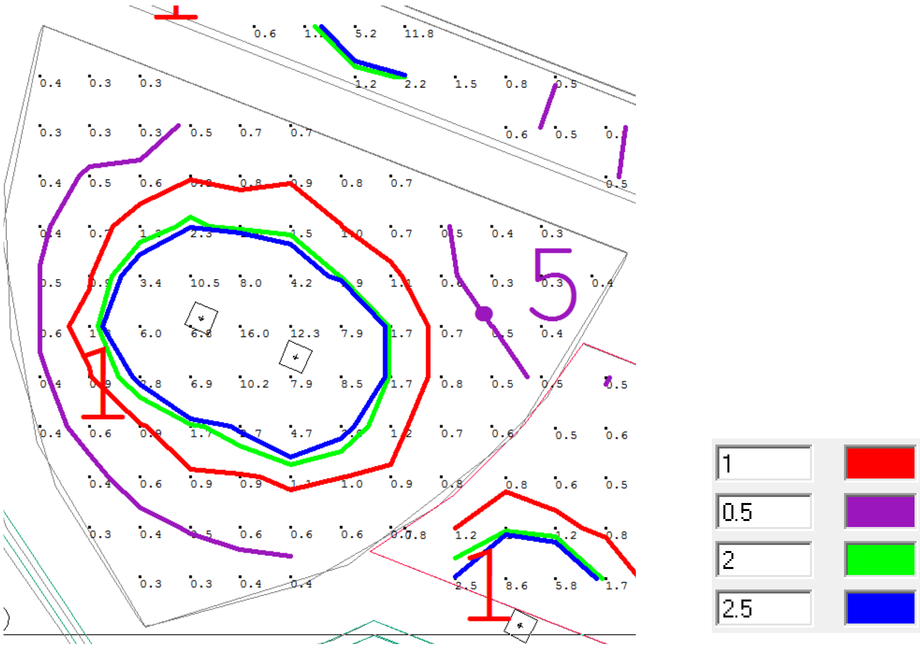


Figure 4.7: Exterior Small Seating Isometric Contour Lines

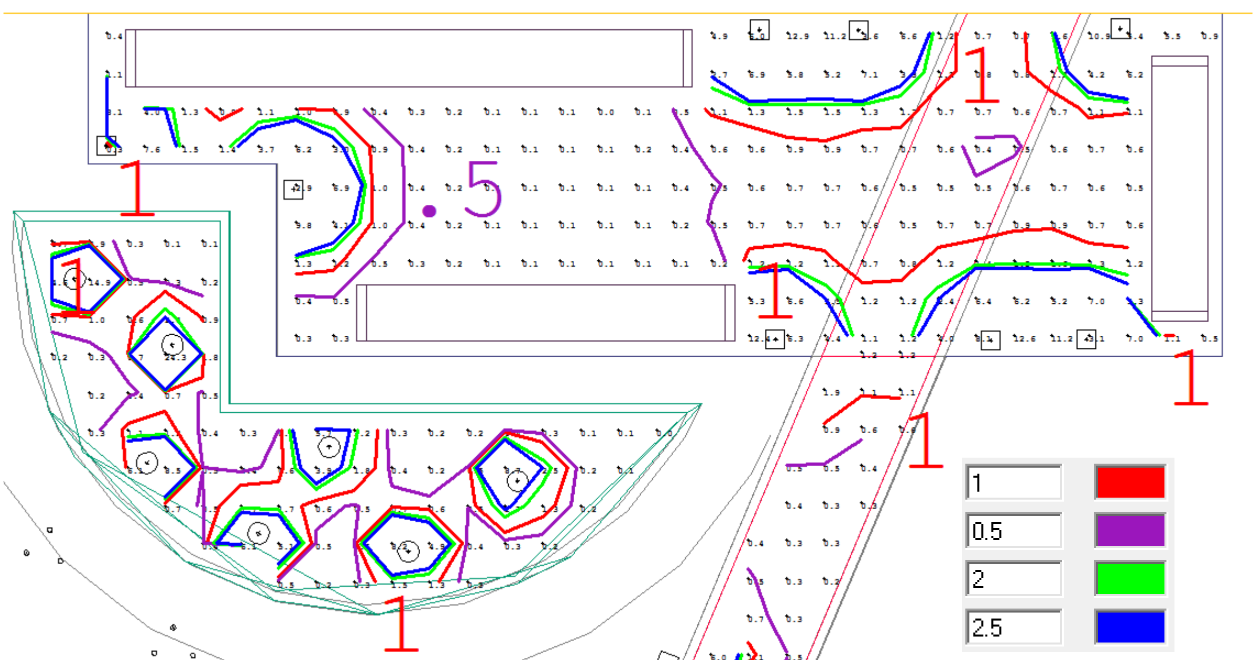


Figure 4.8: Exterior Large Seating Isometric Contour Lines

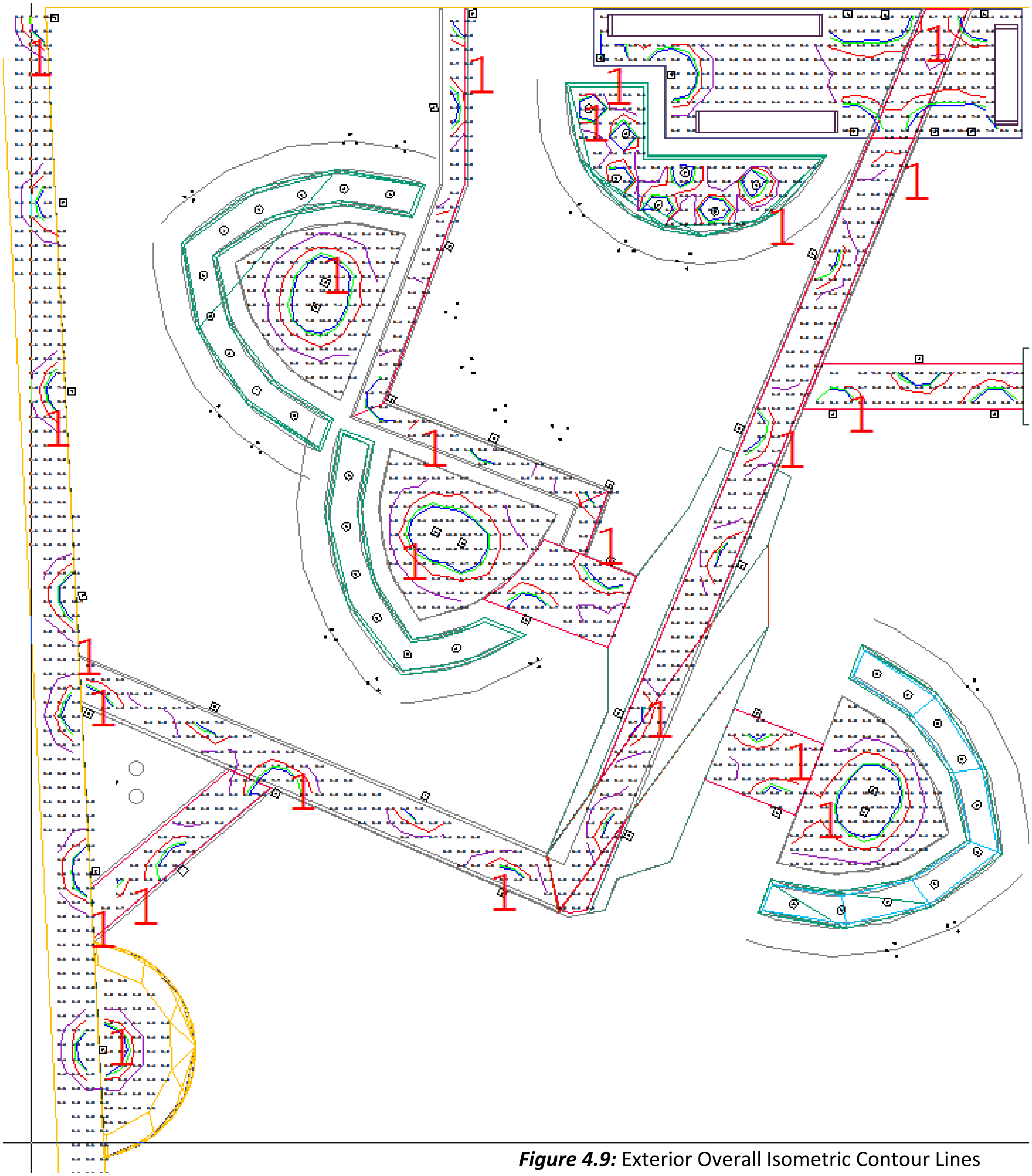
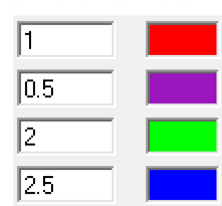


Figure 4.9: Exterior Overall Isometric Contour Lines



CALCULATION SUMMARY:

Exterior Gathering Space					
	Main Pathway	Intermediate Pathway	Small Seating	Large Seating	Round Seating
Avg. Illuminance	1.09	1.73	1.95	2.03	1.00
Avg/Min	10.0	4.80	8.60	12.9	10.0
CRITERIA COMPLIANCE?	1.0 YES	1.0 YES	1.5 YES	2.0 YES	1.0 YES

FINAL RENDERINGS:

Figure 4.10: Exterior Pathway 3ds Max Final Render

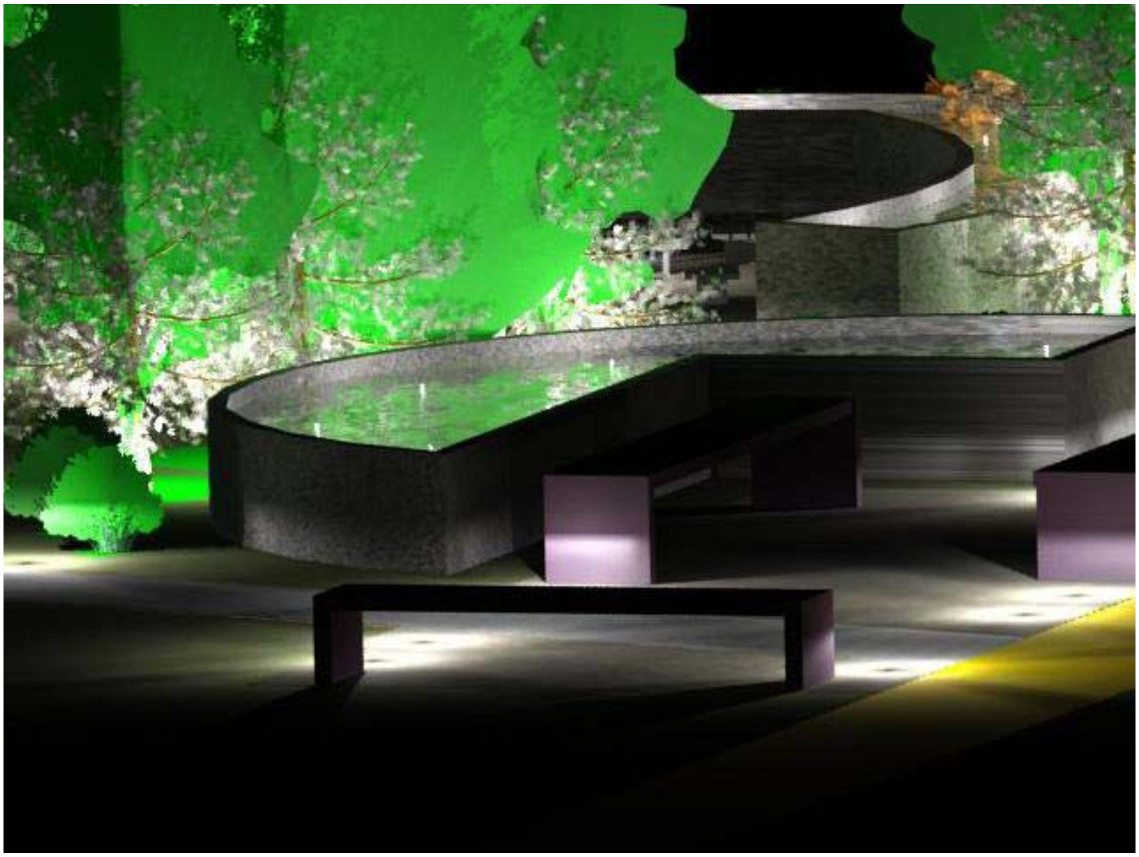


Figure 4.11: Exterior Large Seating Area , 3ds Max Final Render

EVALUATION:

The design of the exterior space meets the needs and hopefully the expectations of Newport News Shipbuilding and their efforts to enhance the waterfront of the James River. This exterior space is considered a great location to begin the enhancements of Newport News because there are many local parks surrounding the site that the VASCIC Facility is situated on. Creating an environment that is both public and obtains private areas tailors to the wants of everyone who may potentially utilize this space. There are multiple pathways and five individual seating areas available, all which incorporate water elements and visually aesthetic luminaires. The idea behind the lighting design was to create an environment where the equipment became part of the landscape. By utilizing glowing spheres in the reflecting pools generates an interesting environment to sit in. Also, square pathway luminaires were chosen to imitate “stepping stones” along the pathway to the water. The luminaires are able to hold the weight of a human while illuminating the landscape you walk on. Additionally, landscaping is placed throughout the site to create enclosed spaces while being in the open-ness of the outdoors. These taller elements are illuminated using LED spot lights also contributing to vertical illuminance throughout.

The lighting design for the space adequately complies with IESNA recommendations in addition to lighting power densities from ASHRAE Standard 90.1-2007. It properly tailors to the needs of the space as well as providing a visually interesting environment for the occupant. The lighting design also contributes to the aesthetic of the landscaping by becoming elements within the space.

ACOUSTICAL BREADTH | ACRYLIC CEILING REDESIGN

INTRODUCTION:

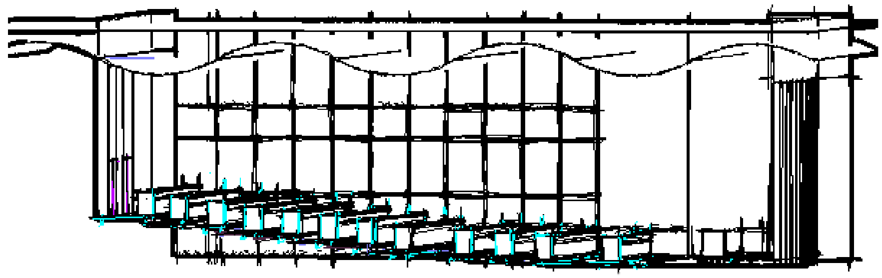


Figure 5.1: Auditorium 3D section

The auditorium is located on the second floor of the Laboratory Wing and seats 180 people in twelve rows occupying 7500 sq. ft. This space is mainly used for meeting situations utilizing a podium speaker and projection screen environment. To enhance to aesthetics of the space, a new ceiling was designed to imitate a wave form. However, the existing ceiling installed is a 2'x4' acoustical ceiling tile system. After redesigning the ceiling, an acrylic material was chosen. This new design could potentially cause problems.

PROBLEM:

Figure 5.2: Auditorium Ceiling System

Because the ceiling ungulates in form in order to imitate a wave of water, echoing may occur due to sound reverberating off the different ceiling heights throughout the space. In addition to the shape of the ceiling, the material change can have a large effect on the reverberation time of sound. Both of these considerations could potentially destroy an aesthetically pleasing space by not being a functional space. Therefore, these problems must be addressed in order to plausibly design the new ceiling in such a way.

In order to analyze the new ceiling, the following equations were used to calculate reverberation time. The acceptable range for reverberation time is between 1.4 seconds and 1.9 seconds.

$\mathrm{T\ (seconds)} = (0.05)(\frac{\mathrm{V}}{\mathrm{a}})$, where "T" is the reverberation time, "V" is the volume of the entire space, and "a" is the square foot area of absorption material.

$\mathrm{a(sabins)} = \sum \mathrm{S}\alpha$, where "α" is the absorption value for each material in the space and "S" is the surface area of that material.

The following table provides the total room volume, the materials considered, their surface area, as well as their absorption value for sound waves at 500 Hz and 1000 Hz. For the reverberation time calculation, "a" will be taken as an average of values at 500 Hz and 1000 Hz to acquire a value in a mid-frequency range.

	Volume: 94259.84 ft^3			
Location	Material	α 500 Hz	α 1000 Hz	Surface Area (sq ft.)
existing ceiling	ACT 3/4" suspension hang	0.83	0.99	27590.8
new ceiling	Actrylic 3/4" suspension hang	0.04	0.03	40187.2
walls	GWB 1/2" thick	0.08	0.04	4287.86
windows	Glass 1" thick pane	0.18	0.12	927.81
doors	wood 1/4" thick paneling with airspace	0.10	0.08	103.56
furniture	wooden chairs	0.22	0.39	per unit
furniture	wooden desks	0.75	0.86	per unit
audience	in upholstered seating	0.8	0.94	per unit

SOLUTION:

The following calculations prove the new acrylic material is not an acceptable material for the auditorium ceiling redesign. However, adding acoustical panels to the east interior wall, the reverberation time is within the acceptable range for the space in question.

	New		Old: medium weight	
Sound Absorption Material	a_{500}	a_{1000}	a_{500}	a_{1000}
Light Weight	1297.03	1423.35	1900.51	3085.96
Heavy Weight	1519.84	1705.19		

$T_{existing}$ = (0.05)(V)/(α_{MW}) = 1.8 seconds → T must be between 1.4 seconds and 1.9 seconds: acceptable

T_{new} = (0.05)(V)/(α_{LW}) = 3.5 seconds → T must be between 1.4 seconds and 1.9 seconds: not acceptable

T_{new} = (0.05)(V)/(α_{HW}) = 2.9 seconds → T must be between 1.4 seconds and 1.9 seconds: not acceptable

$T_{sound\ material}$ = (0.05)(V)/(α_{HW}) = 1.7 seconds → T must be between 1.4 seconds and 1.9 seconds: acceptable

CONCLUSION:

In order to reduce the reverberation time of the new acrylic material, the existing acoustical paneling on the south rear wall must be changed to a heavy weight wall covering as well as the addition of more heavy weight wall coverings along the east interior wall. The wall coverings are available in the same color as the paint within the space to the visibility of the wall panels will be reduced and not affect the aesthetics of the space.

ELECTRICAL DEPTH

INTRODUCTION:

As a result of the new lighting design reducing electrical lighting loads throughout the building, consequently the electrical equipment will need to be redesigned to better fit the system. The spaces in throughout the building that were redesigned include the main lobby and staircase, the fourth floor open office located in the Technology Tower, the multi-purpose auditorium on the second floor of the Laboratory Wing, and a newly designed exterior space located between the VASCIC facility and the waterfront promenade.

The electrical equipment that will be considered for resizing is the lighting panelboards and perspective feeders for each space. In addition, voltage drop calculations, short circuit calculations, and a protection device coordination study will be performed. If necessary, electrical feeders will be resized per results of the calculations.

Two other breadth studies will include the design of a motor control center located in the large electrical room of the Laboratory Wing and a cost analysis study of busduct verses conduit and feeders in the Laboratory Wing.

The following table provides a breakdown of which panels will be affected in each space to be redesigned:

PANELBOARDS						
PANEL TAG	VOLTAGE	SYSTEM	AUDITORIUM	OFFICE	LOBBY	EXTERIOR
LLA	208Y/120, 3P, 4W	N	X			
EDHB	480Y/277, 3P, 4W	N/E	X			
H2A	480Y/277, 3P, 4W	N		X		
EH4A	480Y/277, 3P, 4W	N/E		X		
LGB	208Y/120, 3P, 4W	N			X	
EH4A	480Y/277, 3P, 4W	N/E			X	
HGA	480Y/277, 3P, 4W	N				X

CIRCULATION SPACE | LOBBY ATRIUM

SPACE DESCRIPTION:

The main lobby and staircase is located on the ground floor of the Office Tower occupying approximately 2981 sq. ft. Because of a high water table and floor plane, the reception desk, security, elevators and stairs are the only assets to this space. The reception desk is the main focal point when you walk through the main entrance of the lobby, followed by the grand staircase rising overhead of the desk. The lobby is enclosed in a curtain wall system with reflecting pools surrounding the exterior of the lobby only permitting you to follow certain pathways to the entrances.

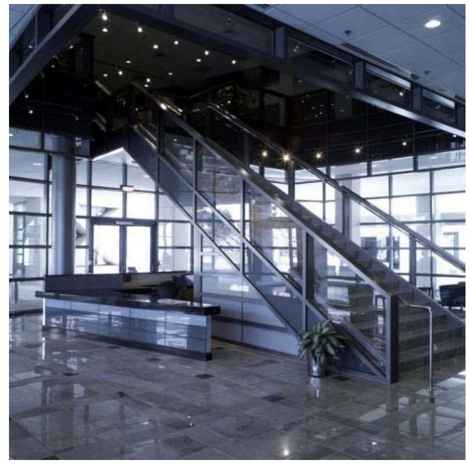


Figure 6.1: Existing Lobby

LIGHTING DESIGN:

The redesigned lighting in the lobby space is tailored towards the design concepts discussed in the Lighting Depth of this report. The main design goal is to illuminate key elements adequately while trying to utilizing more energy efficient fixtures and sources. Throughout the lobby, the entire space is illuminated using LED sources with high color rendering indices and highly efficient luminaires to produce the best environment possible.

Four fixture types are utilized in the lobby in order to create the environment desired. Downlights are evenly spaced throughout the circulation space to illuminate the horizontal surface. Square wall washers highlight the vertical columns emphasizing the vertical element in the space. In addition to the square wall washers, linear recessed wall washers in the ceiling illuminate the central column walls and elevator location for ease of navigation of the occupant. Integrated lighting in the handrail system of the main staircase illuminates the pathway to the upper floors. Lastly, the reception desk utilizes task lighting mounted to the underside of the counter concealing the fixture while illuminating the task surface.

ELECTRICAL DESIGN OBJECTIVES:

The lobby redesign with LED sources is intended to reduce the load on the panelboards and, as a result, the feeder sizes. The lighting loads will remain on the same panelboard, however some existing circuits may not be used used as a consequence of the new lighting design.

CONTROLS:

The lighting design in the lobby space is controlled by three one-way switches located at the reception desk.

EXISTING PANELBOARD SCHEDULES:

The following are the existing panelboard schedules for panel LGB (208Y/120V) and normal-emergency panel EH4A (480Y/277V). The modified circuits are highlighted in pink.

PANELBOARD LGB SCHEDULE

100 AMP BUS 100 AMP MCB 208Y/120 VOLTS 3 PH, 4 W, SN, MIN. 10 KAIC SURFACE MOUNTED

LOAD SERVED	LOAD (AMPS) A	B	C	BKR. TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
RECEPTACLES	7.5			20	12	1	2	12	20	10.0			TRACK LIGHTING XFMR
RECEPTACLES		4.5		20	12	3	4	12	20		10.0		TRACK LIGHTING XFMR
RECEPTACLES			6.0	20	12	5	6	12	20			10.0	TRACK LIGHTING XFMR
RECEPTACLES	6.0			20	12	7	8	12	20	10.0			TRACK LIGHTING XFMR
CCTV CAMERA REC		5.0		20	12	9	10	12	20		10.0		TRACK LIGHTING XFMR
CCTV CAMERA REC			5.0	20	12	11	12	12	20			10.0	TRACK LIGHTING XFMR
CCTV MULTIPLEX, PWR	2.0			20	12	13	14	12	20	3.0			LIGHTS - ELEV. PIT
SPARE				20		15	16		20				SPARE
SPARE				20		17	18		20				SPARE
SPARE				20		19	20		20				SPARE
SPARE				20		21	22		20				SPARE
SPARE				20		23	24		20				SPARE
TOTAL	15.5	9.5	11.0							23.0	20.0	20.0	TOTAL

TOTAL CONNECTED AMPS A: 38.5 B: 29.5 C: 31.0

PANELBOARD EH4A SCHEDULE

100 AMP BUS 70 AMP MCB 480Y/277 VOLTS 3 PH, 4 W, SN, MIN. 14 KAIC SURFACE MOUNTED

LOAD SERVED	LOAD (AMPS) A	B	C	BKR. TRIP	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
LIGHTING - 1ST FLR	9.5			20	12	1	2	12	20	5.0			LIGHTING - 4TH FLOOR
LIGHTING - 1ST FLR		3.0		20	12	3	4	12	20		5.0		LIGHTING - 5TH FLOOR
ENCL CB FOR FACP			6.3	20	12	5	6	12	20			5.0	LIGHTING - 6TH FLOOR
VIA 3 KVA XFMR	6.3						8	12	20				STAIRWELL LIGHTING
LIGHTING - 2ND FLOOR		5.0		20	12	9	10	12	20				STAIRWELL LIGHTING
LIGHTING - 3RD FLOOR			5.0	20	12	11	12		20				SPARE
SPARE				20		13	14		20				SPARE
SPARE				20		15	16		20				SPARE
SPARE				20		17	18		20				SPARE
TOTAL	15.8	8.0	11.3							5.0	5.0	5.0	TOTAL

TOTAL CONNECTED AMPS A: 20.8 B: 13.0 C: 16.3

PANELBOARD REDESIGN:

Below are the redesigned panel boards and their corresponding panelboard sizing worksheet. The modified circuits are highlighted in pink.

PANELBOARD SCHEDULE												
VOLTAGE:	208Y/120V,3PH,4W			PANEL TAG:	LGB					MIN. C/B AIC:	10K	
SIZE/TYPE BUS:	100A			PANEL LOCATION:	Elec. Rm 104					OPTIONS:		
SIZE/TYPE MAIN:	60A/3P C/B			PANEL MOUNTING:	SURFACE							
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Receptacles	Rec. Desk	2565	20A/1P	1	*			2	20A/1P	1344	Lobby	New Lighting
Receptacles	Rec. Desk	1539	20A/1P	3		*		4	20A/1P	1116	Lobby	New Lighting
Receptacles	Lobby	2052	20A/1P	5			*	6	20A/1P	0	Rm 100	Track Lighting XFMR
Receptacles	Maintenance Closets	2052	20A/1P	7	*			8	20A/1P	0	Rm 100	Track Lighting XFMR
Receptacles CCTV	Outside Lobby	1710	20A/1P	9		*		10	20A/1P	0	Rm 100	Track Lighting XFMR
Receptacles CCTV	Outside Lobby	1710	20A/1P	11			*	12	20A/1P	0	Rm 100	Track Lighting XFMR
CCTV Camera Rec	Rm 104	684	20A/1P	13	*			14	20A/1P	1026	Elev 1-3	Lighting Elev Pit
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		
CONNECTED LOAD (KW) - A Ph.		7.67								TOTAL DESIGN LOAD (KW)		18.96
CONNECTED LOAD (KW) - B Ph.		4.37								POWER FACTOR		0.94
CONNECTED LOAD (KW) - C Ph.		3.76								TOTAL DESIGN LOAD (AMPS)		56

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------------->	LGB	Panel Location:	Elec. Rm 104
Nominal Phase to Neutral Voltage------->	120	Phase:	3
Nominal Phase to Phase Voltage-------->	208	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	Receptacles	1	Rec. Desk	2565	w	0.95	2565	2700	
2	A	Track Lighting XFMR	3	Rm 100	1344	w	0.90	1344	1493	nstalled above ceilin
3	B	Receptacles	1	Rec. Desk	1539	w	0.95	1539	1620	
4	B	Track Lighting XFMR	3	Rm 100	1116	w	0.90	1116	1240	nstalled above ceilin
5	C	Receptacles	1	Lobby	2052	w	0.95	2052	2160	
6	C	Track Lighting XFMR	3	Rm 100	0	w	0.95	0	0	nstalled above ceilin
7	A	Receptacles	1	Maintenance Closets	2052	w	0.95	2052	2160	
8	A	Track Lighting XFMR	3	Rm 100	0	w	0.95	0	0	nstalled above ceilin
9	B	Receptacles CCTV	1	Outside Lobby	1710	w	0.95	1710	1800	
10	B	Track Lighting XFMR	3	Rm 100	0	w	0.95	0	0	nstalled above ceilin
11	C	Receptacles CCTV	1	Outside Lobby	1710	w	0.95	1710	1800	
12	C	Track Lighting XFMR	3	Rm 100	0	w	0.95	0	0	nstalled above ceilin
13	A	CCTV Camera Rec	9	Rm 104	684	w	0.95	684	720	
14	A	Lighting Elev Pit	5	Elev 1-3	1026	w	1.00	1026	1026	
15	B	SPARE			0	w		0	0	
16	B	SPARE			0	w		0	0	
17	C	SPARE			0	w		0	0	
18	C	SPARE			0	w		0	0	
19	A	SPARE			0	w		0	0	
20	A	SPARE			0	w		0	0	
21	B	SPARE			0	w		0	0	
22	B	SPARE			0	w		0	0	
23	C	SPARE			0	w		0	0	
24	C	SPARE			0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								15.8	16.7	Amps= 46.4

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	7.7	8.1	48%	67.5
PHASE TOTAL	B	4.4	4.7	28%	38.8
PHASE TOTAL	C	3.8	4.0	24%	33.0

LOAD CATAGORIES			Connected			Demand				
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		11.6	12.2		11.6	12.2	0.95		
3	lighting		2.5	2.7		2.5	2.7	0.90		
5	incandescent lighting		1.0	1.0		1.0	1.0	1.00		
9	unassigned		0.7	0.7		0.7	0.7	0.95		
Total Demand Loads						15.8	16.7			
Spare Capacity			20%			3.2	3.3			
Total Design Loads						19.0	20.1	0.94	Amps=	55.7

PANELBOARD SCHEDULE					
VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	EH4A	MIN. C/B AIC:	14K
SIZE/TYPE BUS:	100A	PANEL LOCATION:	Elec. Rm 510	OPTIONS:	
SIZE/TYPE MAIN:	60A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting 1st Floor	1st Floor	360	20A/1P	1	*			2	20A/1P	1385	4th Floor	Lighting 4th Floor
Lighting 1st Floor	1st Floor	0	20A/1P	3		*		4	20A/1P	1385	5th Floor	Lighting 5th Floor
Encl CB for FACP	Rm 103	1745	20A/2P	5			*	6	20A/1P	4155	6th Floor	Lighting 6th Floor
Encl CB for FACP	Rm 103	1745	20A/2P	7	*			8	20A/1P	0	2-704	Stairwell Lighting
Lighting 2nd Floor	2nd Floor	1385	20A/1P	9		*		10	20A/1P	0	2-726	Stairwell Lighting
Lighting 3rd Floor	3rd Floor	1316	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	3.49	TOTAL DESIGN LOAD (KW)	16.17
CONNECTED LOAD (KW) - B Ph.	2.77	POWER FACTOR	0.98
CONNECTED LOAD (KW) - C Ph.	7.22	TOTAL DESIGN LOAD (AMPS)	20

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	EH4A	Panel Location:	Elec. Rm 510
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	Lighting 1st Floor	3	1st Floor	359.8	w	0.85	360	423	
2	A	Lighting 4th Floor	3	4th Floor	1385	w	1.00	1385	1385	
3	B	Lighting 1st Floor	3	1st Floor	0	w	0.85	0	0	
4	B	Lighting 5th Floor	3	5th Floor	1385	w	1.00	1385	1385	
5	C	Encl CB for FACP	9	Rm 103	1745	w	1.00	1745	1745	
6	C	Lighting 6th Floor	3	6th Floor	4155	w	1.00	4155	4155	
7	A	Encl CB for FACP	9	Rm 103	1745	w	1.00	1745	1745	
8	A	Stairwell Lighting	3	2-704	0	w	1.00	0	0	
9	B	Lighting 2nd Floor	3	2nd Floor	1385	w	1.00	1385	1385	
10	B	Stairwell Lighting	3	2-726	0	w	1.00	0	0	
11	C	Lighting 3rd Floor	3	3rd Floor	218	w	0.85	218	256	
12	C	SPARE			0	w		0	0	
13	A	SPARE			0	w		0	0	
14	A	SPARE			0	w		0	0	
15	B	SPARE			0	w		0	0	
16	B	SPARE			0	w		0	0	
17	C	SPARE			0	w		0	0	
18	C	SPARE			0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								12.4	12.5	Amps= 15.0

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					3.5	3.6	28%	12.8
PHASE TOTAL	B					2.8	2.8	22%	10.0
PHASE TOTAL	C					6.1	6.2	49%	22.2

LOAD CATAGORIES		Connected			Demand				Ver. 1.04
		kW	kVA	DF	kW	kVA	PF		
3	fluorescent lighting	8.9	9.0		8.9	9.0	0.99		
9	unassigned	3.5	3.5		3.5	3.5	1.00		
Total Demand Loads					12.4	12.5			
Spare Capacity		20%			2.5	2.5			
Total Design Loads					14.9	15.0	0.99	Amps=	18.0

FEEDER SIZING:

The data for the summary table below are from the redesigned panelboards LGB and EH4A. The sizing is referenced from the NEC handbook.

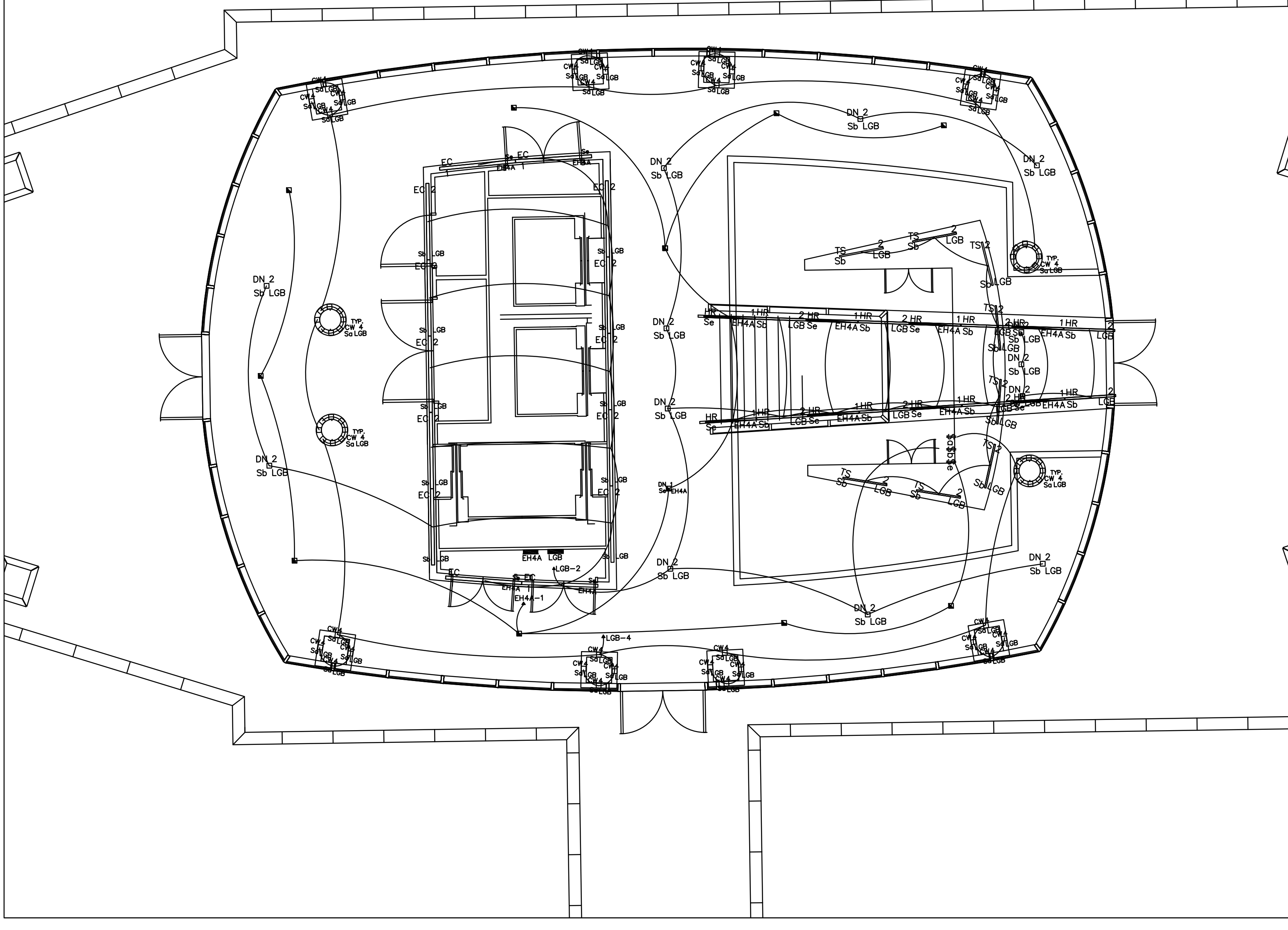
PANELBOARD		
TAG		LGB
VOLTAGE SYSTEM		208Y/120V
CALCULATED DESIGN LOAD (kW)		18.96
CALCULATED POWER FACTOR		0.95
CALCULATED DESIGN LOAD (kVA)		20.1
CALCULATED DESIGN LOAD (A)		55.0
FEEDER		
FEEDER PROTECTION SIZE		60
NUMBER OF SETS		1
WIRE SIZE		
	PHASE	(3) #6 AWG
	NEUTRAL	(1) #6 AWG
	GROUND	(1) #10 AWG
WIRE AREA		
	EACH PHASE	0.0507
	TOTAL - ALL PHASES	0.1521
	NEUTRAL	0.0507
	GROUND	0.0211
	TOTAL - ALL WIRES	0.2239
MINIMUM CONDUIT AREA		0.5598
CONDUIT SIZE		1" EMT
CONDUIT SIZE		1-1/4" EMT
FEEDER LENGTH		17’-6”
FINAL VOLTAGE DROP (V)		119.5V
FINAL VOLTAGE DROP (%)		0.4%
WAS FEEDER RESIZED?		NO

NOTE: *Wire sized for copper THHN at 75˚C

PANELBOARD		
TAG		EH4A
VOLTAGE SYSTEM		480Y/277V
CALCULATED DESIGN LOAD (kW)		14.9
CALCULATED POWER FACTOR		0.99
CALCULATED DESIGN LOAD (kVA)		15.0
CALCULATED DESIGN LOAD (A)		18.0
FEEDER		
FEEDER PROTECTION SIZE		60A
NUMBER OF SETS		1
WIRE SIZE		
	PHASE	(3) #12
	NEUTRAL	(1) #12
	GROUND	(1) #10
WIRE AREA		
	EACH PHASE	0.0133
	TOTAL - ALL PHASES	0.0399
	NEUTRAL	0.0133
	GROUND	0.0211
	TOTAL - ALL WIRES	0.0742
MINIMUM CONDUIT AREA		0.1855
CONDUIT SIZE		1/2" EMT
CONDUIT SIZE		3/4" EMT
FEEDER LENGTH		50’-4”
FINAL VOLTAGE DROP (V)		275.2V
FINAL VOLTAGE DROP (%)		.6%
WAS FEEDER RESIZED?		NO

NOTE: *Wire sized for copper THHN at 75˚C

WIRING DIAGRAM:



KEYNOTES

VIRGINIA ADVANCED SHIPBUILDING AND CARRIER INTEGRATION CENTER
2401 W. AVENUS
NEWPORT NEWS, VA
23607

DRAWN BY: ALYSON LARIMER

PENN STATE AE SENIOR THESIS

ELECTRICAL CONSULTANT: PROF. TED DANNERTH

TITLE: LOBBY WIRING DIAGRAM

DATE: 7-APRIL-2011
SCALE: 1/8" = 1'-0"

N

E1-1

LARGE WORK SPACE | OPEN OFFICE

SPACE DESCTIRTION:

The Office Tower is comprised of 8 floors occupying 12,752 square feet, intended for coordination within new technology research. Floors three through seven utilize an open floor plan for workstation placement. The third floor will be the focus for the workspace requirement. Each floor can hold up to 80 work stations all having a clear view to the exterior due to the Office Tower being enclosed by a curtain wall system of fritted glasses. The office spaces utilize a task-ambient lighting approach to improve the comfort and production level of each employee. By illuminating the ceiling and vertical elements throughout the space produces an open-feeling environment. Additionally, integrated dimming controls at each workstation as well as daylight harvesting throughout the space are utilized.

Figure 7.1: Existing Open Office

LIGHTING DESIGN:

The redesign of the lighting in the open office is intended to adequately illuminate the task surface as well as highlighting the ceiling for ambient lighting. The primary design goal of the space is to illuminate the task surface from a task- ambient approach without hanging fixtures from the ceiling plane. By doing this, the ceiling is uninterrupted by objects but illuminated at the same time. This fixture utilizes an upward and downward component with a single T5 linear fluorescent source that is personally controllable to each occupant. The task-ambient fixtures are mounted to each cubicle on adjacent walls providing proper illumination on the task surface. In addition to the task- ambient lighting, LED wall sconces are mounted on the column walls located around the interior corridor of the Technology Tower.

ELECTRICAL DESIGN OBJECTIVES:

The open office is redesigned with LED and linear fluorescent sources intended to reduce the load on the panelboards and, as a result, the feeder sizes. The lighting loads will remain on the same panelboard, however some existing circuits may not be used as a consequence of the new lighting design.

CONTROLS:

Within the open office plan, it is divided into two zones in order to adequately daylight for increased energy savings. The luminaires chosen for the space offer an integrated wireless hub, Tambient Control Hub that communicates with the photosensors via EnOcean wireless technology throughout the space. Occupancy sensors are also located within the office space that is also a wireless control communicating with the Tambient

Control Hub. Each photosensor and occupancy sensor is capable of communicating with more than one hub due to their coverage range of 98.5'. The control hub has five ports located on the backside and is a plug-and-play module mounted to the underside of a workstation. Generally, the hub can control up to 50 dimming ballasts, however since there are only 5 ports, it is easiest to control 5 luminaires. Each Tambient Control Hub acts as a zone and controls the connected luminaires in unison. In addition, multiple hubs can also be networked together in order to control an entire floor plan as one zone if desired. The photosensors are wireless sensors with dual solar cells within the module and are placed on the ceiling within the daylight zone. Zone 1 controls the first two rows of workstations closest to the windows, which will be affected by daylight most frequently. Zone 2 will be electric light only containing the remaining two rows of workstations closest to the interior corridor. Because the contour of the building façade is a curve, it is best not to network all the Tambient Control Hubs together due to the path of the sun with respect to the shape of the building. Instead, two control hubs adjacent to one another will be networked together creating three uniformly operated zones along the glass façade.

EXISTING PANELBOARD SCHEDULES:

The following are the existing panelboard schedules for panel H2A (480Y/277V) and normal-emergency panel EH4A (480Y/277V). The modified circuits are highlighted in green.

PANELBOARD H2A SCHEDULE

225 AMP BUS 200 AMP MCB 480Y/277 VOLTS 3 PH, 4 W, SN, MIN. 35 KAIC SURFACE MOUNTED

LOAD SERVED	LOAD (AMPS) A	B	C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	B	C	LOAD SERVED
PANELS L2A1 & L2A2	46.4			80	4	1		2	4	80	52.6			PANELS L2B1 & L2B2
VIA		51.9										49.9		VIA
DT TRANSFORMER			45.6										45.2	DT TRANSFORMER
LIGHTING	15.0			20	12	7		8	12	20	8.9			VAV UNIT
LIGHTING		9.0		20	12	9		10	12	20		9.4		VAV UNIT
LIGHTING			9.0	20	12	11		12	12	20			7.4	VAV UNIT
LIGHTING	12.0			20	12	13		14	12	20	5.9			VAV UNIT
LIGHTING		9.0		20	12	15		16	12	20		6.9		VAV UNIT
LIGHTING			9.0	20	12	17		18	12	20			6.3	VAV UNIT
SPARE				20		19		20	12	20	4.8			VAV UNIT
SPARE				20		21		22	12	20		7.4		VAV UNIT
SPARE				20		23		24		20				SPARE
SPARE				20		25		26		20				SPARE
SPARE				20		27		28		20				SPARE
SPARE				20		29		30		20				SPARE
SPARE				20		31		32		20				SPARE
SPARE				20		33		34		20				SPARE
SPARE				20		35		36		20				SPARE
SPACE						37		38						SPACE
SPACE						39		40						SPACE
SPACE						41		42						SPACE
TOTAL	73.4	69.9	63.6								72.2	73.6	58.9	TOTAL

TOTAL CONNECTED AMPS A: 145.6 B: 143.5 C: 122.5

PANELBOARD EH4A SCHEDULE

100 AMP BUS 70 AMP MCB 480Y/277 VOLTS 3 PH, 4 W, SN, MIN. 14 KAIC SURFACE MOUNTED

LOAD SERVED	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	LOAD SERVED
LIGHTING - 1ST FLR	9.5			20	12	1		2	12	20	5.0			LIGHTING - 4TH FLOOR
LIGHTING - 1ST FLR		3.0		20	12	3		4	12	20		5.0		LIGHTING - 5TH FLOOR
ENCL CB FOR FACP			6.3	20	12	5		6	12	20			5.0	LIGHTING - 6TH FLOOR
VIA 3 KVA XFMR	6.3							8	12	20				STAIRWELL LIGHTING
LIGHTING - 2ND FLOOR		5.0		20	12	9		10	12	20				STAIRWELL LIGHTING
LIGHTING - 3RD FLOOR			5.0	20	12	11		12		20				SPARE
SPARE				20		13		14		20				SPARE
SPARE	K27			20		15		16		20				SPARE
SPARE				20		17		18		20				SPARE
		K28								K27				
TOTAL	15.8	8.0	11.3								5.0	5.0	5.0	TOTAL
		TOTAL CONNECTED AMPS					A: 20.8	B: 13.0				C: 16.3		

PANELBOARD REDESIGN:

Below are the redesigned panel boards and their corresponding panelboard sizing worksheet. The modified circuits are highlighted in green.

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	H2A	MIN. C/B AIC:	35K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	Elec. Rm 310	OPTIONS:	
SIZE/TYPE MAIN:	200A/3P C/B	PANEL MOUNTING:	SURFACE		

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Panel L2A1 & L2A2	Rm 307	11567	80A/1P	1	*			2	80A/1P	13113	Rm 325	Panel L2B1 & L2B2
Panel L2A1 & L2A2	Rm 307	12939	80A/1P	3		*		4	80A/1P	12440	Rm 325	Panel L2B1 & L2B2
Panel L2A1 & L2A2	Rm 307	11369	80A/1P	5			*	6	80A/1P	11268	Rm 325	Panel L2B1 & L2B2
Lighting	Rm 331	3000	20A/1P	7	*			8	20A/1P	1849	Rm 331	VAV Unit
Lighting	Rm 331	3000	20A/1P	9		*		10	20A/1P	1953	Rm 331	VAV Unit
Lighting		0	20A/1P	11			*	12	20A/1P	1537	Rm 308	VAV Unit
Lighting		0	20A/1P	13	*			14	20A/1P	1226	Rm 332	VAV Unit
Lighting	Rm 332	6000	20A/1P	15		*		16	20A/1P	1433	Rm 312	VAV Unit
Lighting	Rm 332	0	20A/1P	17			*	18	20A/1P	1309	Rm 332	VAV Unit
SPARE		0	20A/1P	19	*			20	20A/1P	997	Rm 332	VAV Unit
SPARE		0	20A/1P	21		*		22	20A/1P	1537	Rm 318	VAV Unit
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPACE		0	20A/1P	37	*			38	20A/1P	0		SPACE
SPACE		0	20A/1P	39		*		40	20A/1P	0		SPACE
SPACE		0	20A/1P	41			*	42	20A/1P	0		SPACE

CONNECTED LOAD (KW) - A Ph.	31.75	TOTAL DESIGN LOAD (KW)	120.67
CONNECTED LOAD (KW) - B Ph.	39.30	POWER FACTOR	0.93
CONNECTED LOAD (KW) - C Ph.	25.48	TOTAL DESIGN LOAD (AMPS)	157

PANELBOARD SIZING WORKSHEET

Panel Tag--------------------------->	H2A	Panel Location:	Elec. Rm 310
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Panel L2A1 & L2A2	9	Rm 307	11567	w	0.95	11567	12176		
2	A	Panel L2B1 & L2B2	9	Rm 325	13113	w	0.95	13113	13803		
3	B	Panel L2A1 & L2A2	9	Rm 307	12939	w	0.95	12939	13620		
4	B	Panel L2B1 & L2B2	9	Rm 325	12440	w	0.95	12440	13095		
5	C	Panel L2A1 & L2A2	9	Rm 307	11369	w	0.95	11369	11967		
6	C	Panel L2B1 & L2B2	9	Rm 325	11268	w	0.95	11268	11861		
7	A	Lighting	3	Rm 331	3000	w	1.00	3000	3000		
8	A	VAV Unit	6	Rm 331	1849	w	0.75	1849	2465		
9	B	Lighting	3	Rm 331	3000	w	1.00	3000	3000		
10	B	VAV Unit	6	Rm 331	1953	w	0.75	1953	2604		
11	C	Lighting	3		0	w	1.00	0	0	NOT USED	
12	C	VAV Unit	6	Rm 308	1537	w	0.75	1537	2049		
13	A	Lighting	3		0	w	1.00	0	0	NOT USED	
14	A	VAV Unit	6	Rm 332	1226	w	0.75	1226	1635		
15	B	Lighting	3	Rm 332	6000	w	1.00	6000	6000	Other Side Office	
16	B	VAV Unit	6	Rm 312	1433	w	0.75	1433	1911		
17	C	Lighting	3	Rm 332		w	1.00	0	0	Other Side Office	
18	C	VAV Unit	6	Rm 332	1309	w	0.75	1309	1745		
19	A	SPARE			0	w		0	0		
20	A	VAV Unit	6	Rm 332	997	w	0.75	997	1329		
21	B	SPARE			0	w		0	0		
22	B	VAV Unit	6	Rm 318	1537	w	0.75	1537	2049		
23	C	SPARE			0	w		0	0		
24	C	SPARE			0	w		0	0		
25	A	SPARE			0	w		0	0		
26	A	SPARE			0	w		0	0		
27	B	SPARE			0	w		0	0		
28	B	SPARE			0	w		0	0		
29	C	SPARE			0	w		0	0		
30	C	SPARE			0	w		0	0		
31	A	SPARE			0	w		0	0		
32	A	SPARE			0	w		0	0		
33	B	SPARE			0	w		0	0		
34	B	SPARE			0	w		0	0		
35	C	SPARE			0	w		0	0		
36	C	SPARE			0	w		0	0		
37	A	SPACE			0	w		0	0		
38	A	SPACE			0	w		0	0		
39	B	SPACE			0	w		0	0		
40	B	SPACE			0	w		0	0		
41	C	SPACE			0	w		0	0		
42	C	SPACE			0	w		0	0		
PANEL TOTAL								96.5	104.3	Amps=	125.5

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	31.8	34.4	33%	124.2
PHASE TOTAL	B	39.3	42.3	41%	152.6
PHASE TOTAL	C	25.5	27.6	26%	99.7

LOAD CATAGORIES		Connected			Demand				Ver. 1.04
		kW	kVA	DF	kW	kVA	PF		
3	fluorescent lighting	12.0	12.0		12.0	12.0	1.00		
6	HVAC fans	11.8	15.8		11.8	15.8	0.75		
9	unassigned	72.7	76.5		72.7	76.5	0.95		
	Total Demand Loads				96.5	104.3			
	Spare Capacity	25%			24.1	26.1			
	Total Design Loads				120.7	130.4	0.93	Amps=	156.9

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	EH4A	MIN. C/B AIC:	14K
SIZE/TYPE BUS:	100A	PANEL LOCATION:	Elec. Rm 510	OPTIONS:	
SIZE/TYPE MAIN:	60A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting 1st Floor	1st Floor	360	20A/1P	1	*			2	20A/1P	1385	4th Floor	Lighting 4th Floor
Lighting 1st Floor	1st Floor	0	20A/1P	3		*		4	20A/1P	1385	5th Floor	Lighting 5th Floor
Encl CB for FACP	Rm 103	1745	20A/2P	5			*	6	20A/1P	4155	6th Floor	Lighting 6th Floor
Encl CB for FACP	Rm 103	1745	20A/2P	7	*			8	20A/1P	0	2-704	Stairwell Lighting
Lighting 2nd Floor	2nd Floor	1385	20A/1P	9		*		10	20A/1P	0	2-726	Stairwell Lighting
Lighting 3rd Floor	3rd Floor	218	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A Ph.	3.49	TOTAL DESIGN LOAD (KW)	14.85
CONNECTED LOAD (KW) - B Ph.	2.77	POWER FACTOR	0.99
CONNECTED LOAD (KW) - C Ph.	6.12	TOTAL DESIGN LOAD (AMPS)	18

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					EH4A	Panel Location:			Elec. Rm 510		
Nominal Phase to Neutral Voltage------->					277	Phase:			3		
Nominal Phase to Phase Voltage-------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Lighting 1st Floor	3	1st Floor	359.8	w	0.85	360	423		
2	A	Lighting 4th Floor	3	4th Floor	1385	w	1.00	1385	1385		
3	B	Lighting 1st Floor	3	1st Floor	0	w	0.85	0	0		
4	B	Lighting 5th Floor	3	5th Floor	1385	w	1.00	1385	1385		
5	C	Encl CB for FACP	9	Rm 103	1745	w	1.00	1745	1745		
6	C	Lighting 6th Floor	3	6th Floor	4155	w	1.00	4155	4155		
7	A	Encl CB for FACP	9	Rm 103	1745	w	1.00	1745	1745		
8	A	Stairwell Lighting	3	2-704	0	w	1.00	0	0		
9	B	Lighting 2nd Floor	3	2nd Floor	1385	w	1.00	1385	1385		
10	B	Stairwell Lighting	3	2-726	0	w	1.00	0	0		
11	C	Lighting 3rd Floor	3	3rd Floor	218	w	0.85	218	256		
12	C	SPARE			0	w		0	0		
13	A	SPARE			0	w		0	0		
14	A	SPARE			0	w		0	0		
15	B	SPARE			0	w		0	0		
16	B	SPARE			0	w		0	0		
17	C	SPARE			0	w		0	0		
18	C	SPARE			0	w		0	0		
19	A				0	w		0	0		
20	A				0	w		0	0		
21	B				0	w		0	0		
22	B				0	w		0	0		
23	C				0	w		0	0		
24	C				0	w		0	0		
25	A				0	w		0	0		
26	A				0	w		0	0		
27	B				0	w		0	0		
28	B				0	w		0	0		
29	C				0	w		0	0		
30	C				0	w		0	0		
31	A				0	w		0	0		
32	A				0	w		0	0		
33	B				0	w		0	0		
34	B				0	w		0	0		
35	C				0	w		0	0		
36	C				0	w		0	0		
37	A				0	w		0	0		
38	A				0	w		0	0		
39	B				0	w		0	0		
40	B				0	w		0	0		
41	C				0	w		0	0		
42	C				0	w		0	0		
PANEL TOTAL								12.4	12.5	Amps=	15.0
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					3.5	3.6	28%	12.8
PHASE TOTAL			B					2.8	2.8	22%	10.0
PHASE TOTAL			C					6.1	6.2	49%	22.2
LOAD CATAGORIES				Connected			Demand				Ver. 1.11
				kW	kVA	DF	kW	kVA	PF		
3	fluorescent lighting			8.9	9.0		8.9	9.0	0.99		
9	unassigned			3.5	3.5		3.5	3.5	1.00		
Total Demand Loads							12.4	12.5			
Spare Capacity				20%			2.5	2.5			
Total Design Loads							14.9	15.0	0.99	Amps=	18.0

FEEDER SIZING:

The data for the summary table below are from the redesigned panelboards H2A and EH4A. The sizing is referenced from the NEC handbook.

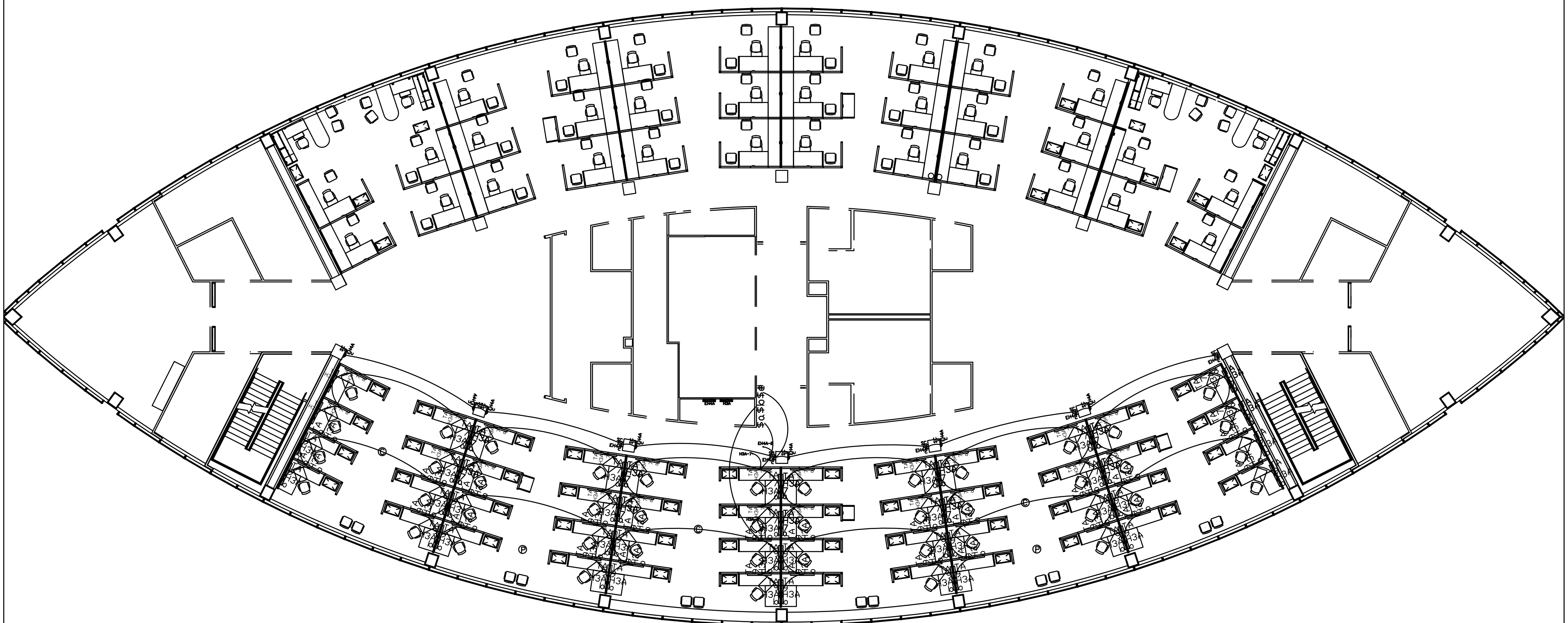
PANELBOARD	
TAG	H2A
VOLTAGE SYSTEM	480Y/277V
CALCULATED DESIGN LOAD (kW)	120.7
CALCULATED POWER FACTOR	0.92
CALCULATED DESIGN LOAD (kVA)	130.4
CALCULATED DESIGN LOAD (A)	156.9
FEEDER	
FEEDER PROTECTION SIZE	225A
NUMBER OF SETS	2
WIRE SIZE	
PHASE	(3) #300 KCMIL
NEUTRAL	(1) #300 KCMIL
GROUND	#4 AWG
WIRE AREA	
EACH PHASE	0.4608
TOTAL - ALL PHASES	1.3824
NEUTRAL	0.4608
GROUND	0.0824
TOTAL - ALL WIRES	1.9256
MINIMUM CONDUIT AREA	4.8140
CONDUIT SIZE	2.5"EMT
CONDUIT SIZE	2.5"EMT
FEEDER LENGTH	15’-4”
FINAL VOLTAGE DROP (V)	0.1V
FINAL VOLTAGE DROP (%)	0.0%
WAS FEEDER RESIZED?	NO

NOTE: *Wire sized for copper THHN at 75˚C

PANELBOARD		
TAG		EH4A
VOLTAGE SYSTEM		480Y/277V
CALCULATED DESIGN LOAD (kW)		14.9
CALCULATED POWER FACTOR		0.99
CALCULATED DESIGN LOAD (kVA)		15.0
CALCULATED DESIGN LOAD (A)		18.0
FEEDER		
FEEDER PROTECTION SIZE		60A
NUMBER OF SETS		1
WIRE SIZE		
	PHASE	(3) #12 AWG
	NEUTRAL	(1) #12 AWG
	GROUND	(1) #10 AWG
WIRE AREA		
	EACH PHASE	0.0133
	TOTAL - ALL PHASES	0.0399
	NEUTRAL	0.0133
	GROUND	0.0211
	TOTAL - ALL WIRES	0.0743
MINIMUM CONDUIT AREA		0.1858
CONDUIT SIZE		1/2" EMT
CONDUIT SIZE		3/4" EMT
FEEDER LENGTH		50’-4”
FINAL VOLTAGE DROP (V)		275.2V
FINAL VOLTAGE DROP (%)		0.6%
WAS FEEDER RESIZED?		NO

NOTE: *Wire sized for copper THHN at 75˚C

WIRING DIAGRAM:



KEY

Ⓒ OCCUPANCY SENSOR

Ⓟ PHOTOSENSOR

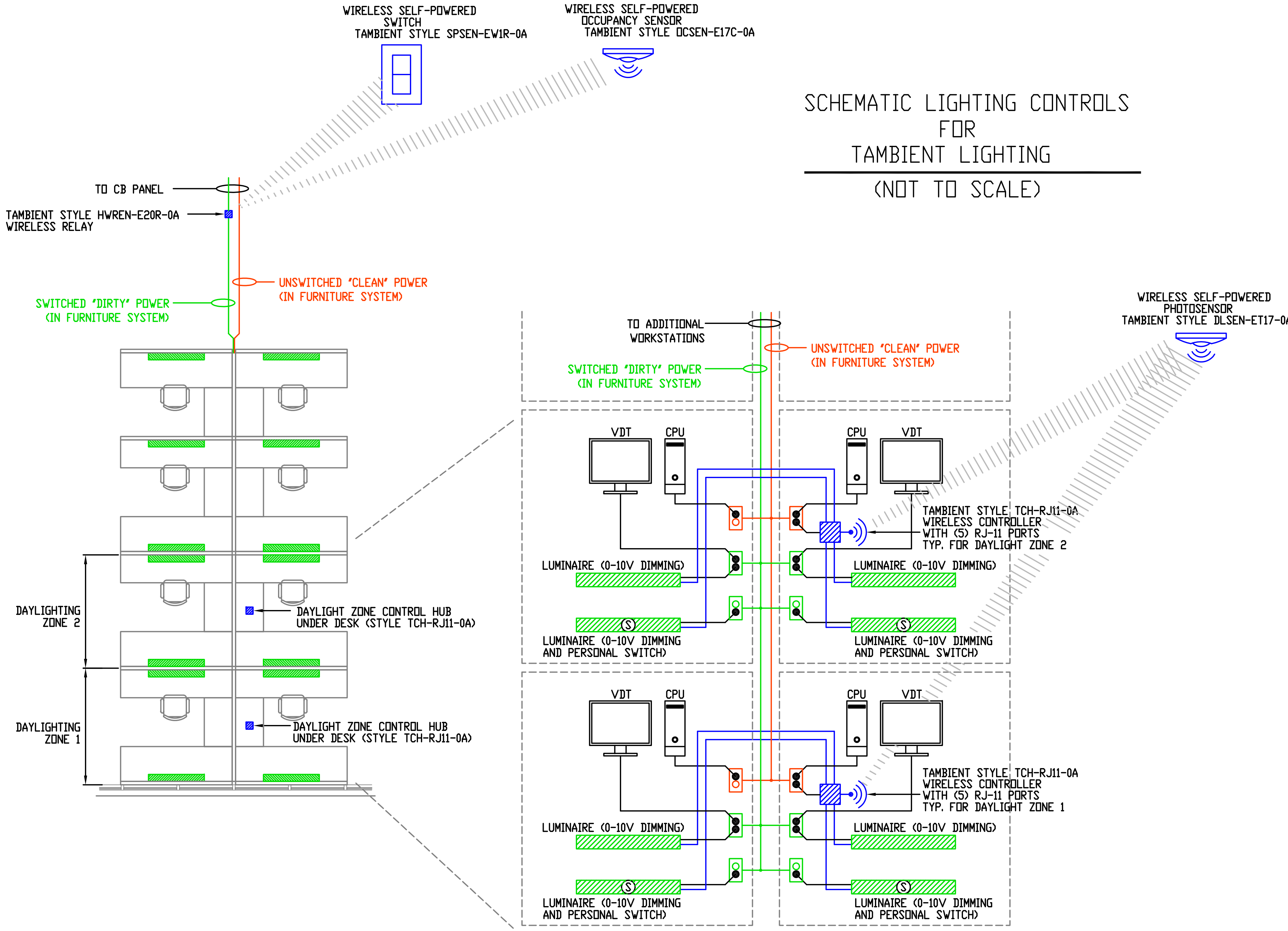
DRAWN BY: ALYSON LARIMER
PENN STATE AE SENIOR THESIS
ELECTRICAL CONSULTANT: PROF. TED DANNERTH
TITLE: OPEN OFFICE WIRING DIAGRAM
DATE: 07–APRIL–2011
SCALE: 1/8" = 1'-0"

1/4" = 1'-0"
1/2" = 1'-0"
1" = 1'-0"

E2-1

SCHEMATIC LIGHTING CONTROLS FOR TAMBIENT LIGHTING

(NOT TO SCALE)



MULTI-PURPOSE SPACE | AUDITORIUM

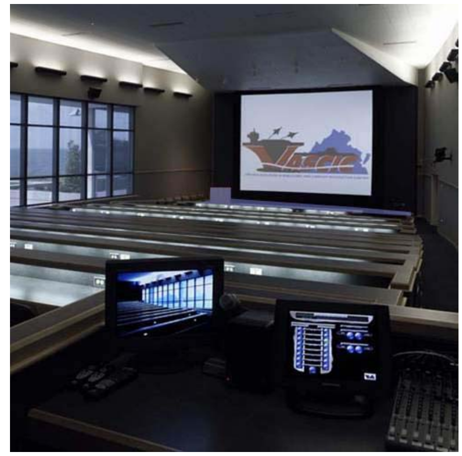


Figure 8.1: Existing Auditorium

SPACE DESCIPTION:

The auditorium is located on the second floor of the Laboratory Wing consisting of 12 rows totaling 180 seats and 7,500 sq. ft. This space is mainly used for meeting situations utilizing podium and presentation style environments. To achieve the desired concept within this space, the ceiling is redesigned with a backlit curved acrylic system covering the entire auditorium. Throughout the space, the sources are all chosen at 3000K color temperature and are linear fluorescents, compact fluorescents, or LEDs.

LIGHTING DESIGN:

The lighting design of the auditorium is centered on the needs of the space. Since the auditorium is used for many different functions, it is important to have a functional lighting design that can tailor to each activity. In addition, a new architectural ceiling is developed for this space. Although it may seem as though the ceiling would be the focal point in the space, it was designed to generate the feeling of water overhead. The ceiling is back light with linear fluorescent strip fixtures either surface mounted at the peak of the “wave” or pendent mounted in the trough of the “wave”. All the ceiling fixtures are mounted 18” above the curved acrylic ceiling. From the ceiling framing hang a track lighting system for stage spotlighting as well as downlighting for added illumination behind the speaker when the presentation screen is not being used. Integrated LED task lighting is mounted under the top counter of the desks for a meeting setting where reading is necessary. Wall mounted cylinders with compact fluorescent lamps are placed above each of the five exit doors in the auditorium and one recessed LED fixture is located in each step riser.

ELECTRICAL DESIGN:

Because the auditorium is considered a multi-purpose space, it is divided into five zones for easy control of lighting scenes within the space. The design goals of the space are to reduce the lighting loads on the designated panelboards of the space while enhancing the visual environment through controllable scene settings. The lighting loads of the auditorium will all remain on the existing panelboards.

CONTROL SCHEME:

There are five zones, which consist of LED step lighting, LED stage and spot lighting, linear fluorescent ceiling lighting, LED task lighting, and compact fluorescent exit door lighting. These five zones are controlled using two Grafik Eye scene controls manufactured by Lutron with integrated shade controllers on normal power and a four-button architectural wallstation on normal-emergency power. The scene controllers will be located at the front entrance next to the stage as well as in the rear of the auditorium next to the sound and maintenance booth.

EXISTING PANELBOARDS:

The following are the existing panelboard schedules for panel LLA (208Y/120V) and normal-emergency panel EDHB (480Y/277V). The modified circuits are highlighted in purple.

PANELBOARD LLA SCHEDULE

225 AMP BUS 225 AMP MLO 208Y/120 VOLTS 3 PH, 4 W, SN, MIN. 10 KAIC SURFACE MOUNTED M2

LOAD SERVED	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	LOAD SERVED
RECEPTACLES	7.5			20	12	1		2	12	20	4.0			SYSTEMS FURNITURE
RECEPTACLES		4.5		20	12	3		4	12	20		2.0		SYSTEMS FURNITURE
RECEPTACLES			6.0	20	12	5		6	12	20			2.0	SYSTEMS FURNITURE
RECEPTACLES	7.5			20	12	7		8	12	20	4.0			SYSTEMS FURNITURE
~~RECEPTACLES~~		~~7.5~~		~~20~~	~~12~~	~~9~~		10	12	20		2.0		SYSTEMS FURNITURE
TRANSFER FANS M1			1.5	20	12	11		12	12	20			4.0	SYSTEMS FURNITURE
~~SPARE~~				~~20~~		~~13~~		14	12	20	2.0			SYSTEMS FURNITURE
RECEPTACLES		6.0		20	12	15		16	12	20		4.0		SYSTEMS FURNITURE
RECEPTACLES			7.5	20	12	17		18	12	20			4.0	SYSTEMS FURNITURE
UNIT HEATER	5.8			15	12	19		20	12	20	2.0			SYSTEMS FURNITURE
FLOOR RECPT		6.0		20	12	21		22	12	20		4.0		SYSTEMS FURNITURE
SPARE				20		23		24	12	20			4.0	SYSTEMS FURNITURE
SPARE				20		25		26	12	20	4.0			SYSTEMS FURNITURE
SPARE				20		27		~~28~~	~~12~~	~~20~~		[illegible]		~~LIGHTING - AUDITORIUM~~
LIGHTING - RM 291			10.0	20	12	29		30	12	20			11.3	LIGHTING - AUDITORIUM
LIGHTING - RM 291	10.0			20	12	31		32	12	20	11.7			LIGHTING - AUDITORIUM
LIGHTING - RM 291		10.0		20	12	33		34	12	20		4.0		SYSTEMS FURNITURE
LIGHTING - RM 291			10.0	20	12	35		~~36~~		~~20~~				~~SPARE~~
SPACE						37		38	10	30	20.0			OVERHEAD DOOR
SPACE						39						20.0		(B AND FL) M3
SPACE						41							20.0	
TOTAL	30.8	34.0	35.0								47.7	45.3	45.3	TOTAL

TOTAL CONNECTED AMPS A: 78.5 B: 79.3 C: 80.3

PANELBOARD REDESIGN:

Below are the redesigned panel boards and their corresponding panelboard sizing worksheet. The modified circuits are highlighted in purple.

PANELBOARDEDHB SCHEDULE

100 AMP BUS 100 AMP MLO 480Y/277 VOLTS 3 PH, 4 W, SN, MIN. 25 KAIC SURFACE MOUNTED

LOAD SERVED	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	LOAD SERVED
LIGHTING - PRK GAR STR	2.4			20	10	1		2	10	30	5.2			PANEL EDLA
LIGHTING - PRK GAR STR		2.4		20	10	3						3.1		VIA 15 KVA XFMR
LIGHTING - PRK GAR			11.2	20	10	5							2.2	
LIGHTING - PRK GAR	10.7			20	10	7		8	12	20	4.3			LIGHTING-AUDITORIUM
						9		10	12	20		10.9		LIGHTING - RM 367
						11		12		20				SPARE
SPACE						13		14						SPACE
SPACE						19		20						SPACE
SPACE						25		26						SPACE
SPACE						31		32						SPACE
SPACE						37		38						SPACE
TOTAL	13.1	2.4	11.2								9.5	14.0	2.2	TOTAL

TOTAL CONNECTED AMPS A: 22.6 B: 16.4 C: 13.4

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W	PANEL TAG: LLA	MIN. C/B AIC: 10K	
SIZE/TYPE BUS: 100A	PANEL LOCATION: Elec. Rm. 367	OPTIONS:	
SIZE/TYPE MAIN: 100A/3P MLO	PANEL MOUNTING: SURFACE		

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Recept.		855	20A/1P	1	*			2	20A/1P	456	Rm 251	Systems Furn.
Recept.	Rm 251	513	20A/1P	3		*		4	20A/1P	228	Rm 251	Systems Furn.
Recept.	Rm 251	684	20A/1P	5			*	6	20A/1P	228	Rm 251	Systems Furn.
Recept.	Rm 251	855	20A/1P	7	*			8	20A/1P	456	Rm 251	Systems Furn.
Recept.	Rm 251	855	20A/1P	9		*		10	20A/1P	228	Rm 251	Systems Furn.
Transfer Fan	Rm 272	153	20A/1P	11			*	12	20A/1P	456	Rm 251	Systems Furn.
SPARE		0	20A/1P	13	*			14	20A/1P	228	Rm 251	Systems Furn.
Recept.	Rm 367	661	20A/1P	15		*		16	20A/1P	456	Rm 251	Systems Furn.
Recept.	Rm 367	855	20A/1P	17			*	18	20A/1P	456	Rm 251	Systems Furn.
Unit Heater	Rm 367	522	15A/1P	19	*			20	20A/1P	228	Rm 251	Systems Furn.
Floor Recept.	Rm 367	684	20A/1P	21		*		22	20A/1P	465	Rm 251	Systems Furn.
SPARE		0	20A/1P	23			*	24	20A/1P	456	Rm 251	Systems Furn.
SPARE		0	20A/1P	25	*			26	20A/1P	456	Rm 251	Systems Furn.
SPARE		0	20A/1P	27		*		28	20A/1P	1869	Rm 250	Auditorium Lighting
Lighting Rm 291	Rm 291	1200	20A/1P	29			*	30	20A/1P	1755	Rm 250	Auditorium Lighting
Lighting Rm 291	Rm 291	1200	20A/1P	31	*			32	20A/1P	361	Rm 250	Auditorium Lighting
Lighting Rm 291	Rm 291	1200	20A/1P	33		*		34	20A/1P	456	Rm 251	Systems Furn.
Lighting Rm 291	Rm 291	1200	20A/1P	35			*	36	20A/1P	0		SPARE
SPACE		0	20A/1P	37	*			38	30A/3P	2280	Rm 277	Overhead Door
SPACE		0	20A/1P	39		*		40	30A/3P	2280	Rm 277	Overhead Door
SPACE		0	20A/1P	41			*	42	30A/3P	2280	Rm 277	Overhead Door

CONNECTED LOAD (KW) - A Ph.	7.90	TOTAL DESIGN LOAD (KW)	33.02
CONNECTED LOAD (KW) - B Ph.	9.90	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C Ph.	9.72	TOTAL DESIGN LOAD (AMPS)	95

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					LLA	Panel Location:			Elec. Rm. 367		
Nominal Phase to Neutral Voltage------->					120	Phase:			3		
Nominal Phase to Phase Voltage-------->					208	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Recept.	1	Rm 251	855	w	0.95	855	900		
2	A	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
3	B	Recept.	1	Rm 251	513	w	0.95	513	540		
4	B	Systems Furn.	1	Rm 251	228	w	0.95	228	240		
5	C	Recept.	1	Rm 251	684	w	0.95	684	720		
6	C	Systems Furn.	1	Rm 251	228	w	0.95	228	240		
7	A	Recept.	1	Rm 251	855	w	0.95	855	900		
8	A	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
9	B	Recept.	1	Rm 251	855	w	0.95	855	900		
10	B	Systems Furn.	1	Rm 251	228	w	0.95	228	240		
11	C	Transfer Fan	6	Rm 272	153	w	0.85	153	180		
12	C	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
13	A	SPARE			0	w		0	0		
14	A	Systems Furn.	1	Rm 251	228	w	0.95	228	240		
15	B	Recept.	1	Rm 367	661	w	0.95	661	696		
16	B	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
17	C	Recept.	1	Rm 367	855	w	0.95	855	900		
18	C	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
19	A	Unit Heater	7	Rm 367	522	w	0.75	522	696		
20	A	Systems Furn.	1	Rm 251	228	w	0.95	228	240		
21	B	Floor Recept.	1	Rm 367	684	w	0.95	684	720		
22	B	Systems Furn.	1	Rm 251	465	w	0.95	465	489		
23	C	SPARE			0	w		0	0		
24	C	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
25	A	SPARE			0	w		0	0		
26	A	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
27	B	SPARE			0	w		0	0		
28	B	Auditorium Lightin	3	Rm 250	1869	w	1.00	1869	1869		
29	C	Lighting Rm 291	3	Rm 291	1200	w	1.00	1200	1200		
30	C	Auditorium Lightin	3	Rm 250	1755	w	1.00	1755	1755	NOT USED	
31	A	Lighting Rm 291	3	Rm 291	1200	w	1.00	1200	1200		
32	A	Auditorium Lightin	3	Rm 250	361	w	1.10	361	328	NOT USED	
33	B	Lighting Rm 291	3	Rm 291	1200	w	1.00	1200	1200		
34	B	Systems Furn.	1	Rm 251	456	w	0.95	456	480		
35	C	Lighting Rm 291	3	Rm 291	1200	w	1.00	1200	1200		
36	C	SPARE			0	w		0	0		
37	A	SPACE			0	w		0	0		
38	A	Overhead Door	9	Rm 277	2280	w	0.95	2280	2400		
39	B	SPACE			0	w		0	0		
40	B	Overhead Door	9	Rm 277	2280	w	0.95	2280	2400		
41	C	SPACE			0	w		0	0		
42	C	Overhead Door	9	Rm 277	2280	w	0.95	2280	2400		
PANEL TOTAL								27.5	28.6	Amps=	79.5
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					7.9	8.3	29%	69.5
PHASE TOTAL			B					9.9	10.3	36%	85.5
PHASE TOTAL			C					9.7	9.9	35%	82.6
LOAD CATAGORIES				Connected			Demand				Ver. 1.11
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			11.2	11.8		11.2	11.8	0.95		
3	lighting			8.8	8.8		8.8	8.8	1.00		
6	HVAC fans			0.2	0.2		0.2	0.2	0.85		
7	heating			0.5	0.7		0.5	0.7	0.75		
9	unassigned			6.8	7.2		6.8	7.2	0.95		
Total Demand Loads							27.5	28.6			
Spare Capacity				20%			5.5	5.7			
Total Design Loads							33.0	34.4	0.96	Amps=	95.4

PANELBOARD SCHEDULE												
VOLTAGE:	480Y/277V,3PH,4W		PANEL TAG:	EDHB					MIN. C/B AIC:	25K		
SIZE/TYPE BUS:	100A		PANEL LOCATION:	Elec. Rm 367					OPTIONS:			
SIZE/TYPE MAIN:	40A/3P MLO		PANEL MOUNTING:	SURFACE								
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting Prk Gar Str	Rm 380	632	20A/1P	1	*			2	30A/3P	4105	Rm 367	Panel EDLA
Lighting Prk Gar Str	Rm 381	632	20A/1P	3		*		4	30A/3P	2447	Rm 367	Panel EDLA
Lighting Prk Gar	3rd Flr Area A	2947	20A/1P	5			*	6	30A/3P	1737	Rm 367	Panel EDLA
Lighting Prk Gar	3rd Flr Area A	2816	20A/1P	7	*			8	20A/1P	880	Rm 250	Lighting Auditorium
		0	20A/1P	9		*		10	20A/1P	2868	Rm 367	Lighting Rm 367
		0	20A/1P	11			*	12	20A/1P	0		SPARE
SPACE		0	20A/1P	13	*			14	20A/1P	0		SPACE
SPACE		0	20A/1P	15		*		16	20A/1P	0		SPACE
SPACE		0	20A/1P	17			*	18	20A/1P	0		SPACE
SPACE		0	20A/1P	19	*			20	20A/1P	0		SPACE
SPACE		0	20A/1P	21		*		22	20A/1P	0		SPACE
SPACE		0	20A/1P	23			*	24	20A/1P	0		SPACE
SPACE		0	20A/1P	25	*			26	20A/1P	0		SPACE
SPACE		0	20A/1P	27		*		28	20A/1P	0		SPACE
SPACE		0	20A/1P	29			*	30	20A/1P	0		SPACE
SPACE		0	20A/1P	31	*			32	20A/1P	0		SPACE
SPACE		0	20A/1P	33		*		34	20A/1P	0		SPACE
SPACE		0	20A/1P	35			*	36	20A/1P	0		SPACE
SPACE		0	20A/1P	37	*			38	20A/1P	0		SPACE
SPACE		0	20A/1P	39		*		40	20A/1P	0		SPACE
SPACE		0	20A/1P	41			*	42	20A/1P	0		SPACE
CONNECTED LOAD (KW) - A Ph.		8.43								TOTAL DESIGN LOAD (KW)		22.88
CONNECTED LOAD (KW) - B Ph.		5.95								POWER FACTOR		0.94
CONNECTED LOAD (KW) - C Ph.		4.68								TOTAL DESIGN LOAD (AMPS)		29

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------------->	EDHB	Panel Location:	Elec. Rm 367
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	Lighting Prk Gar Str	4	Rm 380	632	w	0.95	632	665	
2	A	Panel EDLA	9	Rm 367	4105	w	0.95	4105	4321	
3	B	Lighting Prk Gar Str	4	Rm 381	632	w	0.95	632	665	
4	B	Panel EDLA	9	Rm 367	2447	w	0.95	2447	2576	
5	C	Lighting Prk Gar	4	3rd Flr Area A	2947	w	0.95	2947	3102	
6	C	Panel EDLA	9	Rm 367	1737	w	0.95	1737	1828	
7	A	Lighting Prk Gar	4	3rd Flr Area A	2816	w	0.95	2816	2964	
8	A	Lighting Auditorium	3	Rm 250	880	w	0.82	880	1073	
9	B				0	w		0	0	
10	B	Lighting Rm 367	3	Rm 367	2868	w	0.95	2868	3019	
11	C				0	w		0	0	
12	C	SPARE			0	w		0	0	
13	A	SPACE			0	w		0	0	
14	A	SPACE			0	w		0	0	
15	B	SPACE			0	w		0	0	
16	B	SPACE			0	w		0	0	
17	C	SPACE			0	w		0	0	
18	C	SPACE			0	w		0	0	
19	A	SPACE			0	w		0	0	
20	A	SPACE			0	w		0	0	
21	B	SPACE			0	w		0	0	
22	B	SPACE			0	w		0	0	
23	C	SPACE			0	w		0	0	
24	C	SPACE			0	w		0	0	
25	A	SPACE			0	w		0	0	
26	A	SPACE			0	w		0	0	
27	B	SPACE			0	w		0	0	
28	B	SPACE			0	w		0	0	
29	C	SPACE			0	w		0	0	
30	C	SPACE			0	w		0	0	
31	A	SPACE			0	w		0	0	
32	A	SPACE			0	w		0	0	
33	B	SPACE			0	w		0	0	
34	B	SPACE			0	w		0	0	
35	C	SPACE			0	w		0	0	
36	C	SPACE			0	w		0	0	
37	A	SPACE			0	w		0	0	
38	A	SPACE			0	w		0	0	
39	B	SPACE			0	w		0	0	
40	B	SPACE			0	w		0	0	
41	C	SPACE			0	w		0	0	
42	C	SPACE			0	w		0	0	
PANEL TOTAL								19.1	20.2	Amps= 24.3

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	8.4	9.0	45%	32.6
PHASE TOTAL	B	5.9	6.3	31%	22.6
PHASE TOTAL	C	4.7	4.9	24%	17.8

LOAD CATAGORIES			Connected			Demand				Ver. 1.11
			kW	kVA	DF	kW	kVA	PF		
3	lighting		3.7	4.1		3.7	4.1	0.92		
4	HID lighting		7.0	7.4		7.0	7.4	0.95		
9	unassigned		8.3	8.7		8.3	8.7	0.95		
Total Demand Loads						19.1	20.2			
Spare Capacity			20%			3.8	4.0			
Total Design Loads						22.9	24.3	0.94	Amps=	29.2

FEEDER SIZING:

The data for the summary table below are from the redesigned panelboards LLA and EDHB. The sizing is referenced from the NEC handbook.

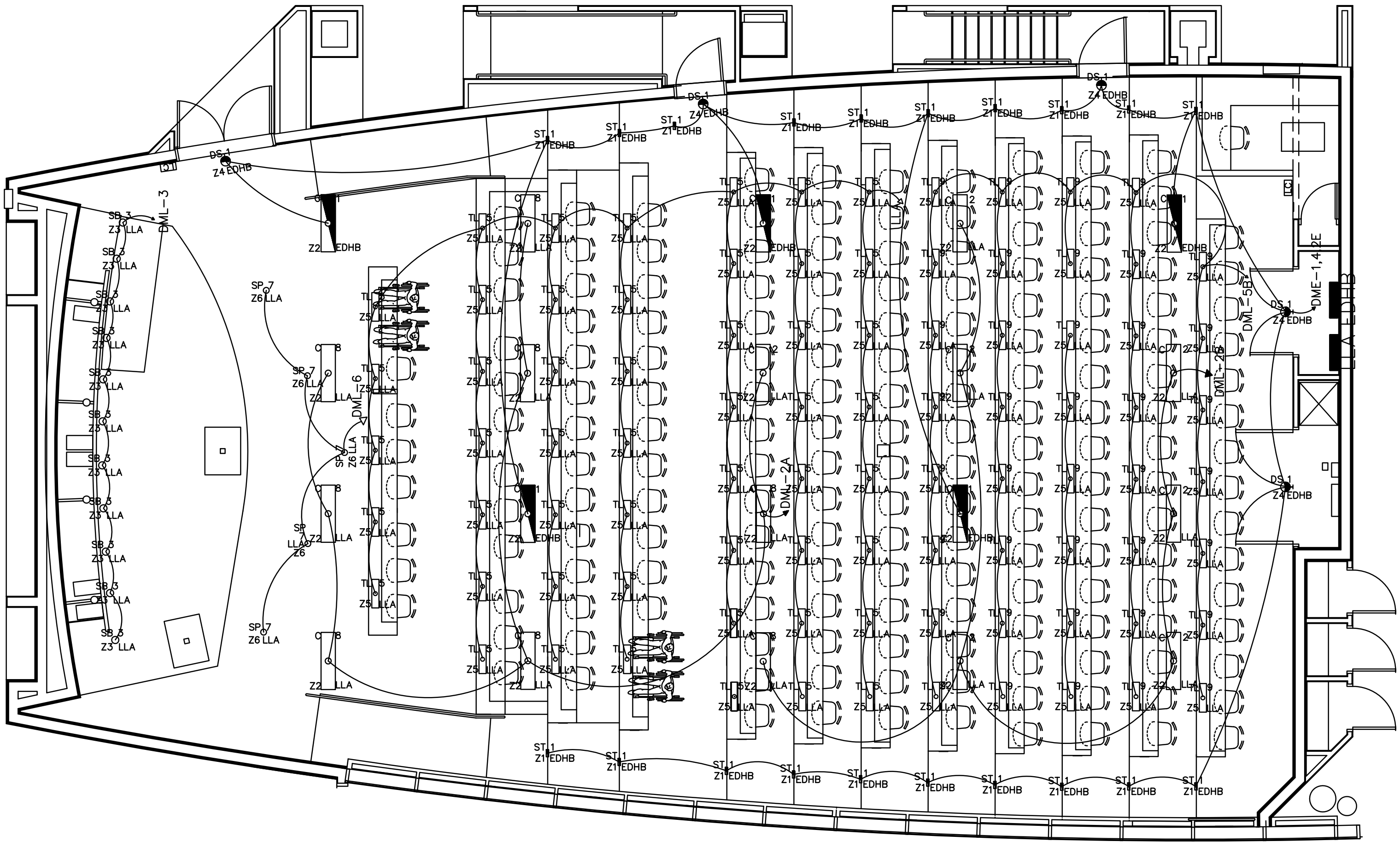
PANELBOARD		
TAG		LLA
VOLTAGE SYSTEM		208Y/120V
CALCULATED DESIGN LOAD (kW)		33.02
CALCULATED POWER FACTOR		0.096
CALCULATED DESIGN LOAD (kVA)		34.4
CALCULATED DESIGN LOAD (A)		95.4
FEEDER		
FEEDER PROTECTION SIZE		100
NUMBER OF SETS		1
WIRE SIZE		
	PHASE	(3) #3 AWG
	NEUTRAL	(1) #3 AWG
	GROUND	(1) #8 AWG
WIRE AREA		
	EACH PHASE	0.0973
	TOTAL - ALL PHASES	0.2919
	NEUTRAL	0.0973
	GROUND	0.0211
	TOTAL - ALL WIRES	0.4103
MINIMUM CONDUIT AREA		1.0258
CONDUIT SIZE		1" EMT
CONDUIT SIZE		1-1/2" EMT
FEEDER LENGTH		2’
FINAL VOLTAGE DROP (V)		0V
FINAL VOLTAGE DROP (%)		0%
WAS FEEDER RESIZED?		NO

NOTE: *Wire sized for copper THHN at 75˚C

PANELBOARD		
TAG		EDHB
VOLTAGE SYSTEM		480Y/277V
CALCULATED DESIGN LOAD (kW)		22.88
CALCULATED POWER FACTOR		0.94
CALCULATED DESIGN LOAD (kVA)		24.3
CALCULATED DESIGN LOAD (A)		29.2
FEEDER		
FEEDER PROTECTION SIZE		40A
NUMBER OF SETS		1
WIRE SIZE		
	PHASE	(3) #10 AWG
	NEUTRAL	(1) #10 AWG
	GROUND	(1) #10 AWG
WIRE AREA		
	EACH PHASE	0.0211
	TOTAL - ALL PHASES	0.0633
	NEUTRAL	0.0211
	GROUND	0.0211
	TOTAL - ALL WIRES	0.1055
MINIMUM CONDUIT AREA		0.2638
CONDUIT SIZE		1/2" EMT
CONDUIT SIZE		3/4" EMT
FEEDER LENGTH		
FINAL VOLTAGE DROP (V)		
FINAL VOLTAGE DROP (%)		
WAS FEEDER RESIZED?		

NOTE: *Wire sized for copper THHN at 75˚C

WIRING DIAGRAM:



KEYNOTES

VIRGINIA ADVANCED SHIPBUILDING AND CARRIER INTEGRATION CENTER

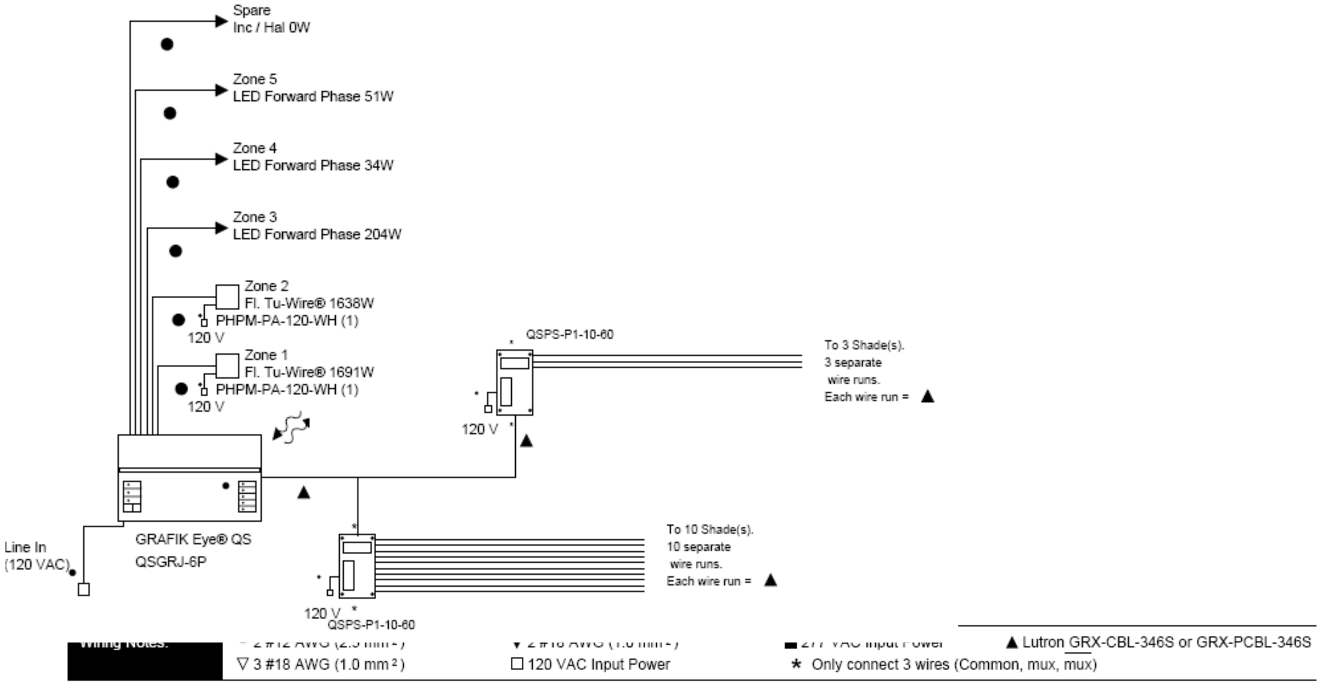
2401 W. AVENUE
NEWPORT NEWS, VA
23607

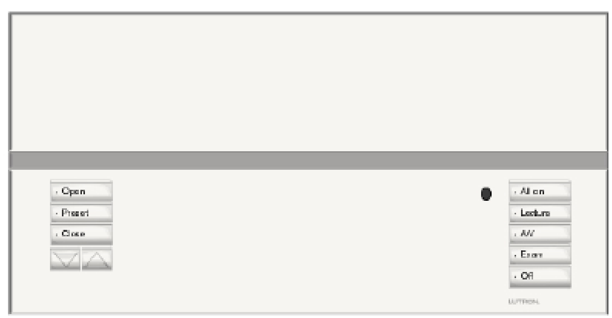
DRAWN BY: ALYSON LARIMER
PENN STATE AE SENIOR THESIS
ELECTRICAL CONSULTANT: PROF. TED DANNERTH
TITLE: AUDITORIUM LIGHTING LAYOUT
DATE: 7-APRIL-2011
SCALE: 1/8" = 1'-0"

E3-1

DIMMING WIRING DIAGRAM:

The following is a wiring diagram for the Grafik Eye scene control and architectural wallstation.





EXTERIOR | GATHERING SPACE

SPACE DESCIPTION:

Originally, there was no gathering space designed along the Victory Landing Pathway promenade that follows the contour of the James River. After executing a landscape architecture design, the gathering space is intended to connect the 23rd Street pedestrian traffic to the waterfront and provide a functional space to enjoy. The new design encompasses 29,888 square feet with three private seating areas and two larger, open seating areas. Throughout the spaces, pools of water are placed around the seating areas imitating ship elements interacting with water.

Figure 9.1: Existing Exterior

LIGHTING DESIGN:

The main objective for the lighting design of the exterior space is to have lighting throughout the space that serves multiple purposes. Fixtures specified for this spaces act more as architectural elements within the space. Globe fixtures are located in the reflecting pools surrounding the seating areas providing a visual element to the space while creating a dividing wall of light from the other spaces. The pathways throughout are illuminated by square modular fixtures that are capable of holding human weight. These fixtures outline the contours of the pathways as well as surrounding the larger, more public seating areas. Uplighting highlight trees and shrubbery as well as two flag poles along the waterfront. Three different light sources are used within the space, which include LEDs, compact fluorescent, and metal halide.

ELECTRICAL DESIGN:

The panelboard designated for the exterior spaces of the building does not include this space because it does not currently exist. However, on the panelboard that does exist, there is extra room to add another circuit for this exterior space. The lighting design is intended to only add a minimal load onto this panelboard so it will not increase the energy significantly.

CONTOLS:

The exterior space is intended to be controlled with a time clock in order to reduce energy from lighting when it is not necessary.

EXISTING PANELBOARDS:

The following are the existing panelboard schedules for panel HGA (480Y/277V). The modified circuits are highlighted in blue.

PANELBOARD HGA SCHEDULE

225 AMP BUS 150 AMP MCB 480Y/277 VOLTS 3 PH, 4 W, SN, MIN. 14 KAIC SURFACE MOUNTED

LOAD SERVED	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	BKR. TRIP	WIRE SIZE	CKT. NO.	PHASE A B C	CKT. NO.	WIRE SIZE	BKR. TRIP	LOAD (AMPS) A	LOAD (AMPS) B	LOAD (AMPS) C	LOAD SERVED
PANEL LGA	44.1			80	4	1		2	12	20	5.0			LIGHTING-WALKWAY
VIA DT TRANSFORMER		34.7						4	12	20		5.0		LIGHTING-WALKWAY
			35.5					6	12	20			4.8	LIGHTING-SITE
VAV UNITS	7.8			20	12	7		8	8	20	1.0			LIGHTING-RM 107 K21
LIGHTING-GROUND FLR		8.6		20	12	9		10	12	20		7.8		LIGHTING-GROUND FLR
SPARE				20		11		12	12	20			3.0	UH-9
SPARE				20		13		14		20				SPARE
SPARE				20		15		16		20				SPARE
SPARE				20		17		18		20				SPARE
SPARE K20				20		19		20		20				SPARE
SPARE				20		21		22		20				SPARE
IN-LINE HEATER			7.2	15	12	23		24		20				SPARE
	7.2							26		20				SPARE
		7.2						28		20				SPARE
SPARE				20		29		30		20				SPARE
SPARE				20		31		32		20				SPARE
SPARE				20		33		34		20				SPARE
SPARE				20		35		36		20				SPARE K23
FILTER PUMP	27.0			40	8	37		38		15				SPARE
20 HP K22		27.0												
			27.0											
TOTAL	86.1	77.5	69.7								6.0	12.8	7.8	TOTAL
TOTAL CONNECTED AMPS							A: 92.1	B: 90.3			C: 77.5			

PANELBOARD REDESIGN:

Below are the redesigned panel boards and their corresponding panelboard sizing worksheet. The modified circuits are highlighted in blue.

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	HGA	MIN. C/B AIC:	14K
SIZE/TYPE BUS:	100A	PANEL LOCATION:		OPTIONS:	
SIZE/TYPE MAIN:	100A/3P C/B	PANEL MOUNTING:	SURFACE		

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Panel LGA		10994	80A/3P	1	*			2	20A/1P	1246	Exterior	Lighting Walkway
Panel LGA		8651		3		*		4	20A/1P	1246	Exterior	Lighting Walkway
Panel LGA		8850		5			*	6	20A/1P	1197	Exterior	Lighting Site
VAV Units		1837	20A/1P	7	*			8	20A/1P	250	Room 107	Lighting
Lighting	Ground Floor	2144	20A/1P	9		*		10	20A/1P	1945	Ground Floor	Lighting
SPARE		0	20A/1P	11			*	12	20A/1P	789	0	UH-9
SPARE		0	20A/1P	13	*			14	20A/1P	1771	Gathering Space	EXTERIOR LIGHTING
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
In-Line Heater		1895	15A/3P	23			*	24	20A/1P	0		SPARE
SPARE		1895		25	*			26	20A/1P	0		SPARE
SPARE		1895		27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A Ph.	17.99	TOTAL DESIGN LOAD (KW)	55.93
CONNECTED LOAD (KW) - B Ph.	15.88	POWER FACTOR	0.91
CONNECTED LOAD (KW) - C Ph.	12.73	TOTAL DESIGN LOAD (AMPS)	74

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					HGA	Panel Location:			xx		
Nominal Phase to Neutral Voltage------->					277	Phase:			3		
Nominal Phase to Phase Voltage-------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Panel LGA	9		10994	w	0.90	10994	12216		
2	A	Lighting Walkway	3	Exterior	1246	w	0.90	1246	1384		
3	B	Panel LGA	9		8651	w	0.90	8651	9612		
4	B	Lighting Walkway	3	Exterior	1246	w	0.90	1246	1384		
5	C	Panel LGA	9		8850	w	0.90	8850	9833		
6	C	Lighting Site	4	Exterior	1197	w	0.90	1197	1330		
7	A	VAV Units	6		1837	w	0.95	1837	1934		
8	A	Lighting	3	Room 107	250	w	0.90	250	278		
9	B	Lighting	3	Ground Floor	2144	w	0.90	2144	2382		
10	B	Lighting	3	Ground Floor	1945	w	0.90	1945	2161		
11	C	SPARE			0	w		0	0		
12	C	UH-9	6		789	w	0.95	789	831		
13	A	SPARE			0	w		0	0		
14	A	EXTERIOR LIGHTING	6	Gathering Space	1771	w	0.85	1771	2084		
15	B	SPARE			0	w		0	0		
16	B	SPARE			0	w		0	0		
17	C	SPARE			0	w		0	0		
18	C	SPARE			0	w		0	0		
19	A	SPARE			0	w		0	0		
20	A	SPARE			0	w		0	0		
21	B	SPARE			0	w		0	0		
22	B	SPARE			0	w		0	0		
23	C	In-Line Heater	6		1895	w	0.95	1895	1995		
24	C	SPARE			0	w		0	0		
25	A	SPARE	6		1895	w	0.95	1895	1995		
26	A	SPARE			0	w		0	0		
27	B	SPARE	6		1895	w	0.95	1895	1995		
28	B	SPARE			0	w		0	0		
29	C	SPARE			0	w		0	0		
30	C	SPARE			0	w		0	0		
31	A	SPARE			0	w		0	0		
32	A	SPARE			0	w		0	0		
33	B	SPARE			0	w		0	0		
34	B	SPARE			0	w		0	0		
35	C	SPARE			0	w		0	0		
36	C	SPARE			0	w		0	0		
37	A	SPARE			0	w		0	0		
38	A	SPARE			0	w		0	0		
39	B	SPARE			0	w		0	0		
40	B	SPARE			0	w		0	0		
41	C	SPARE			0	w		0	0		
42	C	SPARE			0	w		0	0		
PANEL TOTAL								46.6	51.4	Amps=	61.9
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					18.0	19.9	39%	71.8
PHASE TOTAL			B					15.9	17.5	34%	63.3
PHASE TOTAL			C					12.7	14.0	27%	50.5
LOAD CATAGORIES				Connected			Demand				Ver. 1.04
				kW	kVA	DF	kW	kVA	PF		
3	fluorescent lighting			6.8	7.6		6.8	7.6	0.90		
4	HID lighting			1.2	1.3		1.2	1.3	0.90		
6	HVAC fans			10.1	10.8		10.1	10.8	0.93		
9	unassigned			28.5	31.7		28.5	31.7	0.90		
Total Demand Loads							46.6	51.4			
Spare Capacity				20%			9.3	10.3			
Total Design Loads							55.9	61.7	0.91	Amps=	74.2

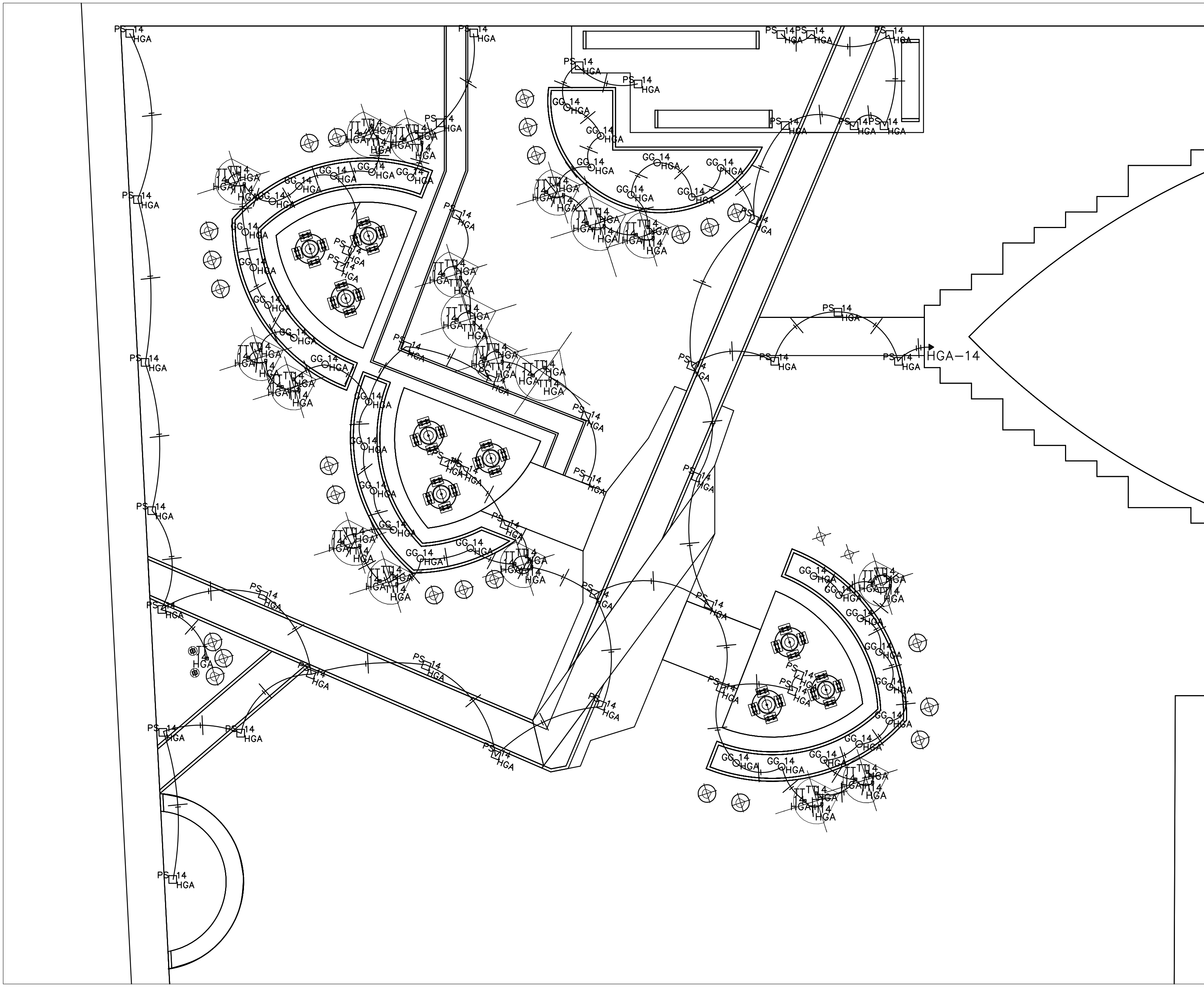
FEEDER SIZING:

The data for the summary table below are from the redesigned panelboard HGA. The sizing is referenced from the NEC handbook.

PANELBOARD	
TAG	HGA
VOLTAGE SYSTEM	480Y/277V
CALCULATED DESIGN LOAD (kW)	55.93
CALCULATED POWER FACTOR	0.91
CALCULATED DESIGN LOAD (kVA)	61.7
CALCULATED DESIGN LOAD (A)	74.2
FEEDER	
FEEDER PROTECTION SIZE	100A
NUMBER OF SETS	1
WIRE SIZE	
PHASE	(3) #4 AWG
NEUTRAL	(1) #4 AWG
GROUND	(1) #8 AWG
WIRE AREA	
EACH PHASE	0.0824
TOTAL - ALL PHASES	0.2472
NEUTRAL	0.0824
GROUND	0.0366
TOTAL - ALL WIRES	0.3662
MINIMUM CONDUIT AREA	0.9155
CONDUIT SIZE	1” EMT
CONDUIT SIZE	1-1/2” EMT
FEEDER LENGTH	135’-3/4”
FINAL VOLTAGE DROP (V)	273.9V
FINAL VOLTAGE DROP (%)	1.1%
WAS FEEDER RESIZED?	NO

NOTE: *Wire sized for copper THHN at 75˚C

WIRING DIAGRAM:



KEY NOTES:

THE VIRGINIA ADVANCED
SHIPBUILDING AND
CARRIER INTEGRATION
CENTER
NEWPORT NEWS, VIRGINIA

DRAWN BY: ALYSON LARIMER
PENN STATE AE SENIOR THESIS
CONSULTANT: PROF. TED DANNERTH
TITLE: EXTERIOR SPACE WIRING DIAGRAM
DATE: 7-APRIL-2011
SCALE: 1/16" = 1'-0"

N

E4-1

ELECTRICAL BREADTH #1 | MOTOR CONTROL CENTER

BREADTH DESCRIPTION:

The design of the motor control center is located in the mechanical room 366 of the Laboratory Wing. Within the space, there are multiple motors that could easily be consolidated into a motor control center to make maintenance easier. Also in this space are two large air handling units. In total, there are six out of the nine air handling units newly placed in the motor control center along with other exhaust fans, four pump sets, pressure boosters, and an air compressor. Each air handling unit contains two motors; one for supply air and another for the exhaust fan. The motor control center is designed for 480V loading and contains variable frequency motors and full voltage non-reversal motors. Each motor starter is an integral type starter containing a disconnect switch and is required to be a type NEMA 1A enclosure.

CONCLUSION:

The motor control center is designed utilizing the Freedom 2100 Series by Eaton Cutler-Hammer. The following is a schedule providing the unit tag corresponding with its location in the motor control center. It also provides the horse power of the motor as well as the NEMA motor size if applicable. For each unit, the dimensions and number of spaces it will occupy is documented. The motor control center is designed with 5 spare spaces noted on the isometric drawing and is fifteen feet long. Following the motor control center schedule is a floor plan noting the location within the mechanical room and a dimensioned isometric drawing of the station.

UNIT TAG	EQUIPMENT TAG	LOAD DESCRIPTION	LOAD (HP)	VOLTAGE	PHASE	PF	OVERCURRENT PROTECTION MCCB	STARTER TYPE	NEMA SIZE	SIZE (in.)	SPACES
A	AHU-SF-4	AIR HANDLING UNIT SUPPLY FAN	50	480	3	0.95	150	VFD	–	54	9
C	AHU-EF-4	AIR HANDLING UNIT EXHAUST FAN	15	480	3	0.95	50	VFD	–	24	4
F	AHU-SF-5	AIR HANDLING UNIT SUPPLY FAN	60	480	3	0.95	175	VFD	–	54	9
H	AHU-EF-5	AIR HANDLING UNIT EXHAUST FAN	25	480	3	0.95	80	VFD	–	36	6
J	AHU-SF-6	AIR HANDLING UNIT SUPPLY FAN	60	480	3	0.95	175	VFD	–	54	9
I	AHU-EF-6	AIR HANDLING UNIT EXHAUST FAN	20	480	3	0.95	60	VFD	–	36	6
L	AHU-SF-7	AIR HANDLING UNIT SUPPLY FAN	50	480	3	0.95	150	VFD	–	54	9
N	AHU-EF-7	AIR HANDLING UNIT EXHAUST FAN	20	480	3	0.95	60	VFD	–	36	6
O	AHU-SF-8	AIR HANDLING UNIT SUPPLY FAN	20	480	3	0.95	60	VFD	–	36	6
D	AHU-EF-8	AIR HANDLING UNIT EXHAUST FAN	7.5	480	3	0.75	25	VFD	–	24	4
E	AHU-SF-9	AIR HANDLING UNIT SUPPLY FAN	15	480	3	0.95	50	VFD	–	24	4
P	AHU-EF-9	AIR HANDLING UNIT EXHAUST FAN	5	480	3	0.95	15	VFD	–	24	4
G	PB-1	PRESSURE BOOST	10	480	3	0.95	150	FVNR	1	12	2
K	PB-2	PRESSURE BOOST	10	480	3	0.95	150	FVNR	1	12	2
M	A-COMP	AIR COMPRESSOR	10	480	3	0.95	150	FVNR	1	12	2
B	PS-1	PUMP SET #1	95	480	3	0.95	150	FVNR	4	18	3
Q	PS-2	PUMP SET #2	225	480	3	0.95	600	FVNR	6	48	8
R	PS-3	PUMP SET #3	20	480	3	0.95	150	FVNR	2	12	2
S	PS-4	PUMP SET #4	15	480	3	0.95	150	FVNR	2	12	2
T	EF-3	EXHAUST FAN #3	5	480	3	0.75	150	FVNR	1	12	2
U	EF-4	EXHAUST FAN #4	5	480	3	0.75	150	FVNR	1	12	2
V	EF-6	EXHAUST FAN #6	2	480	3	0.75	150	FVNR	1	12	2

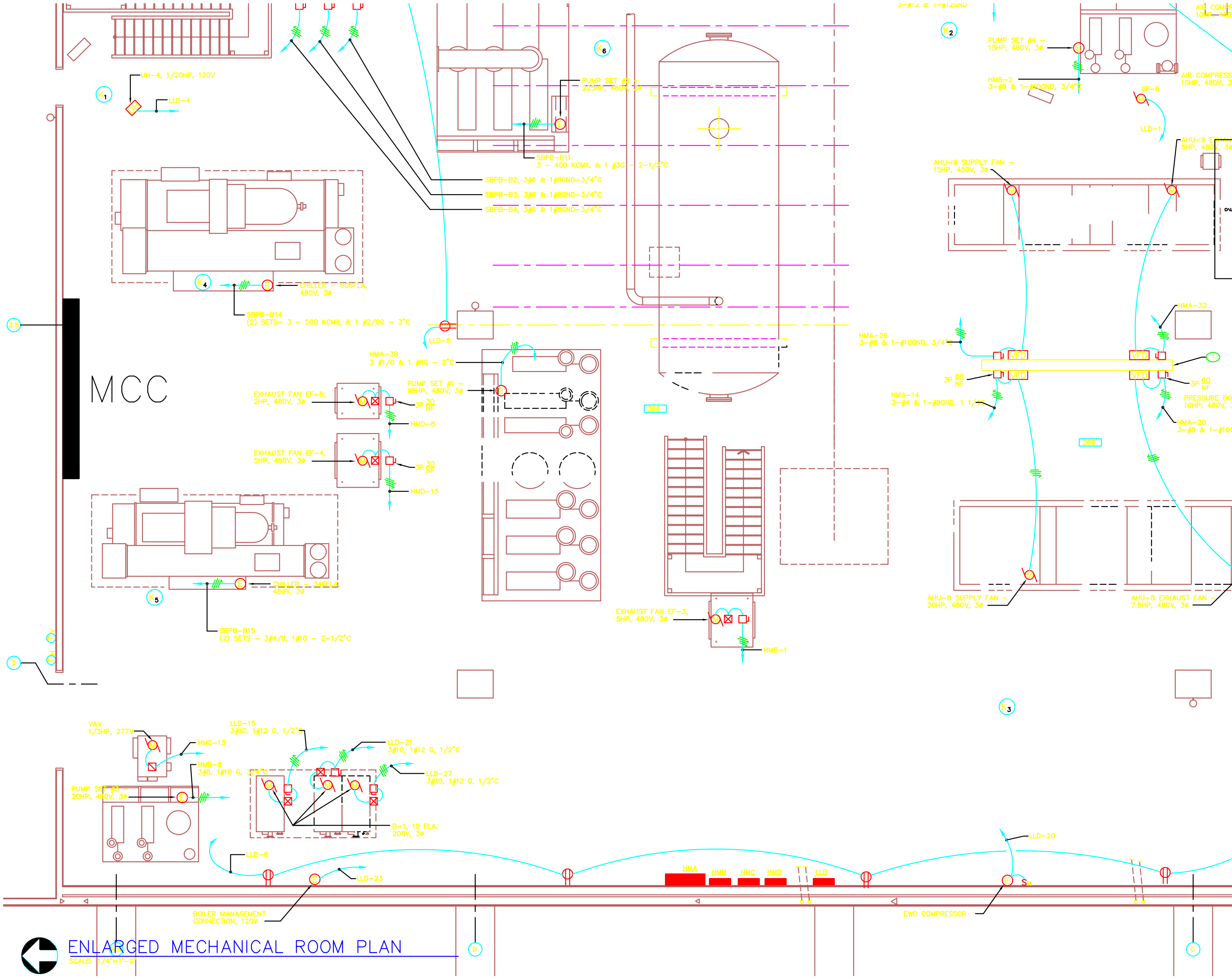
KEYNOTES

VIRGINIA ADVANCED SHIPBUILDING AND CARRIER INTEGRATION CENTER

2401 W. AVENUE
NEWPORT NEWS, VA 23607

DRAWN BY: ALYSON LARIMER
PENN STATE AE SENIOR THESIS
ELECTRICAL CONSULTANT: PROF. TED DANNERTH
TITLE: MOTOR CONTROL CENTER SCHEDULE
DATE: 11–FEB–2011
SCALE: NTS

E002

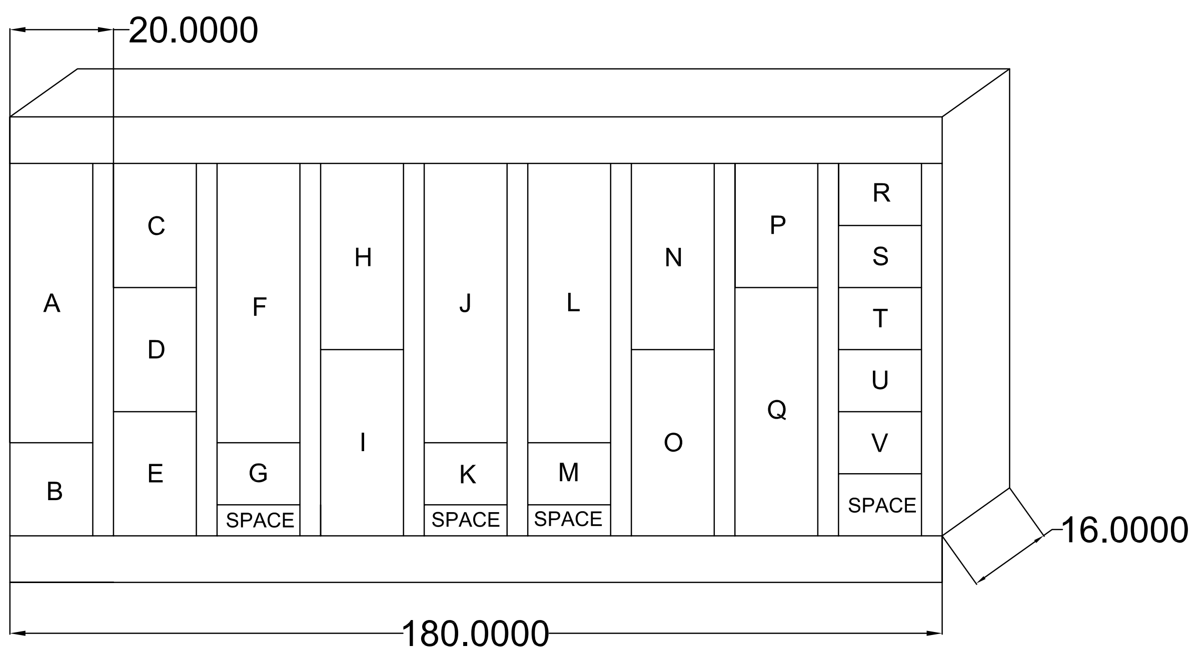


KEYNOTES

VIRGINIA ADVANCED SHIPBUILDING AND CARRIER INTEGRATION CENTER
2401 W. AVENUE
NEWPORT NEWS, VA
23607

DRAWN BY: ALYSON LARIMER
PENN STATE AE SENIOR THESIS
ELECTRICAL CONSULTANT: PROF. TED DANNERTH
TITLE: AUDITORIUM LIGHTING CONTROL DIAGRAM
DATE: 11-FEB-2011
SCALE: 1/4" = 1'-0"

E4-3



KEYNOTES

VIRGINIA ADVANCED SHIPBUILDING AND CARRIER INTEGRATION CENTER
2401 W. AVENUE
NEWPORT NEWS, VA 23607

DRAWN BY: ALYSON LARIMER
PENN STATE AE SENIOR THESIS
ELECTRICAL CONSULTANT: PROF. TED DANNERTH
TITLE MOTOR CONTROL CENTER DETAIL
DATE: 11-FEB-2011
SCALE: 1/2" = 1'-0"

E001

ELECTRICAL BREADTH #2 | BUSDUCT VS. CONDUIT

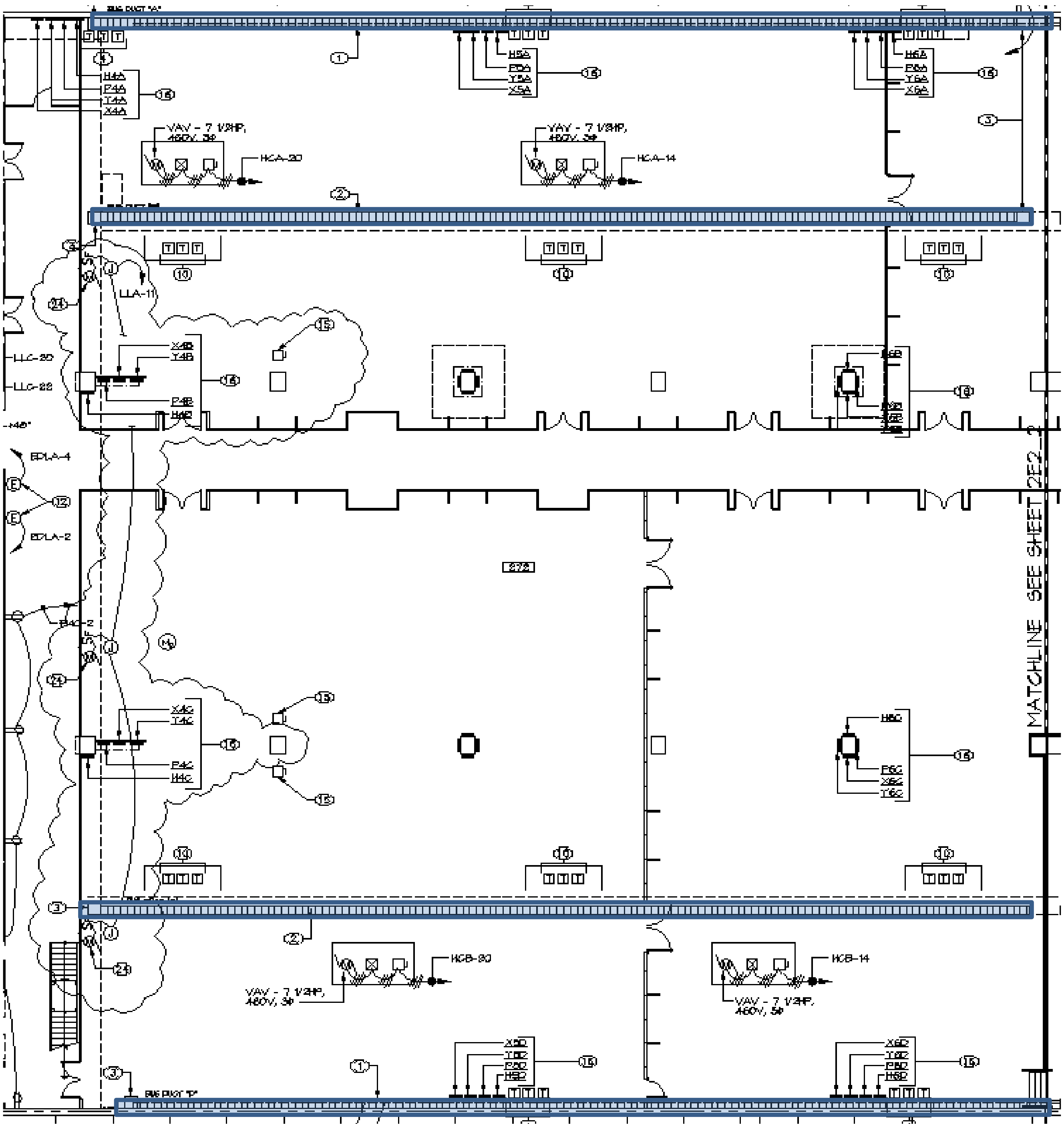
BREADTH DESCRIPTION:

Located in the Laboratory Wing are eight existing sets of busduct. The busducts are plug-in type to accommodate for equipment changes within the space during the development and experimental phases of design in the facility. The goal of this coast analysis is to determine the most cost effective way to supply power to various pieces of equipment within the space. Although the busducts are wall mounted and out of the way, this space is the only location of busducts throughout the facility. This analysis will be solely based on cost excluding the practicality of the installation.

The following is a table of total cost for both installations and a floor plan highlighting the location of busducts throughout the Laboratory Wing.

ASSEMBLY NUMBER	DESCRIPTION	QYT	UNIT	COST PER UNIT		COST PER L.F
				UNIT	TOTAL	
DIVISION D50	SERVICES					
	ASSEMBLY METHOD					
SECT./NO.	**ELECTRICAL: BUSDUCT CONSTRUCTION**					
26 25 13.10 0220	ALUMINUM BUS DUCT (PER 10 FT): INTERIOR 3 POLE, 4 WIRE, STRAIGHT SECTION, 800 AMP	2200	L.F.	10	$ 262	$57,640
26 25 13.10 0440	FEEDER - 800A	8800	L.F.	1	$ 245	$2,156,000
26 25 13.10 1250	CABLE TAP BOXES - 800A	14	E.A	1	$ 1,800	$25,200
26 05 33.35 0400	FLEX CONDUIT - (2) 3-1/2"	54	L.F.	1	$ 41.50	$2,241
26 05 19.90 2800	500KCMIL COPPER STRANDED FEEDER IN FLEX CONDUIT (4)	54	C.L.F	100	$ 1,475	$797
26 05 19.90 1600	#1/0 COPPER STRANDED GROUND (1)	54	C.L.F	100	$ 420	$227
					TOTAL COST	$2,242,104
D50	**ELECTRICAL: CONDUIT/FEEDER CONSTRUCTION**					
26 05 19.90 2400	(4) 300 KCMIL THHN COPPER STRANDED FEEDER (PER SET)	15462	C.L.F	100	$ 980	$151,528
26 05 19.90 1600	(1) #1/0 STRANDED COPPER GROUND (PER SET)	15462	C.L.F	100	$ 420	$64,940
26 27 16.20 0680	JUNCTION BOX - SCREW COER, 5-1/2"H x 4"W x 4-15/16"D	124	E.A	1	$ 125	$15,500
26 28 16.10 0600	CIRCUIT BREAKER - 225A	90	E.A	1	$ 2,150	$193,500
26 28 16.10 0400	CIRCUIT BREAKER - 100A	30	E.A	1	$ 1,000	$30,000
26 28 16.10 1000	CIRCUIT BREAKER - 800A	24	E.A	1	$ 6,875	$165,000
26 05 33.13 5140	CONDUIT - 3" EMT PER SET	46387	L.F.	1	$ 26.50	$1,229,256
					TOTAL COST	$1,849,724

Figure 1.2: Busduct vs. conduit and feeder | NOTE: This cost analysis was computed using values from the Electrical Section of RSMeans 2011.


HCA-20
HCA-14
HCB-20
HCB-14
LLA-11
LLC-20
LLC-22
EDLA-4
EDLA-2
MATCHLINE SEE SHEET 2E2.2

CONCLUSION:

Gathered from the table above, the cost of installing conduit and feeders is less expensive compared to a busduct installation. The cost analysis was computed from RSMeans 2011. The total savings of a conduit and feeder installation would be $392,380. If this study was not focused just on cost but practicality, the better installation would be busducts because of the amount of large equipment needing power. Also, because there are many different types of ships designed at the VASCIC facility, different equipment may be necessary and the busducts allow for easy change of equipment.

PROTECTIVE DEVICE COORDINATION ANLYSIS | SHORT CIRCUIT CALCULATION

INTRODUCTION:

A protective device coordination study addressing a single-path from the service entrance, through a distribution panel, and ending at a redesigned panelboard was calculated using the Per Unit Short Circuit Method. The single-pathway analyzed starts at a utility transformer, through switchgear SGA and SGB, through switchboard SBPB, through emergency distribution panel EDP, and finally to emergency panel EHPA feeding panel EH4A.

Below illustrates the single-path taken from the service entrance through the distribution system of the building termination at a branch panel. In addition, a table following shows a breakdown of each component through the single-path for the short circuit calculation.

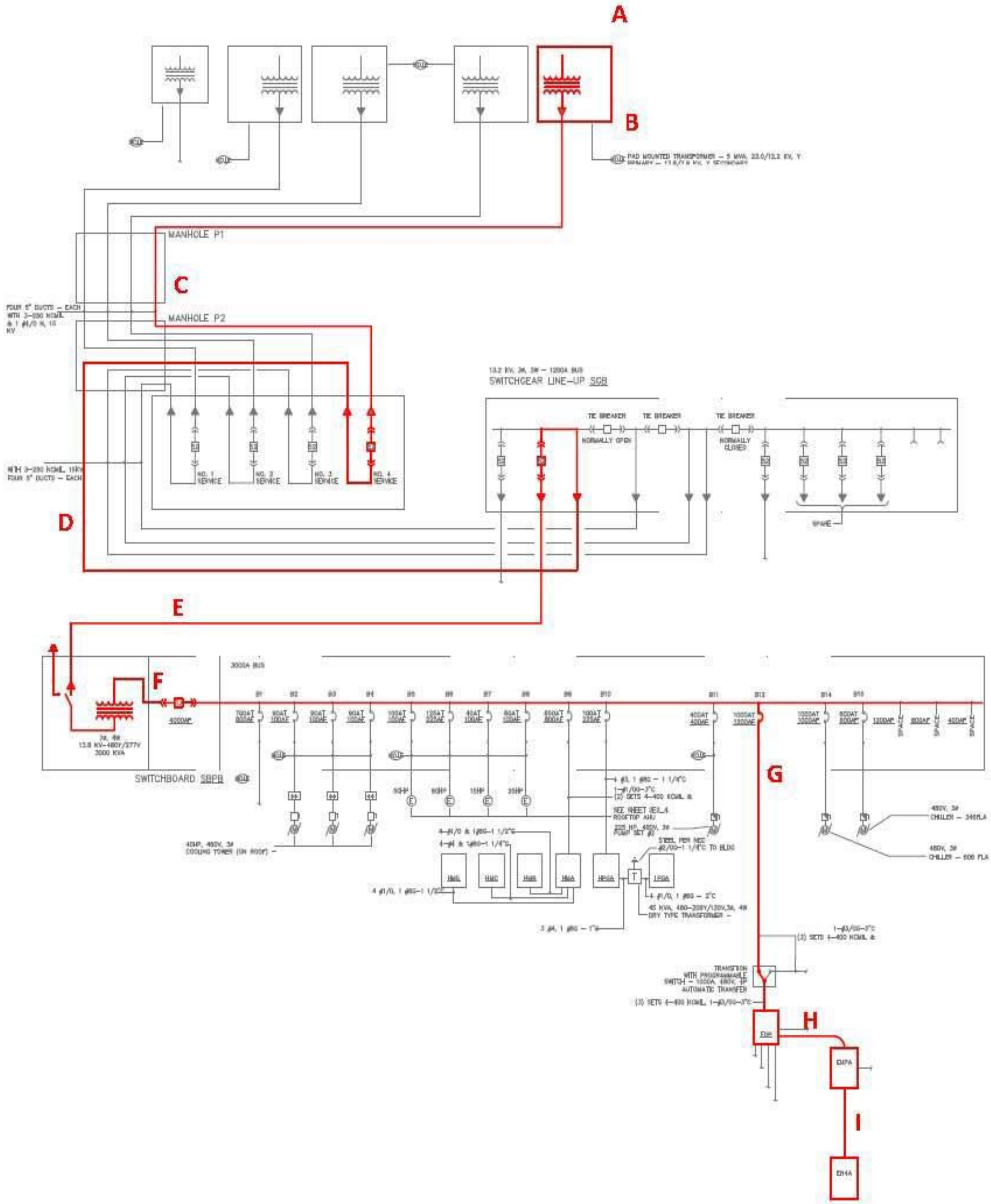


Figure 10.1: Single pathway of analysis

Equipment Characteristics											Per-Unit Value Table					
Mark	%X	%R	%Z	kVA	X/1000ft	R/1000ft	Z/1000ft	Length	# sets	3Ph Voltage (V)	Mark	Xu	Ru	Zu	Isc	Location
Utility	0.5			20000						23000	Utility	0.5000000		0.5000000		
															502.0437	A
MANHOLE-1 XFMR	6.928	1.000	7.000	5000.0							MANHOLE-1 XFMR	0.1385640	0.0200000	0.1399999		
															653.7028	B
FEEDER TO SGA					0.041	0.054	0.067	10	1.000	13800.000	FEEDER TO SGA	0.0000215	0.0000281	0.0000354		
															653.6667	C
SWITCHGEAR SGA											SWITCHGEAR SGA					
															653.6667	
FEEDER TO SGB					0.041	0.054	0.068	10	1.000	13800.000	FEEDER TO SGB	0.0000215	0.0000284	0.0000356		
															653.6303	D
SWITCHGEAR SGB											SWITCHGEAR SGB					
															653.6303	
FEEDER TO XFMR SBPB					0.041	0.054	0.068	286.98	1.000	13800.000	FEEDER TO XFMR SBPB	0.0006178	0.0008137	0.0010217		
															652.5886	E
XFMR SBPB	6.928	1.000	7.000	3000.0							XFMR SBPB	0.2309400	0.0333333	0.2333332		
															13755.4605	F
SWITCHBOARD SBPB											SWITCHBOARD SBPB					
															13755.4605	
FEEDER TO EDP					0.040	0.033	0.052	11.91	3.000	480.000	FEEDER TO EDP	0.0068924	0.0057034	0.0089462		
															13616.1551	G
PANEL EDP											PANEL EDP					
															13616.1551	
FEEDER TO EHPA					0.041	0.054	0.067	200	1.000	480.000	FEEDER TO EHPA	0.3559028	0.4644097	0.5851010		
															8190.9101	H
PANEL EDP											PANEL EDP					
															8190.9101	
FEEDER TO EH4A					0.048	0.321	0.325	35	1.000	480.000	FEEDER TO EH4A	0.0729167	0.4876302	0.4930518		
															6132.0308	I

A base kVA was assumed at 10000 and utility contribution of the service entrance is 20 MVA. The primary side of the utility transformer is 23000V, 3-phase.

Each component along the single-path was calculated using the following equations:

Component per unit, reactance, $X = \dfrac{(\text{m}\Omega\ \text{X})(\text{Base KVA})}{(1000)(\text{KV})^2}$

Component per unit, resistance, $R = \dfrac{(\text{m}\Omega\ \text{R})(\text{Base KVA})}{(1000)(\text{KV})^2}$

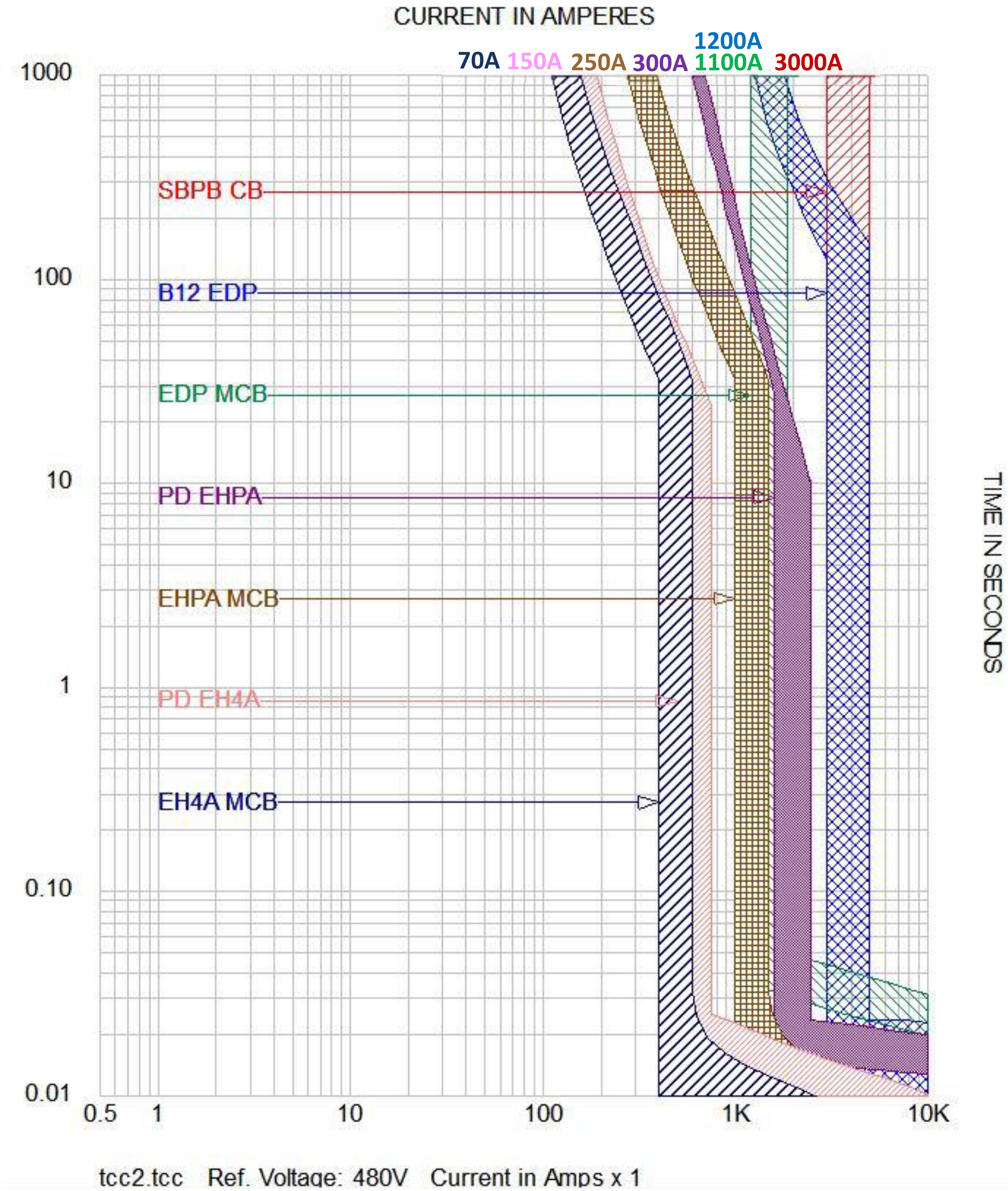
Total impedance, $Z = \sqrt{(X)^2 + (R)^2}$

For feeder calculations, resistance and reactance values were taken from Table 8 and 9 in Chapter 9 of the NEC code book.

The far right column shows the final short circuit current capacity at each point along the path considered.

Additionally, a protection device coordination study was performed to confirm the order of equipment tripping is correct.

Below is a compilation of circuit breakers considered for the short circuit calculation.


CURRENT IN AMPERES
70A
150A
250A
300A
1200A
1100A
3000A
SBPB CB
B12 EDP
EDP MCB
PD EHPA
EHPA MCB
PD EH4A
EH4A MCB
1000
100
10
1
0.10
0.01
0.5
1
10
100
1K
10K
TIME IN SECONDS
tcc2.tcc Ref. Voltage: 480V Current in Amps x 1

CONCLUSION:

The final trip curves were compiled on the same trip graph in order to easily analyze the system. According to the protective device coordination analysis, the 3000A circuit breaker located in the switchboard SBPB was properly sized. All other circuit breakers will trip before the 3000A breaker. However, there are some breakers that overlap within the system. This could become a problem between the 300A and 1100A circuit breaker. All other overlapping should not cause a problem within the system.

SUMMARY & CONCLUSIONS

The main objective of this thesis report was to determine how a single change within a building can affect multiple disciplines throughout the design process. Some changes can be beneficial; however others may jeopardize necessary requirements and therefore need critical thinking to derive a solution without sacrificing the aesthetics of the space.

Throughout the design process, an overall design concept was developed that provided a link between the architecture and the newly designed lighting. The lighting design intended to be functional while enhancing the overall aesthetics and visual environment. Compiling solid design criteria and considerations before implementing final designs was an established foundation throughout the lighting design process. While each lighting design obtained its own design concept and criteria, an integral approach for a quality lighting solution was necessary.

In response the redesigned lighting systems within each space, a reciprocal electrical redesign was necessary to address. In most cases, electrical components were downsized due to more efficient and efficacious luminaires and sources chosen for each space. This action not only reduces energy consumption, but it also provides reduced costs for electrical components. Through other electrical studies, it was found that it was more cost effective to install busduct throughout the Laboratory Wing rather than routing individual feeders and conduits to each piece of equipment. In addition, this installation allowed to equipment changes as well as additional pieces of equipment to be added to the laboratory area. After performing a motor control center design in the main electrical room of the Laboratory Wing, this solution provides an easy means to perform maintenance repairs.

Integrating design research further, an acoustical study performed in the auditorium due to a ceiling material and contour change proved to be inadequate. From this solution, it was necessary to derive a plausible solution to reduce the reverberation time within the acceptable range. By changing the existing acoustical wall panels to a heavy weight material and installing additional panels along the east wall provided a reverberation time within the acceptable range. Additionally, the aesthetics were not jeopardized within the space because the existing materials were used on an adjacent wall.

An addition of an exterior gathering space integrated the VASCIC facility with its surroundings further. This space provided a functional space for the city of Newport News to enjoy as well as the facility occupants. Lighting within this space was intended to be additional landscape elements and to not appear as lighting equipment. This approach led to an integrated design with the landscape and proved to be a successful installation as well as design. Seating areas throughout the space can be enjoyed publically or privately due to installations of taller landscaping framing the smaller seating areas. Also throughout the space, it was important to focus on the purpose of the facility and represent that through the design of the exterior.

Overall, the design process was executed smoothly focusing on the design concepts of the facility and implementing them through lighting. In addition, the lighting design proved to be a function and practical design in respect to the Virginia Advanced Shipbuilding and Carrier Integration Center Facility.

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