2009

Half Moone Cruise and Celebration Center

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Architectural Engineering Thesis

Lighting/Electrical Option

The Pennsylvania State University

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Spring 2009 – 4/6/09

http://www.engr.psu.edu/ae/thesis/portfolios/2009/jcw5009/

HALF MOONE
CRUISE AND CELEBRATION CENTER

JONATHAN WALKER
LIGHTING / ELECTRICAL

PROJECT INFORMATION
LOCATION: 111 Waterside Drive, Norfolk, Virginia
PROJECT SIZE: 89,246 Square Feet
FLOORS: 2
BUILDING COST: $21 Million
CONSTRUCTION TIME: August 2005 - March 2007
DELIVERY METHOD: Design - Bid - Build

ARCHITECTURAL DESIGN
Constructed on a concrete pier, the building's facade is concrete, blue vertical-ribbed metal, and various window systems with a metal roof. The terminal enhances the cruise passenger experience by providing a larger, multipurpose space.

STRUCTURAL SYSTEM
The building is constructed on top of a concrete pier. Various load bearing and non-load bearing concrete walls work with concrete columns to support the structure. Seven supertrusses span spaces up to 117 feet wide.

PROJECT TEAM
OWNER: City of Norfolk
ARCHITECT: BEA International
MEP: Clark Nexsen
STRUCTURAL: BEA International and Clark Nexsen
CONTRACTOR: S.B. Ballard Construction Company

ELECTRICAL SYSTEM
The 3,000A main switchboard is 480Y/277V. A generator backs up particular panels and transformers convert 480V to 208Y/120V when needed. Fluorescent, Halogen and Metal Halide lamps are common, and the Lobby features a large, pendant custom luminaire. Colored LEDs accent the supertrusses.

MECHANICAL SYSTEM
Five Air Handling Units heat and cool the space with a Variable Air Volume system. Two boilers and two chillers are in the Mechanical Room.

CONSTRUCTION
The Base Bid Lump Sum for the building includes the Main Terminal Building, Pedestrian Bridges, Entry Pavilionand Site Work.

http://www.engr.psu.edu/ae/thesis/portfolios/2009/jcw5009

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Executive Summary

The new architectural lighting design of Half Moone Cruise & Celebration Center in Norfolk, Virginia affects the electrical distribution in the building. This report explains a new redesign of the architectural lighting design of several main building spaces. The electrical impact of this new design is analyzed, along with how the lighting will be controlled.

Since the proposed lighting design in the Waiting Area / Ticket Queuing area includes skylights, the mechanical and structural impacts of this design are discussed.

The scope of the new lighting design and electrical work includes:

- Waiting Area / Ticket Queuing area
- Lobby
- Conference Room
- Façade

Design criteria such as illuminance values, glare considerations, daylight considerations, energy efficiency, controls, psychological effects, etc. were generated and the new lighting design was based on this criteria. One particular goal was to reduce the energy density (watts per square foot) in both the Waiting Area / Ticket Queuing area and the Conference Room. The new lighting design sufficiently meets these criteria, and reduces the energy density in major spaces.

The electrical design considers the new lighting loads, and new panelboard calculations and schedules indicate the new design. In addition, the lighting levels were reduced in a large space on the first floor by using more efficacious light sources. The goal of reducing the lighting level was to reduce the size of panelboards with the hope of reducing the switchgear size. However, this goal was not met because the additional lighting to be replaced was already relatively efficient. Another electrical analysis discussed in this report is comparing the cost of aluminum versus copper feeders. This analysis indicates that by switching from copper feeders in the original design to aluminum feeders, approximately $40,000 would be saved.

By adding skylights in the Waiting Area / Ticket Queuing area, the mechanical cooling load is altered. The result of adding 15 skylights to this space is that the cooling load is increased, but there is significant reduction in energy consumption due to the dimming or turning off of electrical lights. Therefore, skylights are a viable option in this space.

Structurally, the roof slab as modeled and calculated will be able to handle the addition of skylights. However, the available information was limited so assumptions were made in this analysis.

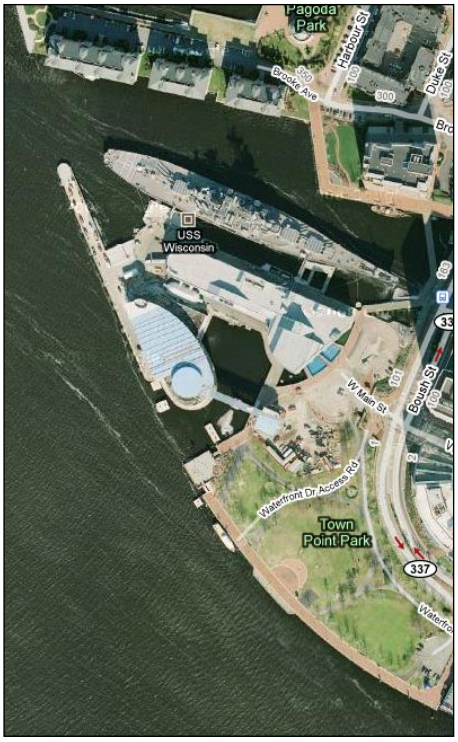
The new design sufficiently meets the design criteria in all areas and reduces the building's energy consumption.

Section 1: Introduction

Half Moone Cruise & Celebration Center is designed to enhance the cruise passenger experience and create a large multipurpose space in downtown Norfolk, Virginia. At about 90,000 square feet, this building can handle the passenger load during cruise events, and features several medium and large spaces for special social events. Before the construction of this building, the cruise passenger experience was lacking and there was less space for conferences and social events in the downtown Norfolk.

Some of the original design objectives include:

- Urban Design
  - Create memorable skyline from the city and the river
  - Enliven Main Street View Corridor Terminus
  - Relate to Town Point Park and Waterside
  - Create a new urban room: The Marina
- Building and Site Design
  - Relate to the powerful Nauticus neighbor
  - Achieve its own identity
  - Break down the scale towards the park
  - Integrate bridges and terminal buildings
  - Augment ground transportation options
  - Improve provisioning access to the pier
  - Create attractive venue for events and functions



The building is very visible in the downtown area. Town Point Park, the adjacent green space, is used throughout the year to host many festivals and special events. The Nauticus, a maritime museum, along with the battleship USS Wisconsin also draw many visitors. With this kind of visibility, Half Moone Cruise & Celebration Center can become an architectural landmark.

The building is constructed on a pier, which was the first phase of the project. The concrete pier continues past the building so that the cruise ship can be secured to it. This pier attaches to the Nauticus pier, and a small marina is formed between the Nauticus and Half Moone Cruise & Celebration Center. A pedestrian bridge connects the building to the Entry Pavilion near Town Point Park.

This report will look at the lighting redesign of four major spaces in this building. The electrical impact of this new lighting design will also be evaluated. Since the lighting design includes the addition of skylights in one of the large spaces, this report shows the effects on the mechanical and structural systems.

Section 2: Building Statistics

The following building statistics show existing building information. No redesign information is presented.

Construction

The Half Moone Cruise and Celebration Center construction required two phases. The pier was constructed in Phase 1, and serves as a base for the Phase 2 building. The Base Bid Lump Sum for Phase 2 includes the Main Terminal Building, Pedestrian Bridges, Entry Pavilion, and site work. The General Contractor was S. B. Ballard Construction Company. The project basis of award was the lowest responsive Total Bid, and the General Contractor agreed to finish the project within 500 calendar days.

The following dates indicate important project developments:
May 16, 2005: Sealed bids are due at City Hall Building in Norfolk, Virginia
500 calendar days: Phase 2 work to be completed

Electrical

The unit substation includes the main switchboard (480Y/277V), from which all other panels branch. The panels designated for mechanical equipment connect directly to the switchboard. Most of the panels designated for lighting and receptacle loads feed through an Automatic Transfer Switch. This ATS switches to the Natural Gas Engine Emergency Generator when there is a power outage from the utility company. There are various transformers in the system to convert 480V to 208Y/120V when needed.

The unit substation is located in the Main Electrical Room. In addition to the Main Electrical Room, the first floor contains the Generator Room and one additional Electrical Room. On the second floor, there are two Electrical Closets.

Lighting

In the Ticket Queuing and Waiting Lounge/Meeting Rooms there are two lighting systems for ambient light: a metal halide system and a incandescent (halogen) system. This space also features a color-changing LED system which grazes the exposed supertruss system.

In the Lobby, there are metal halide lamps in the luminaires nearest the glass curtain wall. Closer to the workplane, compact fluorescent lamps are used.

Direct/Indirect luminaires provide illuminance in the Conference rooms and are controlled to create various scenes.

On the first floor, low bay metal halide luminaires provide the general task lighting in the Luggage Area.

The exterior concrete façade and perimeter walkway on the first floor is illuminated with compact fluorescent luminaires. Luminaires in the Entry Pavilion provide enough illuminance for circulation.

Mechanical

Building heating and cooling is handled by five air handling units which are located near the center of the building. Three are above the first floor in the Luggage Area and two are in the Mezzanine above the second floor. The system is Variable Air Volume.

The Mechanical Room is on the first floor and contains two chillers, two boilers, various pumps and other mechanical equipment. Above the mechanical room, there is space for the boiler stacks.

Structural

The building is constructed on top of the Phase 1 concrete pier. The first floor is 2-1/2" concrete topping with wire mesh over 1-1/2" insulation board. Much of the first floor shell is non-load bearing concrete because concrete columns carry the load.

The second floor is 4.8" concrete slab. In the Ticket Queuing and Waiting Lounge/Meeting Rooms on the second floor, there are concrete columns only along the perimeter. In this space, there are supertrusses which span the entire width of the building. The supertrusses are approximately 7'-8" deep and vary from 57'-7" to 117'-10" long. There are various full-height columns around the Lobby and Mezzanine areas which connect to W10x50 beams as part of the main roof framing. The Lobby also contains steel girders and braces around its circumference.

In the Entry Pavilion, load bearing concrete walls encompass the elevators, and concrete columns support the second floor and roof of the stairs area. The bridge is constructed with open web steel girders and is supported at approximately midspan by two concrete columns. The bridge floor is 5-1/2" composite slab.

Fire Protection

The Fire Alarm Control Panel supports horn/strobe units and manual pull stations. It also supports two power booster panels which support additional horn/strobe units and manual pull stations. Duct smoke detectors are in the air handling units. The Fire Alarm system is a noncoded, analog-addressable system with automatic sensitivity control of certain smoke detectors.

There is no fire pump, but a wet-pipe sprinkler system is in place.

Transportation

Stairs and three elevators serve the Entry Pavilion and move passengers to either the first or second floor. A permanent bridge connects the pavilion to the building's second floor while a retractable bridge spans the water directly under the permanent bridge.

Inside, one elevator and escalator moves passengers from the Ticket Queuing room to the Luggage room. The egress stairs are designed so that occupants can exit the building safely in an emergency, but in normal circumstances occupants cannot bypass Customs.

The Gangway is a motorized, enclosed and adjustable ramp. Cruise passengers enter the ship via the Gangway which leads from the general Ticket Queuing area to the Ship entrance.

Telecommunications

Telephone, CATV and CCTV service enters into the Main Telecommunications room located on the first floor. In addition, there is a LAN Room and on each floor one Telecom Closet. There are various voice and data outlets throughout the building. An overhead paging system contains speakers inside and outside the building and is controlled by zone.

There are color cameras inside and outside the building which connect to the Central Controller and display on monitors. In addition to the normal building security systems for the owner, the U.S. Customs use various security and telecommunication networks and equipment.

Section 3: Lighting

Space 1: Waiting Area / Ticket Queuing

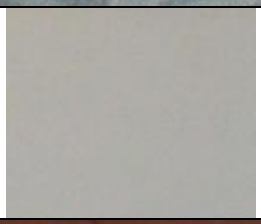
Spatial Overview

This space is one architectural space, despite two separate room numbers. It is 12,063 square feet and is approximately 23'-4" high, though the exposed steel trusses are curved, increasing the height in the spaces center (Figure 8, 11, 12). The northern curtain wall of windows is approximately 16'3" high. During a cruise event, the main purpose of this space is to form queues to the Mobile Ticket Counters and provide a waiting lounge area. During non-cruise special events, the space is used as a ballroom and social gathering area.

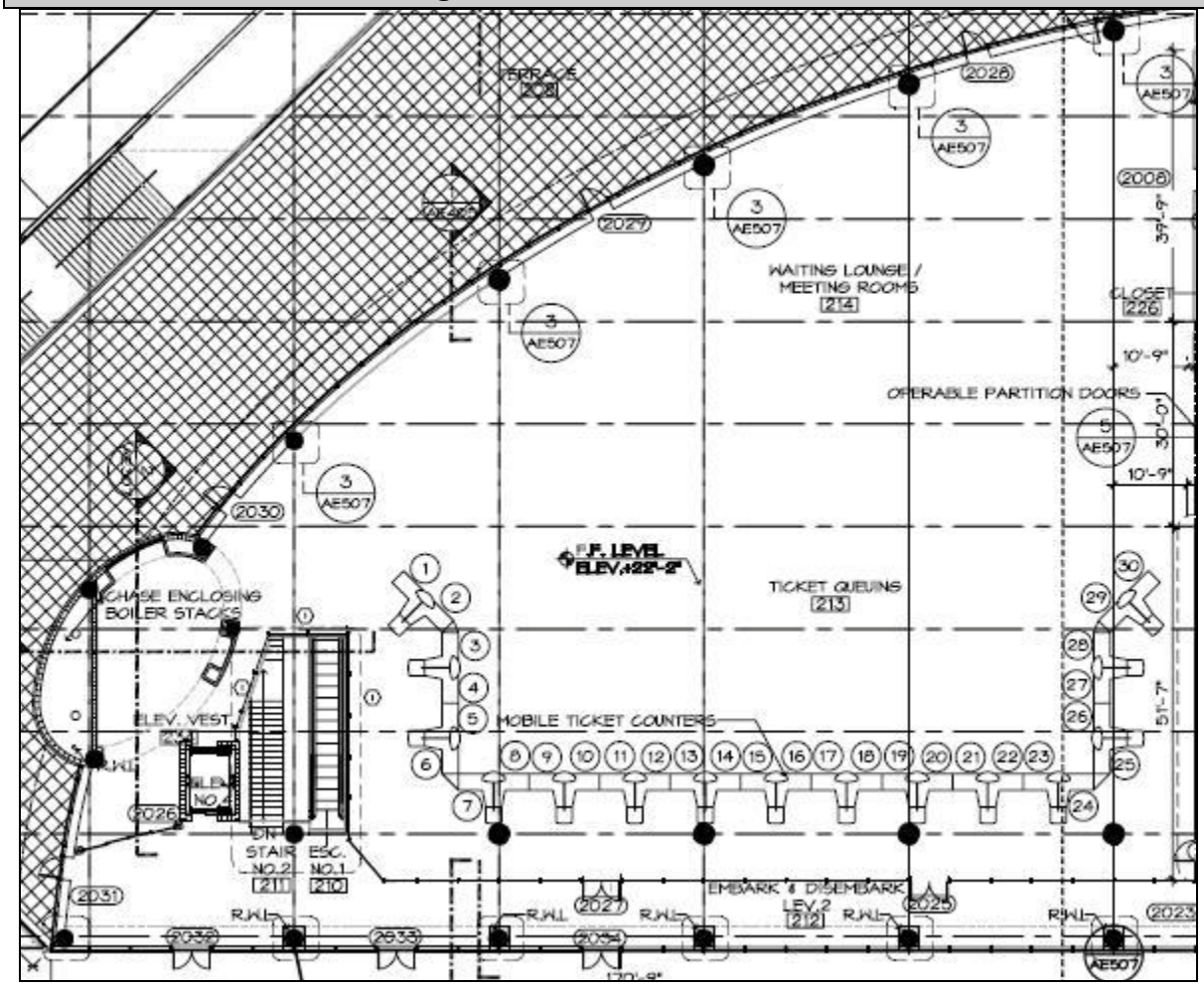
Finishes

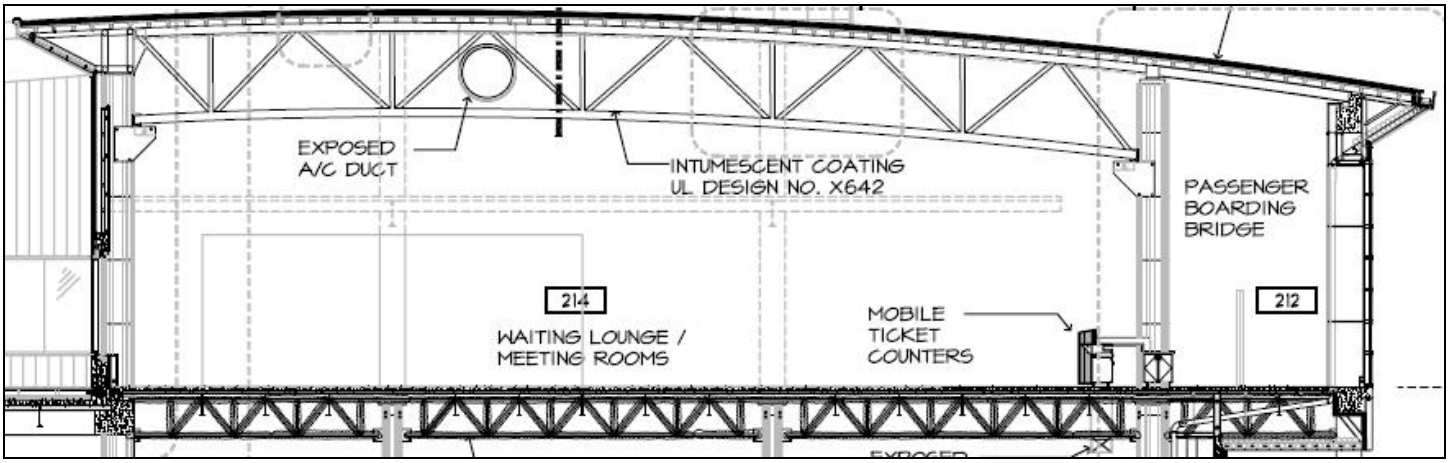
The materials in the Ticket Queuing and Waiting Lounge/Meeting Rooms space are relatively light colored, including the floor. The wood panel system on the wall which leads to the Passageway is the darkest main material in the space. The ceiling is light-painted, ribbed metal.

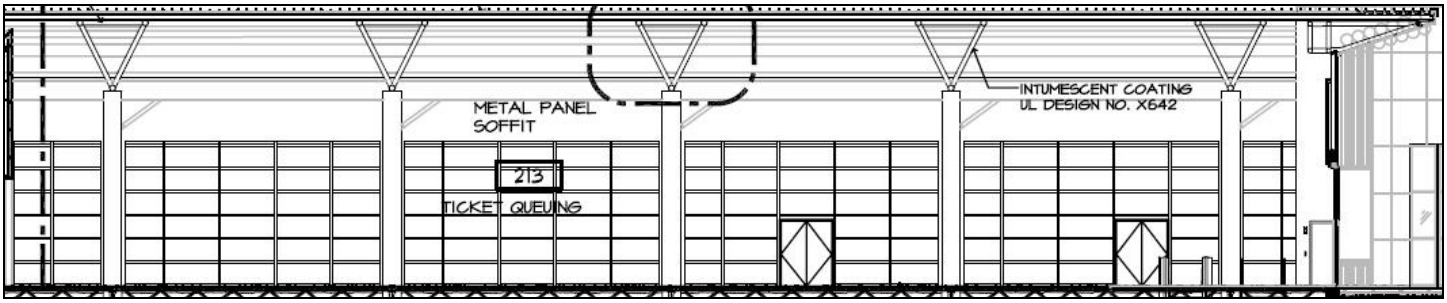
Materials

Floor: 2' carpet tiles and is a light blue-gray color. Reflectance: 45% (Assumed)	
Walls: Light tan color. Reflectance: 65% (Assumed)	
Wood Wall: Reflectance: 15% (Assumed)	
Ceiling: Reflectance: 80% (Assumed)	

Plan and Section Drawings







Luminaire Schedule

Graphic	Luminaire Type	Description	Luminaire Manufacturer	Luminaire Catalog Number
	A	Pendant luminaire with full dimming ballasts, safety cable, (4) 42W compact fluorescent lamps at 3500K, 277V, 18-inch diameter opening with no lens, white aluminum fluted exterior	Sportlite	DX4-T42-35-18ABS-277-1SL-3PEN-DM42-2MX-SC
	B	Wall-washing luminaire, (2) 50W CFL lamps with integral ballast, mounted with external yoke on ceiling canopy. The finish is bright aluminum housing with silver end plates, yoke and canopy. 277V, with dimming ballast, and custom-mounted as noted.	Elliptipar	F113-X250-F-01-V-000
	C	LED floodlight with 40 degree spread lens, with 5200 lumens and 16.7 million additive RGB colors, with 90,000 hours of L50 lumen maintenance at 25C, DMX control. Housed in die-cast aluminum, powder-coated finish and containing a tempered glass lens	Color Kinetics	ColorReach Powercore with 40 degree Spread Lens

	D	ED-17 70W Ceramic Metal Halide lamp in track fixture. Die-cast aluminum lamp housing with no exposed hardware, extruded aluminum ballast housing and powder coat paint. High performance faceted and peened specular aluminum reflector, 90 degree tilt and 358 degree rotation, vertical aiming angle indicator and locking vertical adjustment	Amerlux	ASPV ED-17 MH

Luminaire Schedule (continued)

Luminaire Type	Lamp Manufacturer	Lamp	Lamp Catalog Number	Initial Lumens	Design Lumens	CCT	CRI	Volts	Mounting
A	Philips	(4) 42W CFL	CFTR42W/GX 24q/835	3200	2720	3500	82	277	Pendant
B	Philips	(2) 50W CFL	FT50W/2GII/ RS/835	4300	3870	3500	82	277	See Note 1
C	N/A	LED	N/A	5200	5200	N/A	N/A	100-240VAC	See Note 2
D	Philips	(1) 70W Ceramic MH	MHC70/U/M P/4K/ALTO	5800	4060	4000	92	277	Track. See Note 3

Luminaire Schedule (continued)

Luminaire Type	Ballast Manufacturer	Number of Ballasts	Ballast Catalog Number	Input Watts	Line Amps	Note
A	Advance	2	VEZ-2T42-M3-LD	98	0.33	

B	Advance	1	ICN-2S54	115	0.43	
C	N/A	1	N/A	290	1.05	
D	Advance	1	71A5292-001D	90	0.8	

LLF Table

Luminaire Type	BF	Cleaning	Maintenance Category	LLD	LDD*	RSDD	Total LLF
A	1.0	12 month	IV	0.85	0.89	0.95	0.72
B	1.1	12 month	IV	0.9	0.89	0.95	0.84
C	1	12 month	II	1	0.94	1	0.94
D	1	12 month	IV	0.7	0.89	0.95	0.59

**Assumes Clean Dirt Condition*

Mounting Notes

1. This luminaire shall be surface mounted to the ceiling with mounting equipment from the manufacturer. See the cut sheet for details.
2. The LED floodlight shall be mounted to the concrete structural columns according to the specifications shown on the attached detail drawings.
3. The track light shall be surface mounted to structural steel tubing according to the specifications shown on the attached detail drawings. The steel tubing shall be suspended from the ceiling.

Design Criteria

Illuminance: Because this space is a multipurpose area, the potential Illuminance needs to be higher than a typical Terminal Waiting Room. It could be used more as a Meeting Conference Room, in which case the Horizontal Illuminance criterion is 30 fc. While used for a Terminal Waiting Room, the Horizontal Illuminance should be 5 fc. The Ticket Counters should have a higher Illuminance than the general surroundings, at 50 fc according to IES guidelines for a ticket counter.
Luminance: It is important that there are no unintentional light scallops on the walls because this variation of luminances is distracting. Also, the southern wall should have a higher luminance than other walls.

Glare: Because of the building orientation, dimensions of the space and window height, glare consideration due to the sun are not critical. From electric light, it is more critical that there is minimal glare near the Ticket Counter area.

VDT: VDT criteria should be considered for the mounting of flat panel LCD video displays on columns. It is important that the VDTs have a diffuse screen.

Accent Lighting: Wall emphasis can enhance the space.

Color Appearance: The wooden wall will look the best under warm CCT. High CRI is important because there will be lots of face-to-face communication.

Psychological Aspects: The space should feel spacious since many people will occupy the area at once. To create a pleasant environment, non-uniform lighting and wall emphasis should be used.

Appearance of Space and Luminaires: The space should be able to accommodate the look and feel of a dance hall at one event and a Transportation Terminal Waiting Room during the next building use.

Controls: It is important for the space to have controlled zones because not all electric lights need to be on all the time. There must be at least one control device in this space since it is greater than 10,000 SF (ASHRAE 90.1).

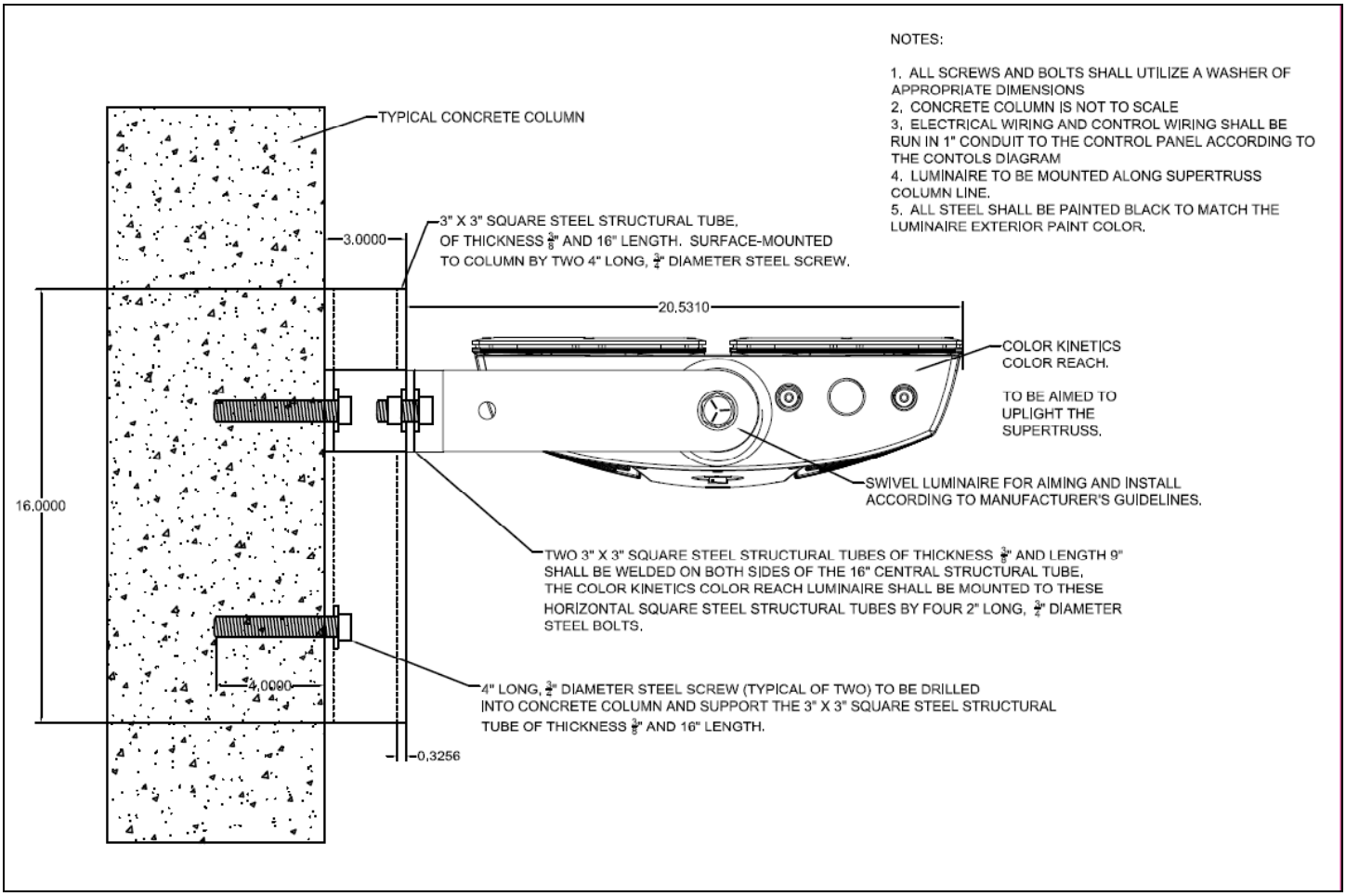
Power Allowance: According to ASHRAE 90.1, 1.3 W/SF is the maximum allowable.

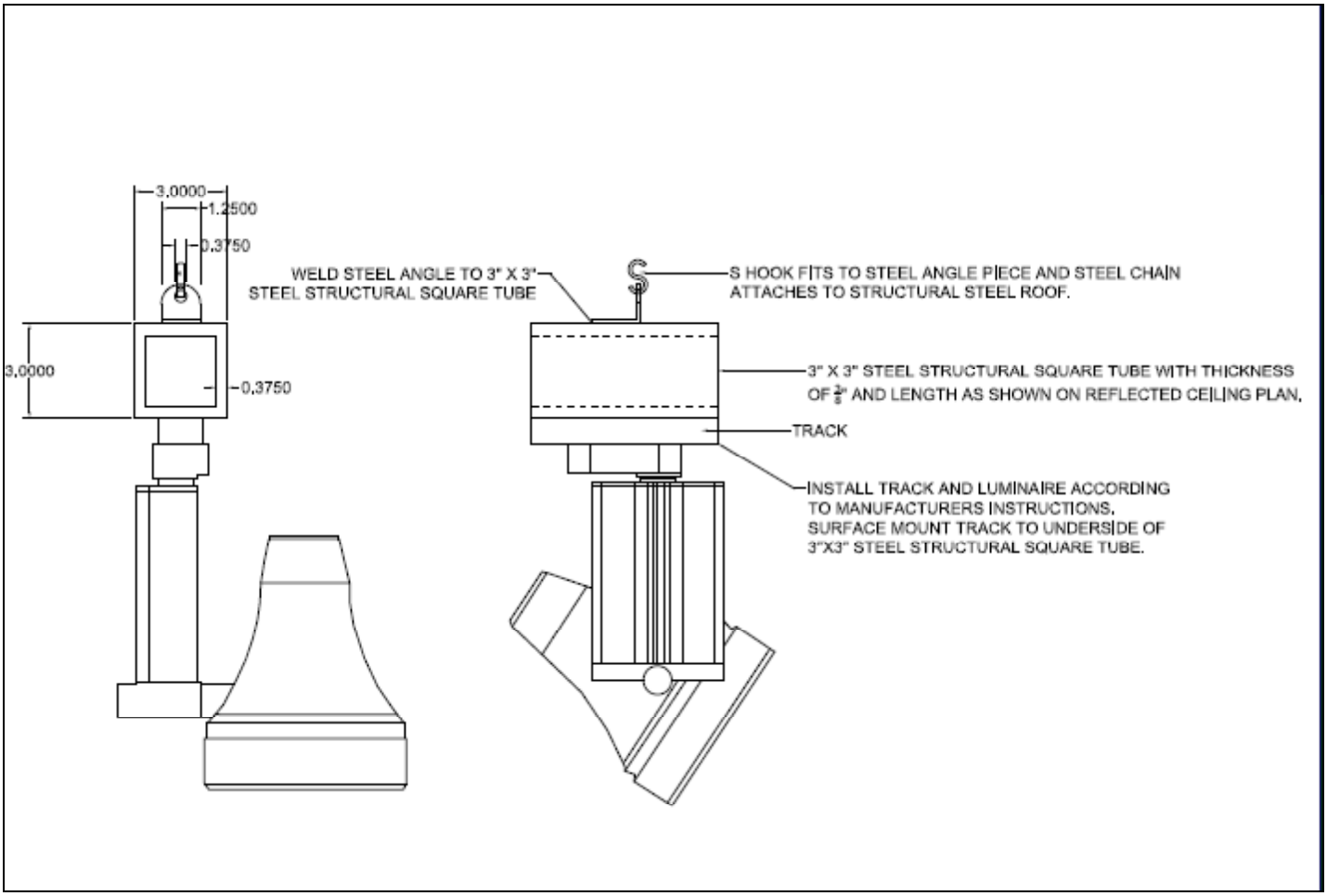
Daylight: Incorporate daylight into the space to save energy, without causing glare.

Lighting Plan

See the lighting plan in the electrical section of this report.

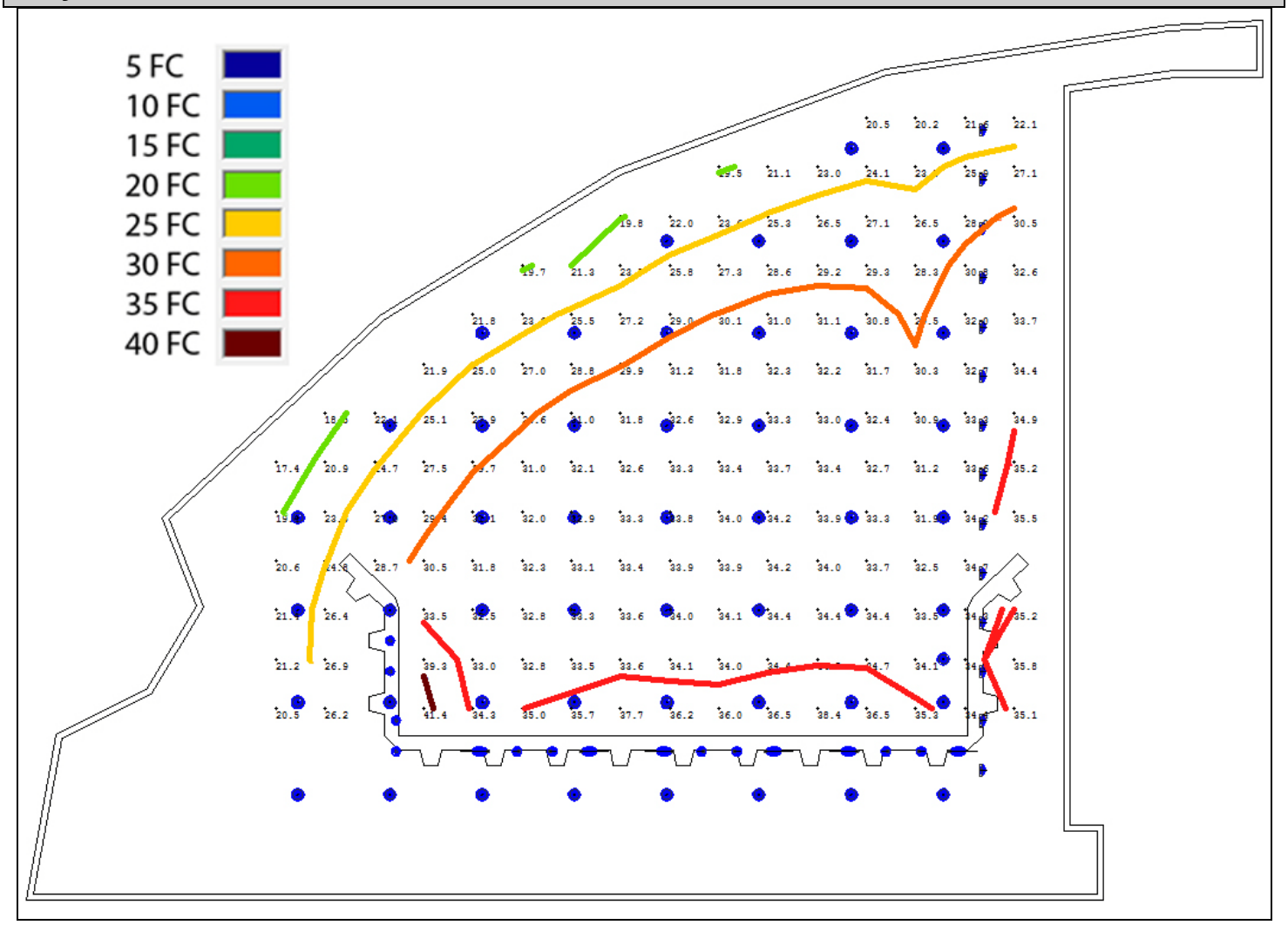
Details


NOTES:
1. ALL SCREWS AND BOLTS SHALL UTILIZE A WASHER OF APPROPRIATE DIMENSIONS
2. CONCRETE COLUMN IS NOT TO SCALE
3. ELECTRICAL WIRING AND CONTROL WIRING SHALL BE RUN IN 1" CONDUIT TO THE CONTROL PANEL ACCORDING TO THE CONTOLS DIAGRAM
4. LUMINAIRE TO BE MOUNTED ALONG SUPERTRUSS COLUMN LINE.
5. ALL STEEL SHALL BE PAINTED BLACK TO MATCH THE LUMINAIRE EXTERIOR PAINT COLOR.
TYPICAL CONCRETE COLUMN
3" X 3" SQUARE STEEL STRUCTURAL TUBE, OF THICKNESS 3/8" AND 16" LENGTH. SURFACE-MOUNTED TO COLUMN BY TWO 4" LONG, 3/4" DIAMETER STEEL SCREW.
3.0000
20.5310
COLOR KINETICS COLOR REACH.
TO BE AIMED TO UPLIGHT THE SUPERTRUSS.
SWIVEL LUMINAIRE FOR AIMING AND INSTALL ACCORDING TO MANUFACTURER'S GUIDELINES.
16.0000
TWO 3" X 3" SQUARE STEEL STRUCTURAL TUBES OF THICKNESS 3/8" AND LENGTH 9" SHALL BE WELDED ON BOTH SIDES OF THE 16" CENTRAL STRUCTURAL TUBE. THE COLOR KINETICS COLOR REACH LUMINAIRE SHALL BE MOUNTED TO THESE HORIZONTAL SQUARE STEEL STRUCTURAL TUBES BY FOUR 2" LONG, 3/4" DIAMETER STEEL BOLTS.
4.0090
4" LONG, 3/4" DIAMETER STEEL SCREW (TYPICAL OF TWO) TO BE DRILLED INTO CONCRETE COLUMN AND SUPPORT THE 3" X 3" SQUARE STEEL STRUCTURAL TUBE OF THICKNESS 3/8" AND 16" LENGTH.
0.3256

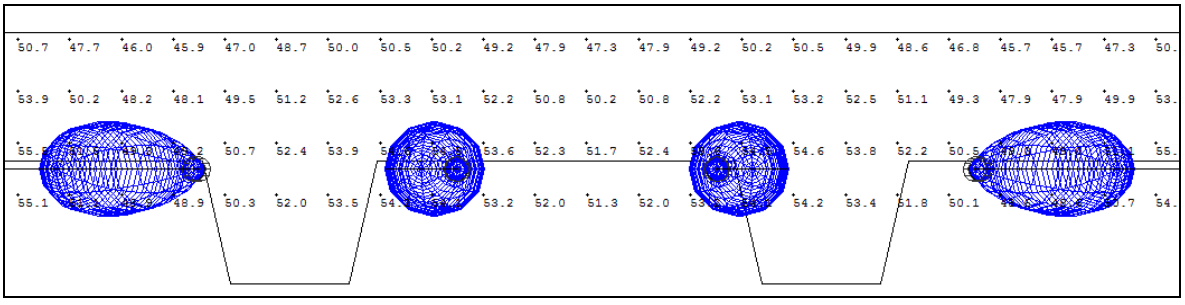


Luminaire “Type B” will be mounted with equipment provided by the manufacturer. More information about the mounting is found on the cutsheet.

Performance data

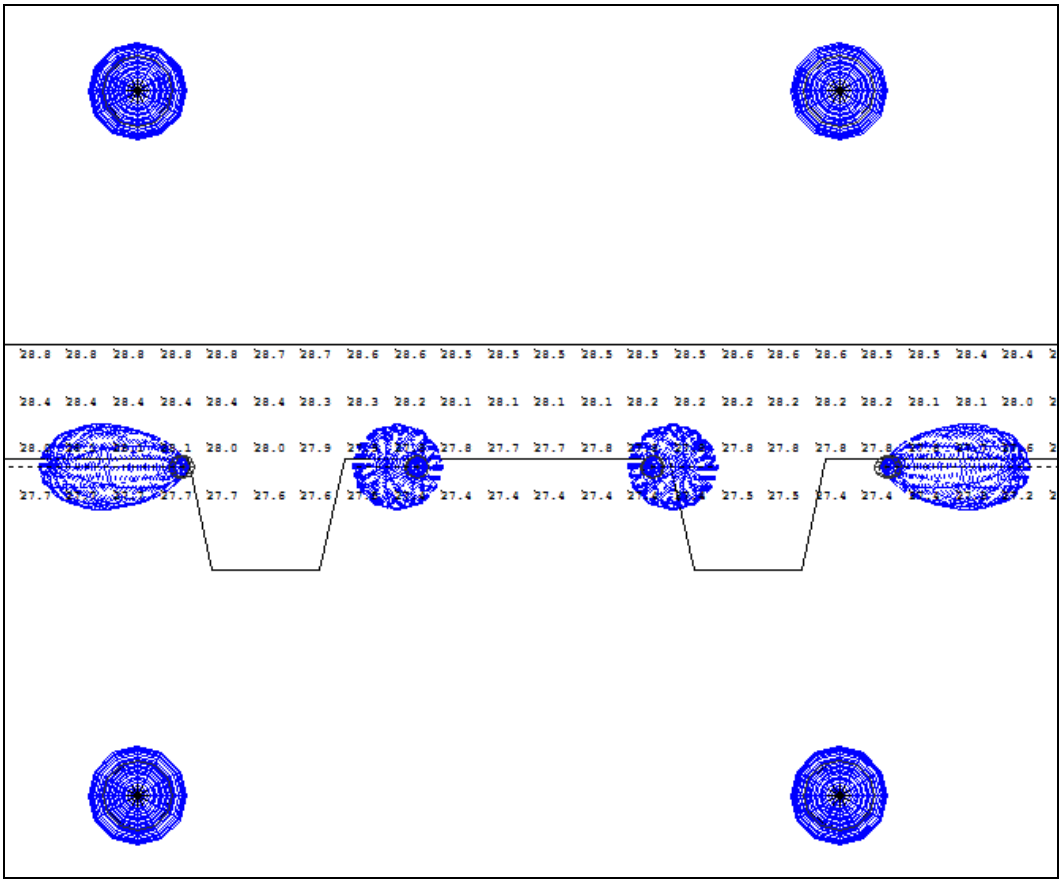


Average Illuminance: 29.6 fc. This satisfies the design criterion of 30 fc. for activities requiring a higher illumination level than the Terminal Waiting Room classification under IESNA's recommendations. This is the maximum electrical light that the space will receive. The lamps will be dimmed when less light is required, or when there is daylight contribution.

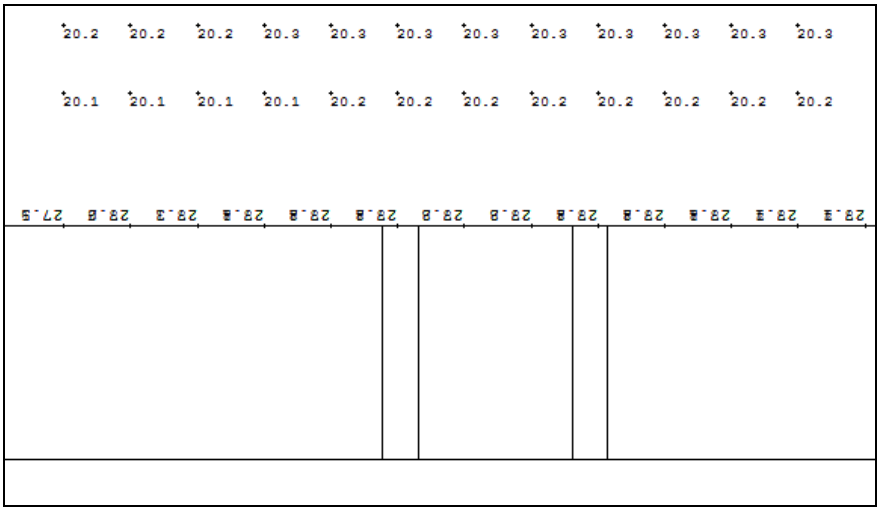


With the direct light contribution from the flood lamps (Luminaire Type "D"), the design criterion of 50 fc on the ticket counter work plan is satisfied with the calculated value of 51.6 fc. Luminaire Type "D" contributes about 50% to 60% of

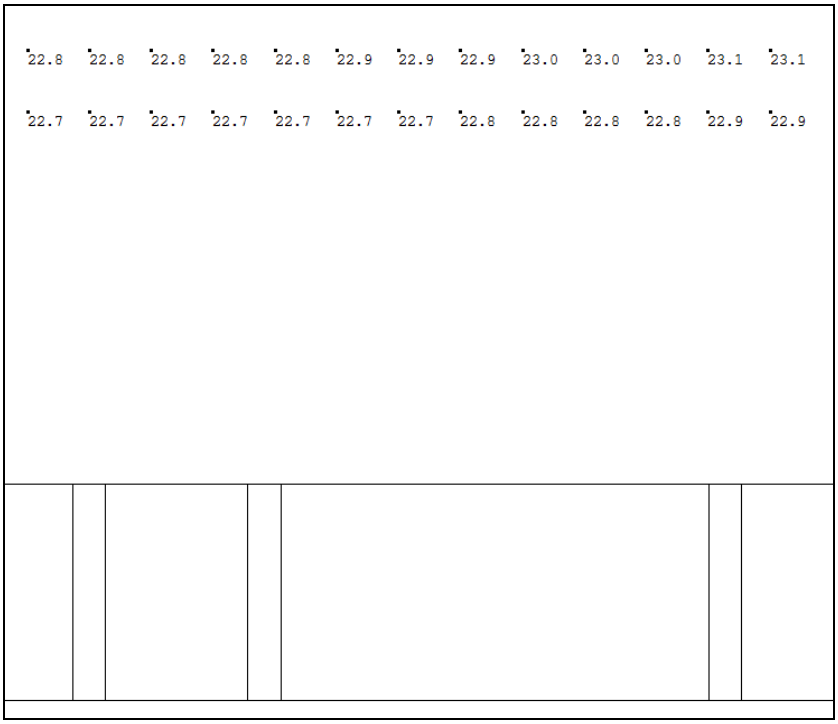
the total illuminance on the ticket counters. Luminaire Type “A” contributes the remainder. These two contributions reduce the contrast of shadows cast from the overhead Luminaire Type “D”.



The above image shows that there are roughly 27 fc. on the ticket counter when the overhead light (Luminaire Type “D”) is neglected.



The above image shows in elevation view that 20 fc of vertical illuminance is achieved for facial illumination at the ticket counters. This satisfies the criterion of facial illumination.



However, there is significant vertical illuminance on the LCD televisions which are mounted on the columns facing into the space. This is not problematic because the televisions have a diffuse screen and high luminance.

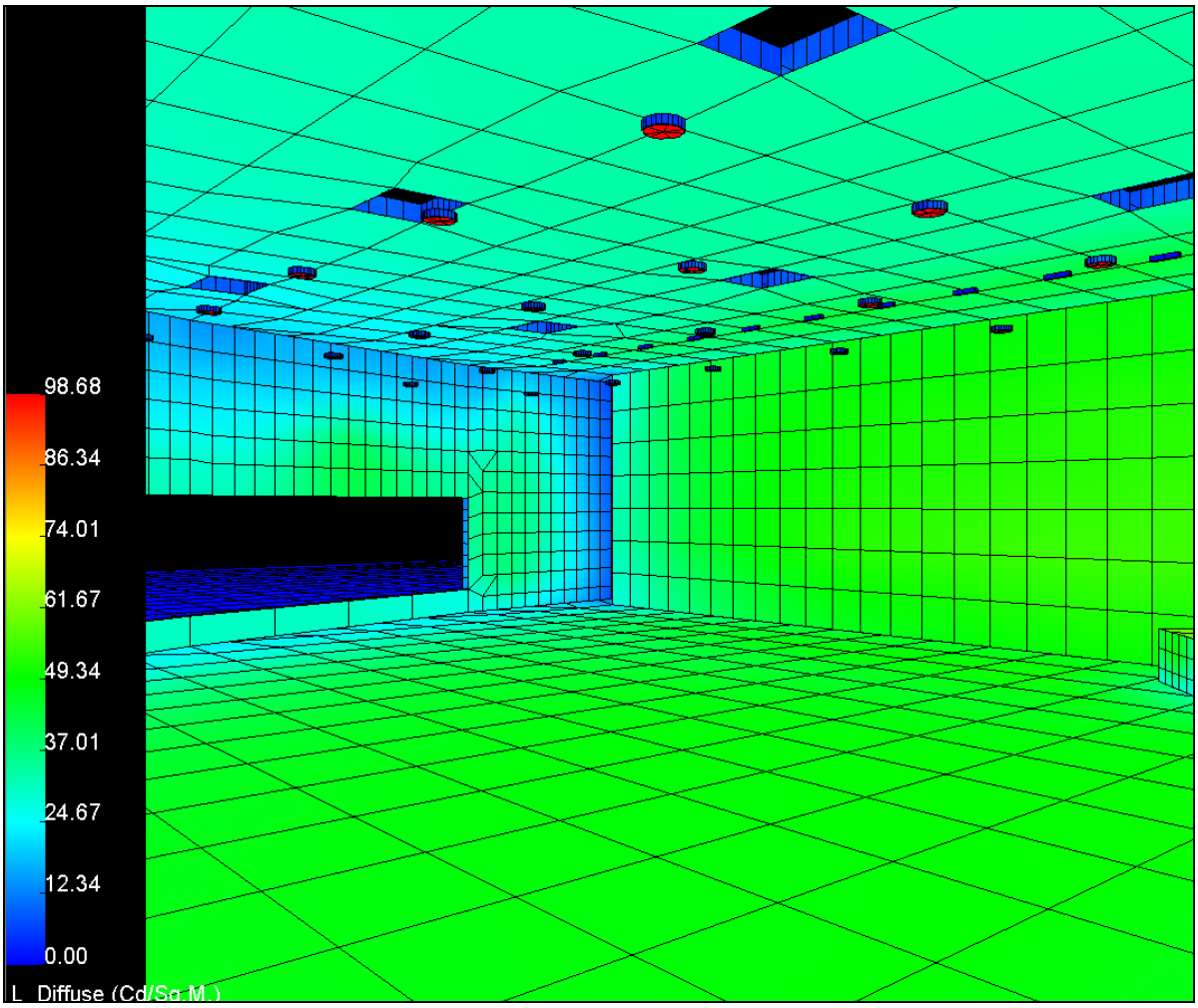
Design Criteria Satisfied:

The solution meets the design criteria for illuminance and luminance, as demonstrated in the preceding images. In addition to this criteria, the following shows how other design criteria are met:

- Illuminance: (see previous discussion)
- Luminance: (see previous discussion)
- Glare: Glare is not a problem in the proposed solution because the luminaire mounting locations are fairly high.
- VDT: (see previous discussion)
- Accent Lighting: The southern wall is washed with light from Luminaire “Type B”.
- Color Appearance: The lamp type that washes the wooden wall is fairly warm (3500K). All of the lamps in the space have an acceptably high CRI ranging from 82 to 92.
- Psychological Aspects: Non-uniform lighting contributes to a spacious feeling.
- Appearance of space and luminaires: The color-changing LEDs that graze the supertrusses can be controlled to enhance the spacious feel, or dynamically altered to create a more festive feeling for entertainment.
- Controls: (see the following discussion)
- Power Allowance: (see the following discussion)
- Daylight: (see the following discussion)

Renderings and Images:

The following image shows that the southern wall has a higher luminance than the other walls, which satisfies a design criterion.



Power Allowance:

Space	Usage	Luminaire Type	# Luminaires	Number of Ballasts	ballast input watts	Total Watts
Waiting Area	Ambient	A	51	2	98	9996
	Task	A	12	2	93	2232
	Wall-Wash	B	14	1	115	1610
	LED	C	5	1	290	1450

Waiting Area Total Watts Sum:	15288
Space Square Feet:	12063
Actual W/SF:	1.27
Allowable W/SF:	1.3
	Acceptable
Additional Allowable Watts:	394

Controls

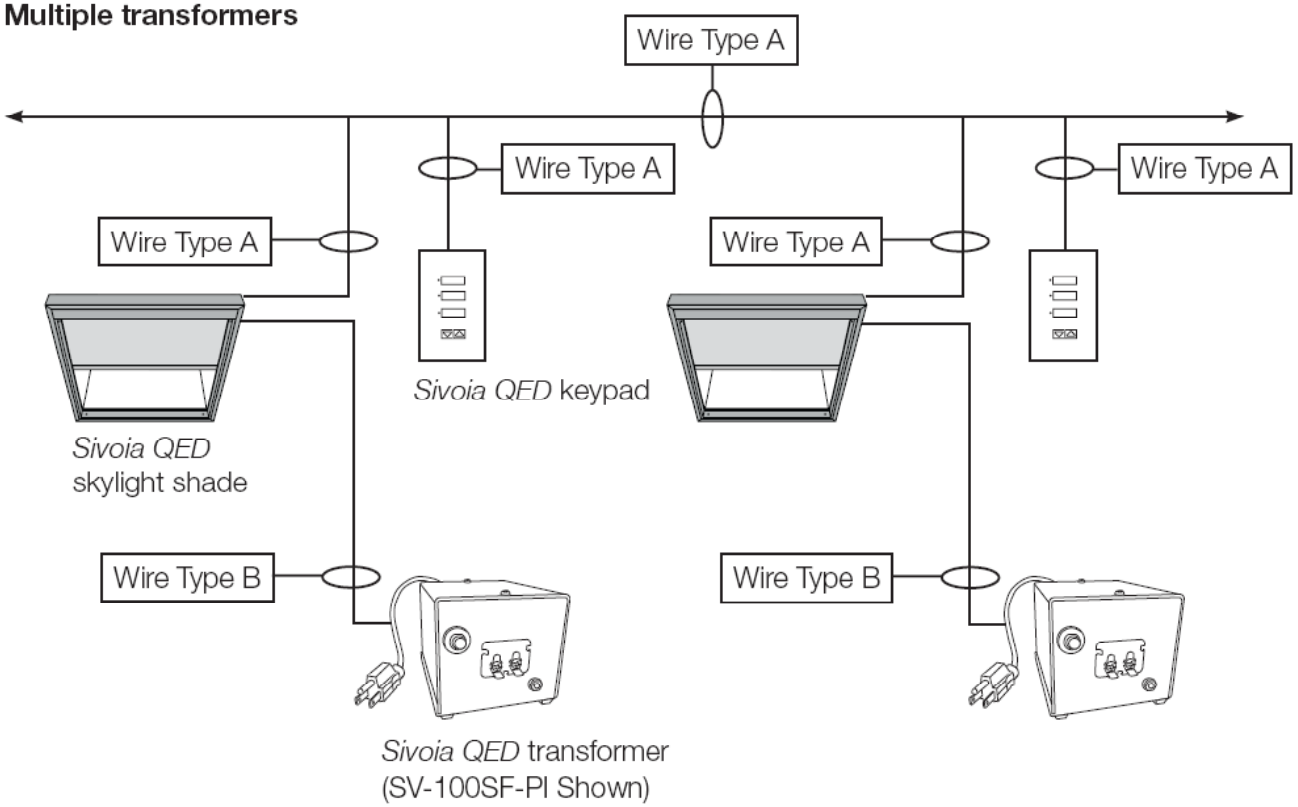
The space will be controlled by a Lutron system as shown. Three lighting panels will be located in the Electrical Closet, which is near the Conference Room on the second floor. The various control units will be located in the space in lockable column-mounted enclosures. This ensures that only authorized personnel can access the lighting controls. Two photo sensors connect to the Photocell Interface, which then allows Luminaires of "Type A" to dim accordingly. Occupancy sensors turn off the lights when the space has not been in use, and a timeclock device ensures energy is not wasted after events are over. For more system information, see the "Controls" section of this report.

Sivoia QED® Skylight Shade (4.75 inch frame) Tension Shade

085-111 7 02.04.09

System wiring

Multiple transformers



NOTE
The *Sivoia QED* link supports up to 96 devices (EDU's, Sivoia QED keypads and control closures)

In addition to the Main Unit 1 controller, there are three smaller controls which can set the lighting to up to four different scenes.

Examples of scenes are:

PRESET SCENE SCHEDULE							
Schedule For: Waiting Area / Ticket Queuing							
Lighting Zone	**Luminaire Type(s)**	**Load Type**	**Day Cruise**	**Night Cruise**	**Conference**	**Entertainment**	**All Off**
1	B	CFL	0%	100%	100%	100%	0%
2	D	CMH	0%	100%	0%	0%	0%
3	D	CMH	0%	100%	0%	0%	0%
4	C	LED	0%	100% (Note 1)	0%	100% (Note 2)	0%
5	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
6	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
7	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
8	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
9	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
10	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
11	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
Skylight Shades							
1			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
2			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
3			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
4			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
5			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
6			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
7			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
8			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
9			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
10			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
11			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
12			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
Note 1	Color-changing mode. Colors are set to blues, greens, purples						
Note 2	Color-changing mode. Colors are set to all colors						

In addition, there are three occupant sensors and 2 daylight photo sensors which will allow the general ambient lights to dim when there is sufficient daylight contribution. Also, shading devices are linked to this control system so that the effective transmittance of the skylights is decreased. This allows the occupants (or facility manager) to have control over the daylight contribution.

Controls: Zones

Each circuit in the Waiting Area / Ticket Queuing is also its own zone. This allows for more precise daylight controlling.

Waiting Area / Ticket Queuing GP Dimming Panel Load Schedule

Panel Name: Panel Unit 1
Lutron Model No.: GP12-2774ML-20
Panel Address / Location: 1 /

Area/Room	Customer Circuit #	Customer Zone	Lutron Circuit #	Lutron Zone	Zone/Circuit Description	Load Type	Actual Load (W/VA)	Max. Load (W/VA)	BRKR Size	Phase
Waiting Area / Ticket Queuing	1	1	1	A1-1	Wall Washing	FL - Hi-Lume	1610	4432	20A-1P	A
Waiting Area / Ticket Queuing	2	2	2	A1-2	Ticket Counter	MHN / HPS	1890	4432	20A-1P	B
Waiting Area / Ticket Queuing	5	5	3	A1-5	Ambient	FL - Hi-Lume	1488	4432	20A-1P	C
Waiting Area / Ticket Queuing	7	7	4	A1-7	Ambient	FL - Hi-Lume	1488	4432	20A-1P	A
Waiting Area / Ticket Queuing	8	8	5	A1-8	Ambient	FL - Hi-Lume	1488	4432	20A-1P	B
Waiting Area / Ticket Queuing	6	6	6	A1-6	Ambient	FL - Hi-Lume	1488	4432	20A-1P	C
Waiting Area / Ticket Queuing	10	10	7	A2-2	Ambient	FL - Hi-Lume	1116	4432	20A-1P	A
Waiting Area / Ticket Queuing	11	11	8	A2-3	Ambient	FL - Hi-Lume	1116	4432	20A-1P	B
Waiting Area / Ticket Queuing	9	9	9	A2-1	Ambient	FL - Hi-Lume	1302	4432	20A-1P	C
Waiting Area / Ticket Queuing	3	3	10	A1-3	Ticket Counter	MHN / HPS	150	4432	20A-1P	A
			11		Spare		0	4432	20A-1P	
			12		Spare		0	4432	20A-1P	

277V, 3Ø-4 Wire Main Lugs GP Dimming Panel containing 1 20A-1Pole branch breaker rated at 14,000AIC for each of the 12 dimming circuits. Max input feed = 80A

Feed Type: Normal

Phase A: 4364 W/VA
Phase B: 4494 W/VA
Phase C: 4278 W/VA

Waiting Area / Ticket Queuing XP Switching Panel Load Schedule

Panel Name: Panel Unit 2
Lutron Model No.: XP4-1204ML-20
Panel Address / Location: 2 /

Area/Room	Customer Circuit #	Customer Zone	Mod	Lutron Circuit #	Lutron Zone	Zone/Circuit Description	Voltage	Load Type	Actual Load (W/VA)	Max. Load (W/VA)	BRKR Size	Phase
	4	4	1	1	A1-4	LED	120V	Non-Dim	1740	1920	20A-1P	A
				2		Spare	120V		0	1920	20A-1P	A
				3		Spare	120V		0	1920	20A-1P	B
				4		Spare	120V		0	1920	20A-1P	B

277V, 3Ø-4 Wire Main Lugs XP Switching Panel containing 1 20A-1Pole branch breaker rated at 10,000AIC for each of the 4 switching circuits. Max feed = 40A

Feed Type: Normal

Phase A: 1740 W/VA
Phase B: 0 W/VA
Phase C: 0 W/VA

Daylighting in Waiting Area: Details

The actual building design does not include skylights, but merely windows on the southwest and north walls. This daylighting study looks at the addition of 15 skylights in the Waiting Area / Ticket Queuing area. In addition to these skylights, the existing windows contribute to the total illuminance in the space. Both the windows and skylights are analyzed in this report. The only luminaire which will be linked to daylighting controls is Luminaire "Type A," which provides general ambient light in the space.

The model used in the daylighting study was created with regions in 3D Autocad. Each surface type was placed on a different layer type. Then, the model was imported into AGI32 for calculations. In AGI32, the correct building orientation was defined, and appropriate reflectance values were applied to each layer. These values align with the values estimated in Technical Report #1. The window transmittance was estimated to be 70%, and the skylight transmittance was 92%, according to the product selection from AIA Industries specifications. The ground reflectance was estimated to be 20%. The daylighting study consisted of 7 different dates (December 21st through June 21st) on monthly intervals. A summary of the study is as follows:

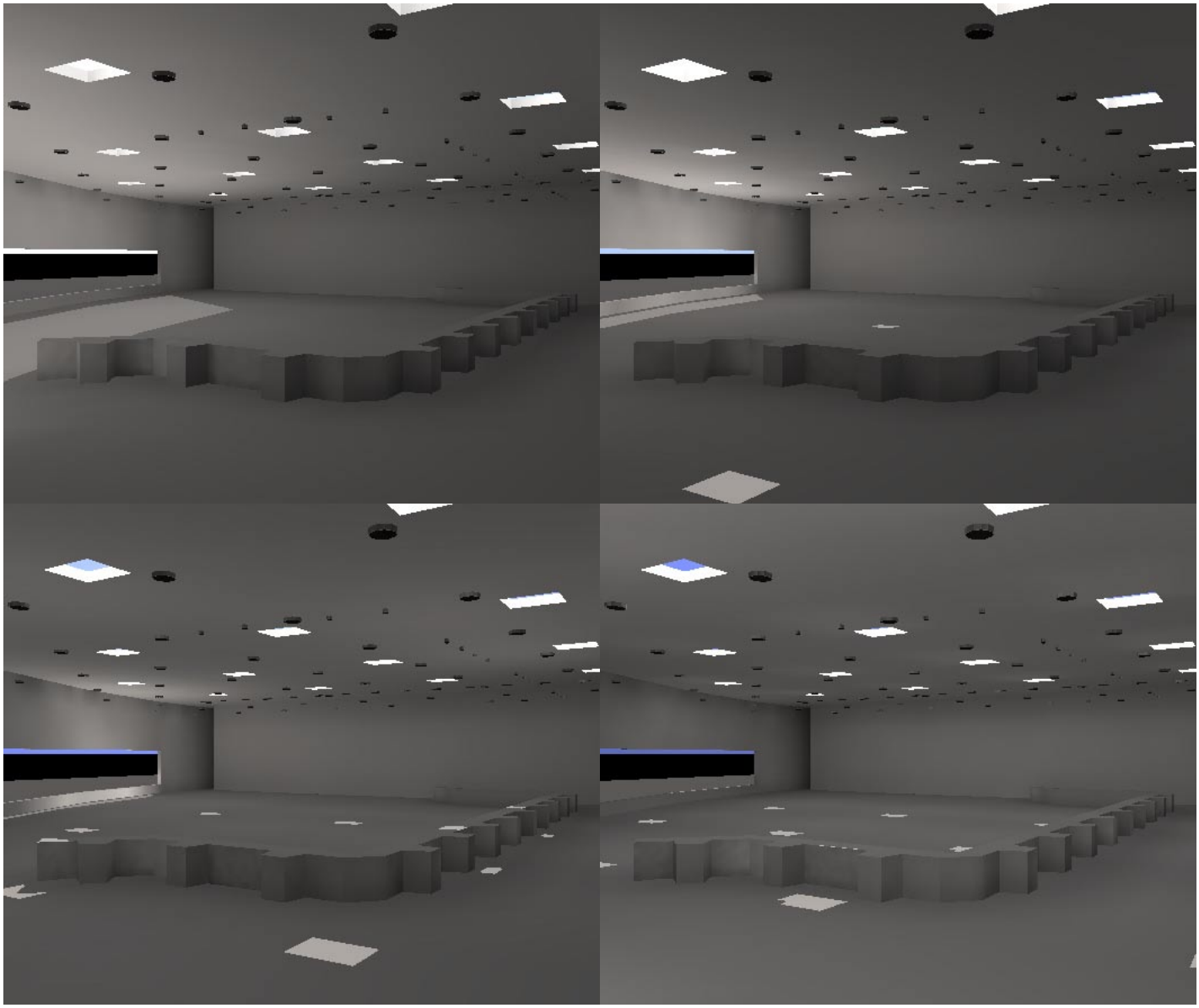
- Site Name: Norfolk, Virginia
- Site Latitude: 36.91N
- Site Longitude: 76.2019 W
- Site Compass: 158 degrees (See Figure)
- Sky Conditions: Clear
- Electric Lighting: Off
- No Daylight Savings
- 21st day of the month at 12:00pm

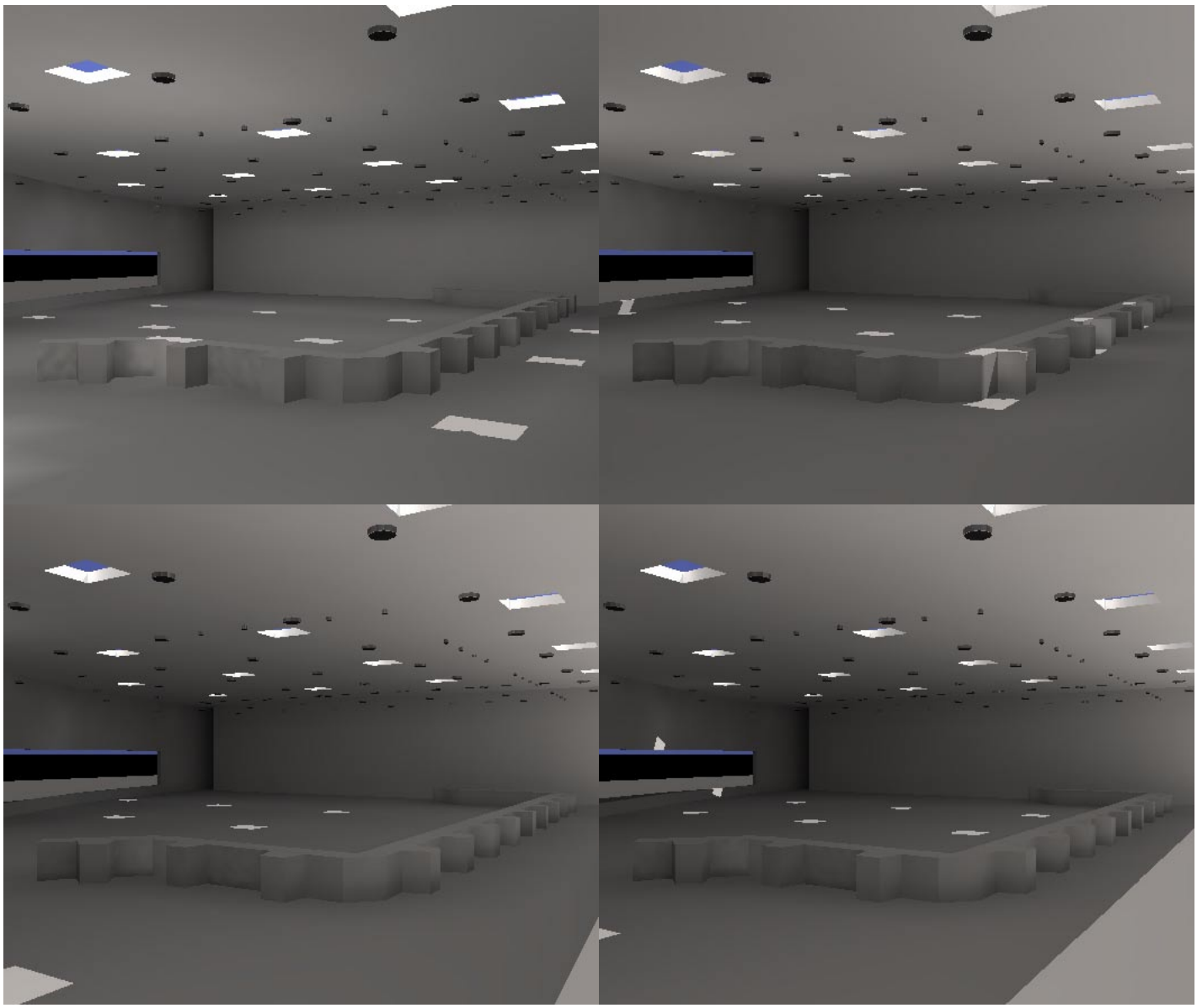
Waiting Area / Ticket Queuing: Daylight Study		
Month	**Day**	**Average Illuminance (fc)**
December	21	77.5
January	21	55.6
February	21	149.5
March	21	140.5
April	21	237.4
May	21	60.0
June	21	223.9

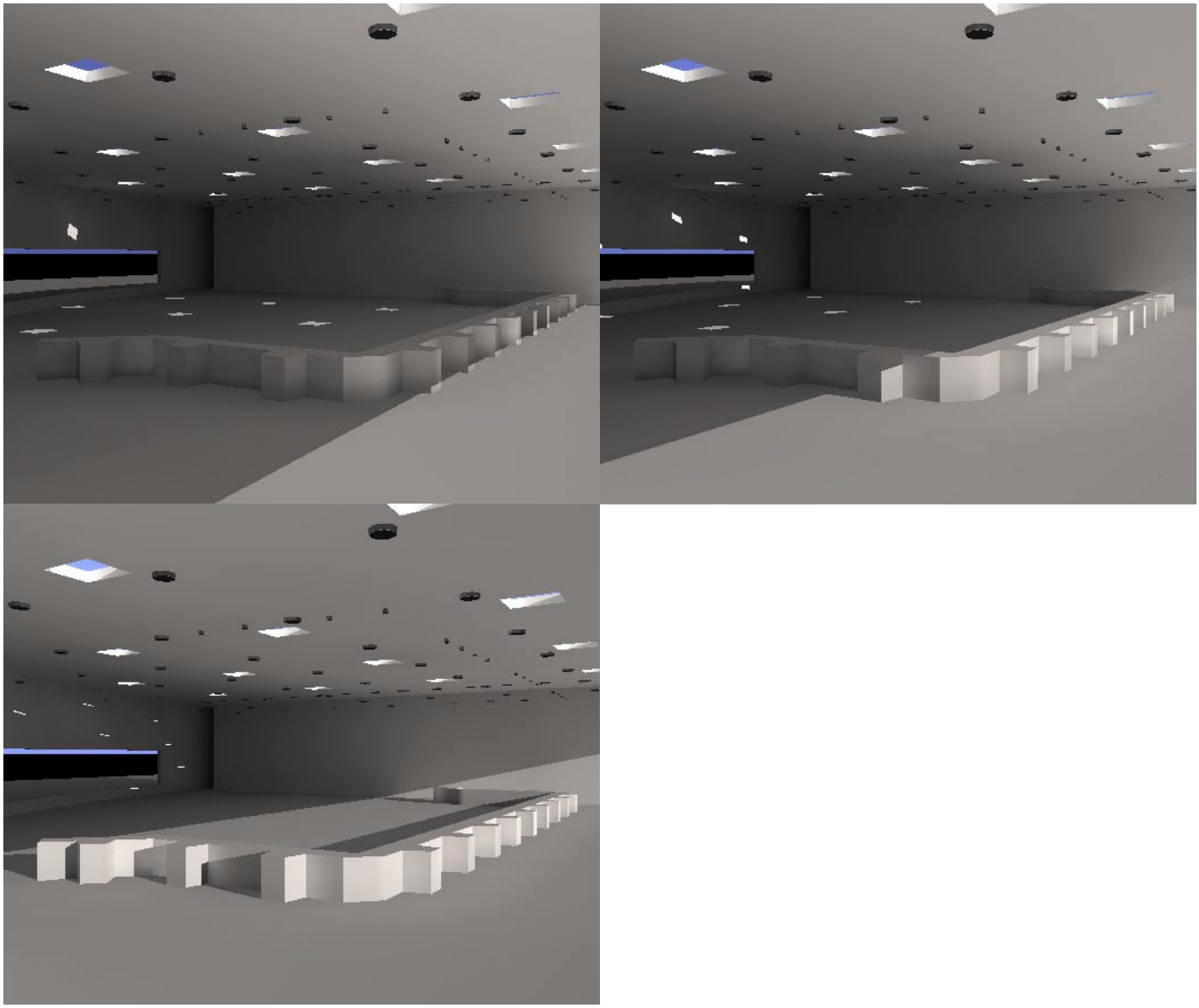
Since the illuminance due to daylight exceeds the design criteria throughout the year, it is desirable to use shading devices controlled by photosensors. This is discussed more in the "Controls" section of the report. It is important to note that since this is a circulation space, its lighting can be dynamic. It is not problematic for direct sun penetration since guests are not expected to be reading for long periods of time, or participating in some other task where direct sunlight is undesirable. This space is much different than, say, the Conference Room, which must have more control of daylight due to the tasks the occupants perform.

The illuminance calculations shown in the preceding table were calculated with AGI32. The same skylight layout was then applied in 3ds Max for rendering.

The following sequence of images shows how the sunlight penetration changes from sunrise to sunset on March 21. It is interesting to note that as the day progresses, there is more daylight penetration.







Details on the skylight used are as follows:

A.I.A. Industries, Inc.

290 East 56th Avenue Denver, Colorado 80216

Brochure Cover Specs. Sizes Glazing Installation Skylight Cut Sheet Home

Custom Sizes Available

Standard Curb Mount Skylights

Square

Model #	Outside Curb Dimensions	Inside Curb Dimensions	Styles		
1616	17 1/2 x 17 1/2	14 1/2 x 14 1/2	-	G	P
2121	22 1/2 x 22 1/2	19 1/2 x 19 1/2	V	G	P
2424	25 1/2 x 25 1/2	22 1/2 x 22 1/2	V	G	P
3232	33 1/2 x 33 1/2	30 1/2 x 30 1/2	V	G	P
3939	40 1/2 x 40 1/2	37 1/2 x 37 1/2	V	G	P
4545	46 1/2 x 46 1/2	43 1/2 x 43 1/2	V	G	P
4848	49 1/2 x 49 1/2	46 1/2 x 46 1/2	V	G	P
5757	58 1/2 x 58 1/2	55 1/2 x 55 1/2	-	G	P
7171	72 1/2 x 72 1/2	69 1/2 x 69 1/2	-	G	P
7777	78 1/2 x 78 1/2	75 1/2 x 75 1/2	-	G	P
9292	93 1/2 x 93 1/2	90 1/2 x 90 1/2	-	G	P
9494	95 1/2 x 95 1/2	92 1/2 x 92 1/2	-	G	P

Rectangular

Model #	Outside Curb Dimensions	Inside Curb Dimensions	Styles		
1624	17 1/2 x 25 1/2	14 1/2 x 22 1/2	V_1	G	P
1632	17 1/2 x 33 1/2	14 1/2 x 30 1/2	V_1	G	P
1636	17 1/2 x 37 1/2	14 1/2 x 34 1/2	V_1	G	P
1648	17 1/2 x 49 1/2	14 1/2 x 46 1/2	V_1	G	P
2146	22 1/2 x 47 1/2	19 1/2 x 44 1/2	V	G	P
2432	25 1/2 x 33 1/2	22 1/2 x 30 1/2	V	G	P
2436	25 1/2 x 37 1/2	22 1/2 x 34 1/2	V	G	P
2448	25 1/2 x 49 1/2	22 1/2 x 46 1/2	V	G	P
2471	25 1/2 x 72 1/2	22 1/2 x 69 1/2	-	G	P
2492	25 1/2 x 93 1/2	22 1/2 x 90 1/2	-	G	P
3248	33 1/2 x 49 1/2	30 1/2 x 46 1/2	V	G	P
3271	33 1/2 x 72 1/2	30 1/2 x 69 1/2	-	G	P
4871	49 1/2 x 72 1/2	46 1/2 x 69 1/2	-	G	P
4892	49 1/2 x 93 1/2	46 1/2 x 90 1/2	-	G	P
6071	61 1/2 x 72 1/2	58 1/2 x 69 1/2	-	G	P

Domes available in all of the above

V= Vent Domes (1 = opens long side only) G = Glass P = Pyramids

Brochure Cover Specs. Sizes Glazing Installation Skylight Cut Sheet Home

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Glazing Properties

	Transmittance		Shading Coefficient	
	Visible Light	Solar Energy	Single Glazed	Double Glazed
Acrylic				
Clear	92 %	85 %	0.98	0.89
Standard White	56 %	52%	0.56	0.46
Bronze	27%	35%	0.53	0.43
Glass 1"				
Clear	79%	61%	-	0.81
Bronze	48%	39%	-	0.58
Heat Mirror 66 Glass 1 1/2"				
Clear	53%	26%	-	0.39
Bronze	32%	16%	-	0.28

Insulating Properties

	U Values BTU's/Hr./Sq. Ft/°F		R Values	
	Winter Heat Loss	Summer Heat Gain	Winter Heat Loss	Summer Heat Gain
3/16" Acrylic				
Single Glazed	1.20	0.80	0.83	1.25
Double Glazed	0.70	0.50	1.42	2.00
Triple Glazed	0.50	0.30	2.00	3.33
Glass 1"	0.48	0.55	2.08	1.82
Heat Mirror 66 Glass 1 1/2"	0.22	0.24	4.55	4.17

All Figures are average and may vary with thickness of sheet and actual tint

Contact A.I.A. Industries, Inc. for more specific properties and full selection of glazing materials

Double Dome skylights are subject to formation of condensation between domes. this may be objectionable when both domes are transparent. Expansion and concentration of acrylic glazing may cause audible popping.

A.I.A. skylights are not designed to support people. Safety devices should be used around skylights for personal safety

A.I.A. Industries, Inc. is continually improving its products and may change sizes and details at any time. All information in this web site is subject to change without notice

Additional information can be found in the “Skylight Analysis” section of the report. This includes mechanical and structural impacts as well as energy and cost saving analysis. Specific information regarding the skylight selection can be found in the Miscellaneous Equipment Appendix

Space 2: Lobby

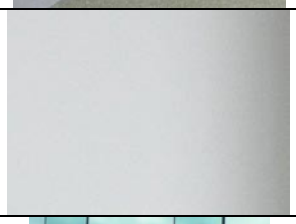
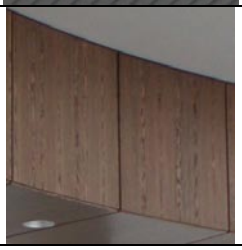
Spatial Overview

The Lobby is the first major room that passengers enter from the Entry Pavilion Bridge. It is approximately 37'-6" high and includes a 54'-2" embedded mermaid image on the terrazzo-finished floor (Figure 1). There are several tiers of finished ceiling stepping up to the highest ceiling point (Figure 3). The windows on the western wall are full-height. Stemming from the Lobby are two Conference Rooms, two exits to an outdoor terrace, and four X-ray stations which lead to the Passageway.

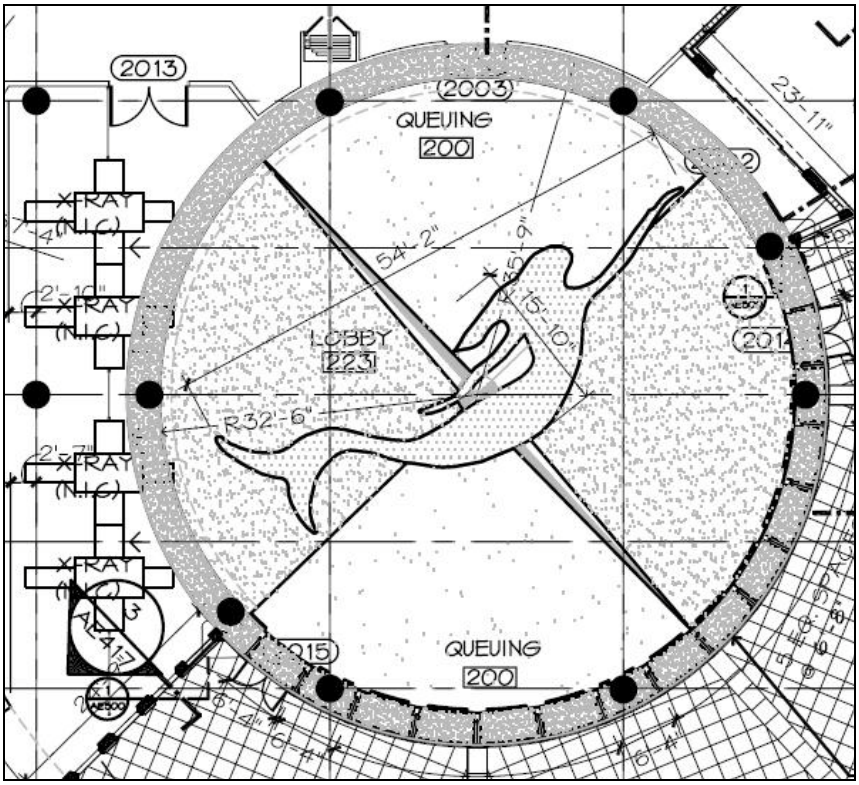
Finishes

Materials in the Lobby contain cool, low saturated colors. The floor is semi-specular, but the other surfaces are mostly diffuse. The lower tier of ceiling has a warm wood finish.

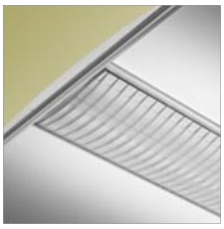
Materials

Floor: Terrazzo Tile – Reflectance 50% (Assumed)	
Walls: Skimcoat plaster over Gypsum Wall Board. Reflectance 70% (Assumed)	
Glass: Transmittance 20% (Assumed)	
Ceiling: Metal finish. Reflectance 10% (Assumed)	
Ceiling Wood: Reflectance 15% (Assumed)	

Plan and Section Drawings



Luminaire Schedule

Graphic	Luminaire Type	Description	Luminaire Manufacturer	Luminaire Catalog Number
	E	One CFL lamp with a high power factor standard, with one injection molded socket. 13" Pendant-mounted, cylindrical luminaire with glare control. Housing is 0.064" rolled seamless aluminum with durable powder coat painted finish.	Prescolite	CF13P157EB - DM - Z
	F	PAR20 lamp in a sturdy aluminum housed track light luminaire. It is adjustable and self-locking in all horizontal and vertical planes and features a hinged front with relamping handle for easy lamp changing.	Lighting Services Inc	LN20-5A-G
	G	1'x4' shallow direct-indirect recessed luminaire contains (2) T5HO lamps.	Corelite	R1-W-B-2-T5-1-D-UNV-14-T1
	H	Intelligent color-changing cove light. Each luminaire is 12" in length and has a narrow beam pattern of 20 degrees x 60 degrees. The luminaire uses a digital power-processing technology that integrates LED power and data management, which eliminates external power supplies.	Color Kinetics	iColor Cove MX Powercore

Luminaire Schedule (continued)

Luminaire Type	Lamp Manufacturer	Lamp	Lamp Catalog Number	Initial Lumens	Design Lumens	CCT	CRI	Volts	Mounting
E	Philips	(1) 70W CFL	CFTR57W/ GX24q/835	4300	3741	3500	82	277	Pendant
F	Philips	(1) 50W PAR20	50PAR20 / HAL / FL25	550	550			120	Track
G	Philips	(2) T5HO	F54T5 / 835 / HO / A / ALTO	5000	4750	3500	85	277	Downlight
H	N/A	LED	N/A	102	102	N/A	N/A	120	Cove. See Note 1

Luminaire Schedule (continued)

Luminaire Type	Ballast Manufacturer	Number of Ballasts	Ballast Catalog Number	Input Watts	Line Amps
E	Advance	1	IZT-2T42-M3-BS	65	0.27
F	N/A	1	N/A	50	0.42
G	Advance	1	VEZ-2S54	125	0.45
H	N/A	1	N/A	12	0.1

LLF Table

Luminaire Type	BF	Cleaning	Maintenance Category	LLD	LDD*	RSDD	Total LLF
E	1	12 month	IV	0.87	0.88	0.95	0.73
F	1	12 month	IV	1.00	0.88	0.95	0.84
G	1	12 month	IV	0.95	0.88	0.95	0.79
H	1	12 month	VI	1.00	0.86	0.95	0.82

**Assumes Clean Dirt Condition*

Mounting Notes

1. Cove-mounted. See the detailed diagram below.

Design Criteria

Illuminance: The Lobby is unique in the building because there is a significant amount of glass. Combined with lightly colored materials, there is potential for high Illuminance values on the workplane. Even though the IES does not recommend high levels of Illuminance, highly reflective materials along with large amounts of southern-facing glass mean that there will be far more Illuminance than required. Since the Lobby is the first space that people enter, it needs to be a transition space in the sense that the light levels need to help the eyes adjust to the interior environment of other spaces in the building. The light levels should be lower than the daylight on the outside. 5 fc on the work plane is recommended.

Luminance: The luminance ratios from the Lobby to the Passageway should be low, even though the Passageway should be appear less bright.

Glare: This means that the Glare should be considered because of the potential for direct sunlight. At night, glare from electrical lights should be minimized.

VDT: There are two flat panel LCD video monitors mounted from the lower wooden ceiling at approximately 10 feet above the floor. It is important to consider Illuminance values on the screen so that the images are clearly visible.

Accent Lighting: There is little need for accenting displays, except on the northwest wall.

Color Appearance: Color rendering is important.

Psychological Aspects: The space should feel spacious and welcoming. Wall emphasis could be used to make the space feel more spacious, but only at night since the contribution of daylight would render additional electric light practically useless.

Appearance of Space and Luminaires: Sparkle could be used to enhance the feeling of the space. According to the IESNA Handbook, the appearance of the space and luminaires is very important. Since it is a large gathering space where occupants will not spend extended amounts of time reading, direct sunlight penetration is acceptable. It could enhance the space and make it feel large and welcoming. If there were a blind system (which there is not), it could be distracting from how the space should feel. The glass wall provides some shielding simply by its transmittance value. This makes the sky, clouds and water seem darker and bluer.

Controls: It is important for the space to have controlled zones because not all electric lights need to be on all the time. There must be at least two control devices in this space since it is less than 10,000 SF (ASHRAE 90.1).

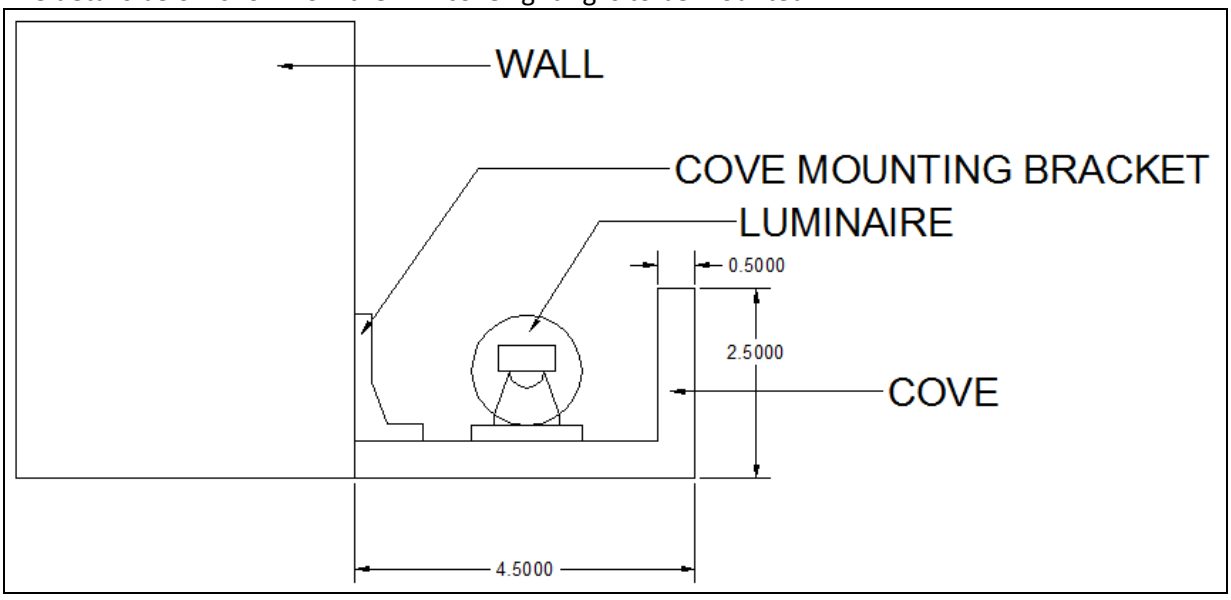
Power Allowance: According to ASHRAE 90.1, 1.3 W/SF is the maximum allowable.

Reflected Ceiling Plan

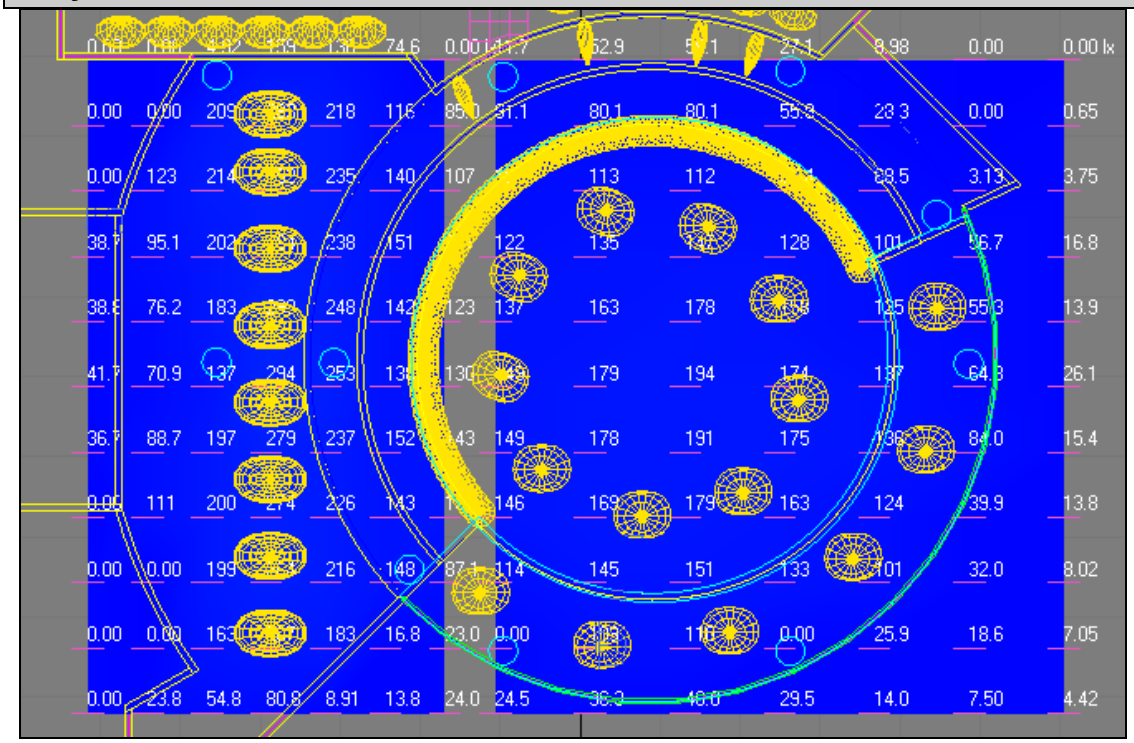
See the lighting plan in the electrical section of this report.

Details

The details below show how the LED cove lighting is to be mounted.



Performance data



Note: The above values are presented in lux.

Design Criteria Satisfied:

The solution meets the design criteria for illuminance and luminance, as demonstrated in the preceding images. In addition to this criteria, the following shows how other design criteria are met:

- **Illuminance:** The illuminance values in the design exceed the recommended IES illuminance levels, but the design is acceptable because it is more of a multi-purpose space than the 5 fc recommendation intends.
- **Luminance:** There is higher luminance on the northwest wall because of accenting artwork. Also, the upper curved wall has a higher luminance from color-changing LEDs grazing its surface.
- **Glare:** During the day there is potential for glare caused by the sun. This is not problematic because the space is used as a circulation space during the day.
- **VDT:** The two wall-mounted televisions shall have a diffuse surface, so occupants can comfortably view the screen even during the day.
- **Accent Lighting:** The accent lighting on the northwest wall provides visual interest on a personal level.
- **Color Appearance:** All the lamps in this space have a high CRI.
- **Psychological Aspects:** The accent lighting on the upper circular wall contributes to a spacious environment by emphasizing the periphery.
- **Appearance of space and luminaires:** Since the overhead lighting exposes bare lamps, there is some sparkle potential.
- **Controls:** (see the following discussion)
- **Power Allowance:** (see the following discussion)
- **Daylight:** (see the following discussion)

Renderings and Images:

Power Allowance:

Space	Usage	Luminaire Type	# Luminaires	Number of Ballasts	ballast input watts	Total Watts
Lobby	Ambient	E	15	1	65	975
	Accent	F	4	1	50	200
	Task	G	8	1	125	1000
	LED	H	79	1	12	948

Lobby Total Watts Sum:	3123
Space Square Feet:	5321
Actual W/SF:	0.59
Allowable W/SF:	1.3
	Acceptable
Additional Allowable Watts:	3794

Controls

The space will be controlled by a Lutron system as shown. For more system information, see the "Controls" section of this report.

Examples of scenes are:

PRESET SCENE SCHEDULE

Schedule For: Lobby

Lighting Zone	Luminaire Type(s)	Load Type	Day Cruise	Night Cruise	Formal	Entertainment	All Off
1	E	CFL	0%	100%	100%	100%	0%
2	E	CFL	Photo Sensor	100%	50%	50%	0%
3	H	LED	0%	100% (Note 1)	100% (Note 2)	100% (Note 3)	0%
4	H	LED	0%	100% (Note 1)	100% (Note 2)	100% (Note 3)	0%
5	F	Halogen	0%	100%	100%	100%	0%
6	G	Fluor	100%	100%	50%	50%	0%

Note 1: Color-changing mode. Colors are set to blues, greens, purples
Note 2: Slow color-changing mode. Colors are set to all colors.
Note 3: Color-changing mode. Colors are set to all colors

Space 3: Conference Room

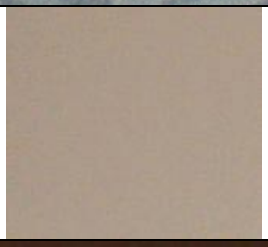
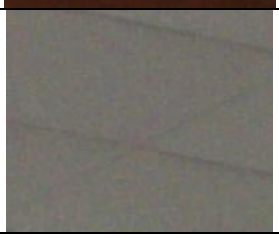
Spatial Overview

This space is connected to Conference Room No. 1 (Room 201) when the folding partition is retracted. There is a continuous row of windows lining the curved exterior wall, and the ceiling height is 15'-3". There is a ceiling-mounted projector aimed to the ceiling-mounted retractable screen on the north wall (Figure 17).

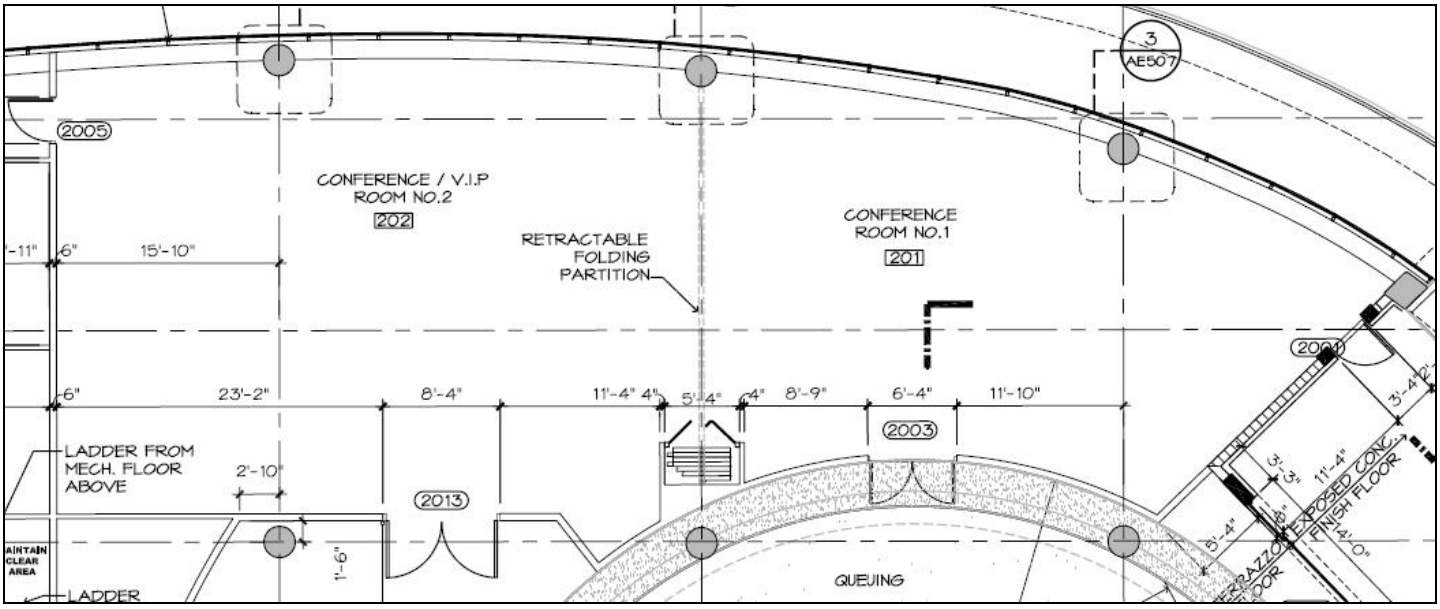
Finishes

The materials in Conference Room #2 are low saturated and neutral colors. Dark, moveable wooden tables, desks and chairs are present throughout the space. The carpet is the same as in the Ticket Queuing and Waiting Lounge/Meeting Rooms.

Materials

Floor: 2' carpet tiles and is a light blue-gray color. Reflectance: 45% (Assumed)	
Walls: Light tan color. Reflectance: 47% (Assumed)	
Wood Tables: Reflectance: 15% (Assumed)	
Ceiling: Reflectance: 80% (Assumed)	

Plan and Section Drawings



Luminaire Schedule

Graphic	Luminaire Type	Description	Luminaire Manufacturer	Luminaire Catalog Number
	J	Designed for wall-washing, this luminaire is scaled for 8' to 12' walls. It features a smooth semi-gloss white exterior, door and lens, integral electronic ballast, screw in yoke for aim locking. CFL lamp.	Elliptipar	F114 - H124 - E02 - V - 000
	K	2'x4' shallow direct-indirect recessed luminaire contains (2) T5HO lamps.	Corelite	R1 -W-B-2-T5-1-D-UNV-24-T1
	L	8" vertical triple tube open downlight, with CFL lamp. Features one-piece 22-guage galvanneal steel, high purity aluminum reflector.	Prescolite	LF8CFV32-EB-8CFV

Luminaire Schedule (continued)

Luminaire Type	Lamp Manufacturer	Lamp	Lamp Catalog Number	Initial Lumens	Design Lumens	CCT	CRI	Volts	Mounting
J	Philips	(1) 42W CFL	CFTR42W/GX24q/835	3200	2720	3500	82	277	Ceiling. See Note 1
K	Philips	(2) T5HO	F54T5 / 835 / HO / A / ALTO	5000	4750	3500	85	277	Downlight
L	Osram Sylvania	(1) 42W CFL	CF42DT / E / IN / 841/ECO	3670	3104	3500	82	277	Downlight

Luminaire Schedule (continued)

Luminaire Type	Ballast Manufacturer	Number of Ballasts	Ballast Catalog Number	Input Watts	Line Amps
J	Advance	1	VEZ-1T42-M2-LD-K	49	0.18
K	Advance	1	VEZ-2S54	125	0.45
L	Advance	1	VEZ-1T42-M2-LD-K	49	0.18

LLF Table

Cleaning	Maintenance Category	LLD	LDD*	RSDD	Total LLF
12 month	IV	0.85	0.88	0.95	0.71
12 month	IV	0.95	0.88	0.95	0.79
12 month	IV	0.85	0.88	0.95	0.71

**Assumes Clean Dirt Condition*

Mounting Notes

2. Luminaire J is to be ceiling mounted so that all luminaires are at equal height A.F.F.

Design Criteria

Illuminance: The lighting system must accommodate various tasks that take place in a conference room. The IES Handbook recommends 30 fc on the workplane and 5 fc for vertical Illuminance.

Luminance: There should be a blinds system which reduces luminance ratios from the outside objects compared to inside surfaces. This is particularly important during video presentations.

Glare: It is important that there is minimal glare from daylight and luminaires.

VDT: It is recommended that there be no more than 5 fc of vertical Illuminance on the projection screen. The conference is not equipped for video conferencing. Veiling reflections of highly luminous objects are problematic for laptop screens and should be avoided.

Accent Lighting: Accent lighting should be used to highlight various displays on the walls.

Color Appearance: The space should have a high CRI. The dark wood furniture will look best under a warm CCT.

Psychological Aspects: Peripheral lighting emphasis is needed to help create an impression of pleasantness and assist with visual clarity.

Appearance of Space and Luminaires: Conference Room #1 and #2 need to function coherently both alone and together. This applies for controls, lighting aesthetics and performance.

Controls: To allow for several scenes, the luminaires must be dimmable and tied into a control system capable of programmable dimming. There must be at least two control devices in this space since it is less than 10,000 SF (ASHRAE 90.1).

Power Allowance: According to ASHRAE 90.1, 1.3 W/SF is the maximum allowable.

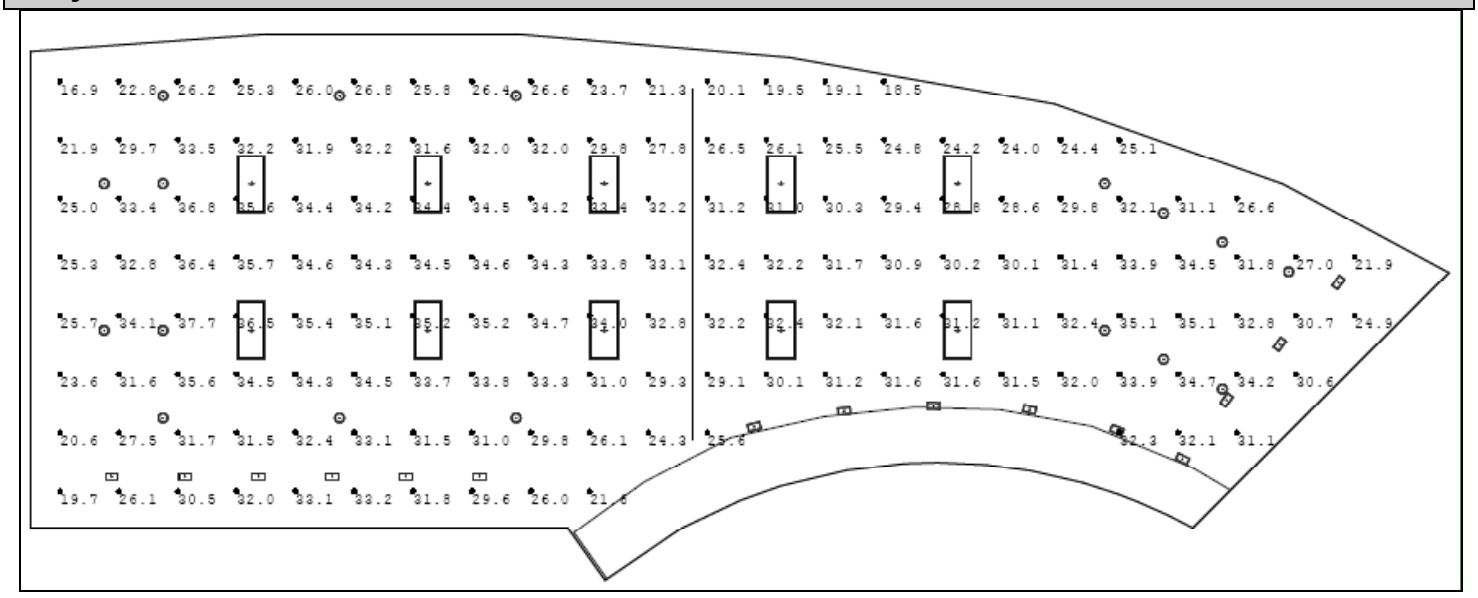
Reflected Ceiling Plan

See the lighting plan in the electrical section of this report.

Details

The projection screen and mechanical partition exist in the original design.

Performance data



Note: The above values are presented in fc.

The following vertical illuminance grids on the projection screen wall show the effects of changing the scene from a Night Conference to a Video Presentation.

Night Conference

15.0	14.5	10.9	11.0	11.3	12.1	13.1	12.5	11.7	11.5	11.9	12.5	11.4	10.2	9.3
20.5	21.9	15.5	14.8	15.7	19.5	24.2	21.4	17.6	17.2	19.9	23.7	19.8	14.9	12.9
21.3	21.7	18.1	18.0	19.7	23.2	26.3	24.8	21.9	21.5	23.6	25.7	23.1	18.9	15.9
20.1	20.9	19.7	20.2	21.9	24.0	25.5	25.0	23.8	23.5	24.3	24.9	23.4	20.8	18.1
19.0	20.1	20.1	20.8	22.1	23.5	24.5	24.5	24.1	23.9	24.0	23.9	22.7	20.8	18.6

Video Presentation

7.1	6.7	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.7	4.6	4.4	4.2	4.0	3.6
9.8	10.4	7.1	6.6	6.7	6.9	7.1	7.2	7.2	7.1	7.0	6.8	6.5	6.1	5.6	5.0
10.1	10.2	8.3	7.9	7.9	8.0	8.1	8.2	8.2	8.1	8.0	7.8	7.5	7.1	6.7	6.0
9.5	9.7	8.9	8.7	8.7	8.7	8.7	8.6	8.6	8.5	8.4	8.3	8.1	7.8	7.4	6.7
8.9	9.2	8.9	8.8	8.8	8.9	8.9	8.8	8.7	8.7	8.6	8.5	8.3	8.0	7.5	6.8

Design Criteria Satisfied:

The solution meets the design criteria for illuminance and luminance, as demonstrated in the preceding images. In addition to this criteria, the following shows how other design criteria are met:

- **Illuminance:** The illuminance criteria are satisfied with this design. As seen in a preceding image, the 30 fc criterion is satisfied. With the contribution of daylight through the windows, the lamps in select zones can dim and the work plane still maintains compliance with the design criterion.
- **Luminance:** During video presentations, the blackout window shades are programmed to be closed.
- **Glare:** During normal day conferences, the blackout are programmed to be open, but can be closed manually. The high ceiling height and careful aiming of wall-washing luminaires reduces glare in the space.
- **VDT:** Regarding vertical illuminance, technically the criterion value of 5 fc is not satisfied. However, 8 fc though not completely ideal, is sufficiently small enough to view video presentations clearly.
- **Accent Lighting:** The wall-washers accent the interior walls, some of which feature large artistic depictions of maps and other aquatic themes.
- **Color Appearance:** All the lamps in this space have a high CRI and 3500K CCT.
- **Psychological Aspects:** Peripheral lighting helps contribute to the feeling of pleasantness and assists with visual clarity.
- **Appearance of space and luminaires:** The control system is versatile. It allows the space to function as two independent rooms or one, large conference room. More information is presented in the controls section of this report.
- **Controls:** (see the following discussion)
- **Power Allowance:** (see the following discussion)

Renderings and Images:

Power Allowance:

Space	Usage	Luminaire Type	# Luminaires	Number of Ballasts	ballast input watts	Total Watts
Conference Room	Wall-Wash	J	15	1	49	735
	Downlight	K	10	1	125	1250
	Downlight	L	18	1	49	882

Conference Room Total Watts Sum:	2867
Space Square Feet:	2542
Actual W/SF:	1.13
Allowable W/SF:	1.3
	Acceptable

Controls

The space will be controlled by a Lutron system as shown. For more system information, see the "Controls" section of this report.

Examples of scenes are:

PRESET SCENE SCHEDULE

Schedule For: Conference Room

Lighting Zone	Luminaire Type(s)	Load Type	Day Conference	Night Conference	Video Presentation	Entertainment	All Off
1	J	CFL	100%	100%	50%	100%	0%
2	J	CFL	100%	100%	50%	100%	0%
3	J	CFL	100%	100%	0%	100%	0%
4	K	Fluor	Photosensor	100%	50%	50%	0%
5	K	Fluor	Photosensor	100%	50%	50%	0%
6	L	CFL	Photosensor	100%	0%	50%	0%
7	L	CFL	Photosensor	100%	100%	50%	0%
8	L	CFL	Photosensor	100%	50%	50%	0%
9							
10							
11							
Window Shades							
1			Open	Open	Closed - Blackout	Open	Open

2			Open	Open	Closed - Blackout	Open	Open
Room Partition							
4			User	User	User	User	User
Projection Screens							
6			Up	Up	Down	Up	Up
7			Up	Up	Down	Up	Up
8							
9							
10							
11							
12							
Note: See the following explanation regarding how the Room Partition status affects the controls.							

The Conference Room can act as one large, continuous space, or, when the partition is used, it can be subdivided into two smaller conference rooms. For the sake of discussion, the northwest space is Conference Room 1 and the southeast space is Conference Room 2.

There will be two Grafik Eye wall controls in the Conference Room (one in Conference Room 1 and one in Conference Room 2). A partition sensor will determine if the mechanical wall partition is open or closed. If it is open, then both Grafik Eye wall controls will control the whole space. On the other hand, if the partition is closed, each Grafik Eye wall control will only control the space in which it resides. Therefore, if the partition is closed, users cannot change the preset scenes or manual settings in the opposite conference room. Similarly, photosensors and occupancy sensors will only control the spaces in which each resides. This control setup is valuable because it saves energy by turning off unneeded light in the opposite space (if only one half is used). It also prevents users from inadvertently controlling lights, projection screens, and shades in another space. This system shall be installed according to Lutron's recommendations.

Space 4: Facade

Spatial Overview

The Entry Pavilion is the main entrance and exit point for most building users (Figure 24 and 28). During cruise ship boarding, people climb the stairs or take one of three elevators to the second floor and cross the bridge to the Lobby (Figure 25 and 26). People leaving a cruise exit the lower retractable bridge, which leads to the first floor of this 2-floor Entry Pavilion (Figure 27).

The Entry Pavilion itself is a large, 2-floor outdoor space with a bridge. It is completely open to the outdoor environment. Extended lighting analysis will be focused on how the façade appears. The scope of analysis will not include the tasks of people using the Entry Pavilion because the scope of this analysis is the façade.

Finishes

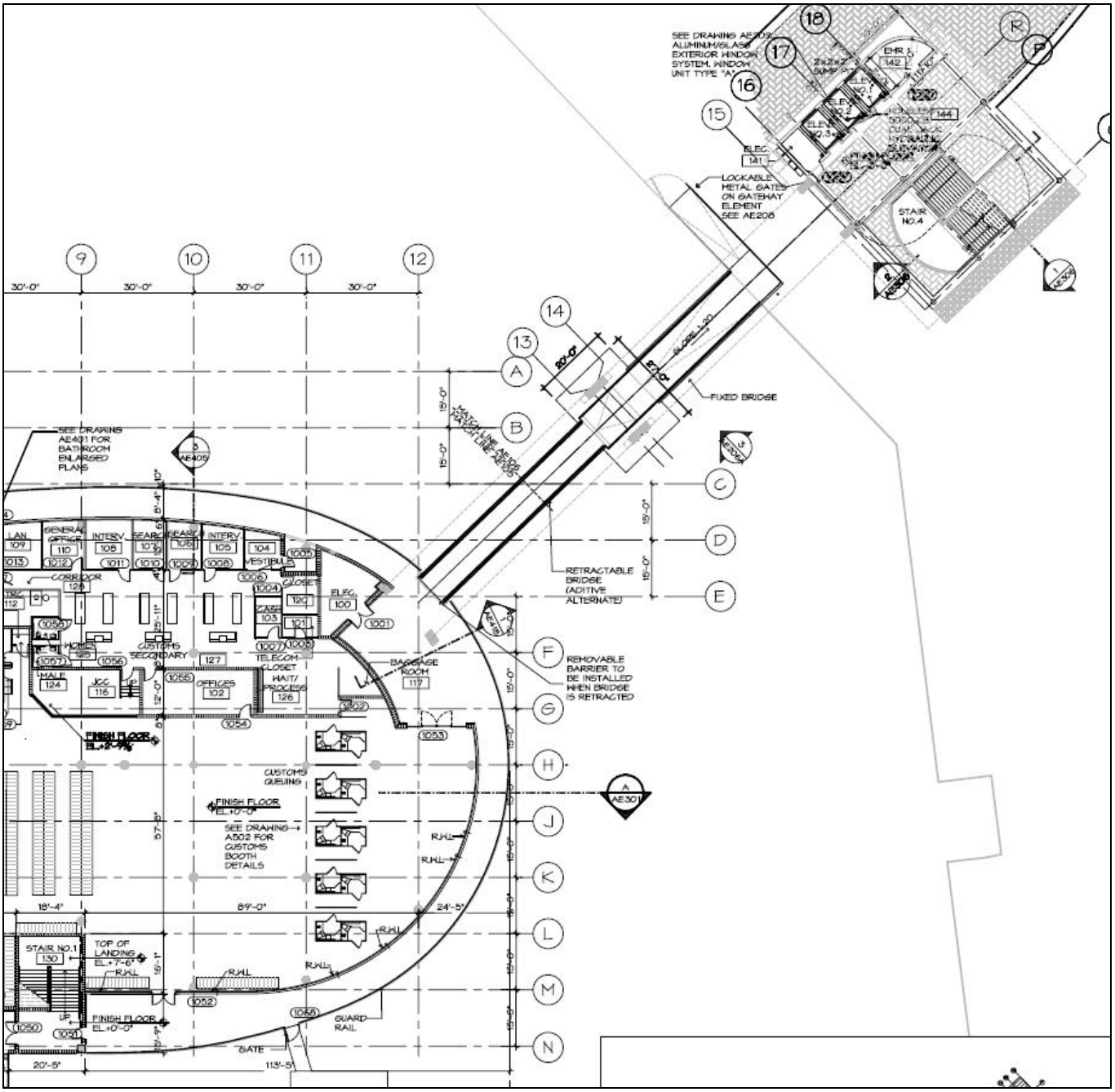
The first floor façade is rugged concrete, which blends into the concrete pier. The second floor features a blue vertical-ribbed metal wall system. The Pedestrian Bridge is constructed with steel trusses and rests on concrete columns. The roof of the Pedestrian Bridge is ribbed metal and rests on steel columns. The overall feel is exposed structure and ruggedness, except for the finished brick floor near the elevators.

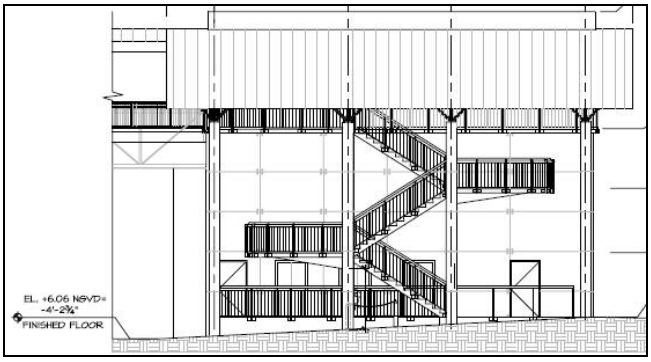
Materials

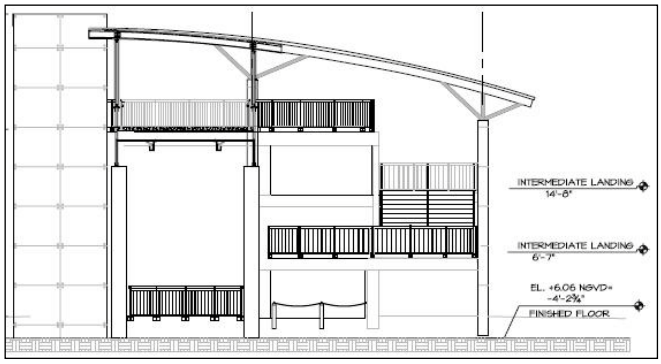
Floor: Red Brick – Reflectance: 37% (Assumed)	
Façade: Blue, vertical-ribbed metal – Reflectance 25% (Assumed)	
Façade: Concrete – Reflectance 38% (Assumed)	

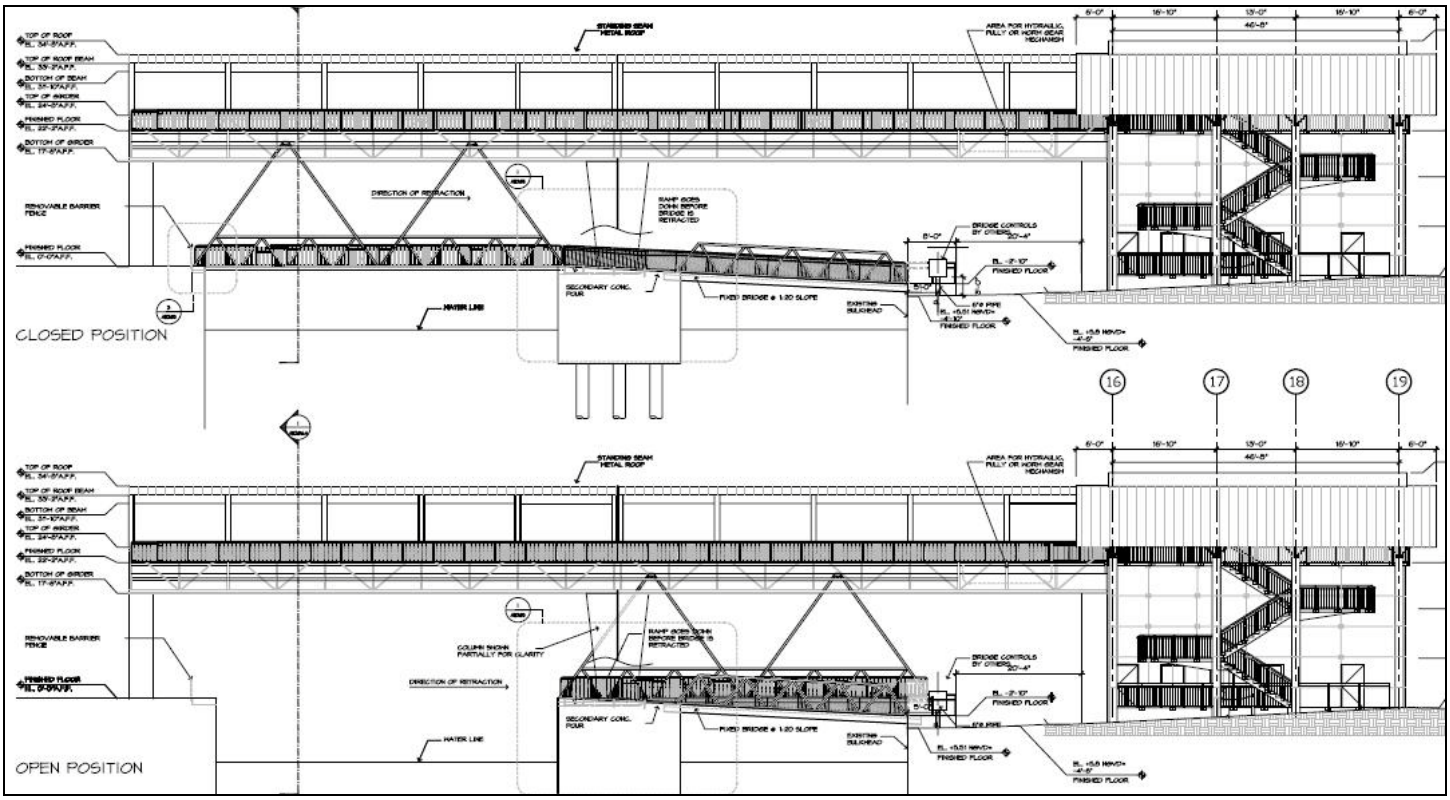
Truss: Painted Aluminum – Reflectance 48% (Assumed)	

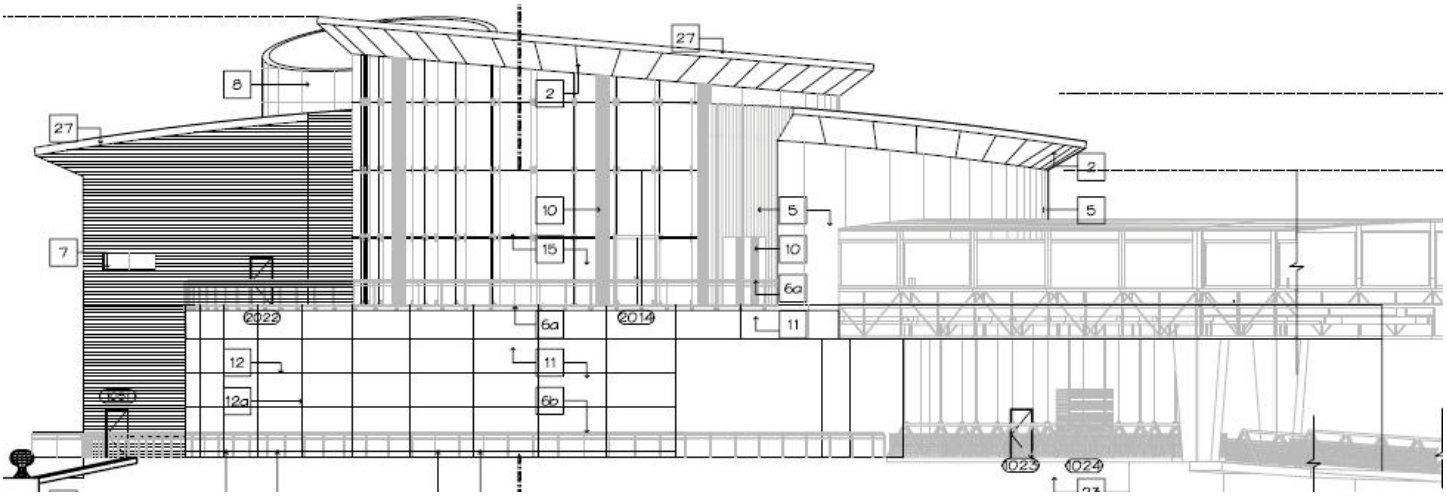
Plan and Section Drawings




EL. +6.06 NGVD=
-4'-2¾"
FINISHED FLOOR


INTERMEDIATE LANDING
14'-8"
INTERMEDIATE LANDING
6'-7"
EL. +6.06 NGVD=
-4'-2¾"
FINISHED FLOOR


CLOSED POSITION
OPEN POSITION
16
17
18
19



Luminaire Schedule

Graphic	Luminaire Type	Description	Luminaire Manufacturer	Luminaire Catalog Number
	M	Features rugged extruded aluminum cylinder with 3/16" end plates with rigid, extruded high purity aluminum with clear anodized specular finish reflector, superior asymmetric distribution.	Elliptipar	M160-35-X-06-A-000

Luminaire Schedule (continued)

Luminaire Type	Lamp Manufacturer	Lamp	Lamp Catalog Number	Initial Lumens	Design Lumens	CCT	CRI	Volts	Mounting
M	Philips	(1) 35W Ceramic MH	CDM-T 35W/830 T6 ICT	3300	3300	3000	81	120	Cantilever. See Mounting Note.

Luminaire Schedule (continued)

Luminaire Type	Ballast Manufacturer	Number of Ballasts	Ballast Catalog Number	Input Watts	Line Amps	Note
M	Advance	1	71A5005-P	55	1.5	

LLF Table

Luminaire Type	BF	Cleaning	Maintenance Category	LLD	LDD*	RSDD	Total LLF
M	1	12 month	IV	0.90	0.6	0.95	0.51

**Assumes Very Dirty Dirt Condition*

Mounting Notes

Luminaire Type M will be mounted so that it washes the desired surface. There are two mounting scenarios: mounting on concrete and mounting on the steel truss system. In both cases, Elliptipar's mounting accessories suffice. The luminaire will be mounted at the end of a cantilever beam that extends perpendicular to the surface. The luminaires are to be cantilever-supported according to the manufacturer's recommendations on the cut sheet.

Design Criteria

Illuminance: Illuminance levels are not critical for this façade lighting. There are Illuminance recommendations for the Bridge and Stairs, but this is not in the scope of the exterior analysis.

Luminance and Accent Lighting: Visual clutter should be avoided. Only key architectural features should be illuminated.

Color Appearance: CCT should be the same for each architectural feature.

Psychological Aspects: The Cruise Terminal is located very near a major public park in Norfolk. There are many festivals and special events in this park each year. It is to the City's advantage to make this area spectacular. The building should be illuminated in a way that emphasizes the architectural and structural elements. Creating visual interest is critical.

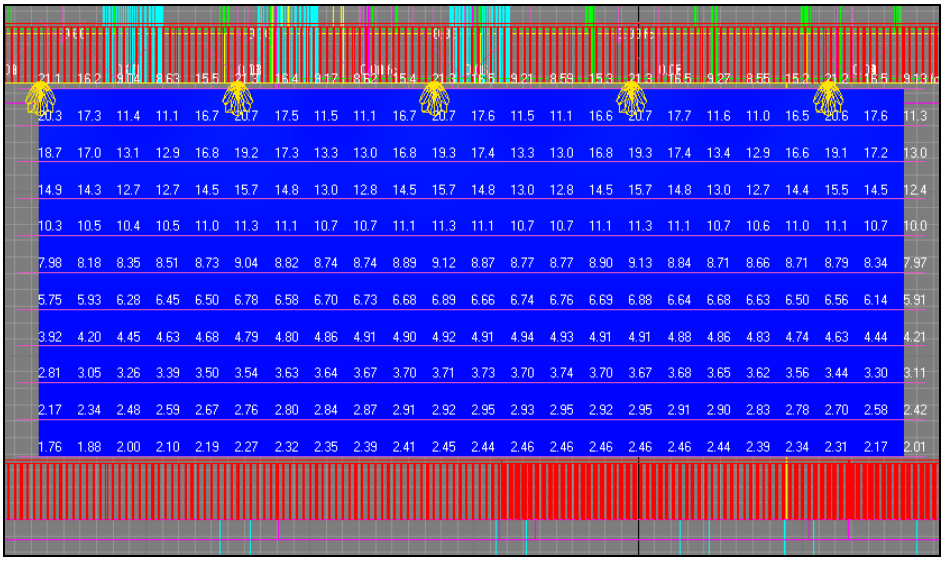
Appearance of Luminaires: The luminaires should appear industrial and durable. Large luminaires are acceptable because of the large building and ship scale.

Controls: The lighting should have controls so that the Owner can turn the accent lighting only when desired. The safety lighting needs to be on according to code, and this light also allows security cameras to work properly.

Lighting Plan

See the lighting plan in the electrical section of this report.

Performance data



Design Criteria Satisfied:

The solution meets the design criteria for illuminance and luminance, as demonstrated in the preceding images. In addition to this criteria, the following shows how other design criteria are met:

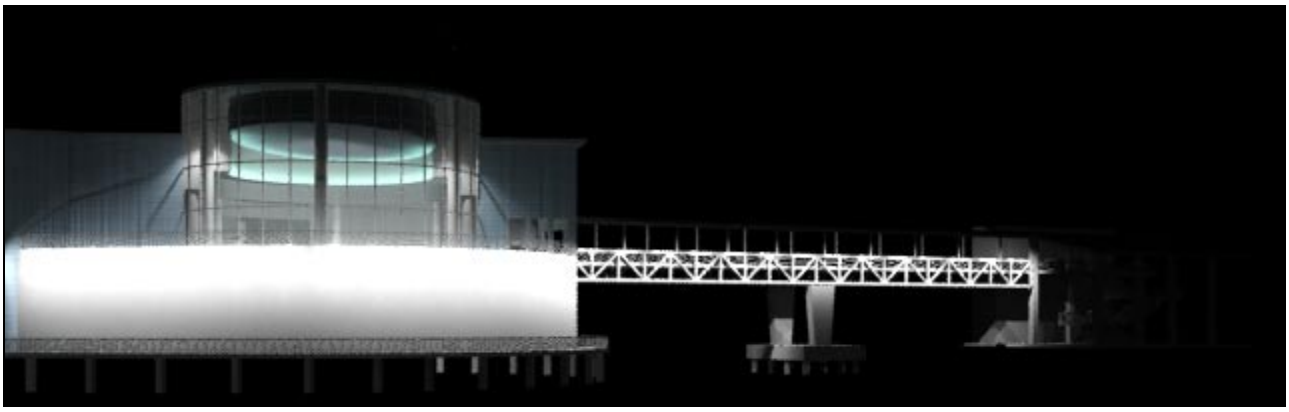
- **Illuminance:** Not critical for the scope of this project.
- Luminance and Accent Lighting: Visual clutter is avoided by accenting the horizontal architectural elements relatively uniformly.
- **Color Appearance:** All the lamps in this space have a high CRI and 3000K CCT.
- **Psychological Aspects:** The design emphasizes two horizontal elements: the concrete façade of the first floor, which acts as a visual foundation for the glass Lobby area, and the pedestrian bridge truss. Since the lobby

curtain wall is made of glass, light escapes from the Lobby's surfaces into the environment. This adds visual interest, especially when the Lobby's color-changing LED cove lighting is activated.

- **Appearance of space and luminaires:** The luminaires do not themselves appear industrial. Instead, they functionally provide light which achieves the desired psychological effect.
- **Controls:** (see the following discussion)
- **Power Allowance:** (see the following discussion)

Renderings and Images:

The following illuminance grid shows that the horizontal uniformity of the concrete wall is relatively uniform, except for the very top of the wall. Despite this non-uniformity at the top of the wall, the design is still successful in achieving the desired psychological effect.



Power Allowance:

Space	Usage	Luminaire Type	# Luminaires	Number of Ballasts	Ballast input watts	Total Watts	Linear Feet	W/ft	Code
Façade	Wall-Wash	M	18	1	55	990	198	5	Acceptable
	Wall-Wash	M	14	1	55	770	158	4.87	Acceptable

Controls

The space will be controlled by a Lutron system as shown. For more system information, see the "Controls" section of this report.

Emergency Lighting

The scope of this project does not include emergency lighting or controls. However, an interface can be used with the Lutron controls to make some lighting emergency powered. The current design does not have any lighting loads on a designated emergency panelboard, however. No emergency system panelboards or circuits are shown, as these are outside the scope.

Controls

The following control information is based on the GRAFIK Eye Designer 7.1 by Lutron. The solution consists of one system (New System 1) which controls all four spaces, a timeclock and system interface, and PC programmable main units. This solution provides panels and controls for both 120V and 277V loads, including the interface for the color-changing LED systems. While the GRAFIK Eye Designer was set to "Balance loads most effectively," it still recommends that 7 panelboards be installed. Even though this would not be the most efficient or cost effective design, for the sake of this thesis project, the GRAFIK Eye Designer 7.1 recommendations will be used.

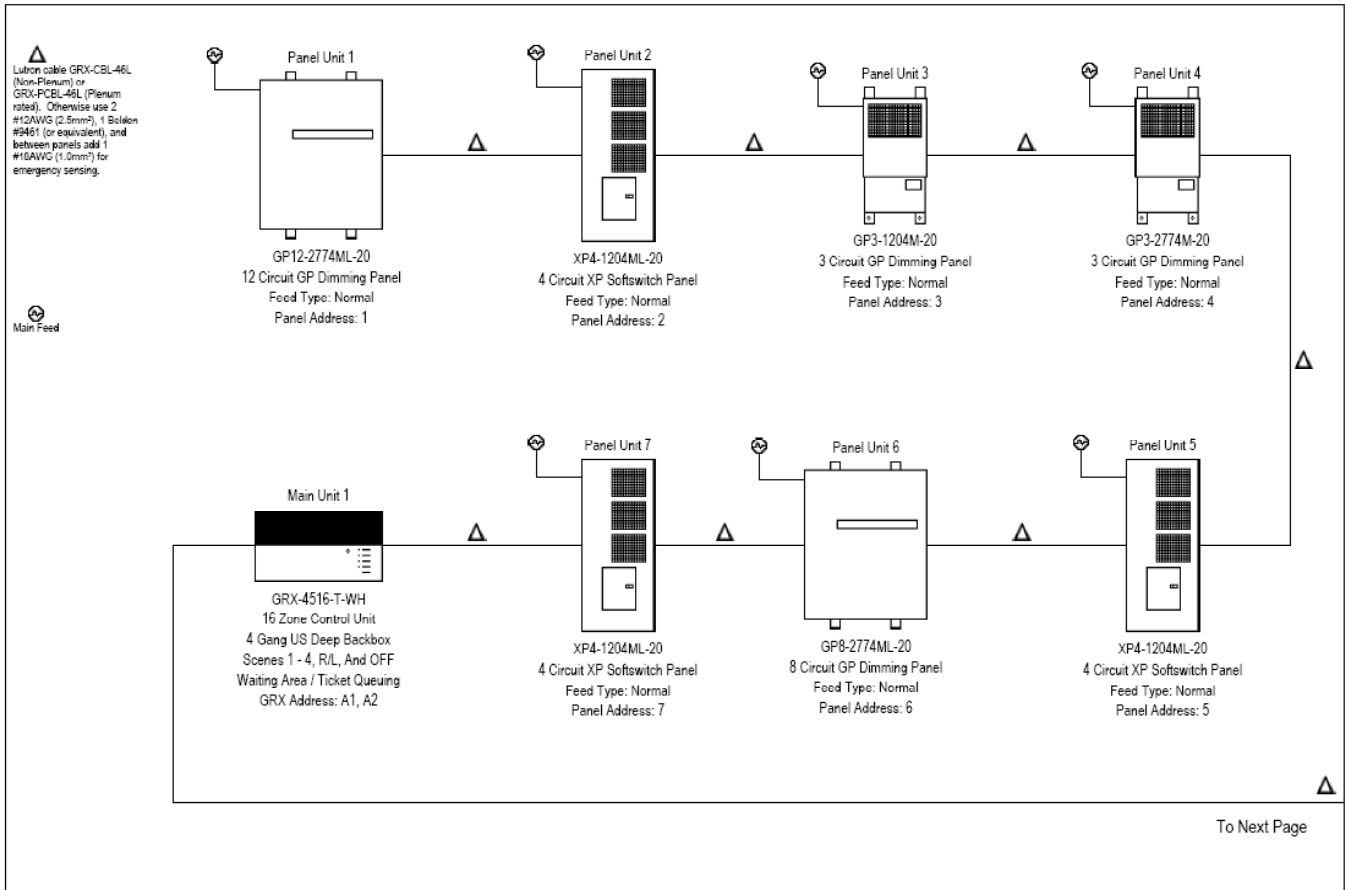
The existing panelboards are as follows:

Existing Panelboards			
Panel Name	**Type**	**Voltage**	**Locations Served**
ELPL4	Dimming	120	Waiting Area, Lobby
LPL3	Dimming	120	Lobby, Conference, Waiting Area, Waiting Area (LEDS)
HPL3	Switching	277	Waiting Area, Conference
EHPL4	Switching	277	Conference, Waiting Area, Façade
ELPL2	Dimming	120	Façade
EHPLP	Switching	277	Façade
EHPL2	Switching	277	Façade

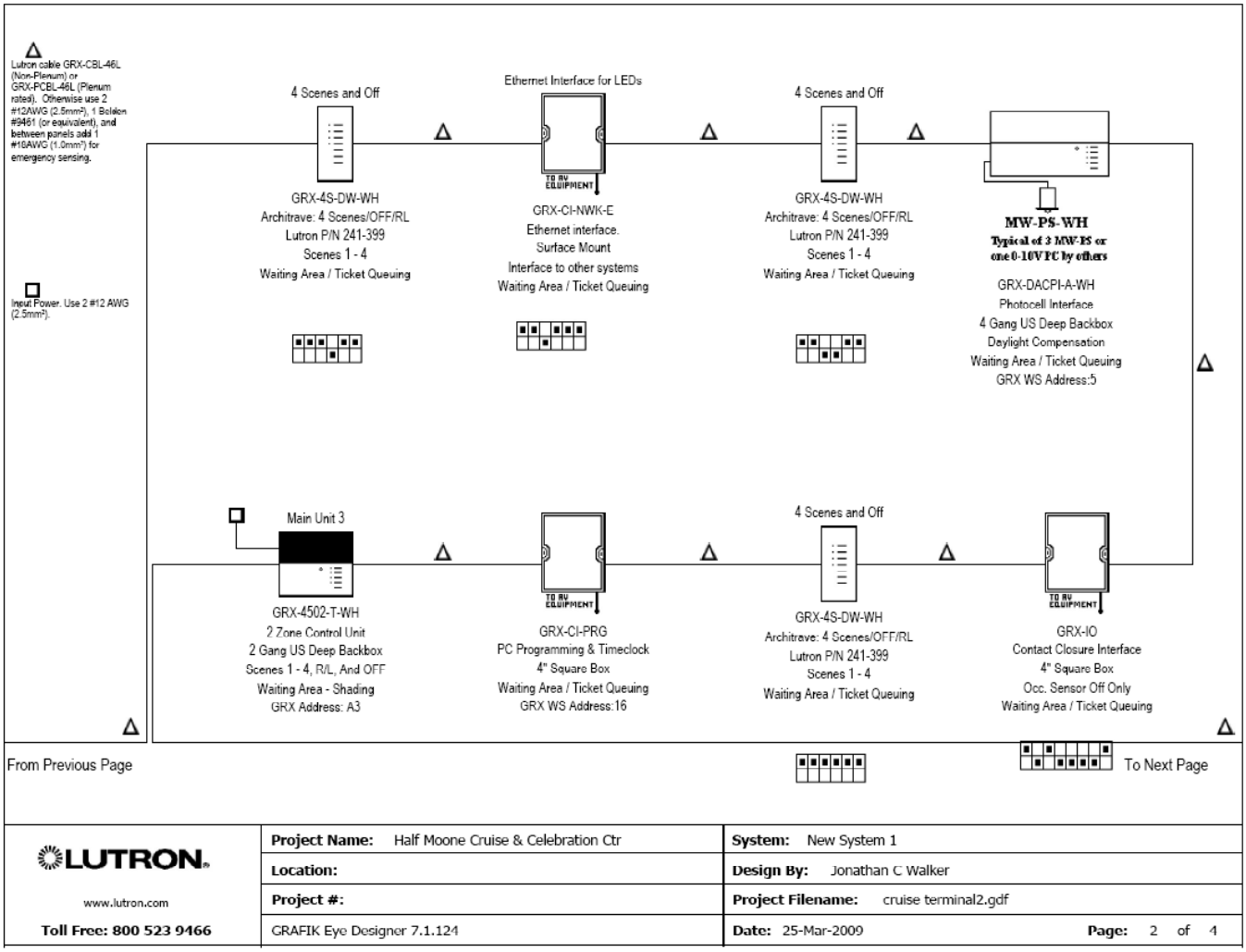
The Lutron GRAFIK Eye Designer solution recommends the following panelboards:

Lutron GRAFIK Eye Designer Solution			
Panel Name	**Type**	**Voltage**	**Locations Served**
Panel Unit 1	Dimming	277	Waiting Area
Panel Unit 2	Switching	120	Waiting Area
Panel Unit 3	Dimming	120	Lobby
Panel Unit 4	Dimming	277	Lobby
Panel Unit 5	Switching	120	Lobby
Panel Unit 6	Dimming	277	Conference
Panel Unit 7	Switching	120	Façade

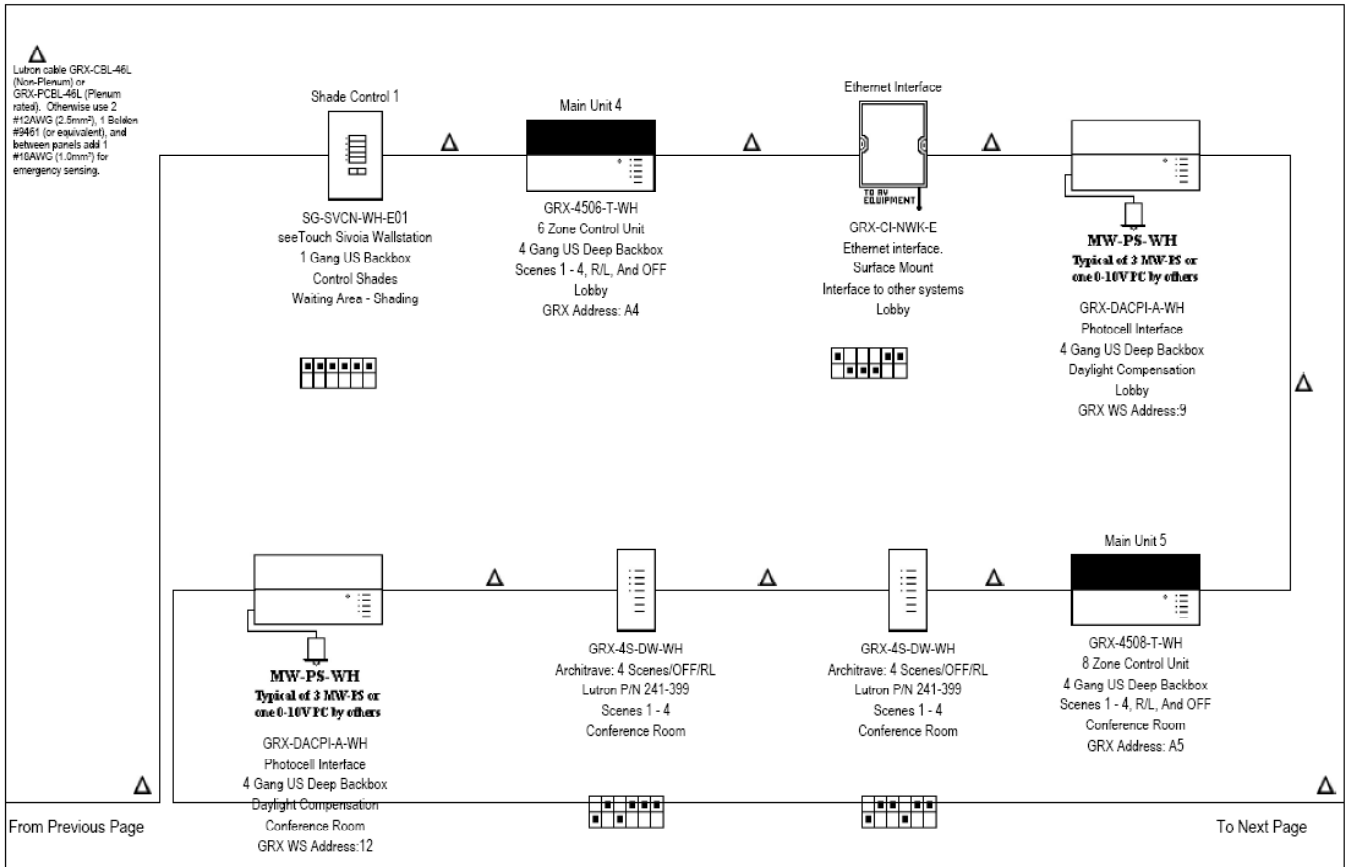
The scenes for the façade lighting are linked to the system time clock, and can be overridden by the owner in case of special events.



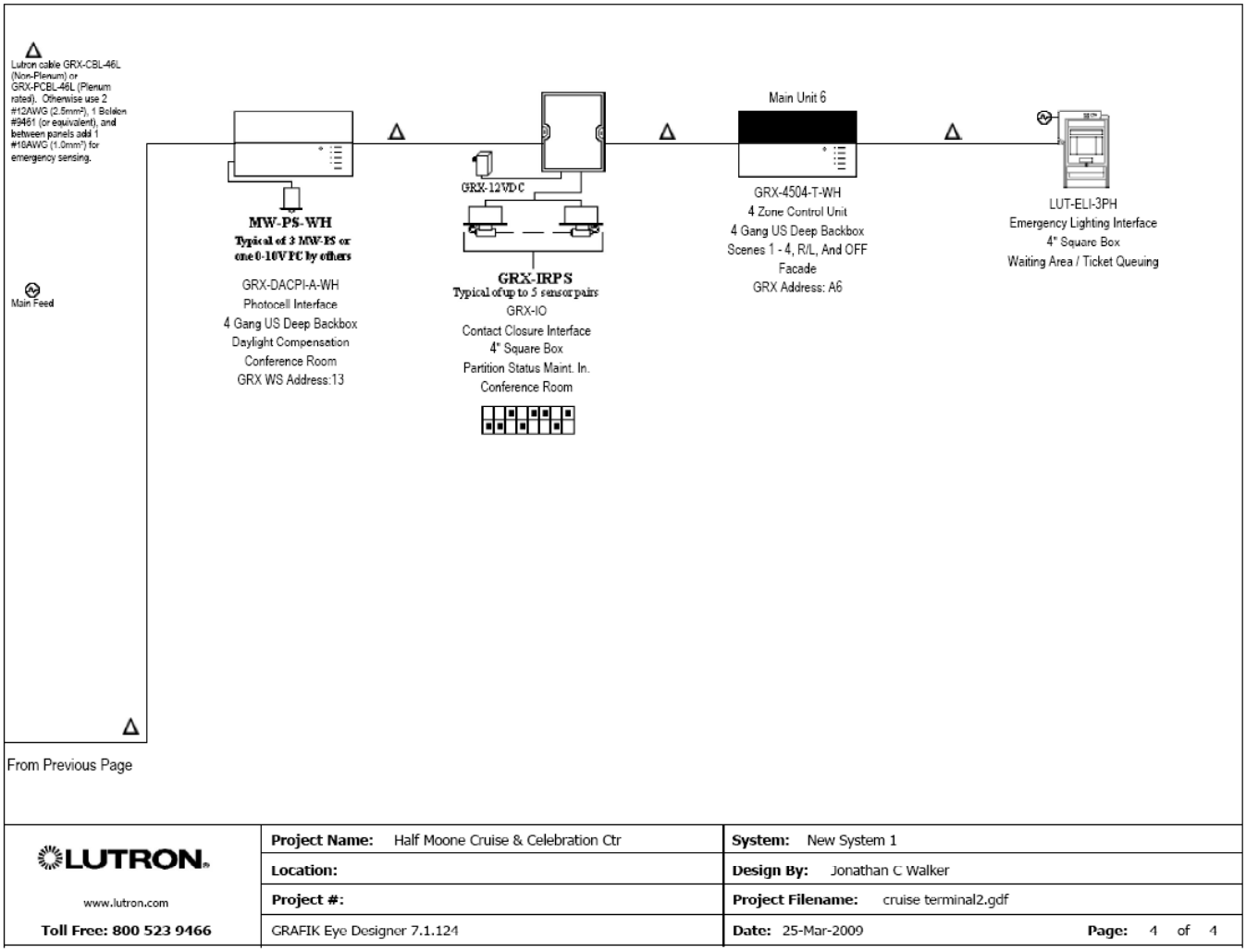
LUTRON www.lutron.com **Toll Free: 800 523 9466**	**Project Name:** Half Moone Cruise & Celebration Ctr	**System:** New System 1
	Location:	**Design By:** Jonathan C Walker
	Project #:	**Project Filename:** cruise terminal2.gdf
	GRAFIK Eye Designer 7.1.124	**Date:** 25-Mar-2009 **Page:** 1 of 4



LUTRON www.lutron.com Toll Free: 800 523 9466	**Project Name:** Half Moone Cruise & Celebration Ctr	**System:** New System 1
	Location:	**Design By:** Jonathan C Walker
	Project #:	**Project Filename:** cruise terminal2.gdf
	GRAFIK Eye Designer 7.1.124	**Date:** 25-Mar-2009 **Page:** 2 of 4



LUTRON www.lutron.com **Toll Free: 800 523 9466**	**Project Name:** Half Moone Cruise & Celebration Ctr	**System:** New System 1
	Location:	**Design By:** Jonathan C Walker
	Project #:	**Project Filename:** cruise terminal2.gdf
	GRAFIK Eye Designer 7.1.124	**Date:** 25-Mar-2009 **Page:** 3 of 4



Note: The line diagram above indicates more panels than actually will be used. For more information, see the "Electrical" section of this report.

The following load summaries show the Lutron Zone number, which corresponds to the panelboard schedules in the "Electrical" section of the report.

Waiting Area / Ticket Queuing Summary Load Schedule

Lutron Zone	Customer Zone	Zone/Circuit Description	Customer Circuit #	Voltage	Load Type	Actual Load (W/VA)
A1-1	1	Wall Washing	1	277V	FL - Hi-Lume	1610
A1-2	2	Ticket Counter	2	277V	MHN / HPS	1890
A1-3	3	Ticket Counter	3	277V	MHN / HPS	150
A1-4	4	LED	4	120V	Non-Dim	1740
A1-5	5	Ambient	5	277V	FL - Hi-Lume	1488
A1-6	6	Ambient	6	277V	FL - Hi-Lume	1488
A1-7	7	Ambient	7	277V	FL - Hi-Lume	1488
A1-8	8	Ambient	8	277V	FL - Hi-Lume	1488
A2-1	9	Ambient	9	277V	FL - Hi-Lume	1302
A2-2	10	Ambient	10	277V	FL - Hi-Lume	1116
A2-3	11	Ambient	11	277V	FL - Hi-Lume	1116

Waiting Area - Shading Summary Load Schedule

Lutron Zone	Customer Zone	Zone/Circuit Description	Customer Circuit #	Voltage	Load Type	Actual Load (W/VA)
A3-1	1	Shades (No Connection)	1	120V	Sivoia QED Shades / Projection Screens	(No Connection)

Lobby Summary Load Schedule

Lutron Zone	Customer Zone	Zone/Circuit Description	Customer Circuit #	Voltage	Load Type	Actual Load (W/VA)
A4-1	1	Ambient	1	277V	FL - Hi-Lume	390
A4-2	2	Ambient	2	277V	FL - Hi-Lume	585
A4-3	3	LED	3	120V	Non-Dim	576
A4-4	4	LED	4	120V	Non-Dim	562
A4-5	5	Accent	5	120V	Incandescent	200
A4-6	6	Task/Ambient	6	277V	FL - Hi-Lume	1000

Conference Room Summary Load Schedule

Lutron Zone	Customer Zone	Zone/Circuit Description	Customer Circuit #	Voltage	Load Type	Actual Load (W/VA)
A5-1	1	Wall-Washing	1	277V	FL - Hi-Lume	294
A5-2	2	Wall-Washing	2	277V	FL - Hi-Lume	294
A5-3	3	Wall-Washing	3	277V	FL - Hi-Lume	147
A5-4	4	Ambient	4	277V	FL - Hi-Lume	750
A5-5	5	Ambient	5	277V	FL - Hi-Lume	500
A5-6	6	Ambient	6	277V	FL - Hi-Lume	196
A5-7	7	Ambient	7	277V	FL - Hi-Lume	294
A5-8	8	Ambient	8	277V	FL - Hi-Lume	343

Facade Summary Load Schedule

Lutron Zone	Customer Zone	Zone/Circuit Description	Customer Circuit #	Voltage	Load Type	Actual Load (W/VA)
A6-1	1	Wall-Wash	1	120V	Non-Dim	594
A6-2	2	Wall-Wash	2	120V	Non-Dim	594
A6-3	3	Wall-Wash	3	120V	Non-Dim	462
A6-4	4	Wall-Wash	4	120V	Non-Dim	462

Section 4: Electrical

Introduction

The four spaces in this report that have redesigned lighting solutions are:

1. Waiting Area / Ticket Queuing
2. Lobby
3. Conference Room
4. Façade

The existing lighting panels that service these spaces are:

1. ELPL4
2. LPL3
3. HPL3
4. EHPL4
5. ELPL2
6. EHPLP
7. EHPL2

The following chart shows which panels serve each space ("X" indicates service).

Panel	Waiting Area / Ticket Queuing	Lobby	Conference Room	Facade
ELPL4	X	X		X
LPL3	X	X	X	X
HPL3	X		X	
EHPL4	X	X	X	X
ELPL2				X
EHPLP				X
EHPL2				X

Design Technique

For the purpose of this report, the design method is different than would occur in a real design. For this report, the design method is as follows:

- Locate all panelboards that have lighting loads in any of the four spaces listed above.
- Remove these existing lighting loads from these panelboards
- With some exceptions, leave these existing panelboards the same, minus the lighting loads that have been deleted. The theory is that these existing panelboards could be used for expansion.
- Add new panelboards according to the new lighting design.

The rationalization behind this approach is that much of the new lighting is 277V, and a significant number of lighting panels in the existing design are at 208Y/120V. Also, some panels are designated dimming and switching in the existing design, but this does not necessarily coordinate with the new lighting design's needs (especially with the different voltage factor). Therefore, with some exceptions, existing panels will not be replaced. Instead, additional panel boards will be added to achieve the new lighting design.

Also, the scope of this project does not include emergency power, but some general lighting circuits (particularly in the exterior spaces) are on emergency panelboards. The design technique for this project is to keep the original panelboards, and add new panelboards according to the Lutron GRAFIK Eye Designer software. Then, some consolidation will occur to reduce the total number of panelboards.

Panelboard Information

The existing panelboards from the original design are as follows. Note that the cells with a thick, black border indicate existing loads that the new design will replace.

PANELBOARD ELPL4(DIM) SCHEDULE

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

DES L	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	DES R
L	EMERG. LTG. RM 213/214	12.6			20	10	1		2	10	20	12.6			EMERG. LTG. RM 213/214	L
L	EMERG. LTG. RM 213/214		4.2		20	10	3		4	10	20		8.4		LIGHTING RM 213/214	L
L	EMERG. LTG. RM 213/214			12.6	20	10	5		6	10	20			12.6	LIGHTING RM 213/214	L
L	EMERG. LTG. RM 213/214	12.6			20	10	7		8	10	20	12.6			LIGHTING RM 213/214	L
L	EMERG. LTG. RM 213/214		8.4		20	10	9		10	10	20		12.6		LIGHTING RM 213/214	L
L	EMERG. LTG. RM 213/214			12.6	20	10	11		12	10	20			12.6	LIGHTING RM 213/214	L
L	LIGHTING RM 224	1.1			20	12	13		14	12	20	4.4			LIGHTING RM 233	L
L	LIGHTING RM 223		4.4		20	12	15		16	12	20		5.0		LIGHTING RM 233	L
L	LIGHTING RM 213/214			12.6	20	10	17		18	12	20			1.1	LIGHTING RM 232	L
L	LIGHTING RM 213/214	4.2			20	10	19		20	10	20	12.6			LIGHTING RM 213/214	L
R	RECEPTACLES		12.0		20	10	21		22	12	20		6.0		RECEPTACLES	R
R	RECEPTACLES			9.0	20	12	23		24	12	20			7.5	RECEPTACLES	R
L	LIGHTING RM 213/214	12.6			20	10	25		26	10	20	12.6			LIGHTING RM 213/214	L
L	LIGHTING RM 223		8.3		20	12	27		28	12	20		4.4		EMERG.LTG. RM 130	L
	SPARE				20		29		30		20				SPARE	
	SPACE						31		32	10	20	8.4			LIGHTING TRUSS	L
	SPACE						33		34	10	20		15.0		EMERG. LTG. AREA 209	L
	SPACE						35		36	10	20			15.0	EMERG. LTG. AREA 209	L
L	EMERG. LTG. RM 212	15.0			20	10	37		38	10	20	10.0			EMERG. LTG. RM 212	L
L	EMERG. LTG. RM 212		5.0		20	10	39		40	12	20		7.5		EMERG. LTG. AREA 222	L
L	EMERG. LTG. AREA 222			5.0	20	12	41		42						SPACE	
	SPACE						43		44						SPACE	
	SPACE						45		46						SPACE	
	SPACE						47		48						SPACE	
	SUB-TOTAL AMPS	58.1	42.3	51.8								73.2	58.9	48.8	SUB-TOTAL AMPS	
	PANEL AMPS	131.3	101.2	100.6		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	131.3	101.2	100.6											FEED-THRU AMPS	
	TOTAL KVA	15.8	12.1	12.1		Version 3.04										

DES	LOAD DESCRIPTION	PNL ELPL4(DIM) CONN LOAD		SUB-FEED CONN LOAD		TOTAL CONN LOAD		D.F. (MULT)	TOTAL DEMAND	
L	LIGHTING	35.8	KVA		KVA	35.8	KVA	1.00	35.8	KVA
R	RECEPTACLES	4.1	KVA		KVA	4.1	KVA	NEC	4.1	KVA
M	MECH EQUIP		KVA		KVA		KVA	1.00		KVA
1	MISCELLANEOUS		KVA		KVA		KVA	1.00		KVA
2			KVA		KVA		KVA	1.00		KVA
3			KVA		KVA		KVA	1.00		KVA
4			KVA		KVA		KVA	1.00		KVA
5			KVA		KVA		KVA	1.00		KVA
6			KVA		KVA		KVA	1.00		KVA
7			KVA		KVA		KVA	1.00		KVA
8			KVA		KVA		KVA	1.00		KVA
9			KVA		KVA		KVA	1.00		KVA
	TOTALS	**40.0**	**KVA**		**KVA**	**40.0**	**KVA**		**40.0**	**KVA**
	TOTAL + SPARE	**48.0**	**KVA**		**KVA**	**48.0**	**KVA**		**48.0**	**KVA**

PNL DES:	ELPL4(DIM)			Notes:
BUS RATING:	225	AMPS		
DEVICE:	MCB			
RATING:	225	AMPS		
MIN KAIC:	10	KAIC		
MOUNTING:	SURFACE			
VOLTAGE:	208	120		
FDR SOURCE:				
SOURCE CB:	125	AMPS		
FDR SIZE:	350	M		Duct (M or N)
QTY PER PH:	1			
LF:	50			
%VD:	0.23	@		100 Amps [Max Load]
%VD:	0.23			[Cummulative]

Comm. No.
2/7/2009

PANELBOARD LPL3(DIM) SCHEDULE

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

DES L	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	DES R
L	LIGHTING RM 224	1.1			20	12	1		2	10	20	12.6			LIGHTING RM 213/214	L
L	LIGHTING RM 223		6.7		20	12	3		4	10	20		8.4		LIGHTING RM 213/214	L
L	LIGHTING RM 232			0.6	20	12	5		6	10	20			12.6	LIGHTING RM 213/214	L
	SPARE				20		7		8	10	20	12.6			LIGHTING RM 213/214	L
	SPARE				20		9		10	10	20		12.6		LIGHTING RM 213/214	L
	SPACE						11		12	10	20			12.6	LIGHTING RM 213/214	L
	SPACE						13		14	12	20	12.6			LIGHTING RM 213/214	L
L	LIGHTING RM 202		8.3		20	12	15		16	12	20		9.6		LIGHTING RM 201	L
L	LIGHTING RM 202			13.3	20	12	17		18	12	20			3.3	LIGHTING RM 201	L
L	LIGHTING RM 202	13.3			20	12	19		20	12	20	5.0			LIGHTING RM 201	L
L	LIGHTING RM 202		13.3		20	12	21		22	10	20		8.4		LIGHTING TRUSS	L
L	LIGHTING PARTITION			5.0	20	12	23		24						SPACE	
L	LIGHTING RM 201	13.3			20	12	25		26						SPACE	
	SPACE						27		28						SPACE	
	SPACE						29		30						SPACE	
	SPACE						31		32						SPACE	
	SPACE						33		34						SPACE	
	SPACE						35		36						SPACE	
	SUB-TOTAL AMPS	27.7	28.3	18.9								42.8	39.0	28.5	SUB-TOTAL AMPS	
	PANEL AMPS	70.5	67.3	47.4												
	PANEL + FEED-THRU AMPS	70.5	67.3	47.4											FEED-THRU AMPS	
	TOTAL KVA	8.5	8.1	5.7	Version 3.04											

DES	LOAD DESCRIPTION	PNL LPL3(DIM) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	22.2 KVA	KVA	22.2 KVA	1.00	22.2 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**22.2 KVA**	**KVA**	**22.2 KVA**		**22.2 KVA**
	TOTAL + SPARE	**26.7 KVA**	**KVA**	**26.7 KVA**		**26.7 KVA**
		74.0 AMPS	**AMPS**	**74.0 AMPS**		**74.0 AMPS**

PNL DES:	LPL3(DIM)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MCB		
RATING:	100	AMPS	
MIN KAIC:	10	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	208	120	
FDR SOURCE:			
SOURCE CB:	50	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.27	@	40 Amps [Max Load]
%VD.	0.27		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 **< INITIALLY SET TO 20%**

Comm. No.
2/7/2009

PANELBOARD HPL3(SWITCH) SCHEDULE

225 AMP BUS | 225 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DESL	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	DESR
L	LTG. COVE RM 213/214	5.8			20	10	1		2	12	20	6.7			LIGHTING RM 202	L
L	LIGHTING RM 213/214		4.4		20	12	3		4	12	20		4.0		LTG. RM 203,204,207,225,226	L
L	LIGHTING RM 213/214			6.6	20	12	5		6	12	20			9.9	LIGHTING RM 213/214	L
L	LIGHTING RM 213/214	8.8			20	12	7		8	12	20	5.3			LIGHTING RM 201	L
L	LTG. COVE RM 213/214		2.8		20	12	9		10		20				SPARE	
	SPACE						11		12		20				SPARE	
	SPACE						13		14						SPACE	
	SPACE						15		16						SPACE	
							17		18							
							19		20							
							21		22							
							23		24							
							25		26							
							27		28							
							29		30							
							31		32							
							33		34							
							35		36							
							37		38							
							39		40							
							41		42							
	SUB-TOTAL AMPS	14.6	7.2	6.6								12.0	4.0	9.9	SUB-TOTAL AMPS	
	PANEL AMPS	26.6	11.2	16.5		*INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	26.6	11.2	16.5											FEED-THRU AMPS	
	TOTAL KVA	7.4	3.1	4.6		Version 3.04										

DES	LOAD DESCRIPTION	PNL HPL3(SWITCH) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	15.0 KVA	KVA	15.0 KVA	1.00	15.0 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**15.0 KVA**	**KVA**	**15.0 KVA**		**15.0 KVA**
	TOTAL + SPARE	**18.0 KVA**	**KVA**	**18.0 KVA**		**18.0 KVA**
		21.7 AMPS	**AMPS**	**21.7 AMPS**		**21.7 AMPS**

PNL DES:	HPL3(SWITCH)		Notes:
BUS RATING:	225	AMPS	
DEVICE:	MLO		
RATING:	225	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	225	AMPS	
FDR SIZE:	140	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.24	@	180 Amps [Max Load]
%VD.	0.24		[Cummulative]
	32,164	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

Comm. No.
2/7/2009

PANELBOARD EHPL4(SWITCH) SCHEDULE

100 AMP BUS | 100 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES L	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	DES R
L	EMERG. LTG. RM 202	2.6			20	12	1		2	12	20	5.5			LIGHTING RM 200	L
L	EMERG. LTG. RM 201		2.6		20	12	3		4	12	20		5.6		LTG. RM 213/214 COVE	L
L	LIGHTING RM 213/214			9.9	20	12	5		6	12	20			12.1	LIGHTING RM 212	L
L	LIGHTING EXTERIOR	8.0			20	12	7		8	12	20	12.1			LIGHTING RM 213/214	L
L	LIGHTING EXTERIOR		6.4		20	12	9		10	12	20		12.1		LIGHTING RM 213/214	L
L	LIGHTING RM 220			8.5	20	12	11		12	10	20			2.0	LIGHTING EXIT LIGHTS	L
L	LIGHTING RM 300	2.4			20	12	13		14	12	20	6.2			LIGHTING RM 223 COVE	L
L	EMERG.LTG. RM 300		1.4		20	12	15		16	12	20		0.5		EMERG. LTG. RM 205	L
L	EMERG. LTG. RM 206			0.5	20	12	17		18	12	20			2.1	LIGHTING RM 215, 219	L
L	EMERG. LTG. RM 216	0.5			20	12	19		20	12	20	3.3			LIGHTING RM 216	L
L	EMERG. LTG. RM 218		0.5		20	12	21		22	12	20		2.5		LIGHTING RM 218	L
L	LIGHTING CLOSETS			0.5	20	12	23		24	12	20			0.5	EMERG. LTG. RM 235, 301	L
	SPACE						25		26		20				SPARE	
	SPACE						27		28		20				SPARE	
	SUB-TOTAL AMPS	13.5	10.9	19.4								27.1	20.7	16.7	SUB-TOTAL AMPS	
	PANEL AMPS	40.6	31.6	36.1		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	40.6	31.6	36.1											FEED-THRU AMPS	
	TOTAL KVA	11.2	8.8	10.0		Version 3.04										

DES	LOAD DESCRIPTION	NL EHPL4(SWITCH) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	30.0 KVA	KVA	30.0 KVA	1.00	30.0 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**30.0 KVA**	**KVA**	**30.0 KVA**		**30.0 KVA**
	TOTAL + SPARE	**36.0 KVA**	**KVA**	**36.0 KVA**		**36.0 KVA**
		43.3 AMPS	**AMPS**	**43.3 AMPS**		**43.3 AMPS**

PNL DES:	EHPL4(SWITCH)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MLO		
RATING:	100	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	100	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.23	@	80 Amps [Max Load]
%VD.	0.23		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

Comm. No.
2/7/2009

PANELBOARD ELPL2 (DIM) SCHEDULE

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

DES L	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	DES R
L	EMERGENCY LTG.-CANOPY	12.5			20	10	1		2	10	20	10.0			EMERGENCY LTG.-BRIDGE	L
L	EMERGENCY LTG.-CANOPY		10.0		20	10	3		4	10	20		10.0		EMERGENCY LTG.-BRIDGE	L
L	EMERGENCY LTG.-BRIDGE			7.5	20	10	5		6	10	20			10.0	EMERGENCY LTG-CANOPY	L
L	EMERGENCY LTG.-BRIDGE	7.5			20	10	7		8	10	20	10.0			EMERGENCY LTG-CANOPY	L
L	LIGHTING RM 116		8.3		20	12	9		10	12	20		5.0		LIGHTING RM 116	L
L	LIGHTING OCCUP.FIXT.			1.0	20	12	11		12	12	20			1.0	LIGHTING OCCUP. FIXT.	L
	SPARE				20		13		14						SPACE	
	SPARE				20		15		16						SPACE	
	SUB-TOTAL AMPS	20.0	18.3	8.5								20.0	15.0	11.0	SUB-TOTAL AMPS	
	PANEL AMPS	40.0	33.3	19.5		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	40.0	33.3	19.5											FEED-THRU AMPS	
	TOTAL KVA	4.8	4.0	2.3		Version 3.04										

DES	LOAD DESCRIPTION	PNL ELPL2 (DIM) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	11.1 KVA	KVA	11.1 KVA	1.00	11.1 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**11.1 KVA**	**KVA**	**11.1 KVA**		**11.1 KVA**
	TOTAL + SPARE	**13.4 KVA**	**KVA**	**13.4 KVA**		**13.4 KVA**
		37.1 AMPS	**AMPS**	**37.1 AMPS**		**37.1 AMPS**

PNL DES:	ELPL2 (DIM)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MLO		
RATING:	100	AMPS	
MIN KAIC:	10	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	208	120	
FDR SOURCE:			
SOURCE CB:	100	AMPS	
FDR SIZE:	2	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.65	@	80 Amps [Max Load]
%VD.	0.65		[Cummulative]
	11,928	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

Comm. No.
2/7/2009

PANELBOARD EHPLP(SWITCH) SCHEDULE

100 AMP BUS | 100 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES L	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	DES R
	SPARE				20		1		2	12	20	6.4			LIGHTING LOWER BRIDGE	L
	SPARE				20		3		4	12	20		3.2		LIGHTING PED. CANOPY	L
L	BUS DEPOT			12.1	20	10	5		6	12	20			4.8	LIGHTING STAIRCASE	L
L	LIGHTING PED. CANOPY	6.8			20	12	7		8	12	20	0.6			LIGHTING STAIRCASE	L
L	LIGHTING PED. CANOPY		6.8		20	12	9		10	12	20		4.8		LIGHTING EXT. UPLIGHTS	L
L	LIGHTING UPPER BRIDGE			8.0	20	12	11		12	12	20			0.3	EMERG. LTG. RM 141	L
L	LIGHTING RM 142	0.3			20	12	13		14	12	20	0.8			LIGHTING RM 228, 230	L
	SPARE				20		15		16		20				SPARE	
							17		18							
							19		20							
							21		22							
							23		24							
							25		26							
							27		28							
							29		30							
							31		32							
							33		34							
							35		36							
							37		38							
							39		40							
							41		42							
	SUB-TOTAL AMPS	7.1	6.8	20.1								7.8	8.0	5.1	SUB-TOTAL AMPS	
	PANEL AMPS	14.9	14.8	25.2		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	14.9	14.8	25.2											FEED-THRU AMPS	
	TOTAL KVA	4.1	4.1	7.0	Version 3.04											

DES	LOAD DESCRIPTION	NL EHPLP(SWITCH) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	15.2 KVA	KVA	15.2 KVA	1.00	15.2 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**15.2 KVA**	**KVA**	**15.2 KVA**		**15.2 KVA**
	TOTAL + SPARE	**18.2 KVA**	**KVA**	**18.2 KVA**		**18.2 KVA**
		22.0 AMPS	**AMPS**	**22.0 AMPS**		**22.0 AMPS**

PNL DES:	EHPLP(SWITCH)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MLO		
RATING:	100	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	100	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.23	@	80 Amps [Max Load]
%VD.	0.23		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

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PANELBOARD EHPL2(SWITCH) SCHEDULE

100 AMP BUS | 100 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES L	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	DES R
L	LIGHTING U.S. CUSTOMS	5.0			20	12	1		2	12	20	1.3			EMERG. LTG. RM. 102	L
L	LIGHTING U.S. CUSTOMS		5.0		20	12	3		4	12	20		12.0		LIGHTING RM 137	L
L	LIGHTING RM 100			0.5	20	12	5		6	12	20			12.5	LIGHTING RM 137	L
L	EXTERIOR LIGHTING	4.4			20	12	7		8	12	20	4.4			LIGHTING RM 137	L
L	EMERG. LTG. RM 100		0.3		20	12	9		10	10	20		1.0		LIGHTING - EXIT LIGHTS	L
L	LIGHTING RM 102			1.3	20	12	11		12	12	20			3.9	LTG. RM 112,121,122,123,124	L
L	EMERG. LTG. RM 115	1.0			20	12	13		14	12	20	1.0			EMERG. LTG. RM. 113	L
L	EMERG. LTG. RM 118		1.3		20	12	15		16	12	20		1.3		EMERG. LTG. RM 119	L
L	EMERG. LTG. RM 111			1.3	20	12	17		18	12	20			0.3	LIGHTING RM 129	L
L	LIGHTING RM 109, 110	1.7			20	12	19		20	12	20	0.7			EMERG. LTG. RM 108	L
L	EMERG. LTG. RM 107		1.3		20	12	21		22	12	20		1.3		EMERG. LTG. RM 106	L
L	EMERG. LTG. RM 105			0.7	20	12	23		24	12	20			0.8	LIGHTING RM 101, 103, 120	L
L	LIGHTING RM 114	0.3			20	12	25		26	12	20	0.5			EMERG. LTG. RM 129	L
	SPARE				20		27		28		20				SPARE	
							29		30							
							31		32							
							33		34							
							35		36							
							37		38							
							39		40							
							41		42							
	SUB-TOTAL AMPS	12.4	7.9	3.8								7.9	15.6	17.5	SUB-TOTAL AMPS	
	PANEL AMPS	20.3	23.5	21.3		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	20.3	23.5	21.3											FEED-THRU AMPS	
	TOTAL KVA	5.6	6.5	5.9		Version 3.04										

DES	LOAD DESCRIPTION	NL EHPL2(SWITCH) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	18.0 KVA	KVA	18.0 KVA	1.00	18.0 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	18.0 KVA	KVA	18.0 KVA		18.0 KVA
	TOTAL + SPARE	21.6 KVA	KVA	21.6 KVA		21.6 KVA
		26.0 AMPS	AMPS	26.0 AMPS		26.0 AMPS

PNL DES:	EHPL2(SWITCH)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MLO		
RATING:	100	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	100	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.23	@	80 Amps [Max Load]
%VD.	0.23		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

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The existing panelboards are as follows:

Existing Panelboards			
Panel Name	**Type**	**Voltage**	**Locations Served**
ELPL4	Dimming	120	Waiting Area, Lobby
LPL3	Dimming	120	Lobby, Conference, Waiting Area, Waiting Area (LEDS)
HPL3	Switching	277	Waiting Area, Conference
EHPL4	Switching	277	Conference, Waiting Area, Façade
ELPL2	Dimming	120	Façade
EHPLP	Switching	277	Façade
EHPL2	Switching	277	Façade

The Lutron GRAFIK Eye Designer solution recommends the following panelboards:

Lutron GRAFIK Eye Designer Solution			
Panel Name	**Type**	**Voltage**	**Locations Served**
Panel Unit 1	Dimming	277	Waiting Area
Panel Unit 2	Switching	120	Waiting Area
Panel Unit 3	Dimming	120	Lobby
Panel Unit 4	Dimming	277	Lobby
Panel Unit 5	Switching	120	Lobby
Panel Unit 6	Dimming	277	Conference
Panel Unit 7	Switching	120	Façade

For the purpose of this thesis project, and since emergency lighting and power systems are not in the scope of the redesign, the following is a list of recommendations:

- All existing panelboards will remain (none will be demolished)
- All existing panelboards which have loads in any of the four redesigned spaces will have modified loads
- Some, but not all, existing panelboards will carry new lighting loads from the redesign
- New panelboards will be required since the conditions of the existing design do not align perfectly with the proposed redesign. For example, if the new redesign requires a 277V Dimming panelboard and the existing design does not have an adequate panelboard which can handle this load type, then a new panelboard will be created
- For the sake of efficiency, the panelboard solutions that Lutron GRAFIK Eye Designer created will be consolidated when appropriate. The consolidated panelboard recommendation is as follows:

Proposed Consolidation of loads
ELPL4
EHPL4
ELPL2
EHPLP
EHPL2
HPL3, Panel Unit 1, Panel Unit 4, Panel Unit 6
LPL3, Panel Unit 2, Panel Unit 5, Panel Unit 7, Panel Unit 3

From now on, the use of “HPL3’ in this report will include loads from the original HPL3, Panel Unit 1, Panel Unit 4 and Panel Unit 6. Also, “LPL3” will include loads from the original LPL3, Panel Unit 2, Panel Unit 5, Panel Unit 7 and Panel Unit 3.

The new, consolidated panelboards are as follows:

PANELBOARD LPL3(DIM) SCHEDULE

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

DESL	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	DESR
L	A4-5	0.7			20	12	1		2	10	20	6.3			A1-4	L
L	A4-3		2.1		20	12	3		4	10	20		2.0		A4-4	L
L	SPARE				20	12	5		6	20	12				SPARE	L
L	SPARE				20	12	7		8	20	12				SPARE	L
L	SPARE				20	12	9		10	20	12				SPARE	L
	SPACE						11		12						SPACE	
	SPACE						13		14						SPACE	
	SPACE						15		16						SPACE	
	SPACE						17		18						SPACE	
	SPACE						19		20						SPACE	
	SPACE						21		22						SPACE	
	SPACE						23		24						SPACE	
	SPACE						25		26						SPACE	
	SPACE						27		28						SPACE	
	SPACE						29		30						SPACE	
	SPACE						31		32						SPACE	
	SPACE						33		34						SPACE	
	SPACE						35		36						SPACE	
	SUB-TOTAL AMPS	0.7	2.1									6.3	2.0		SUB-TOTAL AMPS	
	PANEL AMPS	7.0	4.1													
	PANEL + FEED-THRU AMPS	7.0	4.1												FEED-THRU AMPS	
	TOTAL KVA	0.8	0.5		Version 3.04											

DES	LOAD DESCRIPTION	PNL LPL3(DIM) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	1.3 KVA	KVA	1.3 KVA	1.00	1.3 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**1.3 KVA**	**KVA**	**1.3 KVA**		**1.3 KVA**
	TOTAL + SPARE	**1.6 KVA**	**KVA**	**1.6 KVA**		**1.6 KVA**
		4.4 AMPS	**AMPS**	**4.4 AMPS**		**4.4 AMPS**

PNL DES:	LPL3(DIM)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MCB		
RATING:	100	AMPS	
MIN KAIC:	10	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	208	120	
FDR SOURCE:			
SOURCE CB:	50	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.27	@	40 Amps [Max Load]
%VD:	0.27		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 **< INITIALLY SET TO 20%**

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PANELBOARD HPL3(DIM) SCHEDULE

225 AMP BUS | 225 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES L	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	DES R
L	A1-1	5.8			20	10	1	2	12	20	6.8			A1-2	L
L	A1-3		0.5		20	12	3	4	12	20		4.0		LTG. RM 203,204,207,225,226	L
L	A1-5			5.4	20	12	5	6	12	20			5.4	A1-6	L
L	A1-7	5.4			20	12	7	8	12	20	5.4			A1-8	L
L	A2-1		4.7		20	12	9	10	12	20		4.0		A2-2	L
L	A2-3			4.0	20	12	11	12	12	20			3.6	A4-6	L
L	A4-2	2.1			20	12	13	14	12	20	1.4			A4-1	L
L	A5-5		1.8		20	12	15	16	12	20		1.2		A5-8	L
L	A5-4			2.7	20	12	17	18	12	20			1.1	A5-2	L
L	A5-1	1.1			20	12	19	20	12	20	1.1			A5-7	L
L	A5-3		0.5		20	12	21	22	12	20		0.7		A5-6	L
L	A6-1			2.1	12	20	23	24	12	20			2.1	A6-2	L
L	A6-3	1.7			12	20	25	26	12	20	1.7			A6-4	L
L	SPARE				12	20	27	28	12	20				SPARE	L
L	SPARE				12	20	29	30	12	20				SPARE	L
	SPACE						31	32						SPACE	
	SPACE						33	34						SPACE	
	SPACE						35	36						SPACE	
	SPACE						37	38						SPACE	
	SPACE						39	40						SPACE	
	SPACE						41	42						SPACE	
	SUB-TOTAL AMPS	16.0	7.6	14.3							16.3	10.0	12.2	SUB-TOTAL AMPS	
	PANEL AMPS	32.4	17.6	26.4		*INDICATES EMERGENCY CIRCUIT									
	PANEL + FEED-THRU AMPS	32.4	17.6	26.4										FEED-THRU AMPS	
	TOTAL KVA	9.0	4.9	7.3	Version 3.04										

DES	LOAD DESCRIPTION	PNL HPL3(DIM) CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	21.1 KVA	KVA	21.1 KVA	1.00	21.1 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	21.1 KVA	KVA	21.1 KVA		21.1 KVA
	TOTAL + SPARE	25.4 KVA	KVA	25.4 KVA		25.4 KVA
		30.5 AMPS	AMPS	30.5 AMPS		30.5 AMPS

PNL DES: HPL3(DIM) Notes:
BUS RATING: 225 AMPS
DEVICE: MLO
RATING: 225 AMPS
MIN KAIC: 18 KAIC
MOUNTING: SURFACE
VOLTAGE: 480 277
FDR SOURCE:
SOURCE CB: 225 AMPS
FDR SIZE: 140 M Duct (M or N)
QTY PER PH: 1
LF: 50
%VD: 0.24 @ 180 Amps [Max Load]
%VD: 0.24 [Cummulative]
32,164 Amps Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

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The emergency panelboards remain unchanged, except that the circuits outlined by a bold border (in the previous section) will be removed. Since emergency lighting is not in the scope of this project, the emergency panelboards were not resized.

Technically, there is less load on the emergency panels, and therefore there is potential to reduce the panelboard size. All the lighting loads for this redesign are on either the LPL3 or HPL3. The actual sizes of these two panelboards will remain the same as the existing sizes. LPL3 has a 100 Amp bus and 100 Amp main circuit breaker. HLP3 has a 225 Amp bus and 225 Amp main circuit breaker. Both of these panelboards are redesigned to have additional 20% spare capacity. The feeder is designed to be the minimum size allowed by the National Electric Code NEC Table 310.16, based on the expected amps on the panel (total plus 20% expansion). LPL3 will have a (4)#12 THW feeder and HPL3 will have a (4)#10 THW feeder. These feeders, though technically correct according to the NEC, should be significantly larger according to engineering judgement.

NEC Table 310.16

Size AWG or kcmil	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	Size AWG or kcmil
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14*	20	20	25	—	—	—	—
12*	25	25	30	20	20	25	12*
10*	30	35	40	25	30	35	10*
8	40	50	55	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	150	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0

Also, the shading devices run on low voltage (24 VAC), which Lutron recommends to be installed by the low-voltage contractors. The “Controls” section of this report indicates the load type.

The panelboard locations will not change; all panelboards will remain in the existing electrical closets and electrical rooms, and LPL3 and HPL3 will be located in the second floor electrical closets.

The location of controls is as follows:

Controlled Location	Control Units and Wall Stations
Waiting Area / Ticket Queuing	(2) column-mounted (1) wall-mounted
Lobby	(2) wall-mounted
Conference Room	(3) wall-mounted
Facade	(1) wall-mounted, located in Lobby

Note: all control units and wall stations except those in the Conference Room are in locked enclosures.

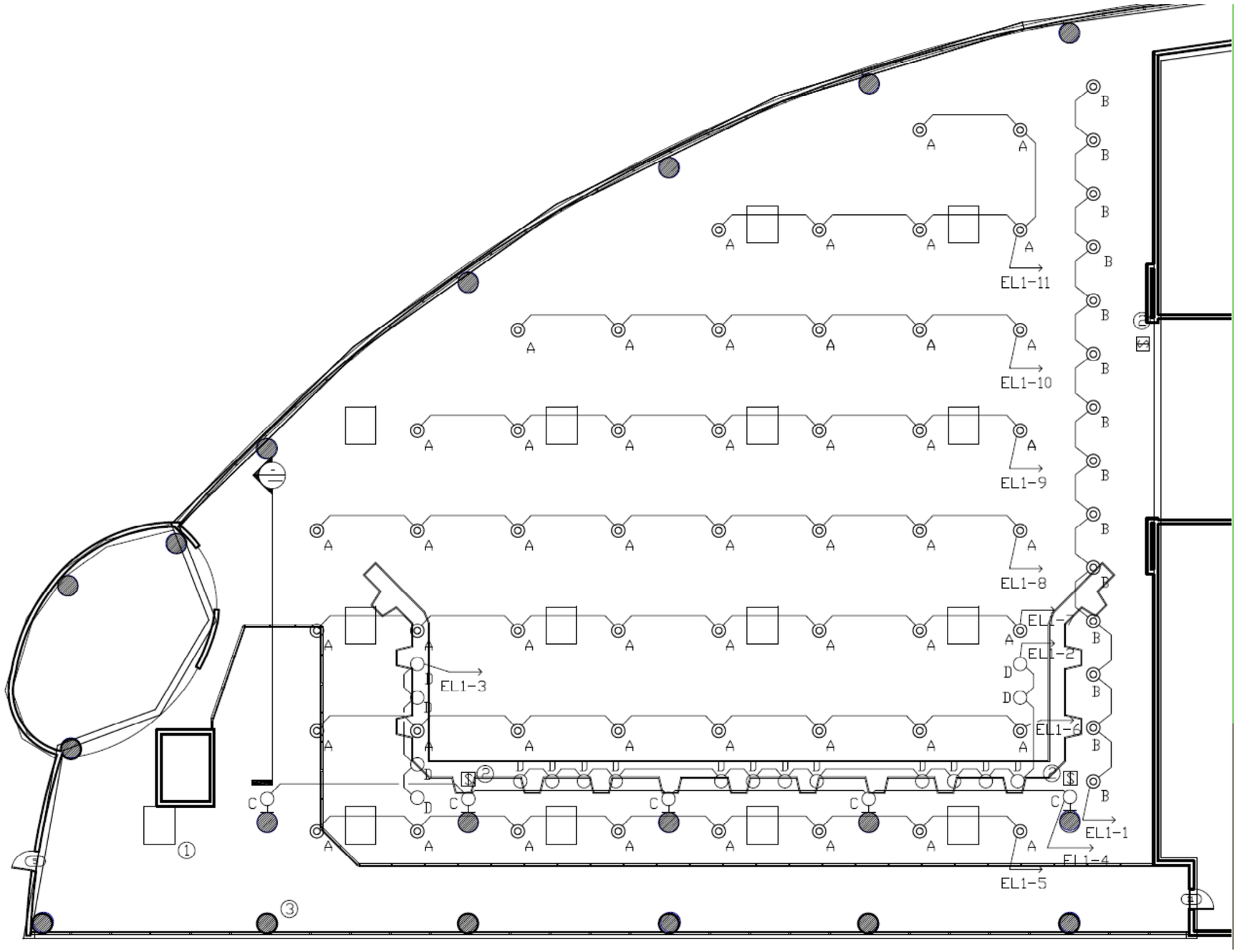
Space 1: Waiting Area / Ticket Queuing

Introduction

The Waiting Area / Ticket Queuing space is one architectural space, despite two separate room numbers. It is 12,063 square feet and is approximately 23'-4" high, though the exposed steel trusses are curved, increasing the height in the spaces center. The northern curtain wall of windows is approximately 16'3" high. During a cruise event, the main purpose of this space is to form queues to the Mobile Ticket Counters and provide a waiting lounge area. During non-cruise special events, the space is used as a ballroom and social gathering area.

Luminaire Layout

Note: There are no tick marks on this diagram, but since a Lutron control system is proposed, there will only be one neutral and one hot wire in every branch circuit, to every luminaire. Then, there will be a separate control wire from the Lutron system running to every luminaire. Fluorescent lamps dim according to the photosensor measurements, which respond to the illuminance from both electric light and light transmitted through the windows and skylights. The task lights provide illuminance for people at the ticket counters, and the LEDs contribute to a dynamic environment.



HALF MOONE CRUISE & CELEBRATION CENTER

LIGHTING PLAN: WAITING AREA

SCALE: 1/16” = 1.0’

PRESET SCENE SCHEDULE							
Schedule For: Waiting Area / Ticket Queuing							
Lighting Zone	**Luminaire Type(s)**	**Load Type**	**Day Cruise**	**Night Cruise**	**Conference**	**Entertainment**	**All Off**
1	B	CFL	0%	100%	100%	100%	0%
2	D	CMH	0%	100%	0%	0%	0%
3	D	CMH	0%	100%	0%	0%	0%
4	C	LED	0%	100% (Note 1)	0%	100% (Note 2)	0%
5	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
6	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
7	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
8	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
9	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
10	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
11	A	CFL	Photo Sensor	50%	Photo Sensor	50%	0%
Skylight Shades							
1			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
2			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
3			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
4			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
5			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
6			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
7			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
8			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
9			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
10			Photo	Closed -	Closed -	Closed -	Open

			Sensor	Blackout	Dimout	Blackout	
11			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
12			Photo Sensor	Closed - Blackout	Closed - Dimout	Closed - Blackout	Open
Note 1	Color-changing mode. Colors are set to blues, greens, purples						
Note 2	Color-changing mode. Colors are set to all colors						

For information about loads on the panelboards, see the previous panelboard discussion and schedules.

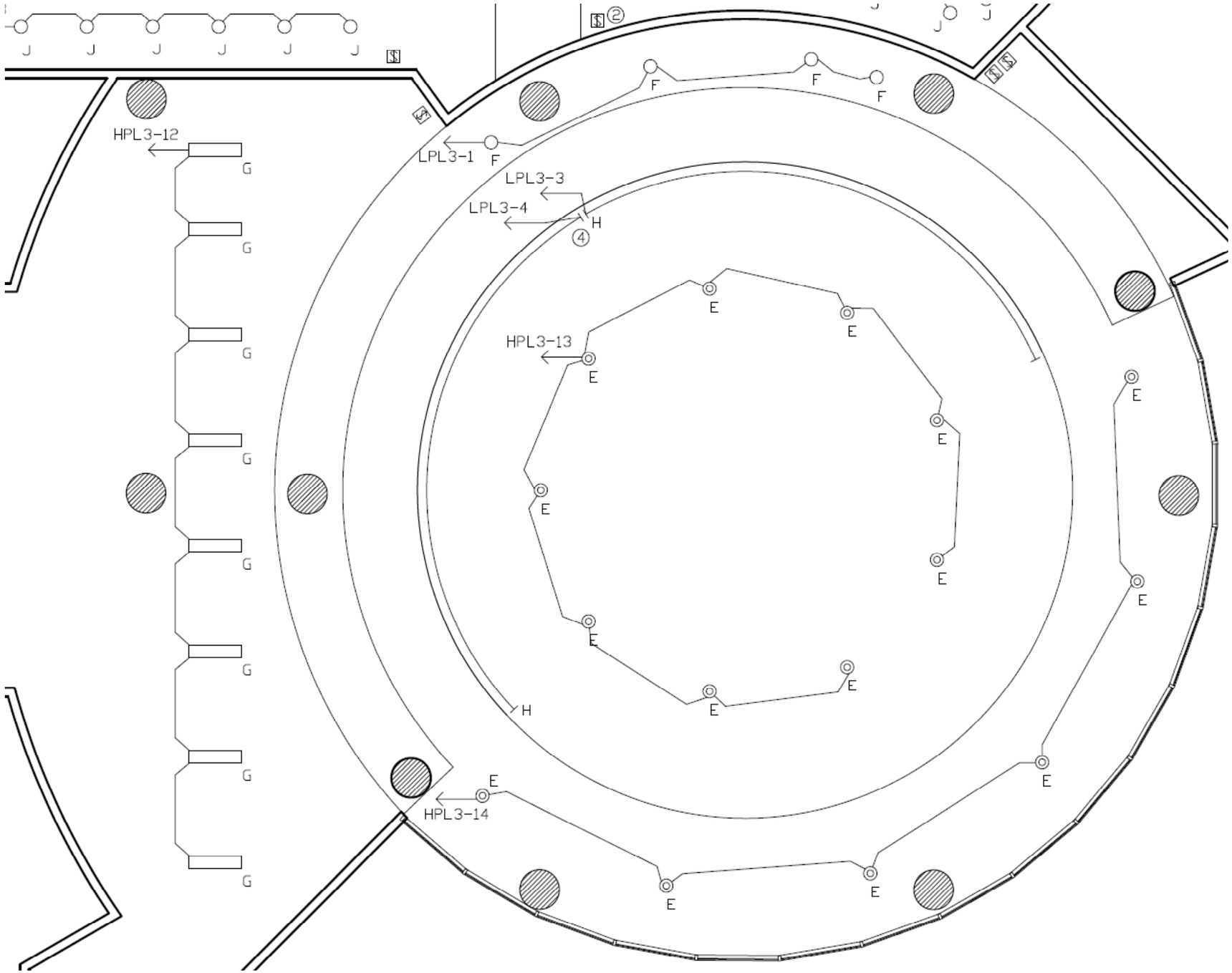
Space 2: Lobby

Introduction

The Lobby is the first major room that passengers enter from the Entry Pavilion Bridge. It is approximately 37'-6" high and includes a 54'-2" embedded mermaid image on the terrazzo-finished floor (Figure 1). There are several tiers of finished ceiling stepping up to the highest ceiling point (Figure 3). The windows on the western wall are full-height. Stemming from the Lobby are two Conference Rooms, two exits to an outdoor terrace, and four X-ray stations which lead to the Passageway.

Luminaire Layout

Note: There are no tick marks on this diagram, but since a Lutron control system is proposed, there will only be one neutral and one hot wire in every branch circuit, to every luminaire. Then, there will be a separate control wire from the Lutron system running to every luminaire. The pendants contribute to ambient light and the 1'x4' luminaires provide task and ambient light near the x-ray machines. Accent lighting illuminates art on the walls.



HALF MOONE CRUISE & CELEBRATION CENTER

LIGHTING PLAN: LOBBY

SCALE: 1/16” = 1.0’

PRESET SCENE SCHEDULE							
Schedule For: Lobby							
Lighting Zone	**Luminaire Type(s)**	**Load Type**	**Day Cruise**	**Night Cruise**	**Formal**	**Entertainment**	**All Off**
1	E	CFL	0%	100%	100%	100%	0%
2	E	CFL	Photo Sensor	100%	50%	50%	0%
3	H	LED	0%	100% (Note 1)	100% (Note 2)	100% (Note 3)	0%
4	H	LED	0%	100% (Note 1)	100% (Note 2)	100% (Note 3)	0%
5	F	Halogen	0%	100%	100%	100%	0%
6	G	Fluor	100%	100%	50%	50%	0%
Note 1: Color-changing mode. Colors are set to blues, greens, purples							
Note 2: Slow color-changing mode. Colors are set to all colors.							
Note 3: Color-changing mode. Colors are set to all colors							

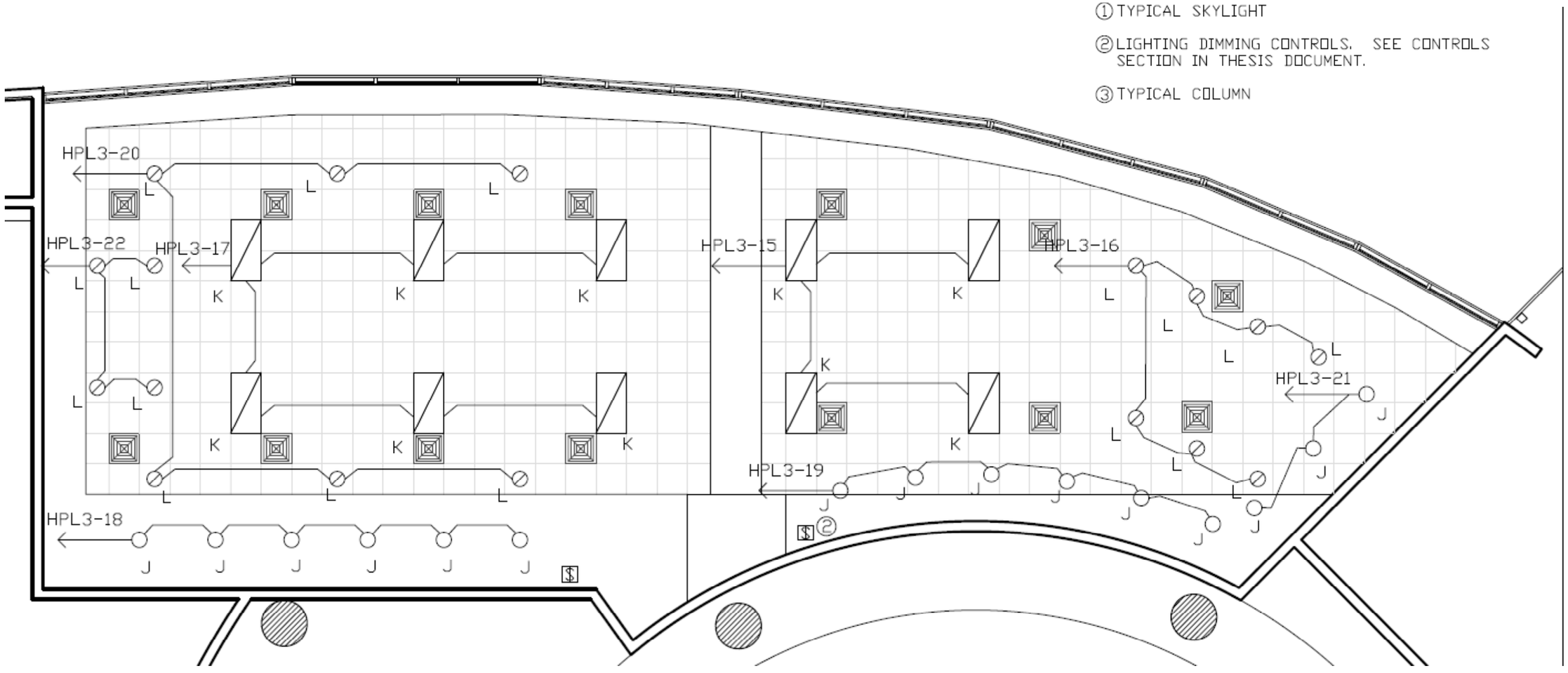
Space 3: Conference Room

Introduction

This space is connected to Conference Room No. 1 (Room 201) when the folding partition is retracted. There is a continuous row of windows lining the curved exterior wall, and the ceiling height is 15’-3”. There is a ceiling-mounted projector aimed to the ceiling-mounted retractable screen on the north wall.

Luminaire Layout

Note: There are no tick marks on this diagram, but since a Lutron control system is proposed, there will only be one neutral and one hot wire in every branch circuit, to every luminaire. Then, there will be a separate control wire from the Lutron system running to every luminaire. The partition sensors are located in this room, and determine which zones each wallstation controls. The controls are especially important in this space since it might be used for video presentations in either two separate rooms or one, continuous space.



HALF MOONE CRUISE & CELEBRATION CENTER

LIGHTING PLAN: CONFERENCE ROOM

SCALE: 1/8” = 1.0’

PRESET SCENE SCHEDULE							
Schedule For: Conference Room							
Lighting Zone	**Luminaire Type(s)**	**Load Type**	**Day Conference**	**Night Conference**	**Video Presentation**	**Entertainment**	**All Off**
1	J	CFL	100%	100%	50%	100%	0%
2	J	CFL	100%	100%	50%	100%	0%
3	J	CFL	100%	100%	0%	100%	0%
4	K	Fluor	Photosensor	100%	50%	50%	0%
5	K	Fluor	Photosensor	100%	50%	50%	0%
6	L	CFL	Photosensor	100%	0%	50%	0%
7	L	CFL	Photosensor	100%	100%	50%	0%
8	L	CFL	Photosensor	100%	50%	50%	0%
9							
10							
11							
Window Shades							
1			Open	Open	Closed - Blackout	Open	Open
2			Open	Open	Closed - Blackout	Open	Open
Room Partition							
4			User	User	User	User	User
Projection Screens							
6			Up	Up	Down	Up	Up
7			Up	Up	Down	Up	Up
8							
9							
10							
11							
12							
Note: See the following explanation regarding how the Room Partition status affects the controls.							

For information about loads on the panelboards, see the previous panelboard discussion and schedules.

Space 4: Façade

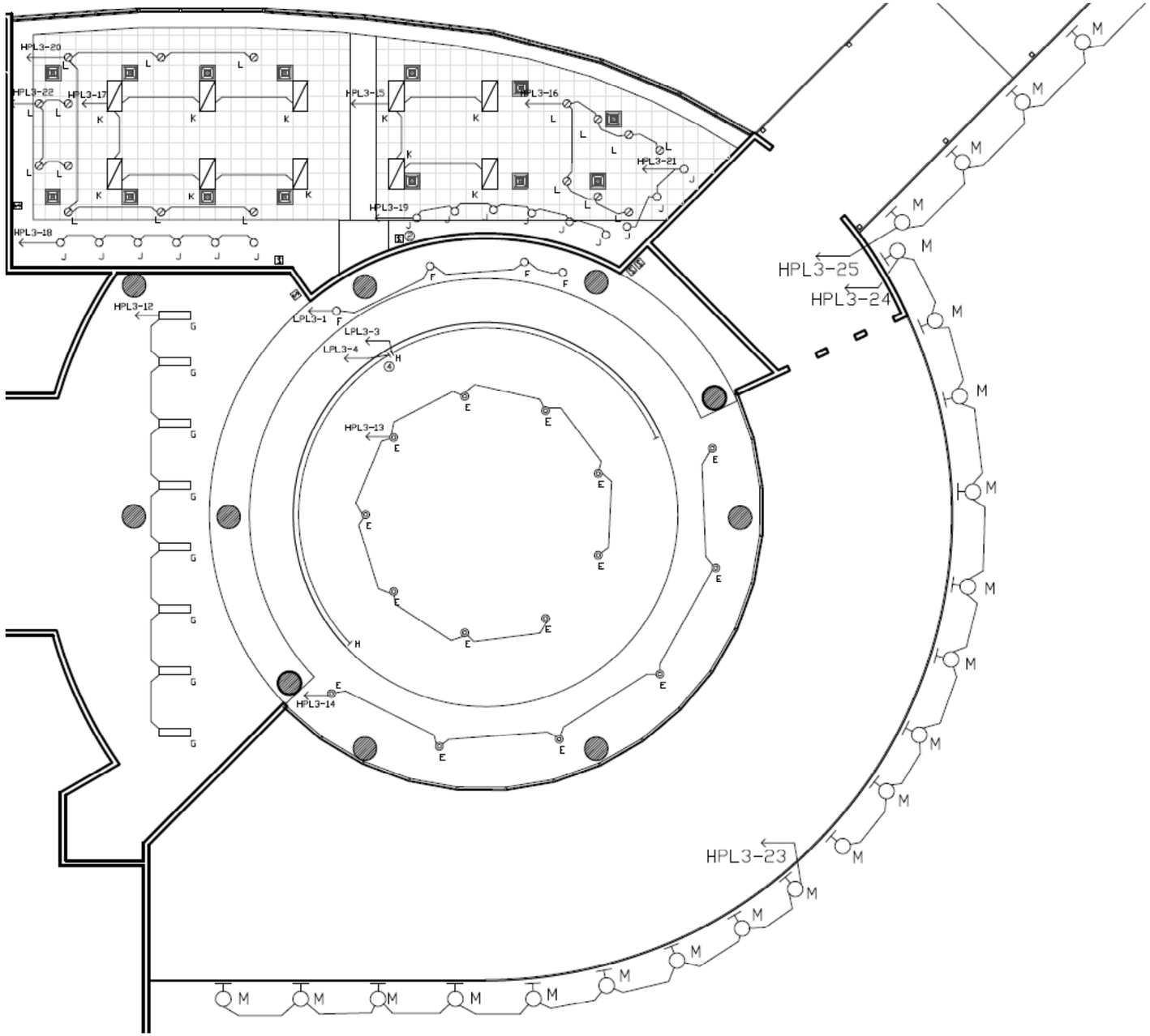
Introduction

The Entry Pavilion is the main entrance and exit point for most building users (Figure 24 and 28). During cruise ship boarding, people climb the stairs or take one of three elevators to the second floor and cross the bridge to the Lobby (Figure 25 and 26). People leaving a cruise exit the lower retractable bridge, which leads to the first floor of this 2-floor Entry Pavilion (Figure 27).

The Entry Pavilion itself is a large, 2-floor outdoor space with a bridge. It is completely open to the outdoor environment. Extended lighting analysis will be focused on how the façade appears. The scope of analysis will not include the tasks of people using the Entry Pavilion because the scope of this analysis is the façade.

Luminaire Layout

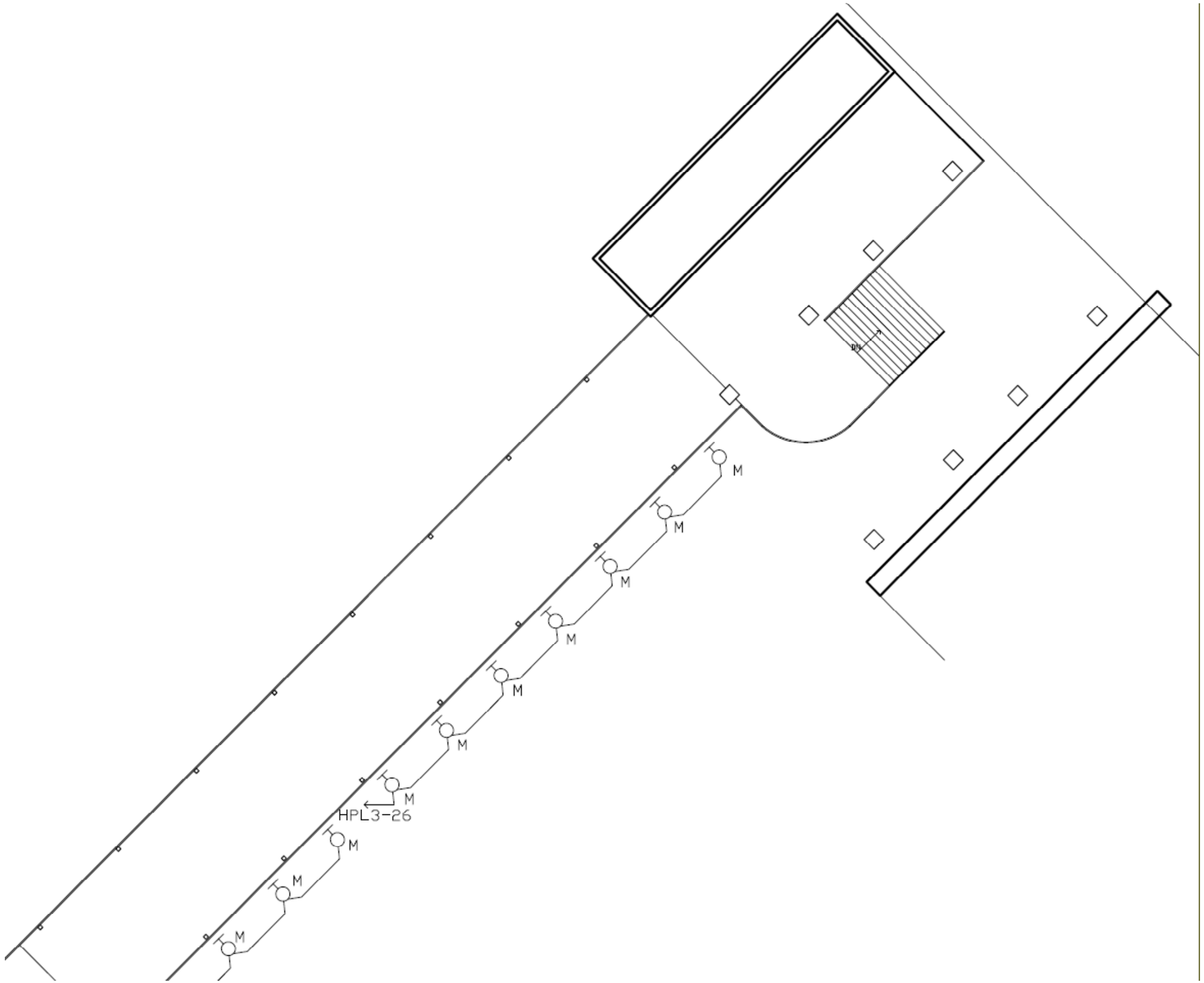
Note: There are no tick marks on this diagram, but since a Lutron control system is proposed, there will only be one neutral and one hot wire in every branch circuit, to every luminaire. Then, there will be a separate control wire from the Lutron system running to every luminaire. The façade lighting design only uses one fixture type and washes the concrete wall and the bridge truss. This, along with light from the Lobby creates an interesting, dynamic lighting design.



HALF MOONE CRUISE & CELEBRATION CENTER

LIGHTING PLAN: FACADE

SCALE: 1/16” = 1.0’



HALF MOONE CRUISE & CELEBRATION CENTER

LIGHTING PLAN: FACADE

SCALE: 1/16” = 1.0’

Depth: Copper versus Aluminum Analysis

The existing feeder material in the building is copper. Aluminum metal is less expensive, but can carry less current than a copper feeder of the same size. This means that larger wire sizes might be necessary, and possibly a different size conduit to hold the wires. The scope of this analysis is to determine the cost savings of switching to aluminum feeders in all panelboards and transformers. Material cost and labor cost of both wire and conduit is considered, and presented to show the total cost savings.

The existing feeders are as follows:

Copper Analysis

			Existing Feeder and Conduit								
Panelboard	Main Size	Length (feet)	# of Sets	# of Wires	Wire Size	Total Ampacity	Conduit Size (in.)	Cost (Wire per 100 ft)	Cost (Wire)	Cost (Conduit per ft)	Cost (Conduit)
HP1	400A	48	2	4	3/0	400	2	560	$2,150	$6.94	$666
HP2	400A	308	2	4	3/0	400	2	560	$13,798	$6.94	$4,275
HP3	600A	270	2	4	300	570	3	923	$19,937	$16.00	$8,640
HP4	100A	25	1	4	1	130	2	307	$307	$6.94	$174
LPC	400A	25	2	4	250	510	2.5	798	$1,596	$13.59	$680
LP1	100A	10	1	4	1	130	2	307	$123	$6.94	$69
LP2	225A	10	1	4	350	310	3	1059	$424	$16.00	$160
CCP1	100A	90	1	4	1/0	150	2	373	$1,343	$6.94	$625
LP3	225A	10	1	4	1/0	150	2	373	$149	$6.94	$69
LPL3	100A	10	1	4	1	130	2	307	$123	$6.94	$69
EHP1	800A	74	2	3	600	840	3	1410	$6,260	$16.00	$2,368
EHPL1	225A	50	1	4	4/0	230	2.5	686	$1,372	$13.59	$680
ELP1	100A	10	1	4	1	130	2	307	$123	$6.94	$69
EHP2	400A	290	1	3	500	380	3	1410	$12,267	$16.00	$4,640
EHPL2	100A	35	1	4	1	130	2	307	$430	$6.94	$243
ELP2	225A	10	1	4	350	310	3	1059	$424	$16.00	$160
ELPL2	100A	10	1	3	2	115	1.5	251.5	$75	$5.64	$56
LUPS	100A	130	1	3	2	115	1.5	251.5	$981	$5.64	$733
EHPP	225A	180	1	4	4/0	230	2.5	686	$4,939	$13.59	$2,446
EHPLP	100A	20	1	4	1	130	2	307	$246	$6.94	$139
ELPP	100A	15	1	4	1	130	2	307	$184	$6.94	$104
EHP3	225A	200	1	4	4/0	230	3	686	$5,488	$16.00	$3,200
EHPL4	100A	15	1	4	1	130	2	307	$184	$6.94	$104
ELP3	100A	10	1	4	1	130	2	307	$123	$6.94	$69
ELPL4	225A	10	1	4	350	310	3	1059	$424	$16.00	$160
HPL3	225A	35	1	4	4/0	230	2.5	686	$960	$13.59	$476
TX1		10	1	3	6	65	1	125.5	$38	$3.26	$33
TX2		10	1	3	2	115	1.5	251.5	$75	$5.64	$56
TX3		10	1	3	2	115	1.5	251.5	$75	$5.64	$56
TXL3		25	1	3	6	65	1	125.5	$94	$3.26	$82
TXC		34	1	3	2/0	175	2	455	$464	$6.94	$236
ETX1		10	1	3	6	65	1	125.5	$38	$3.26	$33
ETX2		30	1	3	2	115	1.5	251.5	$226	$5.64	$169
ETXP		10	1	3	6	65	1	125.5	$38	$3.26	$33
ETX3		15	1	3	6	65	1	125.5	$56	$3.26	$49
TXL4		10	1	3	2	115	1.5	251.5	$75	$5.64	$56
ATS	800A	70	2	3	600	840	3	1410	$5,922	$16.00	$2,240

Total Cost (Wire)
$81,532

Total Cost (Conduit)
$34,117

Total Cost:
$115,649

The proposed aluminum system is as follows:

Aluminum Analysis

			Theoretical Aluminum Feeder and Conduit								
Panelboard	Main Size	Length (feet)	# of Sets	# of Wires	Wire Size	Total Ampacity	Conduit Size (in.)	Cost (Wire per 100 ft)	Cost (Wire)	Cost (Conduit per ft)	Cost (Conduit)
HP1	400A	48	2	4	250	410	2.5	318	$1,221	$13.59	$1,304.64
HP2	400A	308	2	4	250	410	2.5	318	$7,836	$13.59	$8,371.44
HP3	600A	270	2	4	500	620	3	528	$11,405	$16.00	$8,640.00
HP4	100A	25	1	4	2/0	135	2	216	$216	$6.94	$173.50
LPC	400A	25	2	4	400	540	2.5	473	$946	$13.59	$679.50
LP1	100A	10	1	4	2/0	135	2	216	$86	$6.94	$69.40
LP2	225A	10	1	4	500	310	3	528	$211	$16.00	$160.00
CCP1	100A	90	1	4	3/0	155	2	252	$907	$6.94	$624.60
LP3	225A	10	1	4	3/0	155	2	252	$101	$6.94	$69.40
LPL3	100A	10	1	4	2/0	135	2	216	$86	$6.94	$69.40
EHP1	800A	74	3	3	500	930	3	528	$3,516	$13.59	$3,016.98
EHPL1	225A	50	1	4	300	230	2.5	398	$796	$13.59	$679.50
ELP1	100A	10	1	4	2/0	135	2	216	$86	$6.94	$69.40
EHP2	400A	290	2	3	250	410	2	318	$5,533	$6.94	$4,025.20
EHPL2	100A	35	1	4	2/0	135	2	216	$302	$6.94	$242.90
ELP2	225A	10	1	4	500	310	3	528	$211	$16.00	$160.00
ELPL2	100A	10	1	3	1/0	120	1.5	188	$56	$4.62	$46.20
LUPS	100A	130	1	3	1/0	120	1.5	188	$733	$4.62	$600.60
EHPP	225A	180	1	4	300	230	2.5	398	$2,866	$13.59	$2,446.20
EHPLP	100A	20	1	4	2/0	135	2	216	$173	$6.94	$138.80
ELPP	100A	15	1	4	2/0	135	2	216	$130	$6.94	$104.10
EHP3	225A	200	1	4	300	230	3	398	$3,184	$13.59	$2,718.00
EHPL4	100A	15	1	4	2/0	135	2	216	$130	$6.94	$104.10
ELP3	100A	10	1	4	2/0	135	2	216	$86	$6.94	$69.40
ELPL4	225A	10	1	4	500	310	3	528	$211	$16.00	$160.00
HPL3	225A	35	1	4	300	230	2.5	398	$557	$13.59	$475.65
TX1		10	1	3	4	65	1	97.5	$29	$3.26	$32.60
TX2		10	1	3	1/0	120	1.5	188	$56	$4.62	$46.20
TX3		10	1	3	1/0	120	1.5	188	$56	$4.62	$46.20
TXL3		25	1	3	4	65	1	97.5	$73	$3.26	$81.50
TXC		34	1	3	4/0	180	2	275	$281	$6.94	$235.96
ETX1		10	1	3	4	65	1	97.5	$29	$3.26	$32.60
ETX2		30	1	3	1/0	120	1.5	188	$169	$4.62	$138.60
ETXP		10	1	3	4	65	1	97.5	$29	$3.26	$32.60
ETX3		15	1	3	4	65	1	97.5	$44	$3.26	$48.90
TXL4		10	1	3	1/0	120	1.5	188	$56	$4.62	$46.20
ATS	800A	70	3	3	500	930	3	528	$3,326	$16.00	$3,360.00

Total Cost (Wire)
$41,587

Total Cost (Conduit)
$35,219

Total Cost:
$76,806

The total cost of installing aluminum feeders is less than the total cost of installing copper feeders. There are other considerations to weigh before the decision is made to install aluminum feeders. For example, the expansion properties of the two metals are different. This impacts the connections and possibly the installation costs. The total cost savings of aluminum, however, is substantial and could be considered in feeder design, especially as material costs rise.

Depth: Overall reduction in light levels

The existing design of the Half Moone Cruise & Celebration Center includes many luminaires that use energy inefficient lamps. The following evaluation shows the impact on the electrical distribution system if these luminaires are replaced with more energy efficient alternatives.

The method of analysis is to compare the efficacies of each light source in a given space, and find the savings (in terms of watts) for that space if an alternative light source were used. This method assumes that each light source has the average efficacy in the range of efficacies given in IESNA Lighting Handbook Figure 26-3.

Data taken from IESNA Lighting Handbook Figure 26-3:

Light Source	**Efficacy**
Standard Incandescent	13
Tungsten halogen	18
CFL (5-26W)	40
CFL (27-40W)	65
Fluorescent	82
Metal Halide	72
HPS	80

Given this data, and assuming that the total lumen output in the space will remain the same (as in, the zonal lumen method), here are the results of this approximate method.

Three spaces will be evaluated in this study: the Waiting Area / Ticket Queuing Area, the Conference Room, and the Luggage Area on the first floor. Both the Waiting Area / Ticket Queuing Area and the Conference Room have already been redesigned. The loads in both of these areas have been reduced, and the feeders and panelboards have been designed around these loads. Note that the panelboards themselves do not change in size because the loads have been consolidated from multiple spaces. This gives the illusion that there is no energy savings, but the loads on the existing emergency panelboards have been reduced. Since the emergency system is not in the scope of the project, these emergency panelboards have not been reduced in size, and therefore the switchgear will not change due to the reduced load.

The major space that will change is the 28,300 SF Luggage Area on the first floor (Room 137). The existing design uses metal halide lamps, but the new design will use the more efficient fluorescent lamps. The ratio of efficacies for metal halide and fluorescent is 72/82 = 0.878, meaning that the new design will use only 87.8% of the energy that the existing design uses. Since both systems are at the same voltage, this corresponds to approximately 87.8% of the current (amps). The existing load in this space is divided between EHPL1 and EHPL2.

Here are the existing panelboard schedules, and the loads to be replaced are highlighted.

PANELBOARD EHPL1(SWITCH) SCHEDULE

225 AMP BUS | 225 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DESL	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	DESR
L	LIGHTING RM 134	1.0			20	12	1		2	12	20	4.4			EMERG. LTG. RM 140	L
L	EMERG. LTG. RM 134		1.0		20	12	3		4	12	20		1.4		LIGHTING EXTERIOR	L
L	LIGHTING RM 137			13.0	20	12	5		6	12	20			4.4	LIGHTING RM 140	L
L	LIGHTING RM 137	11.9			20	12	7		8	12	20	13.0			LIGHTING RM 137 - EMER	L
L	LIGHTING RM 137		11.8		20	12	9		10	12	20		8.3		LIGHTING -LOADING DOCK	L
L	LIGHTING EXTERIOR			11.2	20	12	11		12	10	20			1.0	LIGHTING - EXIT LIGHTS	L
L	LIGHTING EXT. STEPS	5.3			20	12	13		14	12	20	2.7			LIGHTING RM 132	L
L	EMERG. LTG. RM 132		2.4		20	12	15		16	12	20		0.5		LIGHTING RM 131, 138	L
L	LIGHTING RM 133			2.8	20	12	17		18	12	20			1.8	EMERG. LTG. RM 133	L
L	LIGHTING RM 135	0.8			20	12	19		20	12	20	0.8			EMERG. LTG. RM 135	L
L	LIGHTING RM 136		0.5		20	12	21		22	12	20		0.5		EMERG. LTG. RM 136	L
L	LIGHTING RM 143			1.3	20	12	23		24		20				SPARE	
	SPARE				20		25		26						SPACE	
	SPACE						27		28						SPACE	
							29		30							
							31		32							
							33									
							35									
							37									
							39									
							41									
	SUB-TOTAL AMPS	19.0	15.7	28.3								20.9	10.7	7.2	SUB-TOTAL AMPS	
	PANEL AMPS	39.9	26.4	35.5		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	39.9	26.4	35.5											FEED-THRU AMPS	
	TOTAL KVA	11.1	7.3	9.8	Version 3.04											

DES	LOAD DESCRIPTION	NL EHPL1(SWITC CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	28.2 KVA	KVA	28.2 KVA	1.00	28.2 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**28.2 KVA**	**KVA**	**28.2 KVA**		**28.2 KVA**
	TOTAL + SPARE	**33.8 KVA**	**KVA**	**33.8 KVA**		**33.8 KVA**
		40.7 AMPS	**AMPS**	**40.7 AMPS**		**40.7 AMPS**

PNL DES:	EHPL1(SWITCH)		Notes:
BUS RATING:	225	AMPS	
DEVICE:	MLO		
RATING:	225	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	225	AMPS	
FDR SIZE:	4/0	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	#N/A	@	180 Amps [Max Load]
%VD:	#N/A		[Cummulative]
	#N/A	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

Comm. No.
3/20/2009

PANELBOARD EHPL2(SWITCH) SCHEDULE

100 AMP BUS | 100 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES L	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	DES R
L	LIGHTING U.S. CUSTOMS	5.0			20	12	1		2	12	20	1.3			EMERG. LTG. RM. 102	L
L	LIGHTING U.S. CUSTOMS		5.0		20	12	3		4	12	20		12.0		LIGHTING RM 137	L
L	LIGHTING RM 100			0.5	20	12	5		6	12	20			12.5	LIGHTING RM 137	L
L	EXTERIOR LIGHTING	4.4			20	12	7		8	12	20	4.4			LIGHTING RM 137	L
L	EMERG. LTG. RM 100		0.3		20	12	9		10	10	20		1.0		LIGHTING - EXIT LIGHTS	L
L	LIGHTING RM 102			1.3	20	12	11		12	12	20			3.9	LTG. RM 112,121,122,123,124	L
L	EMERG. LTG. RM 115	1.0			20	12	13		14	12	20	1.0			EMERG. LTG. RM. 113	L
L	EMERG. LTG. RM 118		1.3		20	12	15		16	12	20		1.3		EMERG. LTG. RM 119	L
L	EMERG. LTG. RM 111			1.3	20	12	17		18	12	20			0.3	LIGHTING RM 129	L
L	LIGHTING RM 109, 110	1.7			20	12	19		20	12	20	0.7			EMERG. LTG. RM 108	L
L	EMERG. LTG. RM 107		1.3		20	12	21		22	12	20		1.3		EMERG. LTG. RM 106	L
L	EMERG. LTG. RM 105			0.7	20	12	23		24	12	20			0.8	LIGHTING RM 101, 103, 120	L
L	LIGHTING RM 114	0.3			20	12	25		26	12	20	0.5			EMERG. LTG. RM 129	L
	SPARE				20		27		28		20				SPARE	
							29		30							
							31		32							
							33		34							
							35		36							
							37		38							
							39		40							
							41		42							
	SUB-TOTAL AMPS	12.4	7.9	3.8								7.9	15.6	17.5	SUB-TOTAL AMPS	
	PANEL AMPS	20.3	23.5	21.3		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	20.3	23.5	21.3											FEED-THRU AMPS	
	TOTAL KVA	5.6	6.5	5.9	Version 3.04											

DES	LOAD DESCRIPTION	NL EHPL2(SWITC CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	18.0 KVA	KVA	18.0 KVA	1.00	18.0 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**18.0 KVA**	**KVA**	**18.0 KVA**		**18.0 KVA**
	TOTAL + SPARE	**21.6 KVA**	**KVA**	**21.6 KVA**		**21.6 KVA**
		26.0 AMPS	**AMPS**	**26.0 AMPS**		**26.0 AMPS**

PNL DES:	EHPL2(SWITCH)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MLO		
RATING:	100	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	100	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.23	@	80 Amps [Max Load]
%VD:	0.23		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

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Below are the updated values, which are 87.8% of the original values.

PANELBOARD EHPL1(SWITCH) SCHEDULE

225 AMP BUS | 225 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES L	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	DES R
L	LIGHTING RM 134	1.0			20	12	1		2	12	20	4.4			EMERG. LTG. RM 140	L
L	EMERG. LTG. RM 134		1.0		20	12	3		4	12	20		1.4		LIGHTING EXTERIOR	L
L	LIGHTING RM 137			11.4	20	12	5		6	12	20			4.4	LIGHTING RM 140	L
L	LIGHTING RM 137	10.4			20	12	7		8	12	20	11.4			LIGHTING RM 137 - EMER	L
L	LIGHTING RM 137		10.4		20	12	9		10	12	20		8.3		LIGHTING -LOADING DOCK	L
L	LIGHTING EXTERIOR			11.2	20	12	11		12	10	20			1.0	LIGHTING - EXIT LIGHTS	L
L	LIGHTING EXT. STEPS	5.3			20	12	13		14	12	20	2.7			LIGHTING RM 132	L
L	EMERG. LTG. RM 132		2.4		20	12	15		16	12	20		0.5		LIGHTING RM 131, 138	L
L	LIGHTING RM 133			2.8	20	12	17		18	12	20			1.8	EMERG. LTG. RM 133	L
L	LIGHTING RM 135	0.8			20	12	19		20	12	20	0.8			EMERG. LTG. RM 135	L
L	LIGHTING RM 136		0.5		20	12	21		22	12	20		0.5		EMERG. LTG. RM 136	L
L	LIGHTING RM 143			1.3	20	12	23		24		20				SPARE	
	SPARE				20		25		26						SPACE	
	SPACE						27		28						SPACE	
							29		30							
							31		32							
							33									
							35									
							37									
							39									
							41									
	SUB-TOTAL AMPS	17.5	14.3	26.7								19.3	10.7	7.2	SUB-TOTAL AMPS	
	PANEL AMPS	36.8	25.0	33.9		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	36.8	25.0	33.9											FEED-THRU AMPS	
	TOTAL KVA	10.2	6.9	9.4		Version 3.04										

DES	LOAD DESCRIPTION	NL EHPL1(SWITC CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	26.5 KVA	KVA	26.5 KVA	1.00	26.5 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	**26.5 KVA**	**KVA**	**26.5 KVA**		**26.5 KVA**
	TOTAL + SPARE	**31.8 KVA**	**KVA**	**31.8 KVA**		**31.8 KVA**
		38.2 AMPS	**AMPS**	**38.2 AMPS**		**38.2 AMPS**

PNL DES:	EHPL1(SWITCH)		Notes:
BUS RATING:	225	AMPS	
DEVICE:	MLO		
RATING:	225	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	225	AMPS	
FDR SIZE:	4/0	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	#N/A	@	180 Amps [Max Load]
%VD:	#N/A		[Cummulative]
	#N/A	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

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PANELBOARD EHPL2(SWITCH) SCHEDULE

100 AMP BUS | 100 AMP MLO | 480Y/277 VOLTS | 3 PH, 4 W, SN, | MIN. | 18 KAIC | SURFACE MOUNTED

DES		LOAD AMPS			BKR	WIRE	CKT		CKT	WIRE	BKR	LOAD AMPS				DES
L	LOAD SERVED	A	B	C	TRIP	SIZE	NO.		NO.	SIZE	TRIP	A	B	C	LOAD SERVED	R
L	LIGHTING U.S. CUSTOMS	5.0			20	12	1		2	12	20	1.3			EMERG. LTG. RM. 102	L
L	LIGHTING U.S. CUSTOMS		5.0		20	12	3		4	12	20		10.5		LIGHTING RM 137	L
L	LIGHTING RM 100			0.5	20	12	5		6	12	20			11.0	LIGHTING RM 137	L
L	EXTERIOR LIGHTING	4.4			20	12	7		8	12	20	3.9			LIGHTING RM 137	L
L	EMERG. LTG. RM 100		0.3		20	12	9		10	10	20		1.0		LIGHTING - EXIT LIGHTS	L
L	LIGHTING RM 102			1.3	20	12	11		12	12	20			3.9	LTG. RM 112,121,122,123,124	L
L	EMERG. LTG. RM 115	1.0			20	12	13		14	12	20	1.0			EMERG. LTG. RM. 113	L
L	EMERG. LTG. RM 118		1.3		20	12	15		16	12	20		1.3		EMERG. LTG. RM 119	L
L	EMERG. LTG. RM 111			1.3	20	12	17		18	12	20			0.3	LIGHTING RM 129	L
L	LIGHTING RM 109, 110	1.7			20	12	19		20	12	20	0.7			EMERG. LTG. RM 108	L
L	EMERG. LTG. RM 107		1.3		20	12	21		22	12	20		1.3		EMERG. LTG. RM 106	L
L	EMERG. LTG. RM 105			0.7	20	12	23		24	12	20			0.8	LIGHTING RM 101, 103, 120	L
L	LIGHTING RM 114	0.3			20	12	25		26	12	20	0.5			EMERG. LTG. RM 129	L
	SPARE				20		27		28		20				SPARE	
							29		30							
							31		32							
							33		34							
							35		36							
							37		38							
							39		40							
							41		42							
	SUB-TOTAL AMPS	12.4	7.9	3.8								7.4	14.1	16.0	SUB-TOTAL AMPS	
	PANEL AMPS	19.8	22.0	19.8		* INDICATES EMERGENCY CIRCUIT										
	PANEL + FEED-THRU AMPS	19.8	22.0	19.8											FEED-THRU AMPS	
	TOTAL KVA	5.5	6.1	5.5		Version 3.04										

DES	LOAD DESCRIPTION	NL EHPL2(SWITC CONN LOAD	SUB-FEED CONN LOAD	TOTAL CONN LOAD	D.F. (MULT)	TOTAL DEMAND
L	LIGHTING	17.1 KVA	KVA	17.1 KVA	1.00	17.1 KVA
R	RECEPTACLES	KVA	KVA	KVA	NEC	KVA
M	MECH EQUIP	KVA	KVA	KVA	1.00	KVA
1	MISCELLANEOUS	KVA	KVA	KVA	1.00	KVA
2		KVA	KVA	KVA	1.00	KVA
3		KVA	KVA	KVA	1.00	KVA
4		KVA	KVA	KVA	1.00	KVA
5		KVA	KVA	KVA	1.00	KVA
6		KVA	KVA	KVA	1.00	KVA
7		KVA	KVA	KVA	1.00	KVA
8		KVA	KVA	KVA	1.00	KVA
9		KVA	KVA	KVA	1.00	KVA
	TOTALS	17.1 KVA	KVA	17.1 KVA		17.1 KVA
	TOTAL + SPARE	20.5 KVA	KVA	20.5 KVA		20.5 KVA
		24.6 AMPS	AMPS	24.6 AMPS		24.6 AMPS

PNL DES:	EHPL2(SWITCH)		Notes:
BUS RATING:	100	AMPS	
DEVICE:	MLO		
RATING:	100	AMPS	
MIN KAIC:	18	KAIC	
MOUNTING:	SURFACE		
VOLTAGE:	480	277	
FDR SOURCE:			
SOURCE CB:	100	AMPS	
FDR SIZE:	1	M	Duct (M or N)
QTY PER PH:	1		
LF:	50		
%VD:	0.23	@	80 Amps [Max Load]
%VD:	0.23		[Cummulative]
	14,763	Amps	Isc Available

INPUT FOR % SPARE > 0.20 < INITIALLY SET TO 20%

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There is very little reduction in the current requirements used to size the panelboard. This is largely due to the fact that the existing metal halide lights are very energy efficient to begin with. If, for example, incandescent light sources were replaced with fluorescent, there would be a large reduction in the current requirements for two reasons. The first would be due to the luminous efficacy. The second reason would be due to the voltage differences. The incandescent lamps would require more current because this equipment runs at 120V. The fluorescent can be run at 277V, which means that the current requirements are reduced. This is a similar situation to what occurred in the Waiting Area / Ticket Queuing Area. Since the redesign of the lighting system did not include much 120V lighting, the overall current requirements were less (and thus there is less current on the panelboard).

Protective Device Coordination Study

A sample fault current calculation was performed for the following system path:

Unit Substation Transformer → Switchboard SWBD 1 → Distribution Panel HP1 → Panelboard LP1

Fault Current Analysis (Per Unit Method)										
			System Voltage	=	480	ΣX	ΣR	ΣZ	I_{sc} (A)
			Base KVA	=	10,000				
			Utility Co. Avail. Fault	=	100,000,000				
Utility Primary									
			X(p.u.) = KVAbase / Utility S.C. KVA	=	0.000	0.000	0.000	0.000	120,281,306
			R(p.u.)	=	0.000				
Transformer Secondary									
%Z	=	4.775	X(p.u.) = %X * KVAbase / (100 * KVAxfrmr)	=	0.190	0.190	0.017	0.191	62,975
X/R	=	11	R(p.u.) = %R * KVAbase / (100 * KVAxfrmr)	=	0.017				
%X	=	4.76							
%R	=	0.43							
kVA	=	2500							
Switchboard									
Wire	=	3/0	X = (L/1000) * XL * (1/Sets), X(p.u.)	=	0.023	0.213	0.059	0.221	54,491
Length	=	20	R = (L/1000) * R * (1/Sets), R(p.u.)	=	0.042				
Sets	=	2							
X	=	0.052							
R	=	0.0958							
Panelboard 1									
Wire	=	#2	X = (L/1000) * XL * (1/Sets), X(p.u.)	=	0.114	0.327	0.469	0.572	21,037
Length	=	45	R = (L/1000) * R * (1/Sets), R(p.u.)	=	0.410				
Sets	=	1							
X	=	0.0585							
R	=	0.21							
Panelboard 2									
Wire	=	350	X = (L/1000) * XL * (1/Sets), X(p.u.)	=	0.032	0.359	0.509	0.623	19,307
Length	=	15	R = (L/1000) * R * (1/Sets), R(p.u.)	=	0.040				
Sets	=	1							
X	=	0.0491							
R	=	0.0617							

The following table summarizes the available fault in the previous table, and shows the standard breaking rating (in amps):

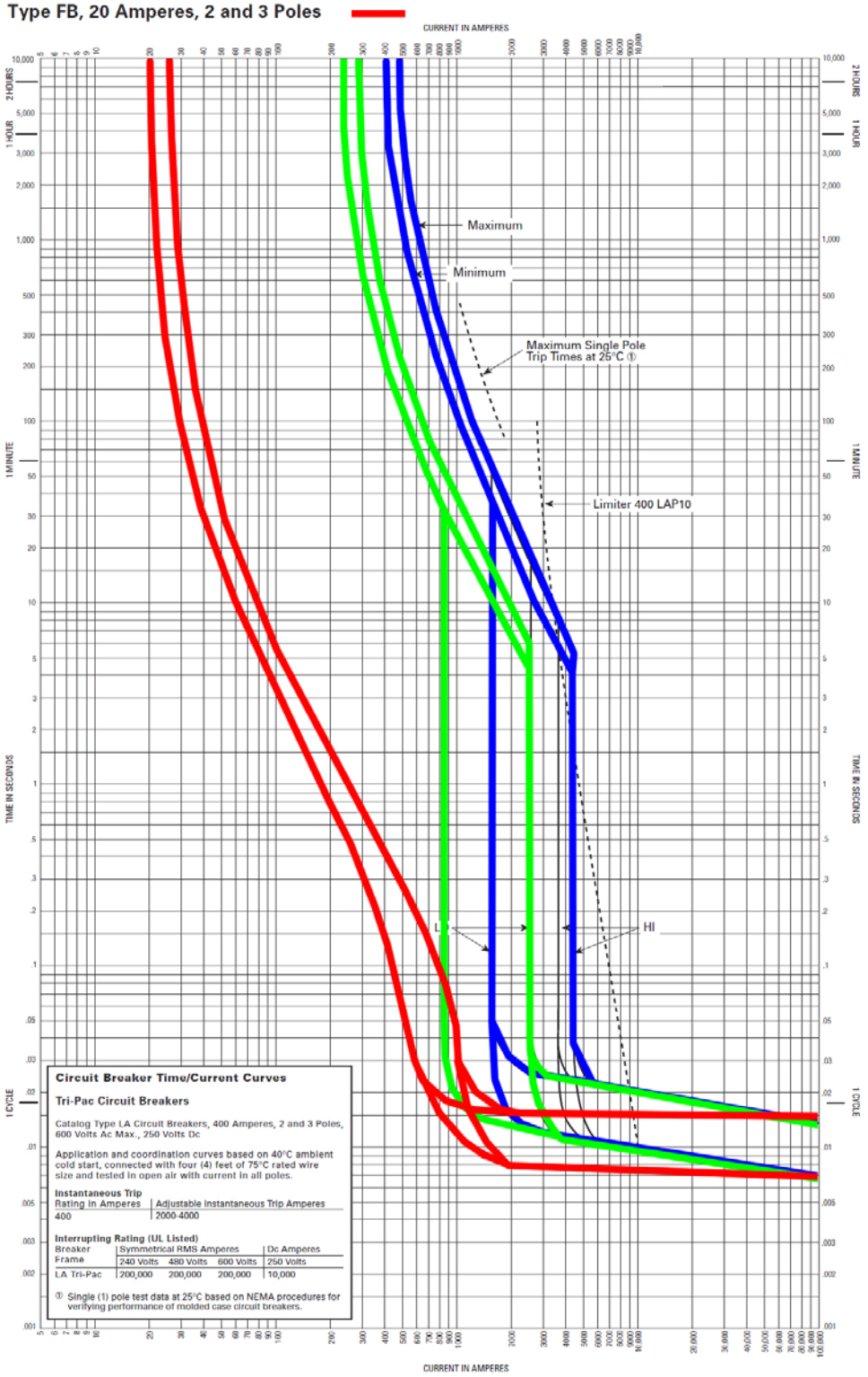
Summary Results of Fault Analysis			
Point	**Location**	**Available Fault**	**Standard Breaker Rating (A)**
A	Unit Substation Transformer	62,975	64,000
B	Switchboard SWBD 1	54,491	64,000
C	Distribution Panel HP1	21,037	22,000
D	Panelboard LP1	19,307	22,000

The following graphs shows the circuit breaker time/current curves for 3 circuit breakers used in the building: 20A circuit breaker for a load on LP2, 225A circuit breaker (main circuit breaker for LP2), and 400A circuit breaker (main circuit breaker for HP2).

Unit Substation Transformer → Switchboard SWBD 1 → Distribution Panel HP2 → Panelboard LP2

These 3 circuit breakers are coordinated well because if there is a short circuit, then the circuit breaker farthest from the switchgear will trip first. It is desired to have the smallest circuit breaker trip first (the circuit breaker closest to the short circuit or overload), so that the circuit breaker closest to the problem will trip instead of a larger, unnecessary portion of the building to lose power. The coordination of these circuit breakers is shown on the following graph.

Type LA, 400 Amperes, 2 and 3 Poles
Type LA, 225 Amperes, 2 and 3 Poles
Type FB, 20 Amperes, 2 and 3 Poles



Curve No. SC-3591-76A

October 1997

EATON

Section 5: Skylight Analysis (Breadths)

Introduction

At 16,600 square feet, the Waiting Area / Ticket Queuing area is a large percentage of the second floor area. Part of the lighting design for this space includes adding skylights and dimming the fluorescent luminaires according to the photosensor controls. Beyond simply a lighting design decision, the skylights impact other building systems such as the mechanical cooling load and the roof structural system. It is important to evaluate the impact on these other systems, and the results are described in the following two sections of this report.

Mechanical Impact

There is no doubt that subtracting roof area and adding skylight glass will affect the cooling load of the building. The purpose of this mechanical study is to determine what the impact will be. The only change on the space will be subtracting roof area and adding skylight area. Therefore, for the purpose of this study, constant sources which contribute to the cooling load do not need to be considered. For example, people, appliances, and exterior walls will not affect the study. Hand calculations are included at the end of this section.

The roof area of the Waiting Area / Ticket Queuing space is 16,600 square feet, or 1,542 square meters. This study compares the cooling load of the existing roof with the cooling load of the proposed skylights.

Assumptions:

- R-value of the roof = 4 m^2K/W
- U-value of roof = 0.25 $W/(m^2K)$
- No adjustments to the CLTD (Cooling Load Temperature Differences) for either of the two scenarios
- Zone B for SCL (Solar Cooling Load) calculations
- The method and equations used are from 1997 ASHRAE Fundamentals Handbook
- 1.0 = F_{sa}, which is the lighting special allowance factor
- Lighting analysis is for special events in the building, where light is needed for 12 hours. Assume 10:00 to 22:00 building use during special events.
- In the skylight scenario, no electric lighting is needed during the hours 13:00 through 17:00.

Existing roof (no skylights):

- Area (A) = 1,542 m^2
- U=0.25
- Equation: q=U*A*(CLTD), where q is in Watts

According to Table 31, the Roof Value = 4, and the CLTD values are as follows. Applying the equation q=U*A*(CLTD), the following cooling load (in Watts) is found:

CLTD Values					
Hour:	13	14	15	16	17
CLTD:	23	30	36	41	43
Watts:	8900	11600	13900	15800	16600

Note: this study only looks at the peak values in the day, hours 13 through 17.

In addition to the load described in the previous table, the electric lighting contributes to the cooling load as follows:

- $q_{el}=W*F_{ul}*F_{sa}*(CLF_{el})$
  - q_{el} (Watts)
  - W = total watts in the space (51 luminaires with (4) 42W lamps each)
  - F_{ul} = lighting use factor, used to indicate approximate dimming
  - F_{sa} = lighting special allowance factor (assumed to be 1.0)
  - CLF_{el} = lighting cooling load factor. The CLF is determined for each hour by determining the Zone (Table 35A – ASHRAE) and how long the lights were on at the desired time (Table 38 – ASHRAE).

Lighting Impact					
Number of hours that lights are ON:	3	4	5	6	7
Hour:	13	14	15	16	17
CLF_{el}:	0.91	0.93	0.95	0.95	0.96
q_{el} (Watts):	7800	7970	8140	8140	8230

Existing Roof (No Skylights)					
Hour:	13	14	15	16	17
Total Watts:	**16700**	**19570**	**22040**	**23940**	**24830**

Roof with skylights:

This calculation is a two-step process. First, the effective area of the roof material is considered. Then, the skylight is considered in two equations (one for conduction and one for solar radiation). Then, the cooling loads are summed to show the total cooling load for the roof with skylights scenario. Note that it is assumed there is no electrical light contribution in this scenario.

Roof material calculation:

- Area (A) = 1,542m^2 – (15 skylights x 2.877 m^2 per skylight) = 1,499 m^2 of roof material
- U=0.25
- Equation: q=U*A*(CLTD), where q is in Watts

Existing Roof (reduced area)					
CLTD	23	30	36	41	43
Watts:	8600	11200	13500	15400	16100

Skylight glazing material calculation:

- Conduction calculation:
  - U=1.3 (from manufacturer)
  - A=43.16 m^2 (15 skylights x 2.877 m^2 per skylight)
  - Equation: q(cond) = U*A*(CLTD)

Skylight Glazing (Watts due to Conduction)					
CLTD	23	30	36	41	43
Watts:	1300	1700	2000	2300	2400

- Solar radiation calculation:
  - A=43.16 m^2 (15 skylights x 2.877 m^2 per skylight)
  - SC = Shading Coefficient (from manufacturer) = 0.39
  - SCL = Solar Cooling Load from Table 36, (W/m^2)

Skylight Glazing (Watts due to Solar Radiation)					
SCL	753	731	668	567	432
Watts:	12700	12300	11200	9500	7300

Lighting Impact					
q_{el} (Watts):	0	0	0	0	0

Therefore, the total cooling load in this scenario is the sum of the existing roof (reduced area), skylight glazing (watts due to conduction), and skylight glazing (watts due to solar radiation). The total cooling load in this scenario is as follows:

Total Cooling Load					
Hour:	13	14	15	16	17
Watts:	**22600**	**25200**	**26700**	**27200**	**25800**

Conclusion:

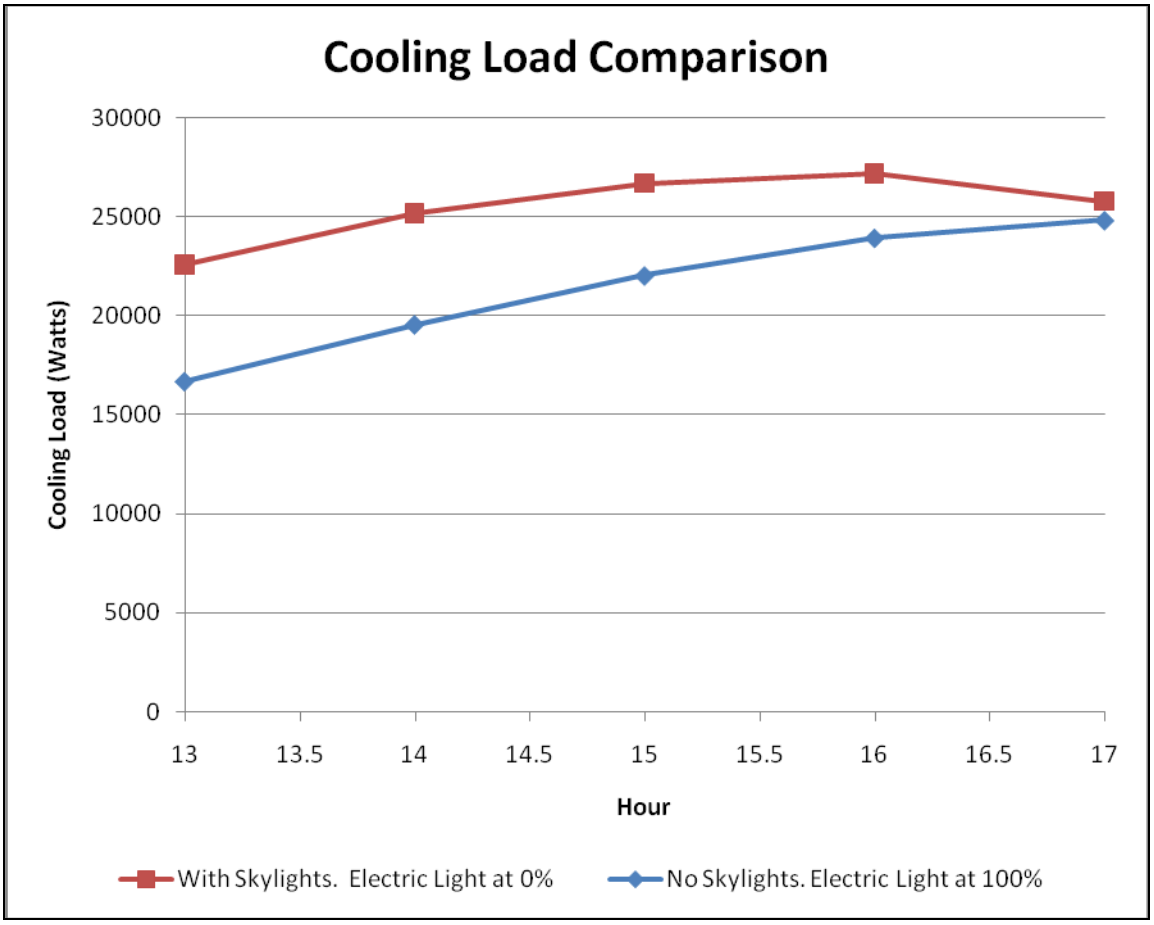
There is a significant difference in the cooling load when the skylights are added. This is mostly due to the solar radiation that is transmitted through the glazing. The difference is minimized when electrical lights are considered.

In the first scenario, there are no skylights but there is cooling load due to electrical lights. In the second scenario, there is no electrical light contribution, but there is more cooling load from the reduction of the roof load (at a higher R value), the addition of the glazing (at a lower R value), and the addition of the solar radiation component. The solar radiation component drives the sum of these components up so that the result of adding skylights is a larger cooling load.

However, this analysis does not consider coefficients of performance and how the total energy analysis. If the 51 luminaires are turned on at 100% (as in scenario 1), then 9,486 watts would be used in energy consumption. From the mechanical view, this is heating the space. In scenario 2 (where there are skylights), there is a 9,486 watt electrical power savings over select hours in scenario 1.

Therefore, skylights should be added to this space.

Cooling Load Comparison (Watts)					
Hour:	13	14	15	16	17
Existing Roof (no skylights):	**16700**	**19570**	**22040**	**23940**	**24830**
Proposed Roof (with skylights):	**22600**	**25200**	**26700**	**27200**	**25800**
Difference:	**5900**	**5630**	**4660**	**3260**	**970**



Mechanical Appendix:

Eqn: $q = UA(CLTD)$

units → $[\text{Watts} = \left(\frac{W}{m^2 \cdot K}\right)(m^2)(CLTD)]$

1997 ASHRAE ~~1997~~ Fundamentals Handbook

Table 31 → Roof Number = 4

Table 30 →

CLTD Values					
Hour:	13	14	15	16	17
	23	~~30~~	36	41	43

Assumptions

- R-Value of roof = $4 \frac{m^2 \cdot K}{W}$
- U-value of roof = $0.25 \frac{W}{m^2 \cdot K}$
- No adjustments to CLTD for either scenario
- Zone B for SCL calculations

U = 0.25

A = ~~1074~~

CLTD =

No. Skylights					
CLTD	23	30	36	41	43
Watts	~~6176~~	~~8035~~	~~9666~~	~~11,009~~	~~11,545~~
	8868	11570	13880	15810	16580

Area of Skylights: $2.877 \frac{m^2}{\text{skylight}} \times 15 \text{ skylights} =$ **43.16 m^2 of skylights**

Area of Roof Material: $1542 m^2 - 43.16 m^2 =$ **1499 m^2 of roof material**

Glazing U value = $0.23 \frac{BTU}{Hr\ ft^2\ °F} \times \left[5.6783 \frac{W}{m^2 K} \Big/ 1 \frac{BTU}{hr\ ft^2\ °F}\right] =$ **$1.3 \frac{W}{m^2 K}$**

Glazing R value = $1/1.3 = 0.769\ m^2K/W$

$\text{Watts} = \text{Watts}_{\text{Area of Roof Material}} + \text{Watts}_{\text{Glazing (conduction)}} + \text{Watts}_{\text{Glazing (solar radiation)}}$

$\text{Watts}_{(\text{Area of Roof Material})} = q = UA(CLTD) = 0.25(1499\ m^2)(CLTD)$

CLTD	23	30	36	41	43
Watts	~~8868~~ 8619	11240	13490	15360	16114

$\text{Watts}_{\text{Glazing(conduction)}} = q_{cond} = UA(CLTD)$

$U = 1.3 \frac{W}{m^2 K}$

$A = 43.16\ m^2$

CLTD	23	30	36	41	43
Watts	1290	1683	2019	2300	2413

$\text{Watts}_{\text{Glazing(Solar Radiation)}} = q_{rad} = A(SC)(SCL)$

$A = 43.16\ m^2$

SC = Shading Coefficient (from manufacturer) =

$= 0.39$

SCL = Solar cooling load from Table 36, (W/m^2)

Table 36
Assume Zone Type B

hour	13	14	15	16	17
SCL	753	731	668	567	432
Watts	12,670	12,304	11,244	9,544	7,271

Summary:

		Hour				
		13	14	15	16	17
Cooling Load (Watts)	No skylights	8868	11570	13880	15810	16580
	With Skylights	22579	25227	26753	27204	25798

Mechanical and Daylight Analysis:

The following analysis is based on SkyCalc, an Excel-based computer program that calculates the impact of adding skylights. It predicts the energy and cost impact of the skylight system throughout the year.

According to the operational manager of the building, the building lights in this space are on according to the following schedule:

- Monday through Friday: 3 hrs per day
- Saturday and Sunday: 0 hrs per day (except for maintenance or special events)
- Special events: 2 per week, at 12 hours per event

This estimated information was inputted into SkyCalc as a user-input option.

The cost of electricity and gas is estimated from information provided by Dominion Power and Virginia Natural Gas.

The results are as follows. The two most important graphs are at the end of this section: "Total Annual Energy Savings from Skylights" and "Total Energy Cost Savings from Skylights." According to SkyCalc, adding these particular skylights will save 9,980 kWh/year and $535/year. While the cost savings might be minimal, this is linked to the cost of utilities in Norfolk, which could change over the course of the building's life. It is important to note that there is a large energy savings from the reduction of electrical light usage. Therefore, even though there might be a long payback period, it still is beneficial to add skylights in this space.

SkyCalc: Skylight Design Assistant - Basic Inputs

Company Name: Half Moone Cruise and Celebration Center
Project Description: Jonathan Walker - Thesis - 2009

Design Skylight to Floor Ratio = 3.7%

Select Location User Generated w/ e-QUEST

Climate data loaded = Norfolk.wea3

Climate data needed =

Skylights:

Number of skylights	15	
Skylight width	4.875	ft
Skylight length	5.791666667	ft

Max skylight spacing = 36 ft (1.5 x ceiling ht)

Skylight Description

Glazing type	Glass
Glazing layers	Double glazed
Glazing color	Clear

Building

Building type	User_Defined_1	
Bldg area	11,563	ft^2
Ceiling height	24	ft
Wall color	Off-white paint	

Skylight Well

Light well height	1	feet
Well color	Off-white paint	
Safety grate or screen	○ Yes, ◉ No	

Shelving/Racks or Partitions?

○ Partitions, ○ Shelves/Racks, ◉ None/Open

No data required	7	ft
No data required	8	ft
No data required	8	ft
No data required		ft

Heating and Air Conditioning Systems

Air Conditioning	Mechanical A/C
Heating System	Gas/Oil Furnace

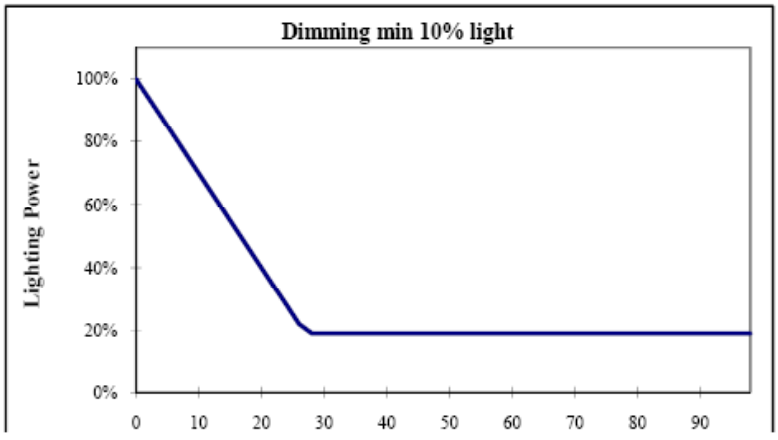
Electric Lighting

Lighting system	Direct/Indirect fluorescent	
Fixture height	20	ft
Lighting control	Dimming min 10% light	

Utilities

Average Elec Cost	$0.060	kWh
Heating Fuel Units	kWh	
Heating Fuel Cost	$0.035	/kWh

Lighting Control Graph - Lighting Setpoint = 30 fc



SkyCalc: Skylight Design Assistant - Optional Inputs

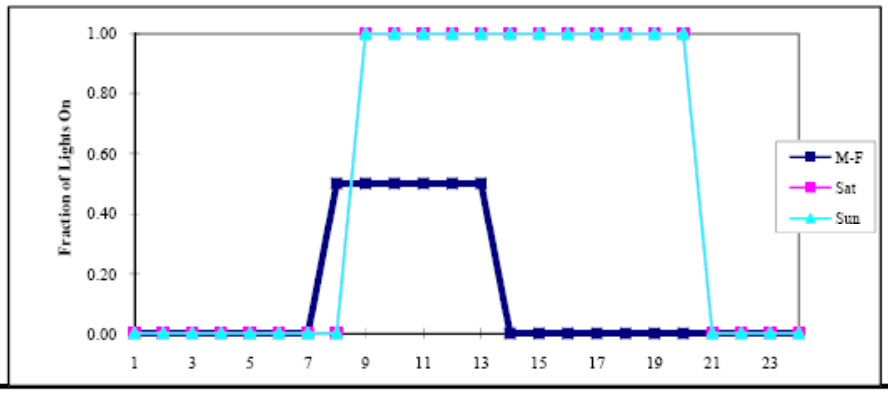
Company Name: Half Moone Cruise and Celebration Center
Project Description: Jonathan Walker - Thesis - 2009

Skylights	Default	User Revisions	Design Input
Skylight shape	Flat	Default	Flat
Height of dome (Rise) (ft)	0		0
Visible transmittance	78%	53%	53%
Solar heat gain coefficient	70%	26%	26%
Curb type	Wood	Default	Wood
Frame type	Metal w/ thermal brk	Default	Metal w/ thermal brk
Unit U-value (Btu/h•°F•ft^2)	0.970	0.230	0.230
Dirt light loss factor	70%		70%
Screen or safety grate factor	100%		100%
Light well reflectance	70%		70%
Well factor (WF)	88%		88%
Bottom of light well:			
Width (ft)	4.88		4.88
Length (ft)	5.79		5.79
Diffuser on bottom of well?	No	○ Yes, ◉ No	No

Building	Default	User Revisions	Design Input
Building width (ft)	76		76
Building length (ft)	152	Change width or area	152
Wall reflectance	70%	65%	65%
Ceiling reflectance	70%	80%	80%
Floor reflectance	20%	45%	45%
Shelving reflectance	40%		40%
Roof U-value (Btu/h•°F•ft^2)	0.065		0.065

Electric Lighting	Default	User Revisions	Design Input
Lighting setpoint (fc)	40	30	30
Task height (ft)	2.50		2.50
Lighting power density (W/ft^2)	0.63		0.63
Fraction lighting uncontrolled	10%		0.10
Lighting schedule	User_Defined_1	User_Defined_1	User_Defined_1
Room and luminaire depreciation	80%		80%

Lighting Schedule Graph

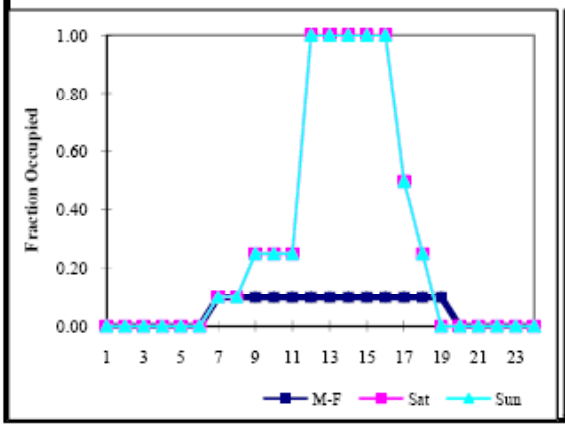


SkyCalc: Skylight Design Assistant - Optional Inputs

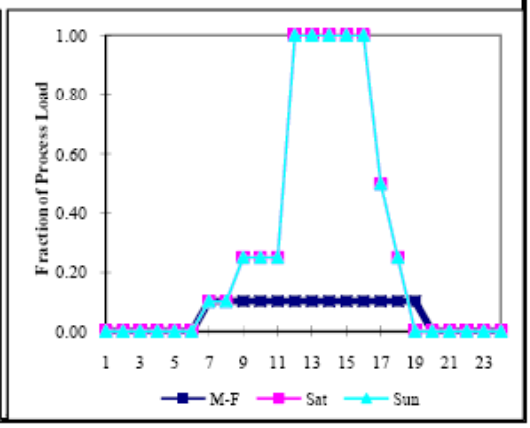
Company Name: Half Moone Cruise and Celebration Center
Project Description: Jonathan Walker - Thesis - 2009

Internal Loads	Default	User Revisions	Design Input
Number of people	39	300	300
Occupancy schedule	User_Defined_1	User_Defined_1	User_Defined_1
Process (plug) loads (W/ft^2)	0.00		0.00
Process schedule	User_Defined_1	User_Defined_1	User_Defined_1

Occupancy Schedule - User_Defined_1

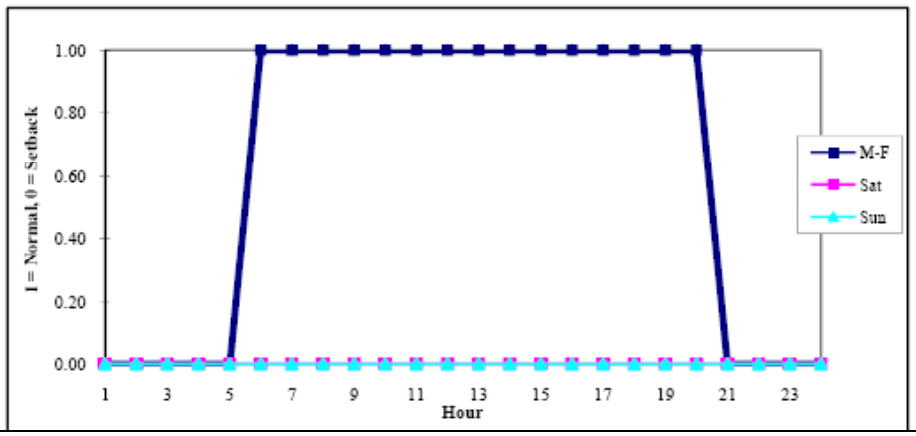


Process Schedule - User_Defined_1



HVAC	Default	User Revisions	Design Input
Heating setpoint temperature (°F)	68		68
Heating setback temperature (°F)	55		55
Cooling setpoint temperature (°F)	72		72
Cooling setup temperature (°F)	88		88
Economizer (Y/N)	Y	(●) Yes, ( ) No	Y
Economizer setpoint (°F)	67		67
HVAC schedule	User_Defined_1	Default	User_Defined_1
Design outside air (cfm)	2,250		2,250

HVAC Schedule - User_Defined_1



SkyCalc: Skylight Design Assistant - Graphic Results

Company Name: Half Moone Cruise and Celebration Center
Project Description: Jonathan Walker - Thesis - 2009

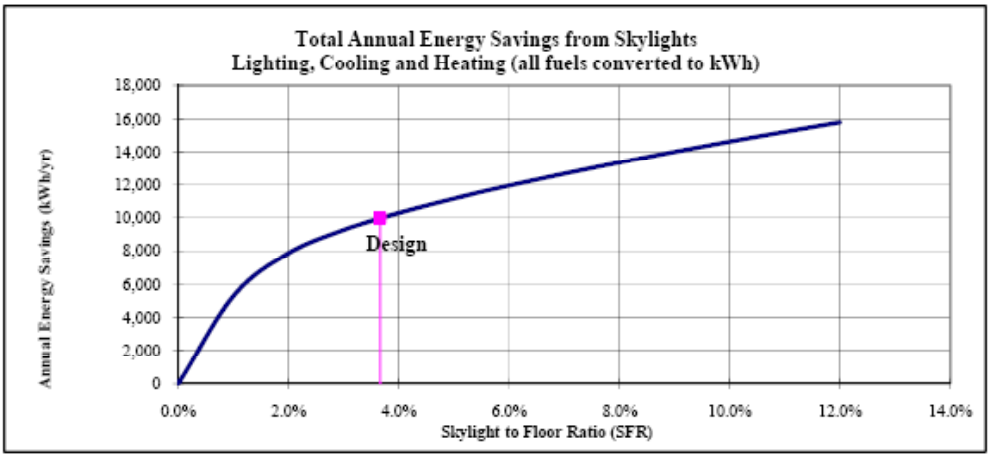
Flat Skylight Effective Aperture = 1.20%, Skylight to Floor Ratio (SFR) = 3.66%

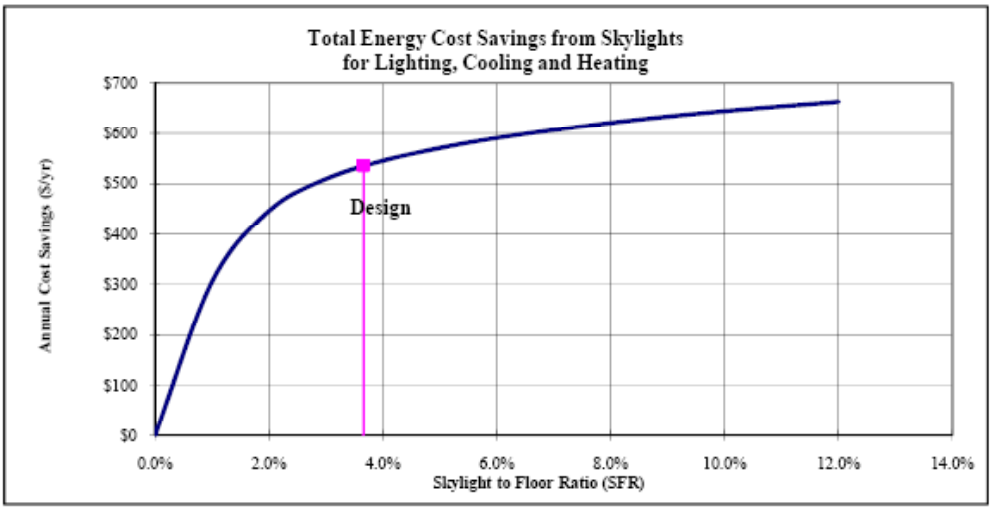
Average daylight footcandles (fc)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0	0	0	0	0	0	0	3	12	26	42	54	54	48	34	18	6	1	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	6	19	38	58	69	70	67	52	32	13	3	0	0	0	0	0	0
Mar	0	0	0	0	0	0	4	14	34	56	72	83	84	81	65	45	22	7	1	0	0	0	0	0
Apr	0	0	0	0	0	2	10	29	57	82	103	112	111	103	85	58	33	12	3	0	0	0	0	0
May	0	0	0	0	0	4	17	40	67	98	114	121	122	110	94	67	42	18	5	0	0	0	0	0
Jun	0	0	0	0	0	6	20	47	76	104	122	131	125	123	106	82	55	25	8	1	0	0	0	0
Jul	0	0	0	0	0	4	17	40	67	94	117	131	128	128	104	75	49	22	7	1	0	0	0	0
Aug	0	0	0	0	0	2	11	32	61	88	112	123	126	123	99	70	40	17	4	0	0	0	0	0
Sep	0	0	0	0	0	0	7	22	47	70	88	103	104	95	74	51	24	7	1	0	0	0	0	0
Oct	0	0	0	0	0	0	4	14	34	60	77	87	83	73	51	27	9	2	0	0	0	0	0	0
Nov	0	0	0	0	0	0	1	7	19	37	53	60	59	43	30	14	4	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	3	12	25	38	44	46	37	24	12	4	0	0	0	0	0	0	0

Design Illuminance = 30 fc
< 1 fc; < 15 fc; < 30 fc; > 30 fc;

Location = Norfolk





SkyCalc: Skylight Design Assistant - Tabular Results

Company Name: Half Moone Cruise and Celebration Center
Project Description: Jonathan Walker - Thesis - 2009

Electric Lighting Usage	kWh/yr		
Ltg. Energy without Skylights	14,874	Lighting Fraction Saved	56%
Lighting Energy w/ Skylights	6,553	Full daylighting (h/yr)	2,494

	Savings from Design Skylighting System		
Savings		Annual Energy Savings (kWh/yr)	Annual Cost Savings ($/yr)
Lighting		8,321	$499
Cooling		-891	-$53
Heating		2,550	$89
Total		**9,980**	**$535**

Skylighting System Description

Skylight unit size (ft^2)	28.2
Number of Skylights	15
Total Skylight Area (ft^2)	424
Skylight to Floor Ratio (SFR)	3.7%
Effective Aperture	1.2%
Floor Area per Skylight	771
Skylight U-value	0.230
Skylight SHGC	26%
Skylight T_{vis}	53%
Well Efficiency (WF)	88%
Dirt and Screen Factor	70%
Overall Skylight System Tvis	33%
Skylight CU	114%

Site Description

Climate Location	Norfolk.wea3	
Climate Zone	CZ3 (warm)	
Building Type	User_Defined_1	
Building Area	11,563	(ft^2)

Elecric Lighting System Description

Lighting Type	Direct/Indirect fluorescent	
Lighting Control	Dimming min 10% light	
Light Level Setpoint	30	fc
Lighting Density	0.63	W/ft^2
Connected Load	7.3	kW
Fraction Controlled	90%	

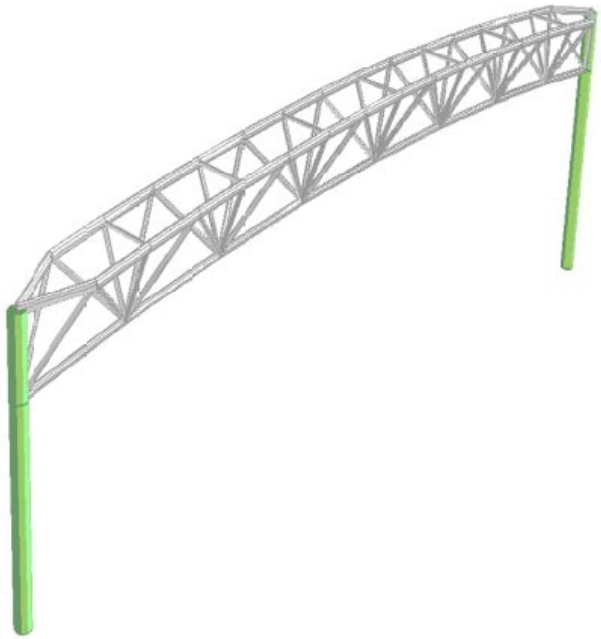
As compared to the design with 15 skylights but no photocontrols

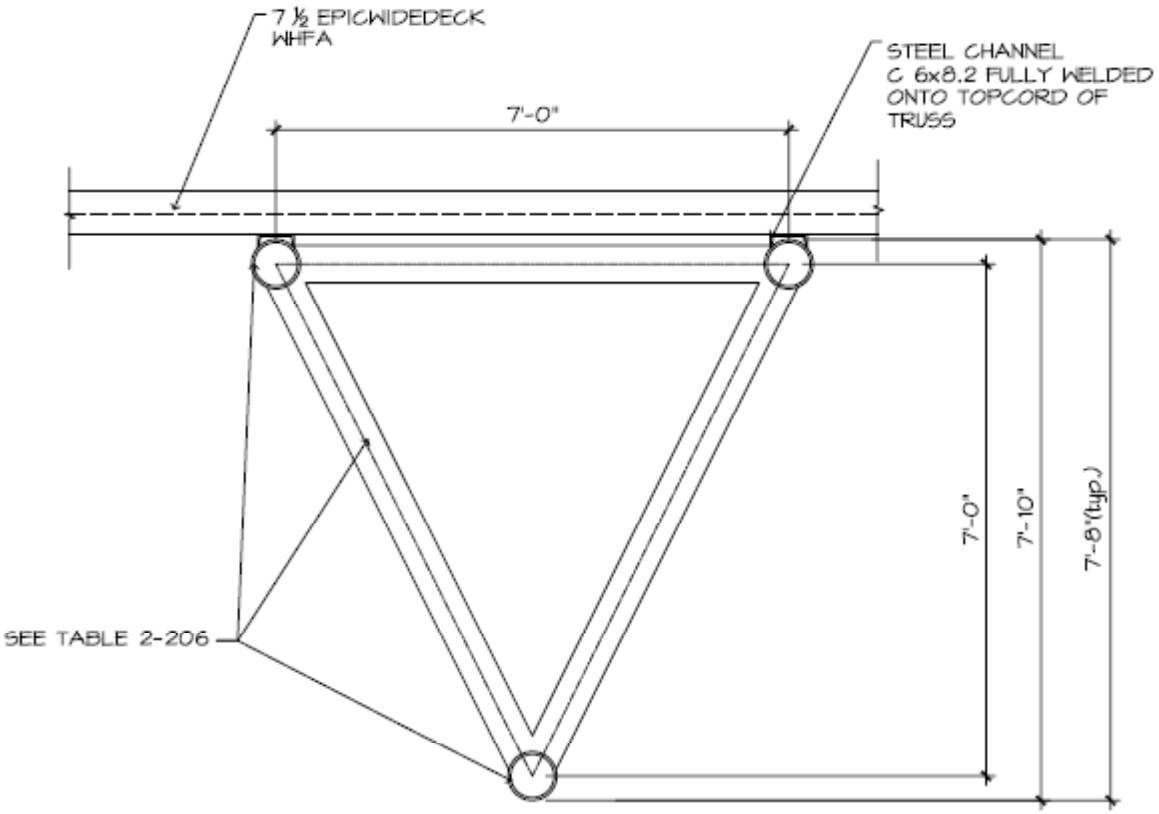
	Savings from Functioning Photocontrol System		
Savings		Annual Energy Savings (kWh/yr)	Annual Cost Savings ($/yr)
Lighting		8,321	$499
Cooling		1,154	$69
Heating		-2,086	-$73
Total		**7,389**	**$496**

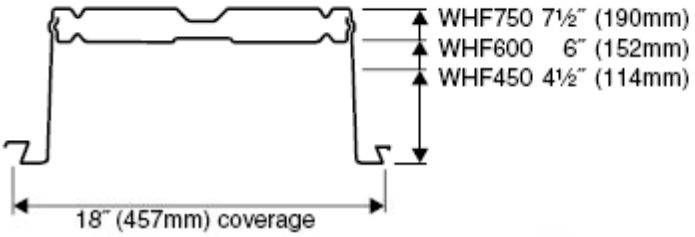
Structural Impact

Background Information:

Beyond the mechanical impact of adding skylights, the building structure is affected, too. The following analysis seeks to determine if adding these skylights is possible with the existing structure, or if additional supports are necessary. The roof deck used on the building is Epic Wideck WHF 7.5" – 16 gage. It spans between the supertrusses as shown on the diagram below.




7 ½ EPICWIDEDECK
WHFA
STEEL CHANNEL
C 6x8.2 FULLY WELDED
ONTO TOPCORD OF
TRUSS
7'-0"
SEE TABLE 2-206
7'-0"
7'-10"
7'-8"(typ.)



U.S. Patent Number 6,691,482

WHF and W Section Properties (per foot of width)

Deck Type	Gage	Weight (psf)	I_P (in.^{4})	S_P (in.^{3})	I_N (in.^{4})	S_N (in.^{3})	Allowable Support Reaction (PLF)	
							End*	Int.*
WHF450/ W450	18	3.28	2.43	.88	2.87	.94	690	1677
	16	4.16	3.30	1.14	3.64	1.21	1156	2476
	14	5.17	4.35	1.46	4.55	1.51	1825	3552
WHF600/ W600	18	3.62	4.74	1.32	5.52	1.31	642	1593
	16	4.58	6.41	1.71	7.11	1.78	1095	2382
	14	5.71	8.46	2.18	8.89	2.27	1749	3446
WHF750/ W750	18	3.95	7.98	1.81	8.79	1.70	594	1510
	16	5.01	10.76	2.35	11.98	2.30	1034	2288
	14	6.24	14.18	3.00	14.98	3.09	1674	3340

*Minimum end and interior support bearing lengths (see Note 2 below):
End = 4"
Interior = 6"

WHF and W Load Table — Uniform Total Load (Dead and Live) in Pounds Per Square Foot

No. Spans	Deck Type	Gage	Span Length Center to Center of Supports (ft.)																	
			12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	WHF450/W450	18	98	83	68	58	49	43												
		16	127	108	90	75	64	55	48	43										
		14	162	138	116	97	82	70	61	54	48									
2	WHF450/W450	18	104	89	77	67	59	52	46	42										
		16	134	115	99	86	76	67	60	54	48									
		14	168	143	123	107	94	84	75	67	60									
1	WHF600/W600	18					80	73	64	56	50	43								
		16					107	95	84	73	64	55	48	42						
		14					136	121	108	94	82	70	60	52	46	41				
2	WHF600/W600	18					80	73	65	58	52	48	43	40						
		16					111	99	88	79	71	65	59	54	49	46	42			
		14					142	126	112	101	91	82	75	69	63	58	54			
1	WHF750/W750	18							66	63	59	57	54	48	43					
		16							115	104	94	85	72	63	55	48	43			
		14							148	133	120	109	93	80	69	61	54	48	44	40

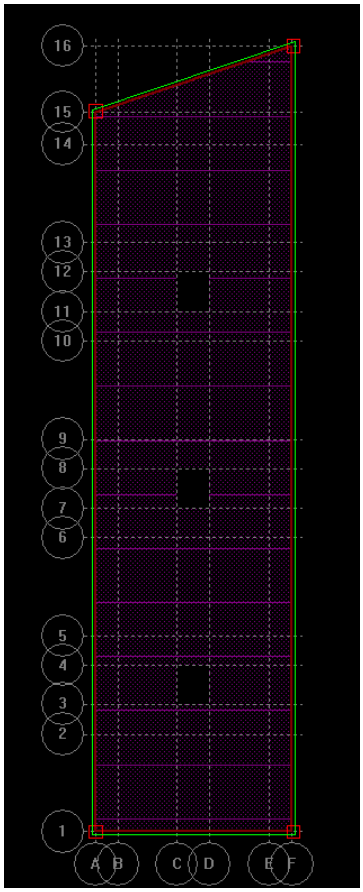
If higher loads or longer spans are required, contact EPIC Metals Corporation.

NOTES: 1. Live load deflection is not in excess of L/240 or 1" maximum. Dead load is assumed at 7 psf plus deck weight.
2. Minimum end support bearing length is 4"; minimum interior support bearing length is 6". If shorter bearing lengths are used, check safe reaction table on page 36.
3. Allowable flexural stress limit is 24 ksi.

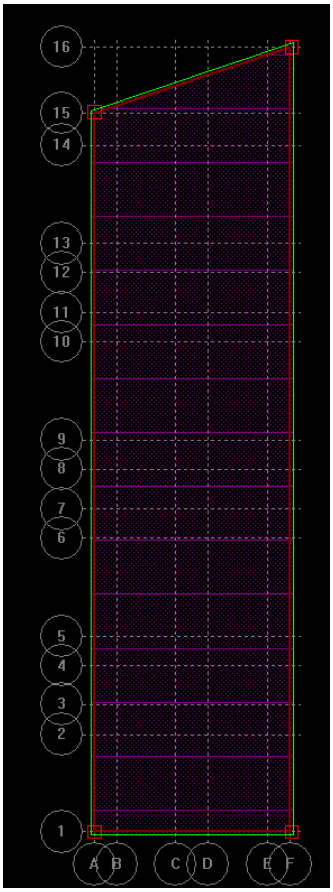
Analysis

To perform structural analysis, RAM Structural System was used. The scope of the analysis was limited to the area between two supertrusses. The following process shows the major steps in creating the structural model:

- Create elements and designate material properties
  - Grid lines
  - 4 Columns
  - Slab
  - Beams
  - Slab openings
- Run analysis
- Interpret analysis



Test 1: With Skylight Openings

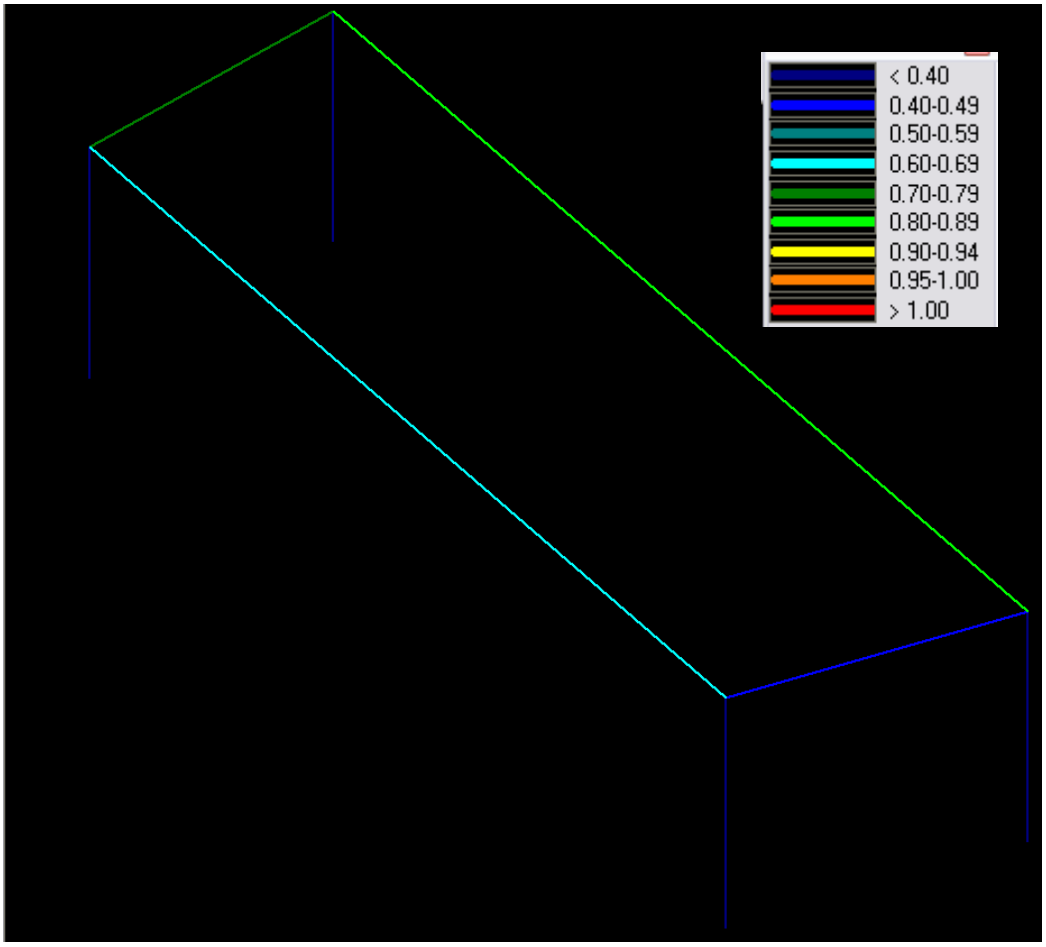


Test 2: Without Skylight Openings

Unfortunately, after extensive modeling and problem checking, RAM still produced 12 errors and was unable to analyze the building. These errors were the result of not having beams on the perimeter of the slab openings. However, it would have been an inappropriate model to add beams in the model, since no beams are present in the actual design.

To resolve this problem, separate slabs were created act as a single slab. These individual slabs were modeled to outline the skylight openings so that no “Slab Opening” function is needed.

The resulting solution is that both cases pass the test. The steel member module check indicated that the members were adequate for load. In the image below, the green and blue colors visually indicate that the structure passes. Two trials were run: one with slab openings (which corresponds to the modified structure with skylight openings)and one with no slab cutouts (which corresponds to the existing structure). Both cases pass. Therefore, this method of analysis indicates that the structure is adequate to handle the additional line loads of the skylights.


< 0.40
0.40-0.49
0.50-0.59
0.60-0.69
0.70-0.79
0.80-0.89
0.90-0.94
0.95-1.00
> 1.00

Section 6: Summary and Conclusions

In general, the design was successful. The summary of each section of the report can be found within that section. Each lighting space was successful because it met the design criteria, reduced the overall energy consumption of the building, and used light to create a desirable atmosphere. The façade lighting, in particular, helps the building achieve a landmark status.

The electrical design was moderately successful because the loads were reduced and panelboard loads were consolidated. Because of the nature of this thesis, clearly defining a scope was difficult since emergency lighting was not to be part of the report. This was challenging because many of the loads were on designated emergency panelboards. It was a challenge trying to balance the scope of the thesis with an attempt at real-world design.

I particularly enjoyed integrating the skylight light aspect of the design because it affected many sections of the report including: lighting design, daylighting analysis, mechanical loads, and a structural impact. I especially enjoyed linking the lighting advantages of adding skylights with reduced energy consumption to dimming of lights, but increased energy consumption due to a higher cooling load. Overall, it would not be a bad decision to use skylights in the Waiting Area / Ticket Queuing area as it would save energy and money.

Section 7: Additional Information

Computer Information

This report can be viewed online.

- http://www.engr.psu.edu/ae/thesis/portfolios/2009/jcw5009/finalreport.html

The copy of this report in PDF form is here:

- http://www.engr.psu.edu/ae/thesis/portfolios/2009/jcw5009/finalreport.pdf

Electronic copies of computer files are also online.

- http://www.engr.psu.edu/ae/thesis/portfolios/2009/jcw5009/finalreport.html

Credits and Acknowledgements

I am grateful to all the people who helped me along the way. I especially want to thank:

- The City of Norfolk, Virginia – for allowing me to use this building for my thesis
- AE Faculty
- Dr. Richard Mistrick – lighting instructor and faculty consultant
- Dr. Kevin Houser – lighting instructor
- Fellow AE students – for helping me resolve technical issues and providing design recommendations
- Clark Nexsen – for helping me obtain a thesis project
- Scott Schwerin – for helping me during my internship in 2008
- Dan Rusnack – for offering assistance throughout my thesis

I also want to thank God, my wife Rachel and my family. Luke 6:46-49

Thank you!