Towson Arena Addition

Lighting Electrical

Towson, Maryland

Joseph Becker Thesis Final Report

May 25, 2012

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Executive Summary:

The proposed thesis shall include information about the Towson Arena Addition. I will present areas of analysis of the Towson University Arena Addition. Finally I will discuss three different breadth options that I will cover for this project.

I have identified problems and solutions for several parts of the building. I will do a lighting redesign of certain spaces. I have chosen to analyze the court area, the press room, a reception area and the northwest exterior entrance. Each lighting redesign will go into my selections for luminaires and controls and will demonstrate my ideas through images and calculations.

Once the four lighting spaces were redesigned I went through the architect provided drawings in search of all the affected panelboards. For each panelboard I removed the existing lighting circuits that were removed and resized new circuits for my new lighting system. From there I then resized the panelboard and feeders.

Once the panelboard redesign was finished I performed a short circuit rating analysis on a single run of the electrical distribution system. I went through and found the time current curves for a comparison, and I went through the calculations to find the short circuit rating for each breaker.

Next I concentrated on two electrical depths of my choosing. I decided to do a cost analysis of the existing emergency generator system and build an SKM model of the existing system. I used RS Means 2010 for the cost comparison of using two generators instead of the existing three. The SKM model was built for ease of demand load and voltage drop calculations. The SKM software can also perform many other calculations once a model is built.

Then I went into my first breadth topic outside of my Lighting/Electrical concentration. I studied the court's acoustic properties for several different uses. I used reverberation time calculations to determine the fit of the space per use. Then recommendations were made for the space to better suit the acoustical needs.

My final breadth topic was a glazing analysis of the court space. A clerestory surrounds the top of the court. I built a model in Trace and chose five different glazing options to study the effects on the cooling load for the year. Depending on the glazing option, different rates of heat loss and gain were calculated with a major contributing factor being the sun.

This sums up the body of my report and I hope you enjoy. I have gained endless knowledge on each of the topics that I studied for countless hours. If there are any questions or comments, please do not hesitate to contact me.

Background:

General Building Data:

Building Name: Towson Center Arena Addition

Location & Site: Towson, Maryland

Building Occupant Name: Towson University

Occupancy: Basketball Arena

Size: 116,586 square feet

Number of stories: 3

Primary Project Team:

Owner: Towson University	http://www.towson.edu/
General Contractor: Gilbane Construction	http://www.gilbaneco.com/
Architect: Hord Coplan Macht	http://www.hcm2.com/
Associated Architects: Sasaki	http://www.sasaki.com/
Civil: Site Resources, Inc.	www.siteresourcesinc.com/
Structural: Faisant Associates, Inc.	http://mysite.verizon.net/faisant/
MEP: James Posey Associates, Inc.	http://www.jamesposey.com/
Landscape: Mahan Rykiel Associates	http://www.mahanrykiel.com/
Code Consultants: Koffel Associates	http://www.koffel.com/
Lighting: Bruce Dunlop Lighting Design LLC	http://www.dunloplighting.com/
IT Consultants: Unlimited Systems Support, Inc.	http://www.ussinet.com/
Foodservice Consultants: Culinary Advisors	http://www.culinaryadvisors.com/

Dates of Construction: May 2011 – March 1, 2013

Cost: 33.5 million (overall project)

Project Delivery Method: Design – Bid – Build

Architecture:

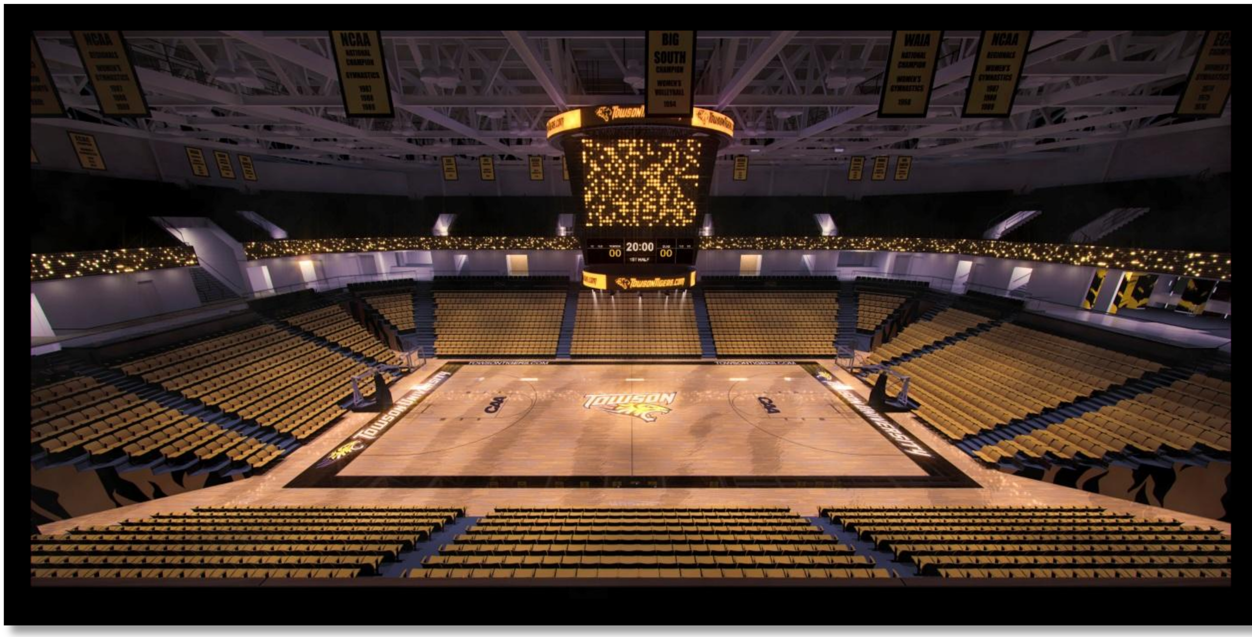
Towson University will build a new state of the art arena for basketball, gymnastics and volleyball. Tiger arena will seat over 5,000 people and also accommodates luxury suites. A zinc, steel and glass façade gives a modern feel to the main entrance of the arena. Vertical windows help stretch the building so as to make it seem taller and more profound. A large overhang covers a glass and steel façade and helps to anchor the building. Floating over the entrance, the overhang gives a sense of strength to the building and exaggerates the grand scale.

Major National Model Codes:

NSPC 2006 – National Standard Plumbing Code/2007 Supplement

IBC 2009 – International Building Code with modifications

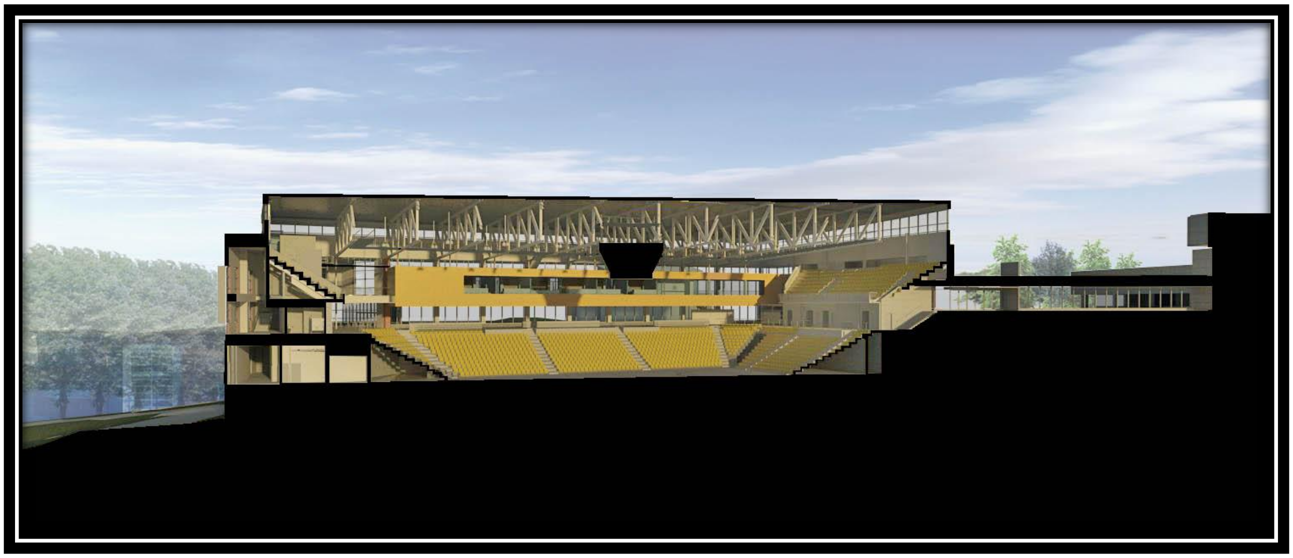
NFPA 101 – National Fire Protection Association

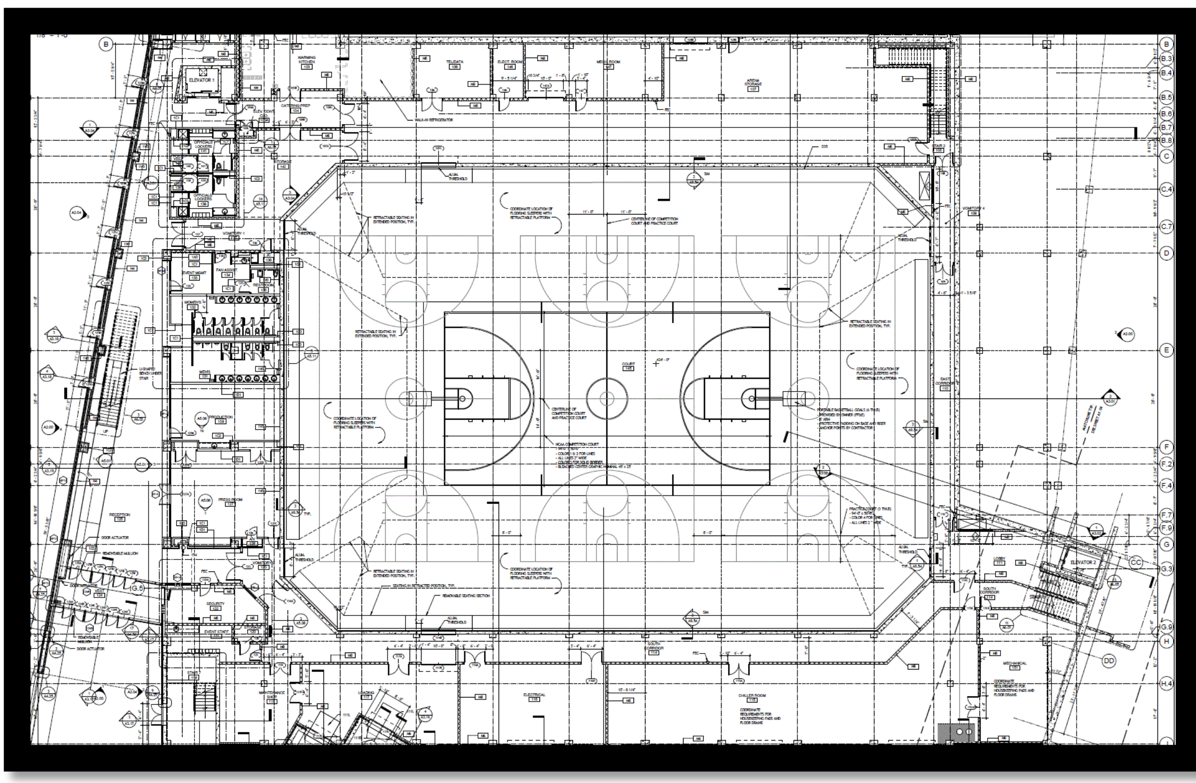


Zoning:

The first and second floors are zoned as A-4. The third floor and mezzanine level are zoned as A-3. There are also areas zoned as B and S. High rise provisions are not applicable because the highest floor is less than 75 feet above the lowest level of fire department access. The building will have a maximum building area of 60,448 square feet. The building will be sprinkled. Based on the A-3/A-4 Use Groups of 1B Construction the allowable area is unlimited. The allowable height is 160 feet and the allowable stories are eleven. To see more Baltimore County Zoning regulations please visit:

Baltimore County Citizen's Guide to Zoning





Statement of the Problem:

The Towson Arena Addition project has four spaces that I have scrutinized where I plan to redesign the lighting. The electrical system's emergency power capabilities will be assessed. Also, the four lighting solutions will need an electrical redesign.

The four spaces for a lighting redesign will be the court, the reception area on the first floor, the press room and the exterior northeast entrance. The court will need a lighting solution to accommodate games, physical education classes and sudden darkness for introductions at basketball games. I will design the reception to have a welcoming and guiding experience for the user. The press room design will have a psychological impression to go along with its design solution. The exterior will easily bring the spectators into the building through the use of an effective lighting design.

The electrical system shall be redesigned as well. The emergency power system will be examined, and I will decide if a better solution exists. The spaces that I plan to redesign with new lighting solutions will need to have their electrical design assessed for safety and code compliance. The branch circuits will need to be examined for the arena's electrical system serving these spaces. I would also like to perform a short circuit analysis of the building's electrical system.

Proposed Solution(s):

Lighting:

The court will be addressed by having a system to meet the NCAA basketball requirements for illuminance. The luminaires will need to be designed in zones to allow for the illumiance values needed for graduation ceremonies while saving energy. Finally, shutters will need to be installed on the luminaires so that the court can be blacked out during introductions of the opposing teams.

The reception area's lighting design will have several objectives. The users of the space will need to be directed through the space. The lighting solution will help direct the viewers. The reception area also should be welcoming so as to foster social interaction among the users. The lighting solution will need to give the users the most comfort in meeting and staying in the space. This will allow users to enjoy the space during pregame, halftime or other recesses when the arena is being used.

The press room will have the psychological impression of being public to help the speakers feel comfortable presenting in front of numerous reporters. This will be achieved by providing enough vertical illumination to allow the speakers to see the audience. The space should be conducive to social interaction among the occupants.

The northeast entrance of the arena will be designed to have ample vertical illumination to allow for facial recognition of the users. There will also be a prominently illuminated entrance of the building that will let the users know exactly where to go. Luminaires will be positioned to create a line of light to the entrance as well. The line of light will be made up of posts.

Electrical:

The existing emergency power system consists of three generators. The needs of the building versus the existing system's capabilities will be checked. Then I will determine if there is a better solution that is more cost-effective. The spaces that will receive a lighting redesign will be examined for protection devices and wire sizing. The branch circuits and panelboard sizing will be examined and redesigned if necessary. I will also perform a short circuit analysis of the Towson Arena's electrical system. Finally an SKM analysis will be performed on the system.

Solution Methods:

In order to find cogent solutions to the design of the four spaces I will need to first research the illuminance values, power densities, codes and any other design concerns that apply to the spaces. The criteria will guide my choices of how to meet the design goals. Then equipment can be looked at in order to decide how I want to place the luminaires to fulfill my design concept. Finally I will create renderings and illuminance calculations with software. Power density calculations will also need to be done to comply with ASHRAE. My design will then be fine-tuned until I find an acceptable solution.

For the emergency power system I will go through the existing building and determine the capacity requirements. Once I determine the existing equipment size, I can assess whether the current system is adequate for the existing building or possible expansion. I would then like to research other emergency power setups to attempt to find a better and more cost-effective solution.

In the spaces that are redesigned, the lighting solutions will need to be examined for safety and code compliance. I will first find the needs of my new proposed lighting system. I will also check the current performance of the existing system. Where upgrades are needed I will make adjustments and redesign the wiring, panelboards or overcurrent protection devices. After I have a new electrical system for the new lighting design I will run a short circuit analysis.

The SKM Analysis will be difficult and a steep learning curve will ensue. A user's manual will need to be obtained to gain a basic understanding of the software. Consultants with experience with the software will be able to give advice. The SKM analysis will cover the buildings entire electrical system.

Tasks and Tools:

Lighting Solution

Task 1: Lighting Research for Design Criteria

a) Find the illuminance values for each space
b) Find the power densities from ASHRAE per space
c) Make note of other design considerations from the 10th edition IESNA handbook

Task 2: Schematic Design

a) Brainstorm design goals that will be achieved in each space
b) Consider focal points or other areas of emphasis in each space
c) Define specific design objectives for each space

Task 3: Choosing Equipment

a) Make choices for lamp types needed per space
b) Research equipment with photometric data that will meet design criteria

Task 4: Calculate with software

a) Use AGi32 to test for compliance with IES guidelines
b) Calculate power density for each space
c) Capture renderings to better explain findings

Emergency Power Solution

Task 1: Determine needs for existing Towson Arena

a) Find the size of the current electrical Towson Arena system
b) Find the classification of the building for the NEC

Task 2: Determine acceptability of current system

a) Compare the current system to code for compliance
b) Determine of current emergency power system has any inadequacies

Task 3: Research better and more cost-effective emergency power system

a) Research more depth on current emergency power system
b) Research available emergency power systems
c) Come up with rough cost estimates for each emergency system for a comparison

Lighting Solution Electrical Redesign

Task1: Finish lighting solution

a) Finalize lighting solution for each space
b) Define electrical needs for new systems' designs

Task 2: Determine Spaces' electrical needs

a) Run calculations to determine the size of each new lighting system
b) Find the limits of the current system through calculations
c) Consult code for existing systems' compliance
d) Make adjustments and redesigns where necessary
e) Run short circuit analysis of new electrical system for each space
f) Consider lighting controls for each space and electrical consumption

Task 3: Present Findings

a) Gather data for existing and new electrical systems
b) Show comparison of existing versus new electrical system per space

SKM Analysis

Task 1: Achieve basic understanding of software

a) Acquire a user's manual
b) Gain basic proficiency of software program
c) Ask for help from professional contacts

Task 2: Use SKM skills to build a model of the electrical system

a) Scrutinize the existing Towson Arena electrical system
b) Make note of all panels and there loads

c) Build computer model in SKM

Task 3: Use SKM skills to run an analysis of the electrical system

a) Run analysis and interpret the results
b) Interpret various reports
c) Present findings

Additional Issues:

The biggest issues that I will encounter will be software, finding adequate ies files, researching emergency power systems and finding LED cost information. There are always issues with file saving and renderings. Elumit is a great site, but I will have to sift through many ies files in order to find suitable replacements for LED fixtures. Also, LEDs don't have the best record of even having ies files. I am quite inept with emergency power systems, so there will be a steep learning curve at first for this portion of my thesis. The LED cost information will be tedious to find. Perhaps I can contact certain reps to help me find correct data.

Breadth Topics:

I would like to do a further study into two aspects of the Towson Arena Addtion in addition to those already discussed. I would like to investigate how glazing affects the heating and cooling loads of the building and the different acoustical needs of the court.

The Towson Arena has lots of glazing and even a clerestory letting light into the court area. I want to determine the effectiveness of the current design. I would like to analyze the change in energy requirements for heating and cooling loads due to changes in the glazing. Certain glass can affect how much solar heat is gained during the course of the day. I would then like to research mechanical systems that would better meet the needs of the different glazing characteristics.

The court space in the Towson Arena will serve many purposes including a basketball court, volleyball court, physical education facility, concert arena and graduation ceremony stage. The acoustics in the court space will be very important for these different uses. Concerts, graduation ceremonies and sporting events all require different acoustic levels. I want to explore the adequacy of the current acoustic system. I'd like to assess the different reverberation times with the existing system and for the multiple uses. There will be different orientations for a concert versus a basketball game and I would like to analyze how sound will move through the space from different directions. Finally I would like to quantify sound levels from various points in the court area. I would like to take measurements from the floor level and higher seating positions.

Lighting Designs:

Court:

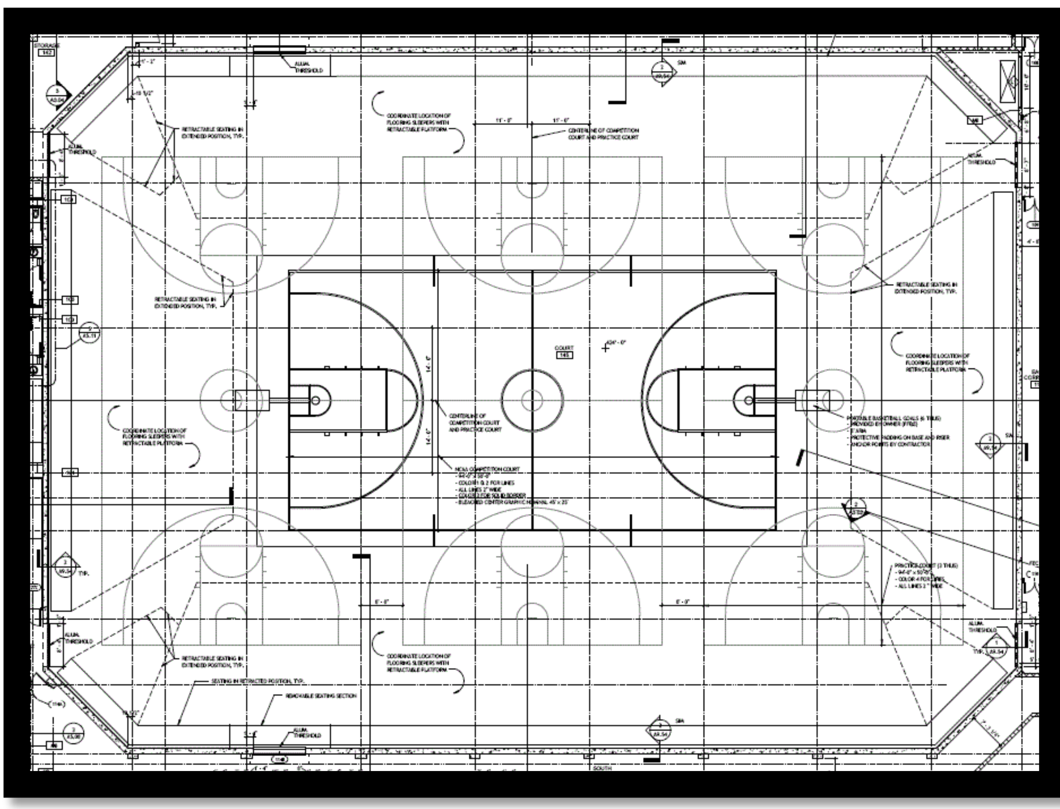


Figure 2.1

The Special Purpose Space will be the court. The basketball and volleyball games will be played in this space. The players will need to be able to see the ball and the other players on the court. Seating is also adjacent to the court, and retractable benches will cover some of this space as well. Light will be needed so the viewers can see the game and navigate the seating. Scorers will need light to record information and update the scoreboard. Daylight will be available in this space. A clerestory is on the top level of the arena, and it will draw in light during daytime activities. The glass is low-e-coated, clear insulating with an overall thickness of 1 inch. The interspace content is air, the visible light transmittance is 74 percent minimum, the U-Value is .35 maximum and the SHGC is .4 maximum. It is room 145 on drawing A1.03 of the first floor. The space is 188' x 136', and it extends three floors. The first floor has retractable bleachers. Concourses on the second floor open to the court area, and the third floor has arena seating and suites. The truss level has a series of catwalks above the court. The floor is a hardened rubber material beneath grade 2 maple that complies with floorscore standards. The ceiling is a structural truss system with a clerestory, and there are two tiers of seating along the edge of the space.

Existing Lighting Systems

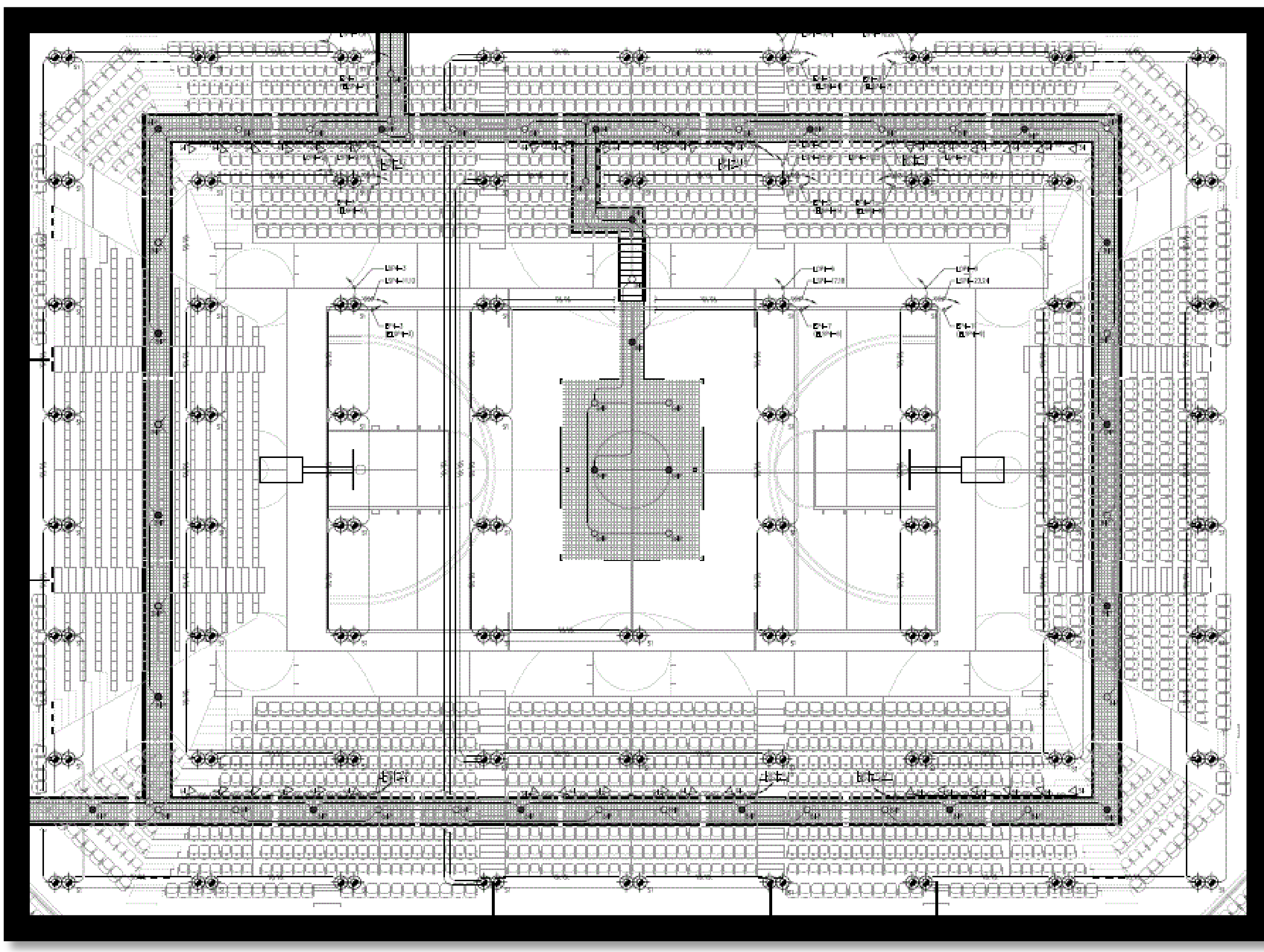


Figure 2.2

The space is illuminated by luminaire types H3, S1, S4. See Figure 2.2 above. Fixture H3 is a four foot gasketed fluorescent fiberglass, high impact acrylic, rated for wet location, and they are located behind the first floor bleachers. There are two 28 Watt T5 lamps with 80 CRI and 4100 Kelvin. Fixture S1 is a four circuit CFL high-bay with three 2-lamp switching ballasts and one 2-lamp 1% dimming ballast, twin-fixture cluster mounting bracket. There are six 42 Watt CFLs at 80 CRI and 4100 Kelvin. Also, there are two 42 Watt CFLs at 80 CRI and 3000 Kelvin. Fixture S4 is a broadcast sports lighting system with motorized shutters, catwalk mounting brackets and safety cables. The lamp is a 1000 Watt metal halide.

Space Lighting Design Theme

Going along with the central theme of social interaction and communication, the court should have an environment so the players and viewers can communicate easily. High light levels are needed for the court, 75 fc. This will spill into the arena seating. Also, lights are needed to light seating areas for egress of aisles. Vertical light levels are important so that the face of someone can be seen. This will aid in the communication of the space if the viewers can see each other easily. The light needed for the court and seating areas will create an environment conducive to conversation.

Space Lighting Design Criteria

The Court area will be used primarily for basketball, and it will be designed for such. Basketball can be categorized as a multi-directional aerial sport due to the fact that games are played in both directions and the ball is in the air for part of the game. Volleyball is also a multi-directional sport, and in fact falls under the same design criteria.

“Higher illuminance values allow the use of high speed shutters and small aperatures that increase image sharpness and depth of field”(DiLaura 35,3). Stop action, slow motion and special effects are aided by more light applied to the area. HDTV can be particularly affected by the lamp’s stroboscopic effect in low frequency ballasts in HID lighting systems. “This can be minimized by ensuring the illumination is provided by multiples of three luminaires, with overlapping beams which are balanced across three electrical phases”(Dilaura 35.3).

The arena will have a maximum capacity of 5000 seats. For a college facility, the class of play is II due to the fact that the spectators will never be greater than 5000.

Basketball: Class II	Observers age 25-65	Eh @ 3'	
Eh: 750 lux	Ev: 200 lux	CVmax: .21	Max:Min: 2.5:1

Stairs: Typical	Observers age 25-65	Eh @ Floor	Ev @ 5'AFF
Eh: 50 lux	Ev: 30 lux	Avg:Min: 2:1	

Horizontal illuminance is calculated 3' above the competition surface while vertical illuminance matters over the entire height of the playing area. I made four vertical calculation grids at 3', 8', 13' and 18'. The 3' grid is angled west, the 8' grid is angled south, the 13' grid is angled east and the 18' grid is angled north. This should cover the range of heights the basketball will be located during a game.

Color temperature is an issue for the space due to windows, clerestories and television cameras. A color temperature range of 3000 K to 6000 K can be balanced for television. Lamps with a color temperature closer to that of daylight will minimize issues. The desired CRI is at least 65.

Power Allowances

By Table 9.5.1, using the building area method to calculate lighting power densities allows 0.78 W/ft^2 for a sports arena.

By Table 9.6.1, using the space-by-space method allows for 0.43 W/ft^2 for audience seating and 1.92 W/ft^2 for Class 2 sports. The facility is a class 2 because it is a college facility with a capacity of 5000 seats.

Existing Lighting System Critique

One of the flaws of this system is in the S4 fixture. It is almost impossible to find photometric information for a 1000W metal halide, sports accent light. This makes it very hard to comprehend the amount of light hitting the surfaces of the arena seating areas.

Space reflectances are assumed to be standard 0.8, 0.5, and 0.2 for ceiling, walls, and floor respectively. Light loss factor of 0.7 is calculated with a 0.9 Ballast Factor, a 0.9 LLD and 0.9 LDD.

The recommended illuminance values are:

Basketball: Class II	Observers age 25-65	Eh @ 3’	
Eh: 750 lux	Ev: 200 lux	Max:Min: 2.5:1	CVmax: .21

The calculated illuminance values are:

Calculated	(lux)				
	Avg	Max	Min	Max/Min	CV
Horz 3’	1499	2069	893	2.31	0.17
Vert 3’	593.1	718.7	267.9	2.7	0.19
Vert 8’	591.5	810.2	277.7	2.9	0.17
Vert13’	629.2	1053.1	302.7	3.5	0.23
Vert 18’	608.3	938.7	278.8	3.4	0.22

The horizontal illluminance values from the model more than compensate for the average illuminance needed for the court. It is acceptable to exceed the recommended as higher illuminance values benefit television cameras. The ratio of Max/Min, 2.31:1 was within the recommended value of 2.5:1. The hot spots are distributed evenly throughout the space to meet the coefficient of variance. The calculated value of 0.17 is below the recommended value of 0.21 for CV.

There is also ample vertical illumination at the different heights on the court. The guideline is 200 lux and each height exceeds this requirement. This will give the light needed for slow motion, stop action and other special effects used for television. See Figure 2.3 below for a distribution of hotspots from the simulated, computer model.

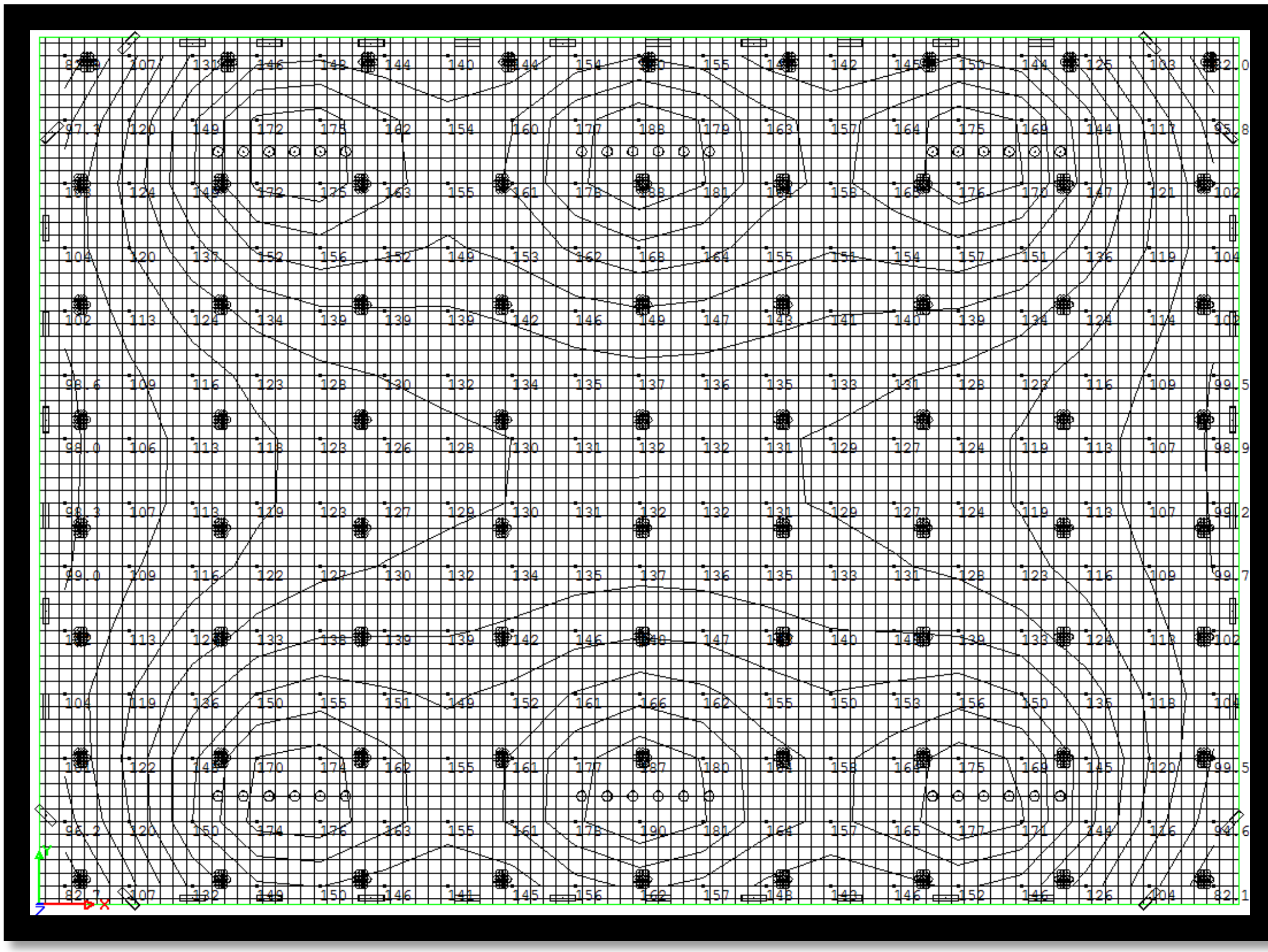


Figure 2.3

The lamp CCTs range from 3000 to 4100. Some of the CFLs are 3000 Kelvin for a warmer feel, however the 4100 Kelvin CFLs will be used with games with the linear fluorescent and metal halide lamps.

Figure: Daytime Rendering of the original system

New Lighting System

For the Court I designed the space with Philips WideLite's AE2 fixture. It is a 1000W MH sports lighting fixture. I chose the fixture for its high light output and blackout shutters. The lighting fixture mounts directly onto a surface so I used the existing catwalk just above the truss level to mount the fixtures. You can see the attached cutsheet for this fixture in the appendix. The luminaire has a Reflector Type A beam pattern which I have chosen for the design. There is an optional dimming ballast option for the luminaire, and the ballast is in the fixture itself. It uses a BT37 1000W MH lamp, and puts out 110,000 lumens of light at 3700K, 65CRI.

It was very difficult to design the space due to the stringent energy codes. I was able to just meet the court horizontal and vertical illuminance levels as well as stay within energy code. I used a total of 20 luminaires to light the space. Fourteen of the luminaires were above the court area and 6 were above the audience space. The following tables indicate the design. Also, the following layout will give you an idea of my fixture spacing on the catwalk and around the scoreboard at the center of the court.

I spaced the 6 luminaires for the audience at the four corners and one in the middle of the two shorter sides. The court area is 72’ x 120’. The luminaires over the court area are positioned in an “I” formation. Horizontally they are spaced 15’ apart on the top and bottom of the “I”. In the middle of the ‘I” the luminaires are spaced 20’ apart horizontally and vertically. The system will have two zones so as to be able to use less light if the use calls for it. There will be two switches near to entrances on the first floor. One switch will control one zone and then the other switch will control the second zone of lights.

Horizontal Plane Calc Grids (footcandles)								
	2nd Tier Audience		1st Tier Audience		Ceremony		Court	
	Design	Criteria	Design	Criteria	Design	Criteria	Design	Criteria
Eh	25.06	5	32.65	5	47.19	30	75.92	75
Ev	25.06	3	22.92	3	24.33	20	next	20
Avg:Min	20.88	2:1	6.66	2:1		3:1	-	-
Max:Min	-	-	-	-	-	-	2.35	2.5:1
CVmax	-	-	-	-	-	-	0.21	0.21

Calculated (lux) Designing all to 20 footcandles					
Court	Avg	Max	Min	Max/Min	CV
Vert 3’	24.33	38.3	24.33	4.3	0.34
Vert 8’	22.92	22.92	36.9	4.19	0.34
Vert13’	25.04	25.04	40.5	5.00	0.36
Vert 18’	22.87	22.87	41.3	5.29	0.40

Improvements that I could have made to the design include a incorporating a daylight friendly system. There is a large clerestory around the top of the court that provides ample daylight for solar sensors and dimming systems to be installed. What left me from designing to this was the need for blackout shutters on the light fixture. I had a lot of trouble looking for a high wattage metal halide fixture with blackout shutters and a photometric file. The fixture does have an optional dimming ballast, but it is meant to have a high and low setting for the blackout shutters. However, for practical cost and time purposes I chose to sacrifice for this system.

Another improvement I could have made on the system was concentrating on having a more uniform design for the audience seating. The Avg:Min ratios are nowhere near where they should be. The light from the court leaks heavily onto the audience seating. It gives enough footcandles for exiting and that is the main goal.

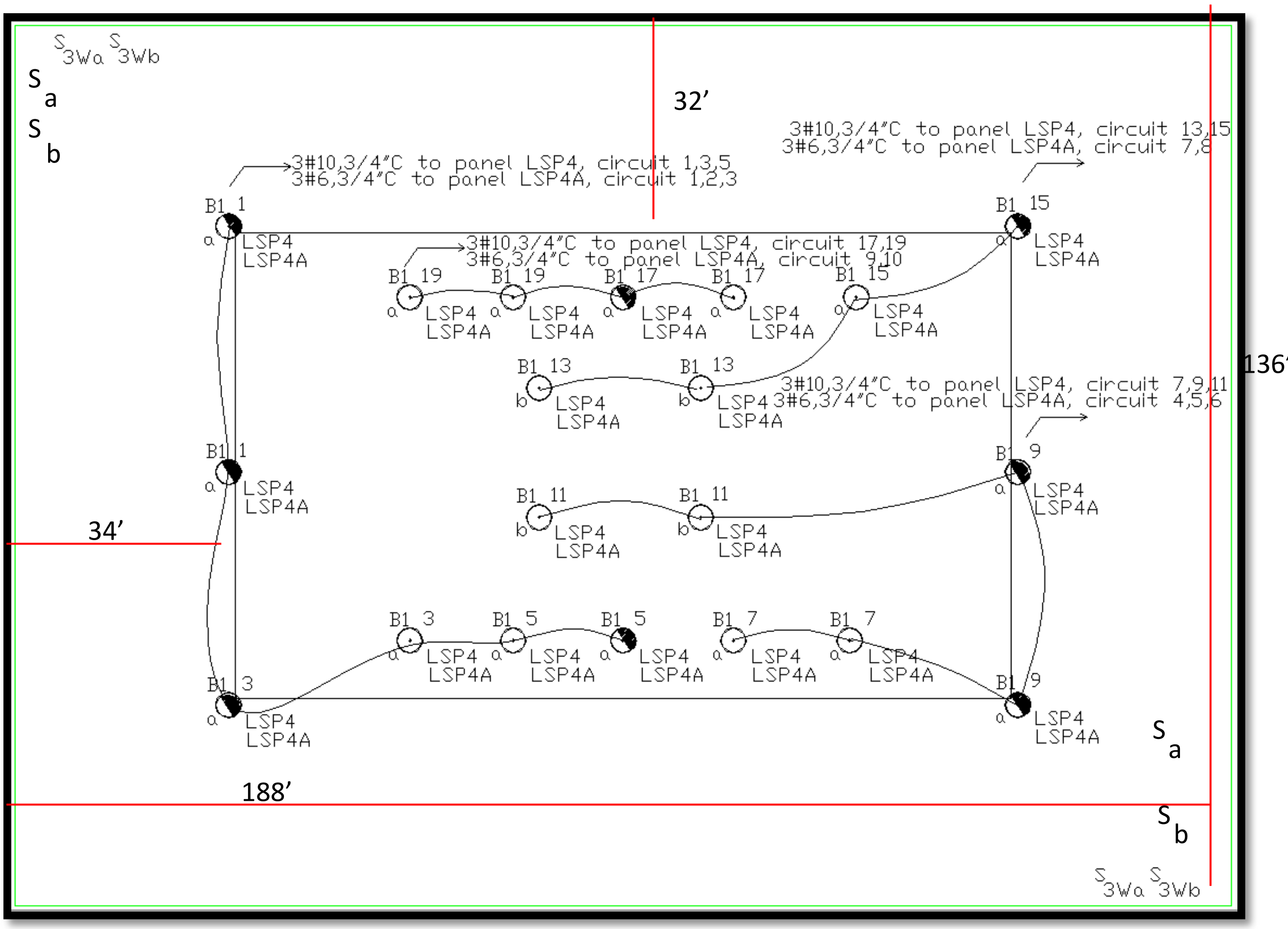


Figure: New design luminaire layout

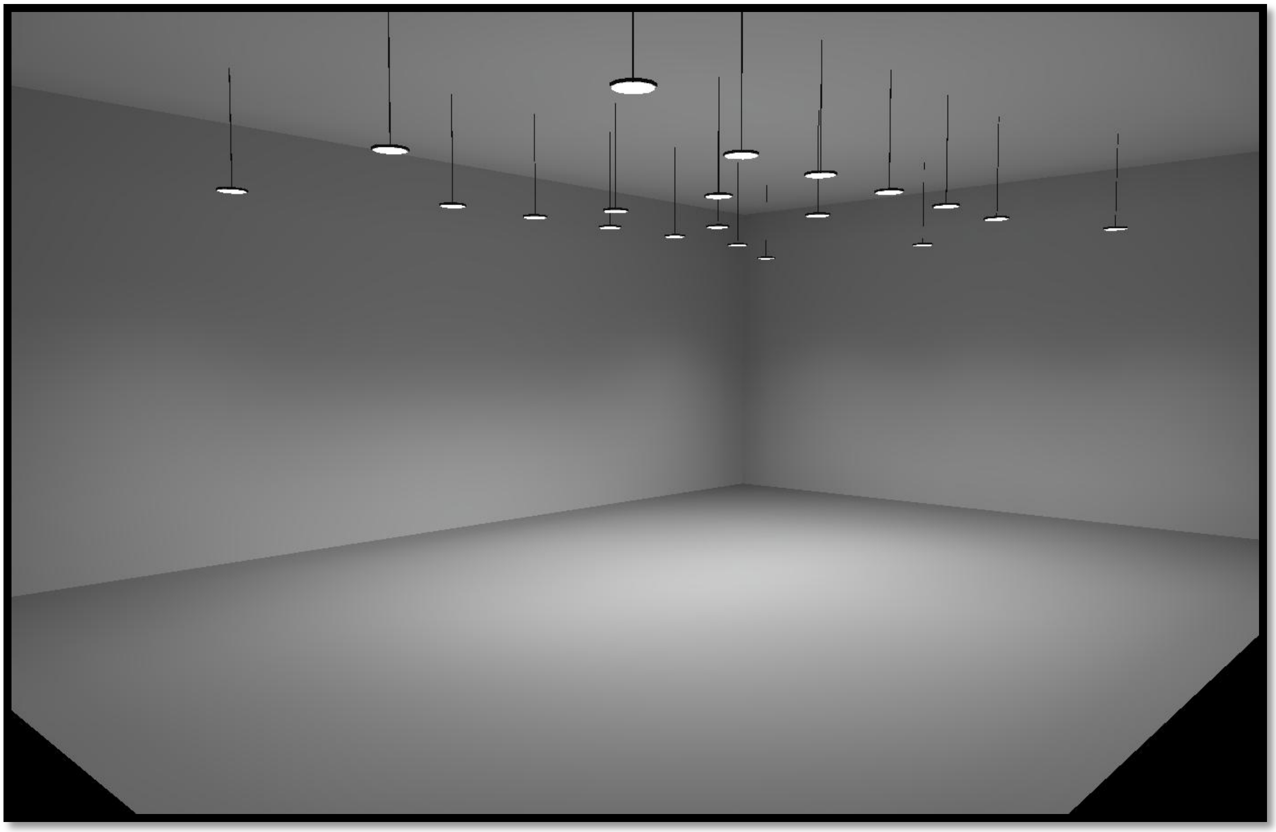


Figure: Simple model showing light in Court area.

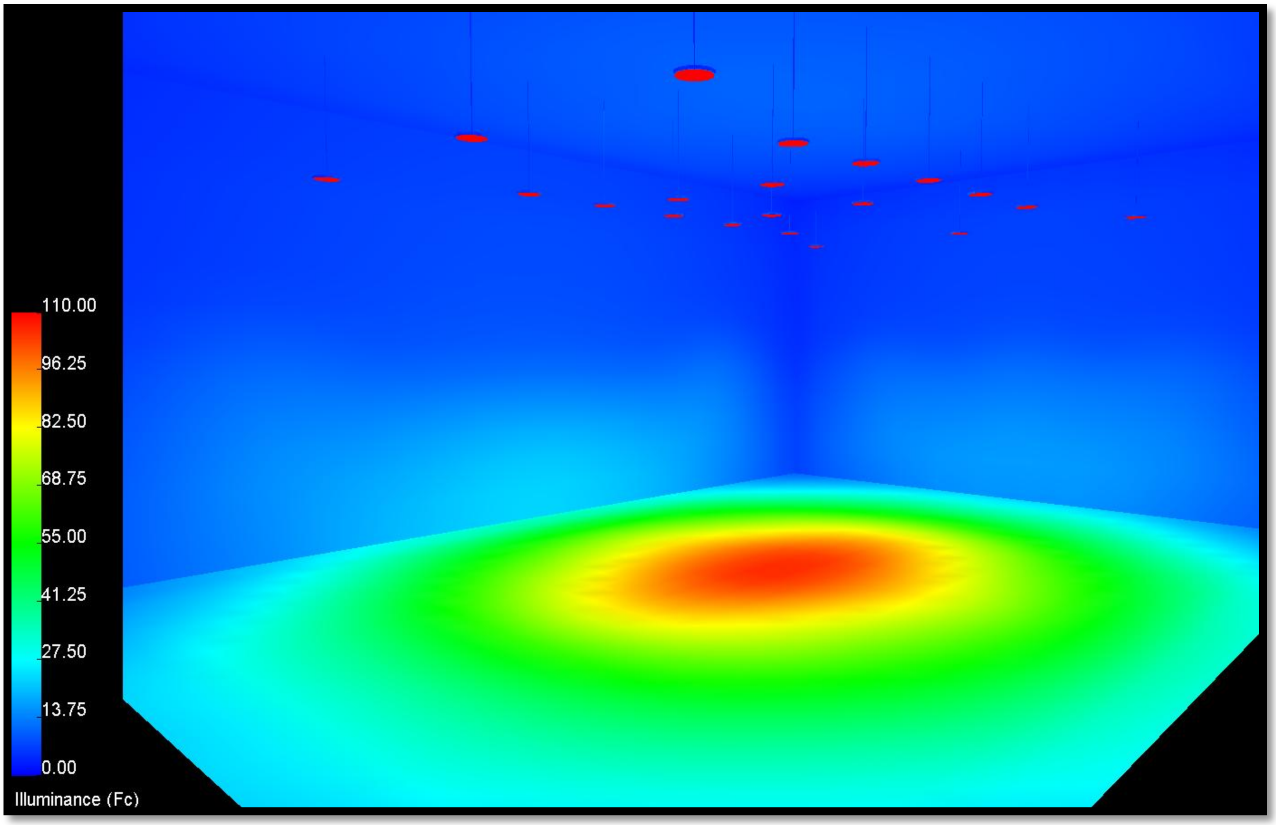


Figure: Pseudo Color of distribution of Light

Reception:

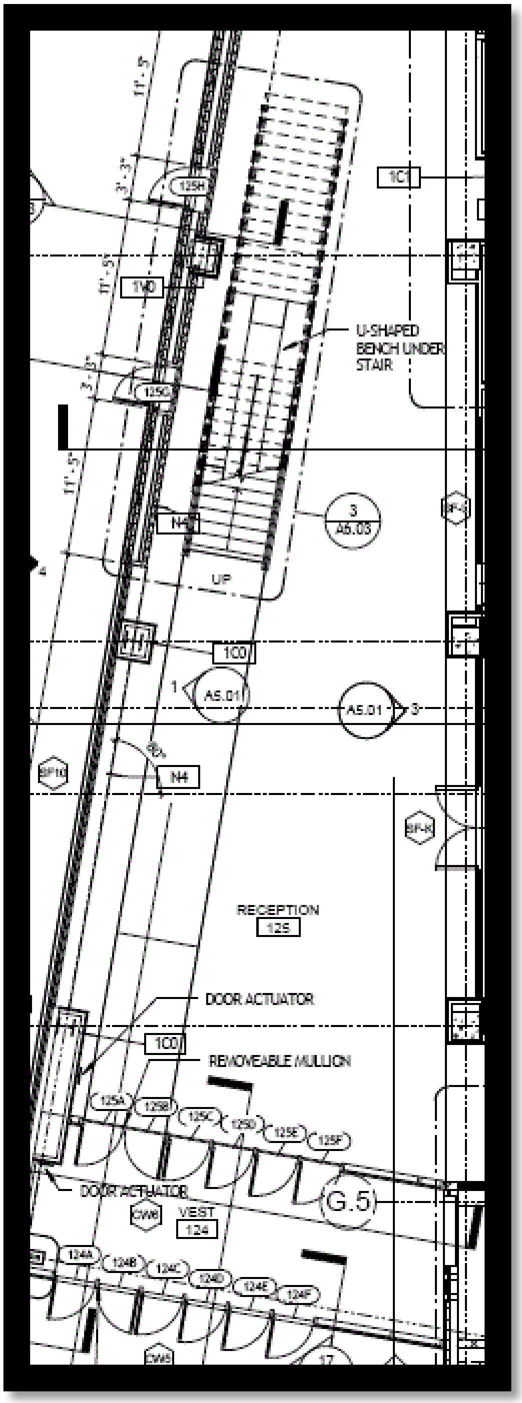


Figure 3.1

The circulation space will be on the first floor reception area. This is an entrance to the building and is a two story atrium with a stairwell that leads to the second floor concourse area. This welcomes VIP players and viewers to the arena. It is a place for people to meet and a transition point into the busier areas. The tasks in this space will primarily be social, so people will need to be able to view each other. There may also be sports memorabilia around the walls and periphery. There are many windows and doors that allow access to this space on the first floor. This will allow daylight to be a factor in the lighting design of the space. The glass is low-e-coated, clear insulating with an overall thickness of 1 inch. The interspace content is air, the visible light transmittance is 74 percent minimum, the U-Value is .35 maximum and the SHGC is .4 maximum. The reception is room 125 on drawing A1.03. The dimensions are 80' x about 16', and the space extends upward two floors. A stairwell hugs a fully glazed wall along the western side of the building. Underneath of the stairwell there is a twelve foot long U-shaped bench. The space is in the shape of a triangle and the widest point is about 30'. The floor is porcelain floor tile of a nickel color, the walls are gypsum wallboard painted silver satin and graphite and the ceiling is acoustical ceiling tile. This space will have three different design solutions.

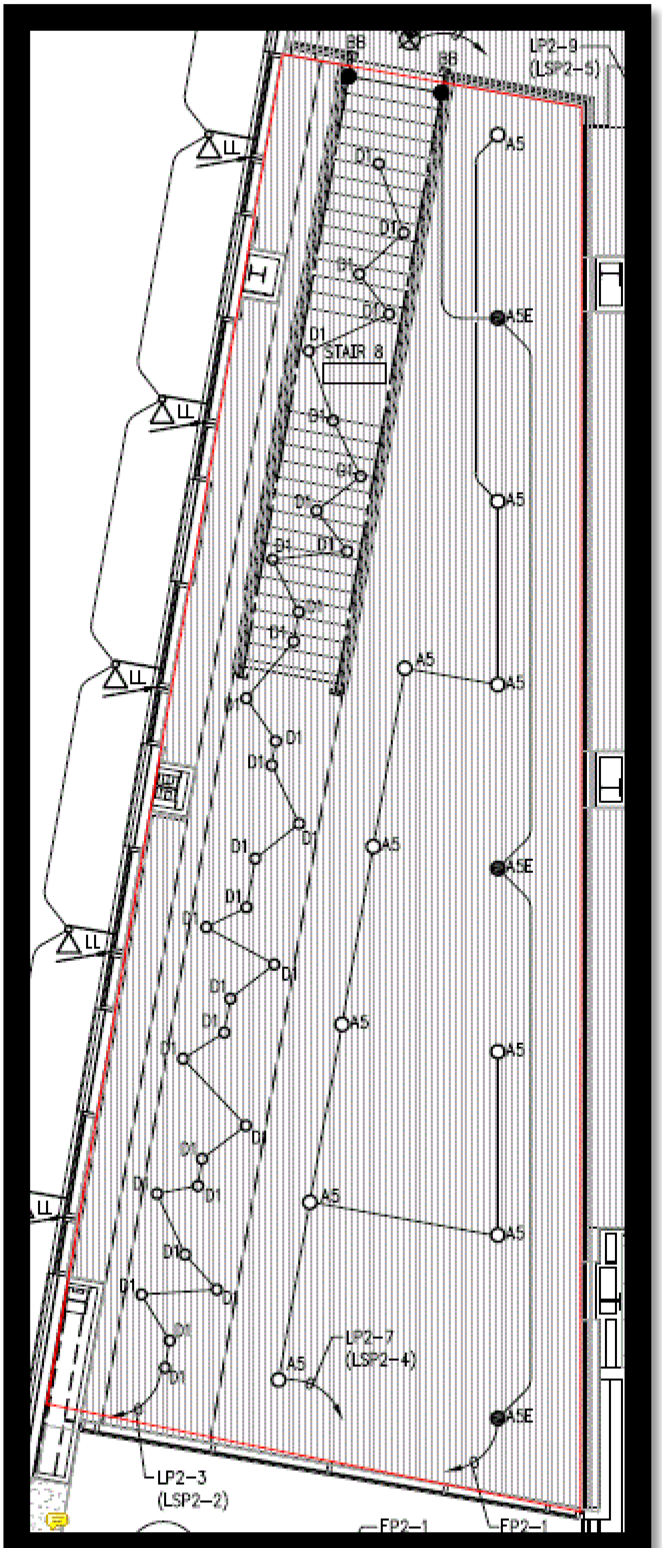


Figure 3.2

Existing Lighting Systems

The space is illuminated by luminaire types A5, D1 and BB. Fixture A5 is a 7" recessed downlight with medium base par lamp, open specular clear alzac cone and steel housing. The lamp is a ceramic metal halide 70 Watt par30 flood. Fixture D1 is a 4-3/4" diameter by various heights LED architectural pendant with remote drivers, processor, manual controls and timeclock. The LEDs are RGB color-changing. Fixture BB is an LED handrail with LEDs at 4100 Kelvin.

Space Lighting Design Theme

The reception area will be conducive to social interaction and communication. It is a meeting and transition space. Vertical illuminance will allow the users to see other people and engage in conversation. It is a two story atrium with full glazing on one side and a staircase in the middle of the glazed wall. The space will feel dynamic and as if everyone will be or will need to be moving. Accent lighting on artwork around the periphery will help take the focus off of the people using the space. This way the users may freely interact with each other and not feel as if they are the center of attention.

Space Lighting Design Criteria

The primary considerations for building entries, from IES, include the following:

Degree to which entries are covered from the elements
Proximity of vehicular traffic to pedestrian traffic
Anticipated nighttime activity levels
Nighttime outdoor lighting zone for the project under consideration
Security

Building Entries: Vestibules – Medium Activity					**Avg:Min**
Day	Eh @ floor	Ev @ 5' AFF	Eh: 100 lux	Ev: 50 lux	2:1
Night	Eh @ floor	Ev @ 5' AFF	Eh: 50 lux	Ev: 30	2:1

Lobbies that are in close proximity to building entry should assist with transition from exterior to interior and vice versa.

Transition Spaces: Lobbies – At building Entries					**Avg:Min**
Day	Eh @floor	Ev @5' AFF	Eh: 100 lux	Ev: 30 lux	4:1
Night	Eh @floor	Ev @5' AFF	Eh: 50 lux	Ev: 20 lux	4:1

Transition Spaces: Stairs					**Avg:Min**
Typical	Eh @floor	Ev @5' AFF	Eh: 50 lux	Ev: 30 lux	2:1

Medium activity is moderate pedestrian traffic with occasional occurrences of swells of activity. Lamp type and color qualities should also be consistent with adjacent spaces to transition space.

The main point of interest in the first floor reception is the stairwell to the second floor. A freestanding column along the curtain wall of glass pulls the viewers' eyes to the left as they enter the space. Their attention will follow the line of the stairs to the second floor.

Power Allowances

By Table 9.5.1, using the building area method to calculate lighting power densities allows 0.78 W/ft^2 for a sports arena.

By Table 9.6.1, using the space-by-space method designates an allowance of 0.90 W/ft^2. An atrium allows for 0.03 W/ft^2 per foot of height for the first 40 feet of height.

Existing Lighting System Critique

It can be difficult to critically analyze the lighting design of a space without a correct computer model. This difficulty is compounded by the uncertainty of lumen output by LED sources. However, assessments and educated inferences may still be made.

The CMH 70w par30 gives off 4700 lumens initially. There are 13 A5 fixutes, so that is roughly 61,100 lumens before LLF. After LLF are applied the lumen output total for all 13 fixtures is roughly 44,500 lumens. The total area is around 524 square meters so the lux in the space is about 85 lux. This value does not include the LED downlights as the lumen output is not precisely known. During the day the required horizontal illuminance may not be met. On a sunny day, there should be enough daylight entering the space in the morning and until about noon. In the afternoon, the space will be in shadow, so there may not be enough horizontal illuminance. Cloudy days may not provide the amount of light needed for the recommended 100 lux during the day. However, on a clear of cloudy night, the 85 lux horizontal value will more than cover the guideline of 50 lux. It is very difficult to predict or calculate the vertical illuminance or Avg:Min ratio.

The space is a two story atrium and a majority of the users will make their way through the space and ascend the stairwell. The existing lighting design has a cluster of LED downlights that follow the path of the entrance to the stairwell. This cluster of brighter light will draw the user to the stairwell. The rest of the space has CMH par30 fixtures that are evenly spaced as to not draw much attention. A LED handrail runs along each side of the stairwell to draw the users' attentions. The illuminated handrail also helps to connect the second and first floor atrium.

Space reflectances are assumed to be standard 0.8, 0.5, and 0.2 for ceiling, walls, and floor respectively. Light loss factor of 0.7 is calculated with a 0.9 Ballast Factor, a 0.9 LLD and 0.9 LDD.

New Lighting System

Transition Spaces: Lobbies – At building Entries					Avg:Min
Day	Eh @floor	Ev @5' AFF	Eh: 100 lux	Ev: 30 lux	4:1
Results (fc)			193.18	174.94	2.99
Night	Eh @floor	Ev @5' AFF	Eh: 50 lux	Ev: 20 lux	4:1
Results (fc)			22.49 fc	6.58 fc	2.78

Transition Spaces: Stairs					Avg:Min
Typical	Eh @floor	Ev @5' AFF	Eh: 50 lux	Ev: 30 lux	2:1
Results (fc)			43.34 fc	6.31 fc	1.54

In my design I used 3500K LED downlight fixtures from Philips. Please see the appendix for the attached cutsheets. I chose a suspended pendant fixture to give a sense of depth to the space. The pendants hover approximately 15' above the floor and stair respectively. Recessed LED downlights also illuminate the space from 28' high ceilings. They are used to supplement the rest of the space with the lighting guidelines.

I have incorporated a wattstopper solar daylight harvesting sensor into the LED dimming system. Depending on the amount of daylight that enters the space, the lights will be dimmed to meet the minimum illumination requirements. The LED driver has dimming capabilities that make the daylightin system possible. There will be two light zones with two switches for each zone as well.

The power densities for the space meet energy code. Using the building wide method for a sports arena the maximum power density is 0.78 W/ft^2, and for the space by space method, the maximum is 0.9 W/ft^2. In the reception area of 1730 ft^2 the total wattage was 1329 Watts so that makes the lighting power density 0.768 W/ft^2 which is within the guidelines.

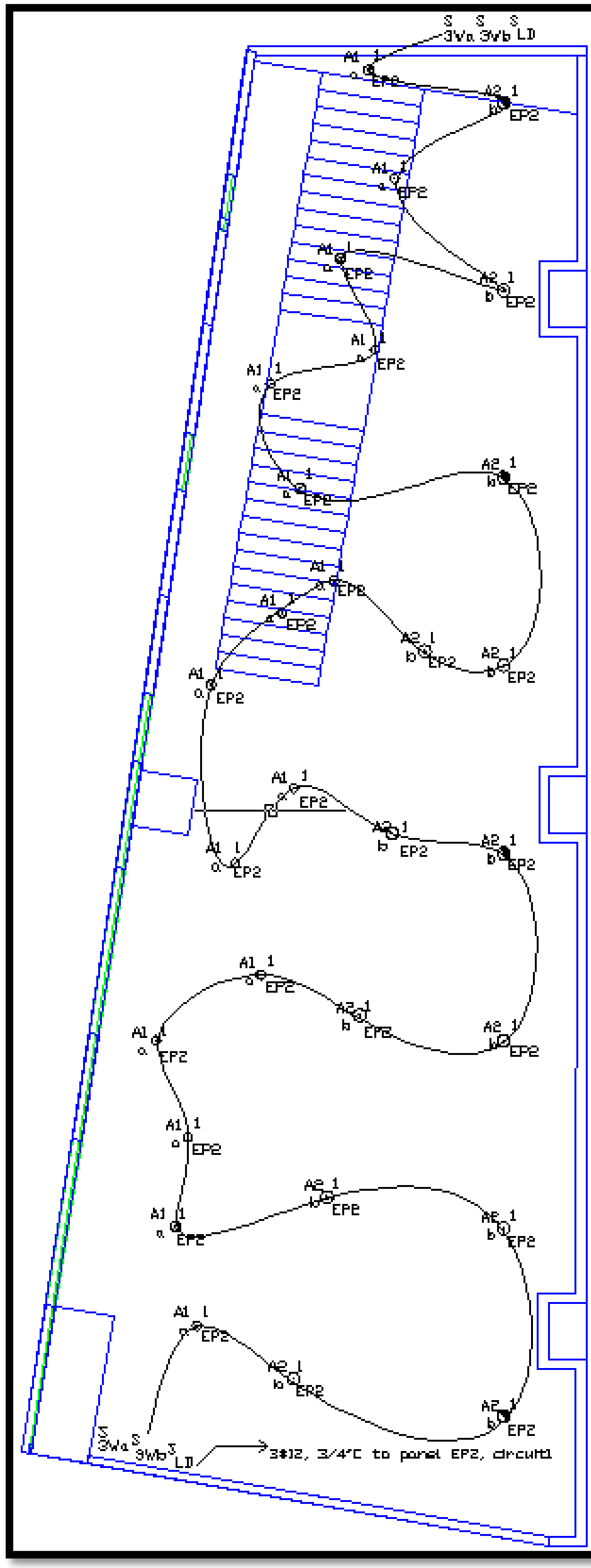


Figure: Fixture Layout

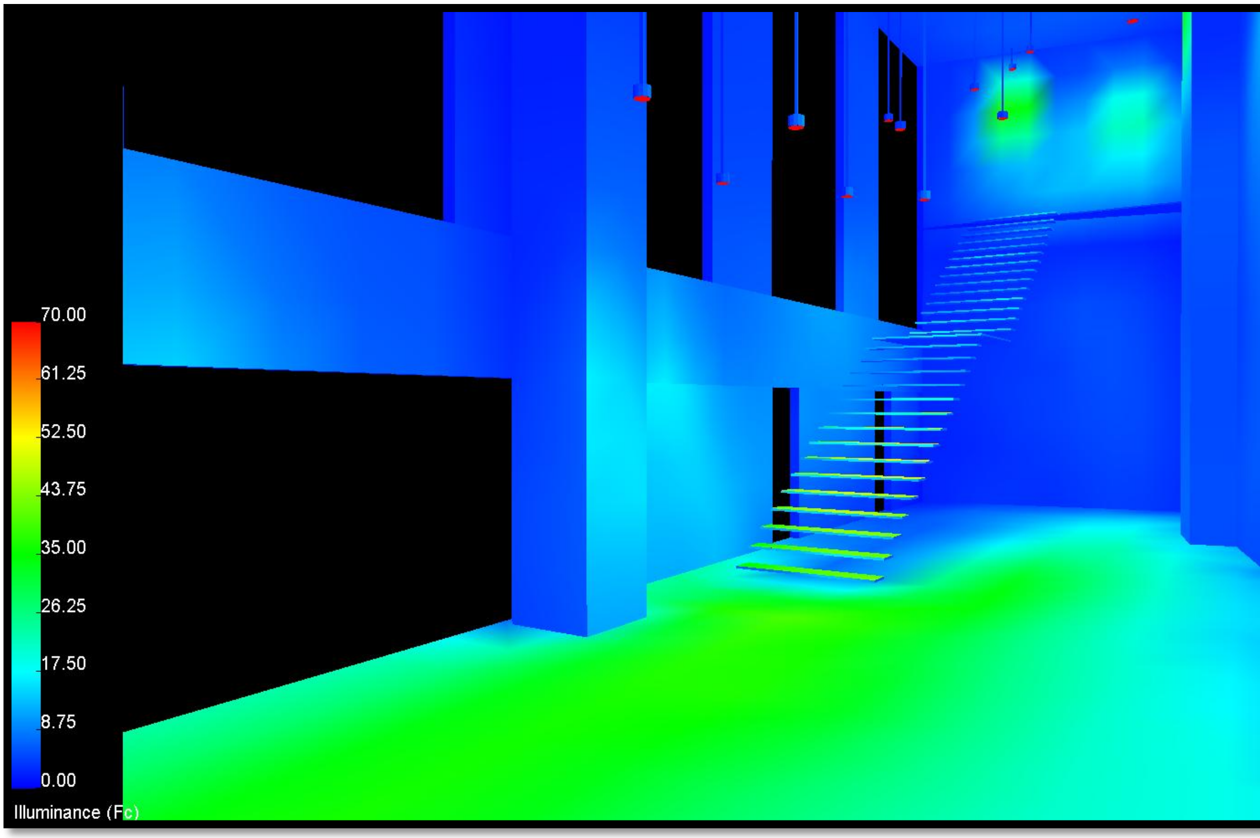


Figure: Reception Pseudo Color

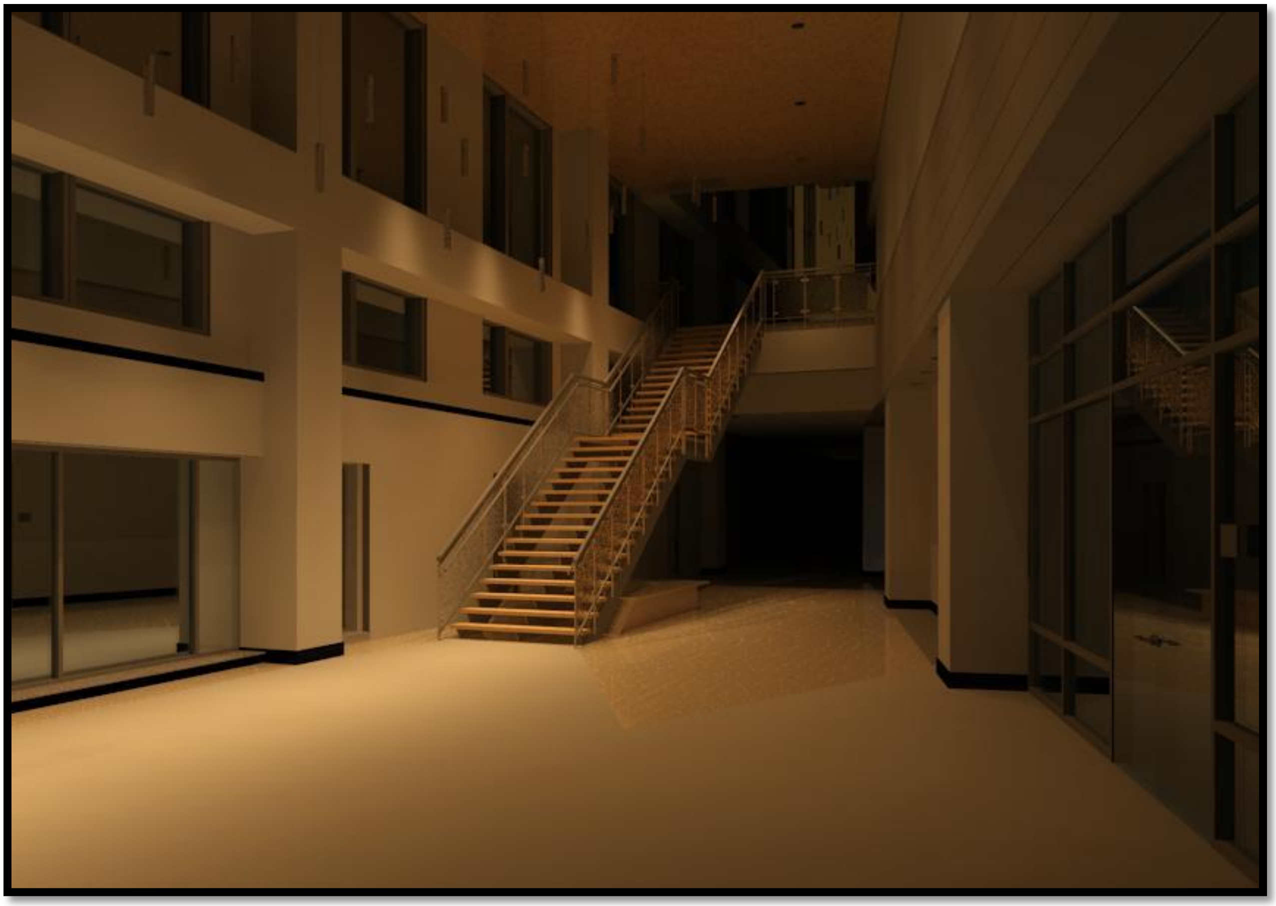


Figure: Rendering Reception Artificial Light

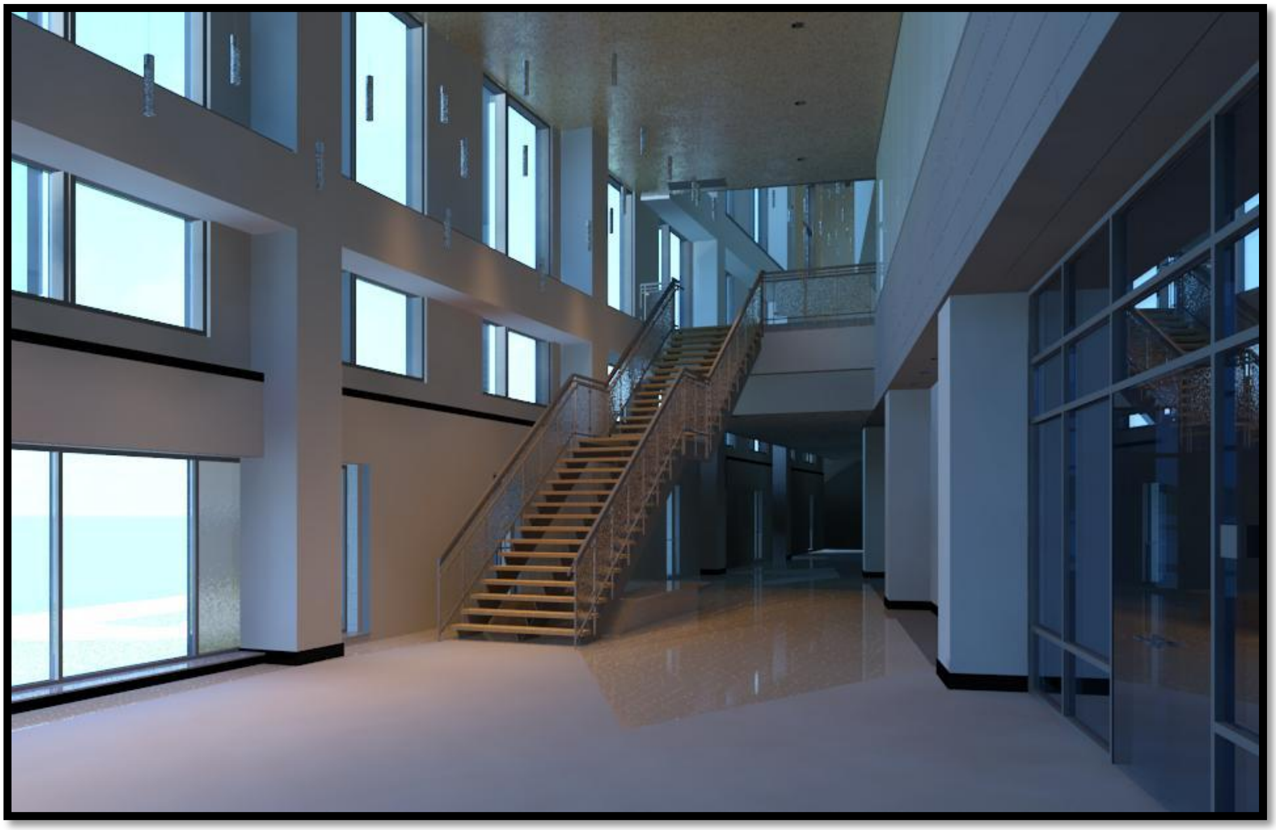


Figure: Rendering of Reception with Artificial and Daylight

Outdoor Space: Northeast Entrance

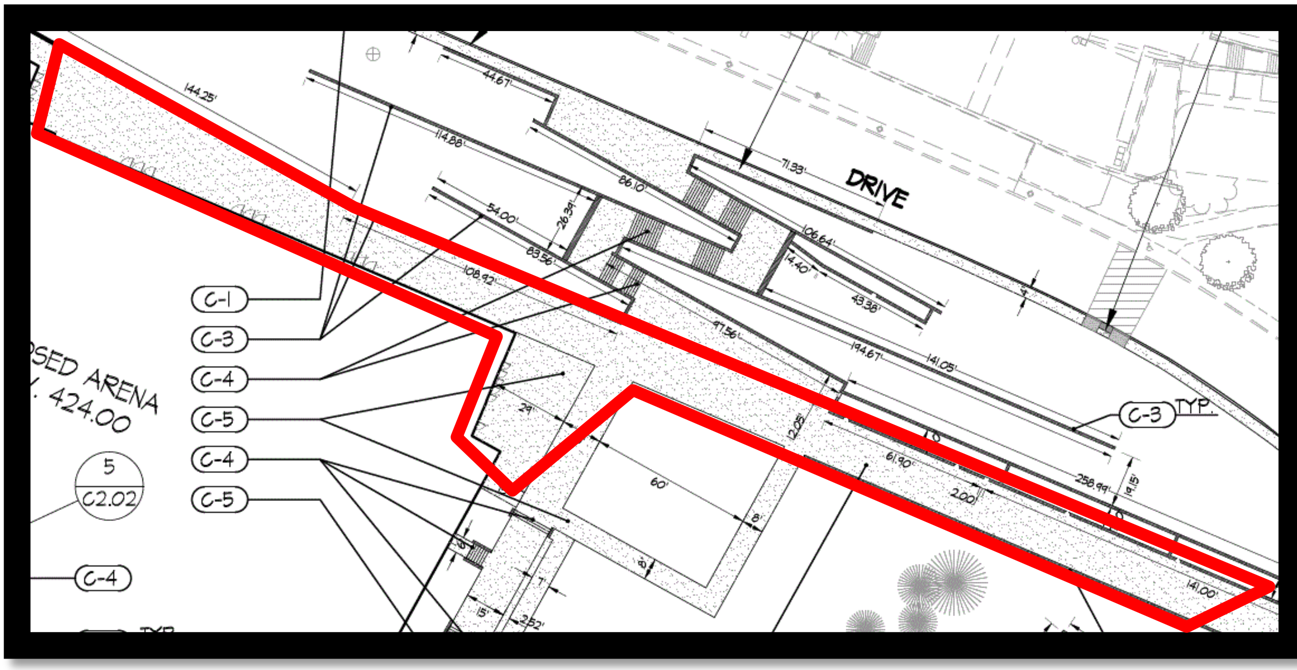


Figure 4.1

The outdoor space will be the northeast entrance to the tiger arena. Most of the attendees will enter and pass through this space. There is a large glass façade and overhang at the corner and all along the northern side of the building. A grassy lawn and system of stairs and ramps is also in this space. People may use this space to meet or just as a transition space into the building. After events many people will need to exit the building at once and enough light needs to allow people to see as they exit the grounds. This space can be viewed on drawing C2.01. The dimensions are approximately 18' x 520' for with walkway, and 40' x 120' for the entrance area. The walkways and plaza are concrete. No exterior seating or benches exist, only walkways. The façade is metal paneling and glazing. This space will be a social space and a way to egress away from the building. The walkways need to be visible and other people need to be visible for the users of the space.

Existing Lighting Systems

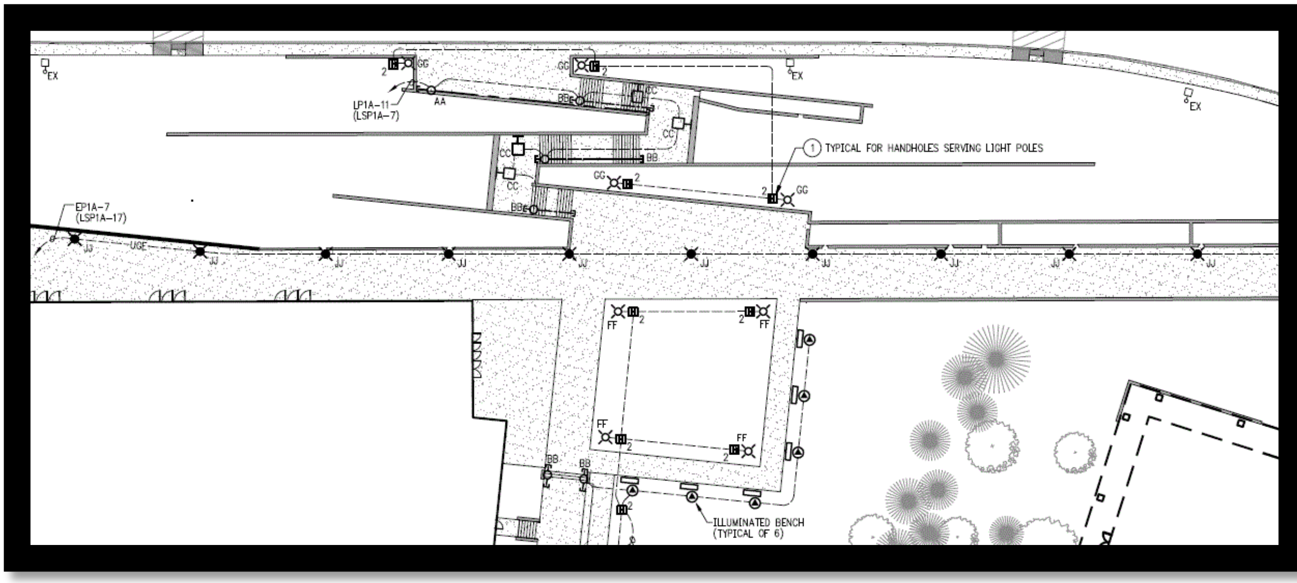


Figure 4.2

The space is illuminated by luminaire types JJ, BB, GG, FF, AA and CC. Fixture JJ is a 13' promenade post light with indirect light source behind tempered glass and specular reflector, type V distribution, included tapered pole with handhole. The lamp is a 150 Watt pulse start metal halide. Fixture BB is an LED handrail with LEDs at 4100 Kelvin. Fixture FF is a post top metal halide site fixture with a vertical lamp and type V distribution on a 12' pole. Fixture AA is a linear LED wall grazer with a wet location listing, and the LEDs are 4000K. Fixture GG is a post top metal halide site fixture, vertical lamp, Type V distribution on an 18' pole. The lamp is a 150 Watt metal halide at 277V.

Space Lighting Design Theme

During the day the exterior of the building will be well illuminated so as to foster social interaction and communication. At night, the space will be much different. While exterior lighting is required for egress purposes, this does not always accommodate communication. Vertical illuminance is essential for people to feel safe. Seeing someone's face registers a feeling of safety, and if that face is familiar then it is easier to communicate as well. Power density for the exterior of the building will be monitored stringently, but pole mounted lights can help spread light and illuminate users. The exterior space should be a place for people to discuss the preceding events and enjoy the plaza and building. Light levels that allow communication will encourage people to use the space.

Space Lighting Design Criteria

The main point of interest at the northeast entrance is the glass façade that encases the building underneath an L-shaped overhang. The users will need to see this part of the building and be able to decide that this is the entrance into the arena. The exterior walkway, plaza and stairs are transition spaces to and from the arena. The busiest time of use will be immediately following a sporting event in the arena. This is when all of the spectators will be leaving. Before the event there will be a steady stream of pedestrians, but a swell will occur at the end.

Other points of particular interest include the plaza area. The plaza will need a certain level of light for egress, and it is a gathering point outside the arena. The plaza will give the viewer an encompassing view of the northeast entrance.

Other considerations include foliage in the vicinity of the luminaires. If not properly cared for, light may be shielded from walkway surfaces. BUG rating is also important when trying to control light spill from luminaires.

The following are design guidelines from the IESNA handbook:

Table 22.2 Common Applications Illuminance Recommendations

Building Entries: Canopied Entries – High Activity					Max:Avg	Avg:Min
LZ3	Eh @grade	Ev @5' AFG	Eh: 30 lux	Ev: 15 lux	4:1	Eh 2:1 Ev 4:1

The walkway underneath the overhang will have periods when pedestrian traffic will swell, and the users will be adapted to LZ3, moderately high ambient light levels, from the arena. The primary considerations for building entries, from IES, include the following:

Degree to which entries are covered from the elements
Proximity of vehicular traffic to pedestrian traffic
Anticipated nighttime activity levels
Nighttime outdoor lighting zone for the project under consideration
Security

Suggested guidelines for exterior lighting include:

Establish and confirm the need for light

Carefully define areas of application and the application itself
Establish the lowest illuminance criteria appropriate to the need
Independently address unique areas of interest
Design lighting layouts to address only those areas of interest
Select equipment with distribution and optical control to address criteria
Use controls to energize, dim and extinguish lighting to address activity levels

Table 34.2 Retail Illuminance Recommendations

Centers, Outdoor: Plazas – High Activity					**Max:Avg**	**Avg:Min**
LZ3	Eh @pavement	Ev @5’ AFG 2-dir	Eh: 6 lux	Ev: 2 lux	4:1	5:1

The vertical illuminance is measured in two directions and should be coordinated with security cameras.

Power Allowances

From ASHRAE 90.1, Table 9.4.3A Exterior Lighting Zones, the lighting zone for the northeast entrance will be categorized as Lighting Zone 3. The base site allowance for Zone 3 is 750 W. Tradable surfaces include building grounds, building entrances and exits, and canopies and overhangs.

Table 9.4.3B Individual Lighting Power Allowances for Building Exteriors	
Building Grounds	
Walkways 10 ft wide or greater/Plaza areas	0.16 W/ft^{21}
Building entrances and exits	
Main entries	30 W/linear foot of door width
Other doors	20 W/linear foot of door width
Entry canopies	0.4 W/ft^2

Nontradable Surfaces include building facades and are in addition to the tradable surfaces already addressed in the previous table. The allowance for building facades is 0.15 W/ft^2 for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length, for Zone 3.

By Table 9.5.1, using the building area method to calculate lighting power densities allows 0.78 W/ft^2 for a sports arena.

Existing Lighting System Critique

It is difficult to understand the horizontal and vertical illumiance values for an exterior space without a computer model. Within the confines of walls, it is easy to estimate the horizontal illuminance, but with a wide open area it is hard to determine where the light will reach.

A "Z" shaped step system is illuminated by LED handrails, recessed CFLs and 18' metal halide pole lights. The illuminated handrails pull the users through the space by giving their eyes a path to follow as they traverse the space. From the parking roadway an LED wall grazer invites the user to the main site stair.

The main walkway has a colonnade of 13' pole metal halide lights. They line the walkway and lead right to the entrance of the arena. They lights pull the users through the space. There are also 12' metal halide pole lights that illuminate a green plaza area. This aids as a transition area from the exterior of the building into the main entrance of the arena. The brightly illuminated façade will also draw the users through the space once they get a glimpse of the arena.

Space reflectances are assumed to be standard 0.8, 0.5, and 0.2 for ceiling, walls, and floor respectively. Light loss factor of 0.7 is calculated with a 0.9 Ballast Factor, a 0.9 LLD and 0.9 LDD.

New Lighting System:

The new lighting system design for the exterior uses LED pole luminaires and LED downlights to illuminate the northeast walkway and entry plaza. Energy code and lighting design criteria were achieved for the spaces under consideration.

Philips Lumec Leonis pole mounted LED fixture was used along the walkway and up to the entry. Philips Omega recessed LED downlight was used for the canopied entry. The Leonis fixture is 47 Watts with 3829 lumen output, 70 CRI, 4000K, minimum 100 lumens per Watt, 70,000 hours for which 50% still have over 70% original lumen output, a 16' pole with 26" arm, and a Type II light distribution. The Omega downlight uses 53 Watts with a lumen output of 3254 lumens, 8" recessed LED cylinder, CCT 4000K, 80 CRI 50,000 hour lifetime at 70% lumen maintenance.

The Leonis LED pole fixtures were spaced at 33' between fixtures along the length of the 520' pathway. The recessed Led downlights are spaced at 5', but vary over the main entry. The lighting design criteria was met for all spaces, and energy code was complied with. The walkway lighting will be on an automatic timeclock set by the owner while the arena façade lighting will be switched just inside the arena entrances. The following figures show the luminaire layout, and the tables give the calculated values versus the design guidelines.

Table 22.2 Common Applications Illuminance Recommendations

Building Entries: Canopied Entries – High Activity					Max:Avg	Avg:Min
LZ3	Eh @grade	Ev @5' AFG	Eh: 30 lux	Ev: 15 lux	4:1	Eh 2:1 Ev 4:1
Calculated			Eh: 8.2 fc	Ev:9.23 fc	Eh: 1.52	Eh:2.00 Ev: 2.71

Table 34.2 Retail Illuminance Recommendations

Centers, Outdoor: Plazas – High Activity					Max:Avg	Avg:Min
LZ3	Eh @pavement	Ev @5' AFG 2-dir	Eh: 6 lux	Ev: 2 lux	4:1	5:1
			Eh: 3.26 fc	Ev: 2.5 fc	Eh: 3.22	Eh: 1.72

Table 9.4.3B Individual Lighting Power Allowances for Building Exteriors	
Building Grounds	
Walkways 10 ft wide or greater/Plaza areas	0.16 W/ft^2
Calculated	0.086 W/ft^2
Building entrances and exits	
Main entries	30 W/linear foot of door width
Calculated	20 W/linear foot
Other doors	20 W/linear foot of door width
Calculated	3.53 W/linear foot
Entry canopies	0.4 W/ft^2
Calculated	0.385 W/ft^2

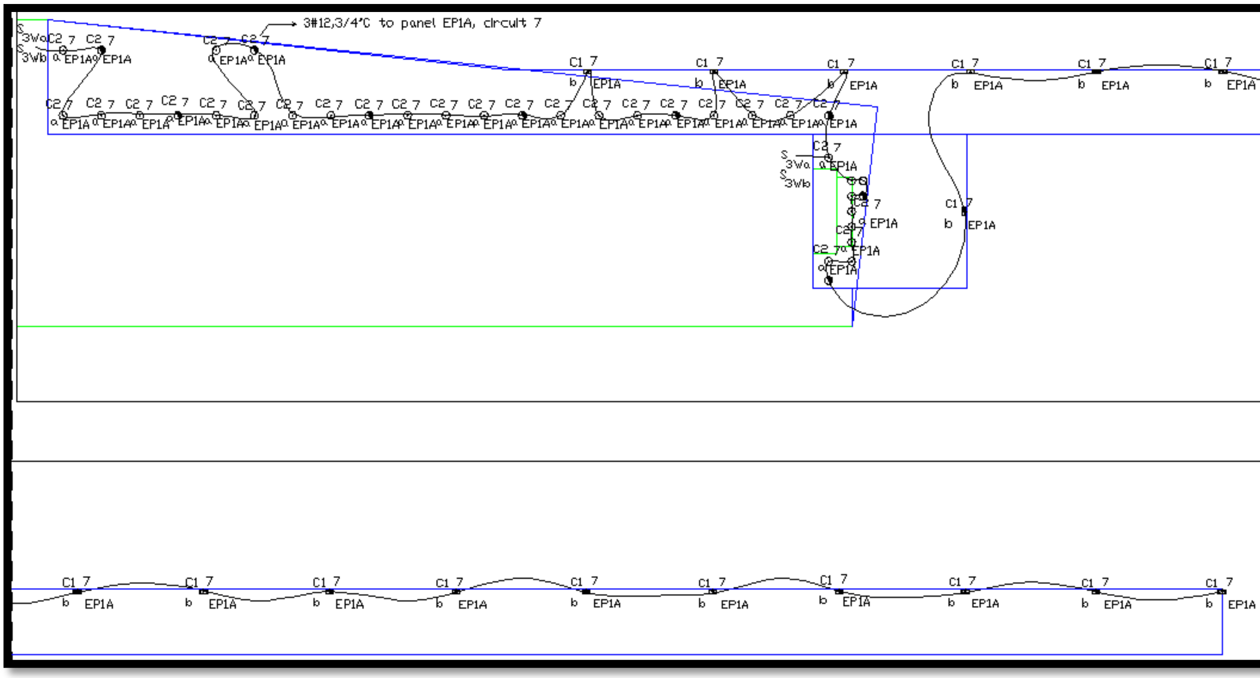


Figure: Fixture Layout for main entrance: Fixture A is Leonis and Fixture B is the recessed LED downlight.

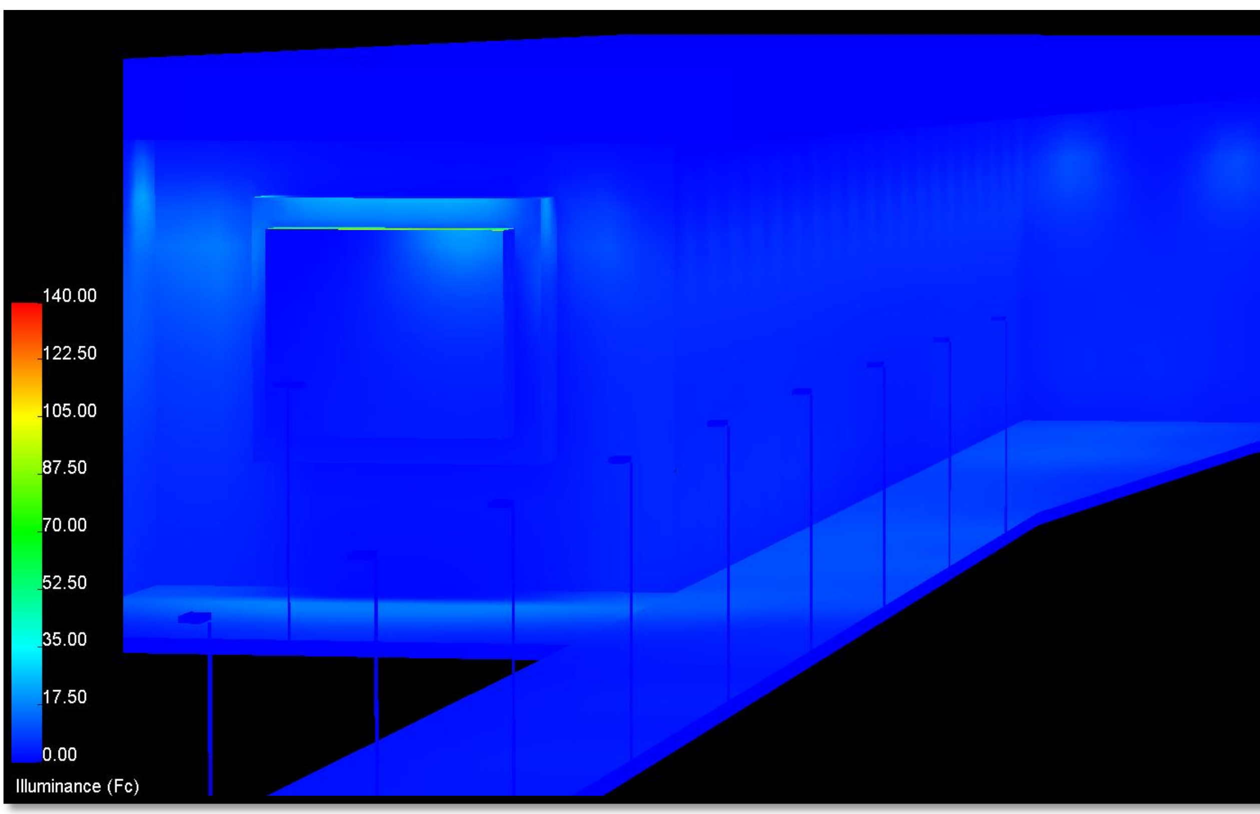


Figure: Pseudo color or Northeast Entrance

Figure: Exterior Rendering at Night

Large Work Space: Press Room

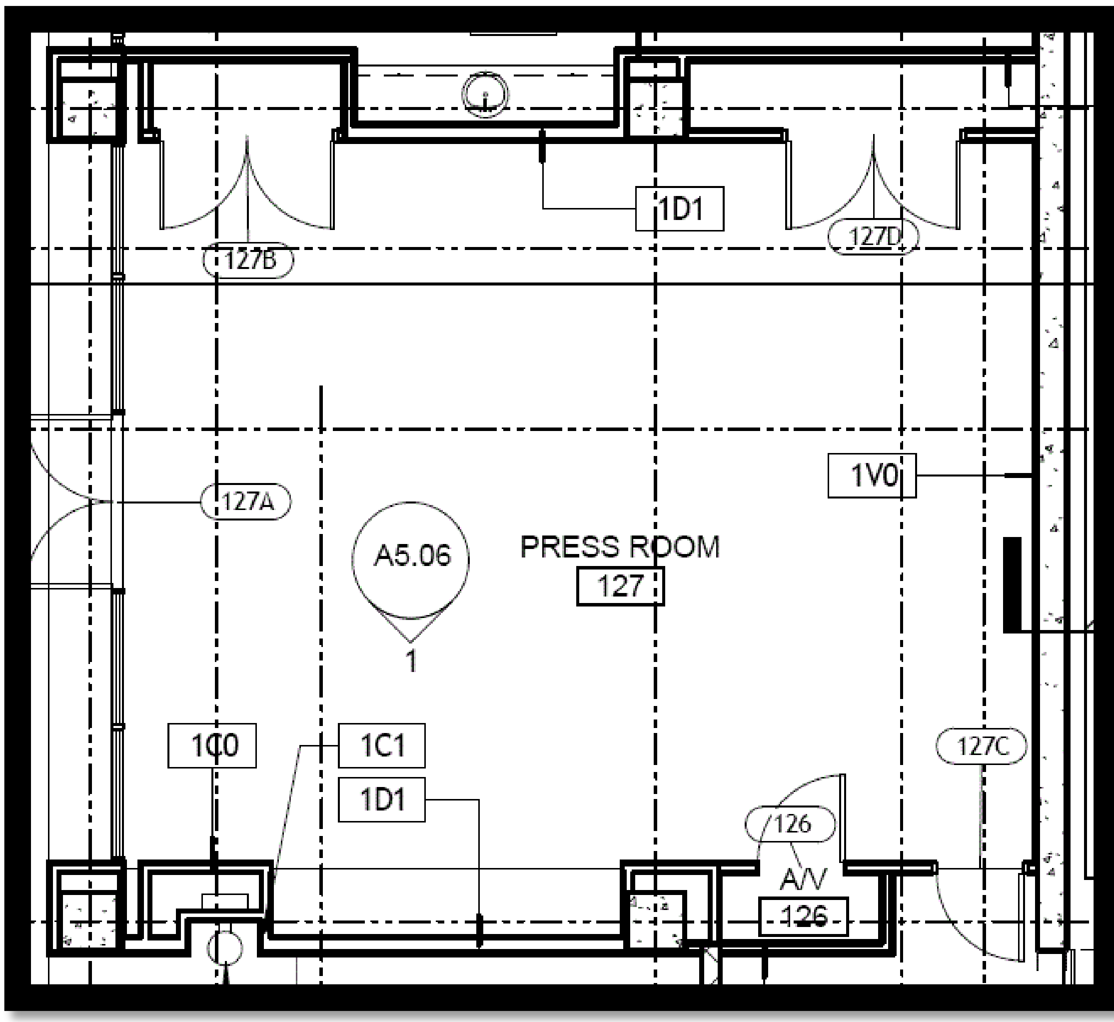


Figure 1.1

The large workspace will be the press room. Please see Figure 1.1 above. This will be designed to feel public. The press room is located on the first floor, adjacent to the court. It will be used to hold conferences after a game so that the media can receive feedback on the previous event from the players and coaching staff. It is room 127 on A1.03. The dimensions are 25' x 32' so the room is in a rectangular shape. The ceiling is a 10 feet high acoustical tile system, the walls are gypsum wall board painted satin silver and the floor will be painted a sunshine color. A podium or table will be placed at one end of the room. Chairs will be placed in rows for reporters to see. Artwork will be placed on the walls of the space. The space will be used for the press to take notes via electronic devices or paper. There needs to be enough light to record what is said, and there must be enough light on the speaker for television to broadcast the event. There is no daylight contribution in the press room.

Existing Lighting Systems

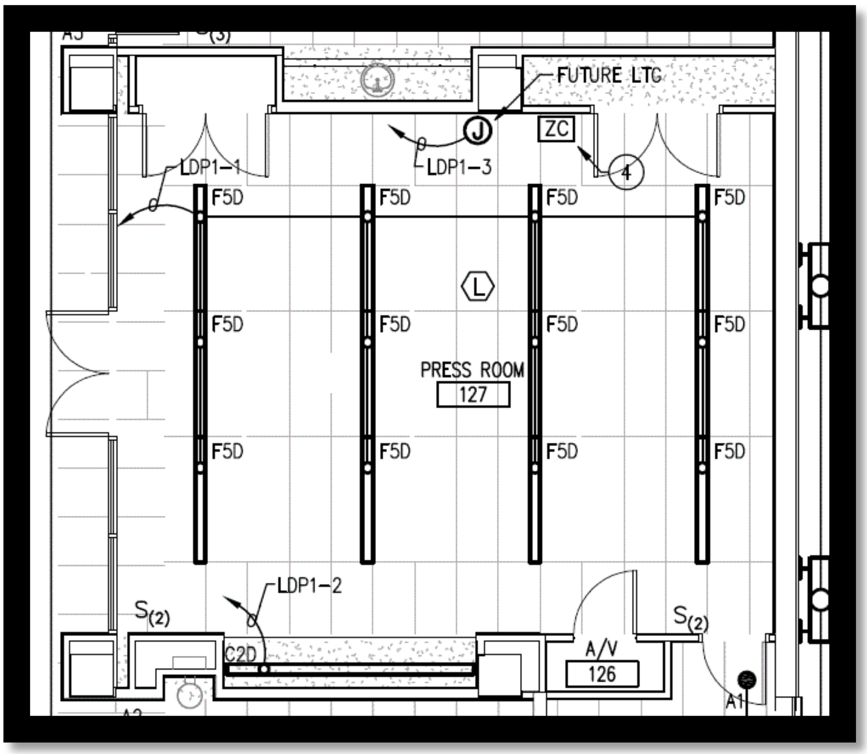


Figure 1.2

The space is illuminated by luminaire types F5D and C2D. Please see Figure 1.2 above. Fixture F5D is a 6 foot linear, surface mounted fluorescent with a 1% dimming ballast. There are two 21 Watt T5 lamps of 80 CRI and 4100 Kelvin. Fixture C2D is a linear LED cove accent lighting with adjustable mounting bracket and a dimmable driver. The LEDs are 2700 Kelvin.

Space Lighting Design Theme

The theme of the lighting design is to have spaces conducive to social interaction and communication. In the press room one or a few people will be speaking to a room full of reporters and television crews. The goal of the space is to make the speakers feel comfortable answering questions. A public ambiance will help the speakers easily communicate to the reporters.

Psychological Impression Space

Going along with the theme of encouraging social interaction and communication, the press room will have a public feel. By making a space, where millions of viewers may be watching at one time, feel private, the speaker will be more willing to share their thoughts and reflections.

Press rooms need high levels of light on the speaker for the television cameras. This will make the speaker feel like they are the center of attention. Fortunately this has become institutionalized and it is expected and understood. Ample light will be needed for reporters to record notes on laptops, ipads or notepads. Veiling reflections are a big design concern. Also, high vertical illuminance values will be needed on the speaker.

Space Lighting Design Criteria

Default illuminance ratio recommendations are as follows:
The space may be classified as a conference space. The guidelines are as follows:

Meeting: Discourse			**Avg: Min**
Eh @ 2’-6”	Eh = 300 lux	Task Area	2:1
Ev @ 4’ AFF	Ev = 75 lux	Task Area	

Presenter: Fixed Position		**Avg:Min**
Face: Ev @ 5’ AFF	Avg ≥ 1 times but ≤ 3 times audience task Eh	3:1
Task Surface: Eh @ 3’-6” AFF	Avg ≥ 1 times but ≤ 3 times audience task Eh	2:1

Handwritten Work: white or canary paper			
Pencil, Graphite:	Eh @ 2’-6” AFF	Ev @ 4’ AFF	Medium veiling reflection
	Eh: 300 lux	Ev: 75 lux	
Ballpoint Pen:	Eh @ 2’-6” AFF	Ev @ 4’ AFF	Small veiling reflection
	Eh: 300 lux	Ev: 75 lux	

Reading & Writing: VDT Screen & Keyboard		
CSA/ISO Types I & II	Matte or Semi-specular Finish	Positive polarity
Eh @ 2’-6” AFF	Ev @ 3’-6” AFF	Small veiling reflection
Eh: 300 lux	Ev: 150 lux	
CSA/ISO Type III	Specular Finish	Positive polarity
Eh @ 2’-6” AFF	Ev @ 3’-6” AFF	Medium veiling reflection
Eh: 150 lux	Ev: 50 lux	

The main points of interest in the Press Room are the speaking area and the reporter area. The reporter area will consist of chairs with possible retractable desks, and the speaking area will consist of a podium or desk with adjacent seats.

Power Allowances

By Table 9.5.1, using the building area method to calculate lighting power densities allows 0.78 W/ft^2 for a sports arena.

By Table 9.6.1, using the space-by-space method allows 1.23 W/ft^2 for Conference/Meeting/Multipurpose.

Existing Lighting System Critique

The space is 25' x 32' so it is 800 ft^2(73.5 m^2). The two fixtures are a linear fluorescent source and an LED source. Type F5D uses two 21 Watt T5 lamps, and the LEDs are a strip of LEDs. The T5 linear fluorescent has initial lumens of 2100. Light loss factor of 0.7 is calculated with a 0.9 Ballast Factor, a 0.9 LLD and 0.9 LDD. Space reflectances are assumed to be standard 0.8, 0.5, and 0.2 for ceiling, walls, and floor respectively.

The calculated values are as follows:

Illuminance (lux)	Avg	Max	Min	Avg/Min	CV
Horz	297.0	493.3	71.9	4.1	4.4
Vert 4	128.3	229.8	39.2	3.3	4.6
Vert 5	133.0	252.6	37.0	3.6	5.0

The design values are as follows:

Illuminance (lux)	Avg	Max	Min	Avg/Min	CV
Horz	300			1.5:1	
Vert 4	75			1.5:1	
Vert 5	300 ≤ Avg ≤ 900			3:1	

The calculated average from the model is slightly less than what is recommended for horizontal illuminance. This could be a result of not adding in the LED accent light along the southern wall. With the addition of the LED accent light, more of the room would have higher lux values, but the avg/min ratio will be altered as well. Adding more light will increase the max and average, but the calculated ratio of 4.1 is already the recommended value of 1.5:1. The average vertical illuminance calculated in the model is acceptable for 4’ AFF, but the 5’ vertical illuminance for presenters is well under. Again, having a photometric file for the LED accent luminaire would help with analyzing a more accurate calculation. Each ratio of Avg/Min exceeds the recommended values. This means there are areas of excessive darkness that keeps the room from being uniformly illuminated. Please see Figure 1.3 below for identification of hotspot areas.

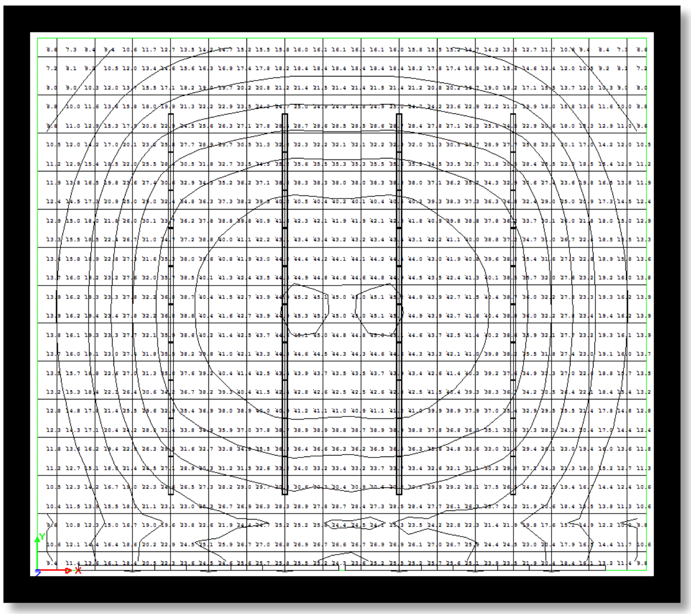


Figure 1.3

The space will need adequate accent on the speakers during conferences. Video conferencing may require up to 400 lux on vertical surfaces. Without having specification data on the LED fixture it is difficult to scrutinize the system. The space will be used by speakers and reporters/camera crews. The average illuminance is adequate, but more accent lighting may be needed on the speakers, especially for television. Also, the space is a simple rectangle, so a uniform layout is an easy solution to the space.

New Lighting System

The new lighting system will be designed for 30 fc on the work plane at 2’-6” and the vertical illuminance guideline is 7.5 fc for the general press room area. There will be a position that the speaker presents and that will have a vertical illuminance equal to but not exceeding 3 times the task area horizontal illuminance, 30 fc. There are also guidelines for handwritten design criteria and vdt use for reporters to take notes.

I used two Omega Philips LED fixtures for this design. Both fixtures put out about 3000 lumens, but one fixture is a downlight while the other is a wallwasher. I chose 3500K, 80 CRI LEDs to give a warmer feel to the space. There are four wallwashers at the front of the room with two extras that provide extra light on the presenter. The design criteria called for the vertical illuminance on the presenter to be at least that of the audience task horizontal illuminance. However I could not get this to work out because the more wall washers I added, the higher the audience horizontal illuminance became. In the end I designed for the Ev of the presenter to be above 30fc which is the design value for the audience Eh. The space is controlled with a single lighting zone. The space will only be used for presentations to the press, so there is no need for multiple zone switching.

Please see the following tables for my calculated values and images for renderings and luminaire layout.

Meeting: Discourse			**Avg: Min**
Eh @ 2'-6"	Eh = 300 lux	Task Area	2:1
Ev @ 4' AFF	Ev = 75 lux	Task Area	
Calculated	Eh: 50.46	Ev: 22.94	1.63

Presenter: Fixed Position		**Avg:Min**
Face: Ev @ 5' AFF	Avg ≥ 1 times but ≤ 3 times audience task Eh	3:1
Task Surface: Eh @ 3'-6" AFF	Avg ≥ 1 times but ≤ 3 times audience task Eh	2:1
Calculated	Eh: 69.75	

Handwritten Work: white or canary paper			
Pencil, Graphite:	Eh @ 2'-6" AFF	Ev @ 4' AFF	Medium veiling reflection
	Eh: 300 lux	Ev: 75 lux	
Ballpoint Pen:	Eh @ 2'-6" AFF	Ev @ 4' AFF	Small veiling reflection
	Eh: 300 lux	Ev: 75 lux	

Reading & Writing: VDT Screen & Keyboard		
CSA/ISO Types I & II	Matte or Semi-specular Finish	Positive polarity
Eh @ 2'-6" AFF	Ev @ 3'-6" AFF	Small veiling reflection
Eh: 300 lux	Ev: 150 lux	
CSA/ISO Type III	Specular Finish	Positive polarity
Eh @ 2'-6" AFF	Ev @ 3'-6" AFF	Medium veiling reflection
Eh: 150 lux	Ev: 50 lux	

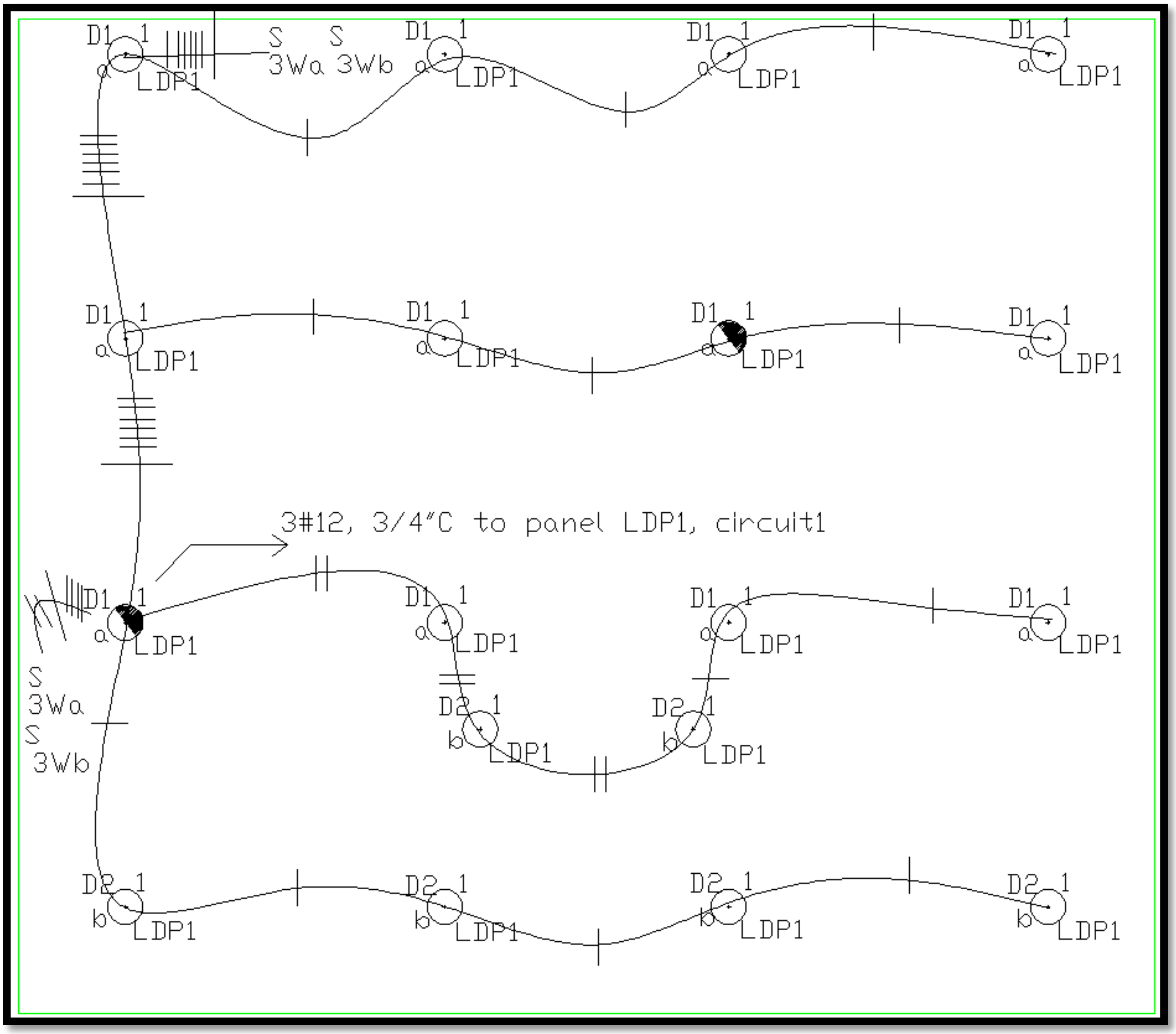


Figure: Luminaire Layout showing wallwashers as B and downlights as A with switching locations

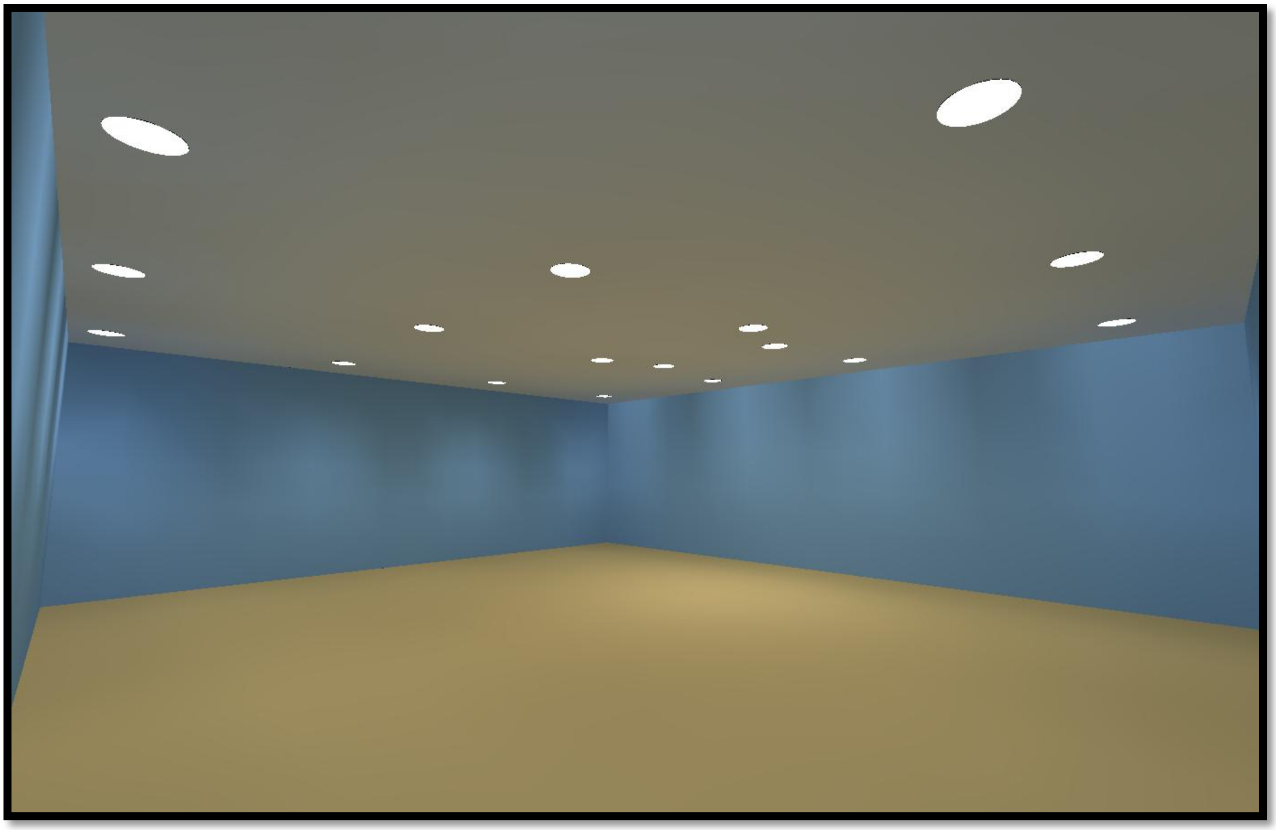


Figure: Press Room Rendering

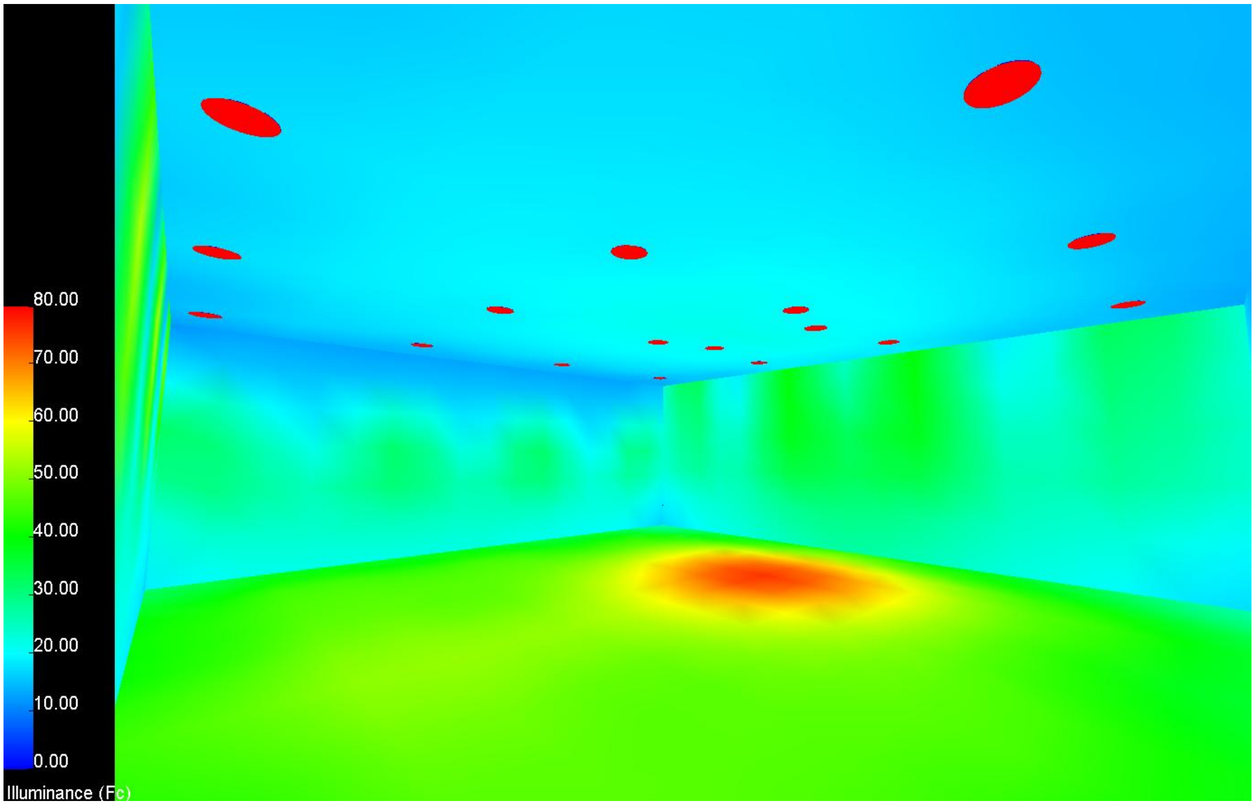


Figure: Press Room Pseudo Color showing the distribution of light

Electrical Design:

The new lighting designs for my four spaces need to have their electrical panels redesigned. Lighting circuits will need to be added to the existing panelboards. I will also do a short circuit study for one line of the Towson Arena distribution system. Then I will go into detail on an emergency generator system cost analysis and the abilities of SKM software to simulate a system.

Branch Circuit Redesign:

Introduction:

After redesigning all of the lighting spaces the panelboards that feed the lighting circuits will need to be updated. The existing circuits that the lights were on initially can be left with the lights that were not altered in the panelboard. Otherwise, the panelboards will have spare breakers for the empty circuits. My new lights might be able to fit on those existing circuits or on the spare breakers.

The court is a large space, 187'x137'x74' and will be used for sporting events, concerts, and ceremonies. The Reception is a lobby on the ground floor that greets the spectators as they come into the arena. It is two stories with an open stairwell. The northeast entrance brings the occupants into the space and allows for them to exit the space safely. There is a long pathway that leads to the parking lot as well as a canopied entrance that wraps around the building. The Press Room is a small room only 25' x 32'. It is where conferences for coaches and players will take place before or after sporting events. There is space for reporters as well as speakers.

The court has been redesigned with 20 1000W Metal Halide fixtures that have a shutter system available for blackouts during sporting events. The Reception has been redesigned with 39W LED suspended downlights and recessed 53W LED downlights that are both on a daylight dimming system. The exterior pathway has been redesigned with 40W LED pole mounted exterior fixtures and recessed 53W LED downlights over the entry. The press Room has been redesigned with recessed with 53W LED downlights and 53W LED wallwashers.

For the electrical redesign I will plan to use the minimum wire size required by the NEC to keep costs on the project low. The existing panelboards will be utilized for the new circuits. The emergency lighting will fixtures will be shown as normal/emergency fixtures. The conduit will be THWN EMT conduit. The wiring diagrams and layouts will follow.

Existing Panelboard Modifications:

Panelboards						
Panel Tag	Voltage	System	Court	Reception	Exterior	Press Room
LSP4	480/277,3P,4W	N	X			
LSP4A	120/277 (DUAL VOLTAGE)	N	X			
LDP4			X			
EP4			X			
EP2	480/277,3P,4W	N		X		
LP2				X		
EP1A	480/277,3P,4W	N			X	
LP1A					X	
LDP2					X	
ELDP2					X	
LDP1	277,3P,4W	N				X

Controls:

The reception will be controlled by two switches as shown for two zones as shown by line voltage switching. There will also be a low voltage dimming control for the two zones as shown. The dimming capabilities will require low voltage wiring. There will be Emergency/Normal fixtures. Please see the attached fixture layout sheet in the appendix.

The court will have line voltage switching in two locations near the northwest entrance to the court and the southeast entrance toward the Towson Center. There will be Emergency/Normal fixtures, and two zones will allow for different uses of the space. The light fixtures will have a 480/277V and a 208/120V feed because the shutter motor taps off of the ballast at 120V. So the 277V feed will come from LSP4 and the 120V feed will come from LSP4A. These two dimmer panels have a 20A relay capacity. I did not show the circuits going to the switches for simplicity of the drawing and ease of reading. Please see the attached fixture layout in the appendix.

The exterior is powered by one panel, EP1A. The fixture layout is long so it is broken into two views with no overlapping luminaires. There are to line to voltage switches for two zones. One zone illuminates the canopied entrance while the other zone is the extending pathway. Please see the attached fixture layout sheet in the appendix.

The Press Room will have two lighting zones with line voltage three way switching. One zone illuminates the speaker with wallwashers. The other zone illuminates the rest of the room for reporters during press conferences. The fixtures are fed from lighting dimming panel LDP1. Please see the attached fixture layout sheet in the appendix.

Existing Panelboard Schedules:

SCHEDULE OF LIGHTING SWITCHING PANEL LSP4

277 / 480 VOLTS | 3 PHASE 4 WIRE | 100A MCB | SURFACE MOUNTED

RELAY NUMBER	CIRCUIT NUMBER	LOCATION	NORMAL/ EMERG.	RELAY & CIRCUIT BREAKER CAPACITY (AMPS)	CIRCUIT LOAD (WATTS)	WIRE / CONDUIT	NOTES
1	1	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
2	3	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
3	5	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
4	7	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
5	9	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
6	11	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
7	13	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
8	15	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
9	17	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
10	19	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
11	21	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
12	23	SPORTS FLOODLIGHTING	N	20	3300	#12-3/4"C	–
13	25	SPARE	N	20	–	—	–
14	27	SPARE	N	20	–	—	–
15	2	CATWALK	N	20	1584	#12-3/4"C	–
16	4	NORTH MECHANICAL AREA	N	20	484	#12-3/4"C	–
17	6	NORTH VIDEO AREA	N	20	284	#12-3/4"C	–
18	8	UPPER DECK SEATING	N	20	2430	#12-3/4"C	–
19	10	UPPER DECK SEATING	N	20	720	#12-3/4"C	–
20	12	LED INDIRECT FLOODS	N	20	1750	#12-3/4"C	–
21	14	LED INDIRECT FLOODS	N	20	1750	#12-3/4"C	–
22	16	3RD FLOOR LOBBY	N	20	878	#12-3/4"C	–
23	18	CLEANING LIGHTS BELOW UPPER DECK SEATING	N	20	1024	#12-3/4"C	–
24	20	SPARE	N	20	–	—	–
25	22	SPARE	N	20	–	—	–
26	24	SPARE	N	20	–	—	–
27	26	SPARE	N	20	–	—	–
28	28	SPARE	N	20	–	—	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.
B. TIMECLOCK SCHEDULING SHALL BE COORDINATED WITH FACILITIES AND PROGRAMMED ACCORDINGLY.

CONNECTED LOAD = 50.50 KVA
DEMAND LOAD = 50.50 KVA
MIN AIC RATING = 10,000 AMPS SYM
LOCATION

SCHEDULE OF LIGHTING SWITCHING PANEL LSP4A							
120 / 277 VOLTS (DUAL VOLTAGE)			FEED-THRU		SURFACE MOUNTED		
RELAY NUMBER	CIRCUIT NUMBER	LOCATION	NORMAL/ EMERG.	RELAY CAPACITY (AMPS)	CIRCUIT LOAD (WATTS)	WIRE / CONDUIT	NOTES
1	LP4-1	SPORTS FLOODLIGHTING SHUTTER CONTROL	N	20	150	#12-3/4"C	–
2	LP4-1	SPORTS FLOODLIGHTING SHUTTER CONTROL	N	20	150	#12-3/4"C	–
3	LP4-1	SPORTS FLOODLIGHTING SHUTTER CONTROL	N	20	150	#12-3/4"C	–
4	LP4-1	SPORTS FLOODLIGHTING SHUTTER CONTROL	N	20	150	#12-3/4"C	–
5	LP4-1	SPORTS FLOODLIGHTING SHUTTER CONTROL	N	20	150	#12-3/4"C	–
6	LP4-1	SPORTS FLOODLIGHTING SHUTTER CONTROL	N	20	150	#12-3/4"C	–
7	LP4-3	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	2232	#12-3/4"C	–
8	LP4-5	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	2232	#12-3/4"C	–
9	LP4-7	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	1488	#12-3/4"C	–
10	LP4-7	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	1488	#12-3/4"C	–
11	LP4-9	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	744	#12-3/4"C	–
12	LP4-9	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	744	#12-3/4"C	–
13	LP4-11	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1116	#12-3/4"C	–
14	LP4-11	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1116	#12-3/4"C	–
15	LP4-13	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1116	#12-3/4"C	–
16	LP4-13	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1116	#12-3/4"C	–
17	LP4-15	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1674	#12-3/4"C	–
18	LP4-15	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1674	#12-3/4"C	–
19	LP4-17	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	2232	#12-3/4"C	–
20	LP4–19	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	2232	#12-3/4"C	–
21	LP4-21	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	1488	#12-3/4"C	–
22	LP4-21	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	1488	#12-3/4"C	–
23	LP4-23	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	744	#12-3/4"C	–
24	LP4-23	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	744	#12-3/4"C	–
25	LP4-25	MECHANICAL ROOM 325	N	20	832	#12-3/4"C	–
26	LP4-25	LED BARS @ EAST WINDOWS	N	20	500	#12-3/4"C	–
27	–	SPARE	N	20	–	–	–
28	–	SPARE	N	20	–	–	–
29	–	SPARE	N	20	–	–	–
30	–	SPARE	N	20	–	–	–
31	–	SPARE	N	20	–	–	–
32	–	SPARE	N	20	–	–	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 27.90 KVA
DEMAND LOAD = 27.90 KVA
MIN AIC RATING = 10,000 AMPS SYM
LOCATION ELEC 132

SCHEDULE OF EMERGENCY LIGHTING SWITCHING PANEL ELSP4							
120 / 277 VOLTS (DUAL VOLTAGE)			FEED-THRU		SURFACE MOUNTED		
RELAY NUMBER	CIRCUIT NUMBER	LOCATION	NORMAL/ EMERG.	RELAY CAPACITY (AMPS)	CIRCUIT LOAD (WATTS)	WIRE / CONDUIT	NOTES
1	EP4-1	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	2232	#12-3/4"C	–
2	EP4-3	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	1488	#12-3/4"C	–
3	EP4-3	HI-BAY LIGHTING (4100K LAMPS) LEFT COURT	N	20	744	#12-3/4"C	–
4	EP4-5	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1116	#12-3/4"C	–
5	EP4-5	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1116	#12-3/4"C	–
6	EP4-7	HI-BAY LIGHTING (4100K LAMPS) CENTER COURT	N	20	1674	#12-3/4"C	–
7	EP4-9	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	2232	#12-3/4"C	–
8	EP4-11	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	1488	#12-3/4"C	–
9	EP4-11	HI-BAY LIGHTING (4100K LAMPS) RIGHT COURT	N	20	744	#12-3/4"C	–
10	EP4-13	UPPER DECK SEATING	N	20	1440	#10-3/4"C	–
11	EP4-13	UPPER DECK SEATING	N	20	810	#10-3/4"C	–
12	EP4-15	CATWALK	N	20	968	#10-3/4"C	–
13	EP4-15	NORTH VIDEO AREA	N	20	132	#12-3/4"C	–
14	EP4-17	3RD FLOOR LOBBY	N	20	450	#12-3/4"C	–
15	EP4-19	STAIR 7	N	20	384	#12-3/4"C	–
16	EP4-19	STAIR 7	N	20	384	#12-3/4"C	–
17	EP4-21	ROOF LTG	N	20	680	#12-3/4"C	–
18	EP4-17	MECHANICAL ROOM 325	N	20	256	#12-3/4"C	–
19	–	SPARE	N	20	–	–	–
20	–	SPARE	N	20	–	–	–
21	–	SPARE	N	20	–	–	–
22	–	SPARE	N	20	–	–	–
23	–	SPARE	N	20	–	–	–
24	–	SPARE	N	20	–	–	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 18.34 KVA

DEMAND LOAD = 18.34 KVA

MIN AIC RATING = 10,000 AMPS SYM

LOCATION ELEC 132

SCHEDULE OF DIMMER PANEL LDP4								
277 VOLTS		3 PHASE 4 WIRE		100A MLO		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	ARENA	HI-BAY LIGHTING (2700K LAMPS)	1	DIM	CFL	4500	2232	–
2	ARENA	HI-BAY LIGHTING (2700K LAMPS)	2	DIM	CFL	4500	1488	–
3	ARENA	HI-BAY LIGHTING (2700K LAMPS)	3	DIM	CFL	4500	744	–
4	ARENA	HI-BAY LIGHTING (2700K LAMPS)	4	DIM	CFL	4500	1116	–
5	ARENA	HI-BAY LIGHTING (2700K LAMPS)	5	DIM	CFL	4500	1116	–
6	ARENA	HI-BAY LIGHTING (2700K LAMPS)	6	DIM	CFL	4500	1674	–
7	ARENA	HI-BAY LIGHTING (2700K LAMPS)	7	DIM	CFL	4500	2232	–
8	ARENA	HI-BAY LIGHTING (2700K LAMPS)	8	DIM	CFL	4500	1488	–
9	ARENA	HI-BAY LIGHTING (2700K LAMPS)	9	DIM	CFL	4500	744	–
10	ARENA	CENTER COURT LED SPOTS	10	DIM	LED	4500	100	–
11	ARENA	CENTER COURT LED SPOTS	11	DIM	LED	4500	100	–
12	ARENA	CENTER COURT LED SPOTS	12	DIM	LED	4500	100	–
13	ARENA	CENTER COURT LED SPOTS	13	DIM	LED	4500	100	–
14	ARENA	CENTER COURT LED SPOTS	14	DIM	LED	4500	100	–
15	ARENA	CENTER COURT LED SPOTS	15	DIM	LED	4500	100	–
16	ARENA	CENTER COURT LED SPOTS	16	DIM	LED	4500	100	–
17	ARENA	CENTER COURT LED SPOTS	17	DIM	LED	4500	100	–
18	SUITE 311	DOWNLIGHTS - MAIN	18	DIM	CFL	4500	116	–
19	SUITE 311	DOWNLIGHTS - FRONT	19	DIM	CFL	4500	58	–
20	SUITE 311	COVE	20	DIM	LED	4500	182	–
21	SUITE 312	DOWNLIGHTS - MAIN	21	DIM	CFL	4500	290	–
22	SUITE 312	DOWNLIGHTS - FRONT	22	DIM	CFL	4500	145	–
23	SUITE 312	COVE	23	DIM	LED	4500	238	–
24	SUITE 313	DOWNLIGHTS - MAIN	24	DIM	CFL	4500	290	–
25	SUITE 313	DOWNLIGHTS - FRONT	25	DIM	CFL	4500	145	–
26	SUITE 313	COVE	26	DIM	LED	4500	238	–
27	SUITE 314	DOWNLIGHTS - MAIN	27	DIM	CFL	4500	116	–
28	SUITE 314	DOWNLIGHTS - FRONT	28	DIM	CFL	4500	58	–
29	SUITE 314	COVE	29	DIM	LED	4500	182	–
30	SUITE 316	DOWNLIGHTS - REAR	30	DIM	CFL	4500	261	–
31	SUITE 316	DOWNLIGHTS - FRONT	31	DIM	CFL	4500	319	–
32	SUITE 316	DOWNLIGHTS - WINDOW	32	DIM	CFL	4500	116	–
33	SUITE 316	REFRESHMENTS	33	DIM	CFL	4500	58	–
34	SUITE 316	LINEAR SLOTS	34	DIM	FLUORESCENT	4500	320	–
35	SUITE 316	COVE	35	DIM	LED	4500	136	–
36	SUITE 317	DOWNLIGHTS	36	DIM	CFL	4500	116	–
37	VIDEO 308	DOWNLIGHTS	37	DIM	CFL	4500	184	–
38	3RD FLOOR CORRIDOR	WALLWASHERS - WOODEN BOX	38	DIM	FLUORESCENT	4500	1152	–
39	MULTIPURPOSE 301	DOWNLIGHTS	39	DIM	CFL	4500	480	–
40	MULTIPURPOSE 301	DOWNLIGHTS - FRONT	40	DIM	CFL	4500	92	–
41	MULTIPURPOSE 301	WALL GRAZER	41	DIM	FLUORESCENT	4500	42	–
42	MULTIPURPOSE 301	ACCENT LIGHTS	42	DIM	CFL	4500	92	–
43	MULTIPURPOSE 301	DECORATIVE PENDANTS	43	DIM	LED	4500	80	–
44	RECEPTION 202	DOWNLIGHTS	44	DIM	CFL	4500	322	–
45	–	SPARE	45	DIM	–	4500	–	–
46	–	SPARE	46	DIM	–	4500	–	–
47	–	SPARE	47	DIM	–	4500	–	–
48	–	SPARE	48	DIM	–	4500	–	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 19.42 KVA
DEMAND LOAD = 19.42 KVA
MIN A/C RATING = 25,000 AMPS SYM
LOCATION ____________

WIRING SCHEDULE: PANEL EP4																	
480 / 277 VOLTS			3 PHASE 4 WIRE					100 AMP MAINS					SURFACE MOUNTED				
CIR- CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	AØ		BØ		CØ		CIR- CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - COURT LTS (VIA ELSP4)	#12-3/4"C	1	20	2.3	0.5					2	2	LTG - ELEVATOR SHAFT	#12-3/4"C	1	20
3	3	LTG - COURT LTS (VIA ELSP4)	#12-3/4"C	1	20			2.2	1.0			4	4	LTG - 3RD FLOOR EXIT SIGNS	#10-3/4"C	1	20
5	5	LTG - COURT LTS (VIA ELSP4)	#12-3/4"C	1	20					2.2	1.0	6	6	LTG - STAIR 3	#12-3/4"C	1	20
7	7	LTG - COURT LTS (VIA ELSP4)	#12-3/4"C	1	20	1.7	2.2					8	8	LTG - SKYBOX RESTROOMS	#12-3/4"C	1	20
9	9	LTG - COURT LTS (VIA ELSP4)	#12-3/4"C	1	20			2.2	0.5			10	10	SMOKE DAMPERS	#10-3/4"C	1	20
11	11	LTG - COURT LTS (VIA ELSP4)	#12-3/4"C	1	20					2.2			12	SPARE		1	20
13	13	LTG - SEATING LTS (VIA ELSP4)	#12-3/4"C	1	20	2.3							14	SPARE		1	20
15	15	LTG - TRUSS LEVEL LTG (VIA ELSP4)	#12-3/4"C	1	20			1.1					16	SPARE		1	20
17	17	LTG - 3RD FLOOR LTG (VIA ELSP4)	#12-3/4"C	1	20					0.5			18	SPARE		1	20
19	19	LTG - STAIR 7 (VIA ELSP4)	#12-3/4"C	1	20	0.8							20	SPARE		1	20
21	21	LTG - ROOFTOP	#12-3/4"C	1	20			0.7					22	SPARE		1	20
	23	SPARE		1	20								24	SPARE		1	20
	25	SPARE		1	20								26	SPARE		1	20
	27	SPARE		1	20								28	SPARE		1	20
	29	SPARE		1	20								30	SPARE		1	20
-	31	SPACE & PROVISIONS	-	1	-	-	-					-	32	SPACE & PROVISIONS	-	1	-
-	33	SPACE & PROVISIONS	-	1	-			-	-			-	34	SPACE & PROVISIONS	-	1	-
-	35	SPACE & PROVISIONS	-	1	-					-	-	-	36	SPACE & PROVISIONS	-	1	-
-	37	SPACE & PROVISIONS	-	1	-	-	0.5					38	38	DIMMER PANEL ELDP4	4#8+	3	50
-	39	SPACE & PROVISIONS	-	1	-			-	0.5			-	40		#10G-		
-	41	SPACE & PROVISIONS	-	1	-					-	0.5	-	42		3/4"C		
						7.1	3.2	6.2	2.0	4.9	1.5						
		CONNECTED LOAD =	24.9	KVA		10.3		8.2		6.4							
														MAIN BREAKER	100	AMPS	
		DEMAND LOAD =	24.8	KVA		NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT											
		MIN AIC RATING =	18,000	AMPS SYMMETRICAL										LOCATION	ABOVE SKYBOX		

WIRING SCHEDULE: PANEL LP4																	
480 / 277 VOLTS			3 PHASE 4 WIRE					400 AMP MAINS					SURFACE MOUNTED				
CIR- CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	KVA / Ø AØ		BØ		CØ		CIR- CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - SPORT LIGHT SHUTTERS (VIA LSP4A)	#12-3/4"C	1	20	0.9	0.2					2	2	LTG - 3RD FLOOR STORAGE RMS	#12-3/4"C	1	20
3	3	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20			2.2	0.4			4	4	LTG - 3RD FLOOR STORAGE & JAN	#12-3/4"C	1	20
5	5	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20					2.2			6	SPARE		1	20
7	7	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20	2.9							8	SPARE		1	20
9	9	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20			1.5					10	SPARE		1	20
11	11	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20					2.2			12	SPARE		1	20
13	13	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20	2.2							14	SPARE		1	20
15	15	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20			3.3					16	SPARE		1	20
17	17	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20					2.2			18	SPARE		1	20
19	19	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20	2.2							20	SPARE		1	20
21	21	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20			2.9					22	SPARE		1	20
23	23	LTG - COURT LTG (VIA LSP4A)	#12-3/4"C	1	20					1.5			24	SPARE		1	20
25	25	LTG - MECH RM 325 (VIA LSP4A)	#12-3/4"C	1	20	1.2							26	SPARE		1	20
	27	SPARE		1	20								28	SPARE		1	20
	29	SPARE		1	20								30	SPARE		1	20
31	31	PANEL RP4A (VIA XFMR TRP4A)	3#1/0+	3	150**	23.3	16.8					32	32	SWITCHING PANEL LSP4	4#2+	3	100
-	33		#6G-					23.3	16.8			-	34		#8G-		
-	35		2"C							21.7	16.8	-	36		1-1/4"C		
37	37	PANEL RP4 (VIA XFMR TRP4)	3#4/0+	3	225**	40.2	6.5					38	38	DIMMING PANEL LDP4	4#8+	3	50
-	39	(SUB-FEED CIRCUIT BREAKER)	#4G-					37.0	6.5			-	40		#10G-		
-	41		3"C							41.0	6.5	-	42		1"C		
						72.9	23.5	70.2	23.7	70.8	23.3						
		CONNECTED LOAD =	284.4	KVA		96.4		93.9		94.1							
														MAIN BREAKER	400	AMPS	
		DEMAND LOAD =	236.6	KVA		NOTES: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT											
						** PROVIDE SUB-FEED CIRCUIT BREAKER											
		MIN AIC RATING =	4 25,000	AMPS SYMMETRICAL										LOCATION	ABOVE SKYBOX		

WIRING SCHEDULE: PANEL EP2

480 / 277 VOLTS | 3 PHASE 4 WIRE | 100 AMP MAINS | SURFACE MOUNTED

CIR-CUIT	POLE	DESCRIPTION	WIRE/CONDUIT	BREAKER POLE	BREAKER AMP	AØ		BØ		CØ		CIR-CUIT	POLE	DESCRIPTION	WIRE/CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - CONCOURSE LOBBIES (VIA ELSP2)	#10-3/4"C	1	20	1.2	2.2					2	2	LTG - 2ND FLOOR RESTROOMS	#10-3/4"C	1	20
3	3	LTG - CONCOURSE (VIA ELSP2)	#10-3/4"C	1	20			2.5	0.1			4	4	LTG - 2ND FLOOR EXITS	#10-3/4"C	1	20
5	5	LTG - LINK (VIA ELSP2)	#10-3/4"C	1	20					1.2	0.1	6	6	SMOKE DAMPER	#10-3/4"C	1	20
7	7	LTG - UPPER DECK STAIRS (VIA ELSP2)	#10-3/4"C	1	20	1.8							8	SPARE		1	20
9	9	LTG - UPPER DECK STAIRS (VIA ELSP2)	#10-3/4"C	1	20			0.9					10	SPARE		1	20
	11	SPARE		1	20								12	SPARE		1	20
	13	SPARE		1	20								14	SPARE		1	20
	15	SPARE		1	20								16	SPARE		1	20
	17	SPARE		1	20								18	SPARE		1	20
	19	SPARE		1	20								20	SPARE		1	20
	21	SPARE		1	20								22	SPARE		1	20
	23	SPARE		1	20								24	SPARE		1	20
-	25	SPACE & PROVISIONS	-	1	-	-	-					-	26	SPACE & PROVISIONS	-	1	-
-	27	SPACE & PROVISIONS	-	1	-			-	-			-	28	SPACE & PROVISIONS	-	1	-
-	29	SPACE & PROVISIONS	-	1	-					-	-	-	30	SPACE & PROVISIONS	-	1	-
-	31	SPACE & PROVISIONS	-	1	-	-	-					-	32	SPACE & PROVISIONS	-	1	-
-	33	SPACE & PROVISIONS	-	1	-			-	-			-	34	SPACE & PROVISIONS	-	1	-
-	35	SPACE & PROVISIONS	-	1	-					-	-	-	36	SPACE & PROVISIONS	-	1	-
37	37	PANEL EP4	4#3+	3	100	10.3	1.4					38	38	DIMMER PANEL ELDP2	4#8+	3	50
-	39		#8G-					8.2	1.4			-	40		#10G-		
-	41		1 1/4"C							6.4	1.4	-	42		3/4"C		
						13.3	3.6	11.6	1.5	7.6	1.5						
		CONNECTED LOAD =	39.0	KVA		16.9		13.1		9.1							

MAIN BREAKER 100 AMPS

DEMAND LOAD = 38.8 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 25,000 AMPS SYMMETRICAL

LOCATION ELECT RM 246

WIRING SCHEDULE: PANEL LP2

480 / 277 VOLTS | 3 PHASE 4 WIRE | 225 AMP MAINS | SURFACE MOUNTED

CIR-CUIT	POLE	DESCRIPTION	WIRE/CONDUIT	BREAKER POLE	BREAKER AMP	KVA / Ø AØ		BØ		CØ		CIR-CUIT	POLE	DESCRIPTION	WIRE/CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - WEST LOBBY 260 (VIA LSP2)	#12-3/4"C	1	20	0.9	0.7					2	2	LTG - JAN & STORAGE	#12-3/4"C	1	20
3	3	LTG - DECORATIVE PENDANTS (VIA LSP2)	#12-3/4"C	1	20			0.3					4	SPARE		1	20
5	5	LTG - WEST CONCOURSE (VIA LSP2)	#12-3/4"C	1	20					1.1			6	SPARE		1	20
7	7	LTG - RECEPTION 125 (VIA LSP2)	#12-3/4"C	1	20	0.9							8	SPARE		1	20
9	9	LTG - HALL OF FAME 225 (VIA LSP2)	#12-3/4"C	1	20			0.3					10	SPARE		1	20
11	11	LTG - TICKETING 203 (VIA LSP2)	#12-3/4"C	1	20					0.6			12	SPARE		1	20
13	13	LTG - VESTIBULE 124 (VIA LSP2)	#12-3/4"C	1	20	0.1							14	SPARE		1	20
	15	SPARE		1	20								16	SPARE		1	20
	17	SPARE		1	20								18	SPARE		1	20
	19	SPARE		1	20								20	SPARE		1	20
	21	SPARE		1	20								22	SPARE		1	20
	23	SPARE		1	20								24	SPARE		1	20
-	25	SPACE & PROVISIONS	-	1	-	-	-					-	26	SPACE & PROVISIONS	-	1	-
-	27	SPACE & PROVISIONS	-	1	-			-	-			-	28	SPACE & PROVISIONS	-	1	-
-	29	SPACE & PROVISIONS	-	1	-					-	-	-	30	SPACE & PROVISIONS	-	1	-
-	31	SPACE & PROVISIONS	-	1	-	-	-					-	32	SPACE & PROVISIONS	-	1	-
-	33	SPACE & PROVISIONS	-	1	-			-	-			-	34	SPACE & PROVISIONS	-	1	-
-	35	SPACE & PROVISIONS	-	1	-					-	-	-	36	SPACE & PROVISIONS	-	1	-
37	37	PANEL RP2 (VIA XFMR TRP2)	3#1/0+	3	150**	26.1	4.0					38	38	DIMMING PANEL LDP2	4#8+	3	50
-	39	(SUB-FEED CIRCUIT BREAKER)	#6G-					23.9	4.0			-	40		#10G-		
-	41		2"C							22.7	4.0	-	42		3/4"C		
						28.0	4.7	24.5	4.0	24.4	4.0						
		CONNECTED LOAD =	89.6	KVA		32.7		28.5		28.4							

MAIN BREAKER 200 AMPS

DEMAND LOAD = 71.7 KVA

NOTES: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT
** PROVIDE SUB-FEED CIRCUIT BREAKER

MIN AIC RATING = 4 35,000 AMPS SYMMETRICAL

LOCATION ELEC. RM 246

WIRING SCHEDULE: PANEL EP1A

480 / 277 VOLTS | 3 PHASE 4 WIRE | 100 AMP MAINS | SURFACE MOUNTED

CIRCUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	KVA / Ø AØ		BØ		CØ		CIRCUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - MECHANICAL 147 (VIA LSP1A)	#10-3/4"C	1	20	0.9	0.3					2	2	LTG - ELEC RM 146	#10-3/4"C	1	20
3	3	LTG - STORAGE RMS (VIA LSP1A)	#10-3/4"C	1	20			0.8	0.1			4	4	LTG - 1ST FLOOR EXITS	#10-3/4"C	1	20
5	5	LTG - 1ST FLOOR CORRIDORS (VIA LSP1A)	#10-3/4"C	1	20					1.1	2.2	6	6	LTG - 1ST FLOOR RESTROOMS	#10-3/4"C	1	20
7	7	LTG - EXTERIOR LTG (VIA LSP1A)	#10-3/4"C	1	20	2.4	-					8	8	SPARE	-	1	20
9	9	SPARE	-	1	20			-	-			10	10	SPARE	-	1	20
11	11	SPARE	-	1	20					-	-	12	12	SPARE	-	1	20
13	13	SPARE	-	1	20	-	-					14	14	SPARE	-	1	20
15	15	SPARE	-	1	20			-	-			16	16	SPARE	-	1	20
17	17	SPARE	-	1	20					-	-	18	18	SPARE	-	1	20
19	19	SPARE	-	1	20	-	-					20	20	SPARE	-	1	20
21	21	SPARE	-	1	20			-	-			22	22	SPARE	-	1	20
23	23	SPARE	-	1	20					-	-	24	24	SPARE	-	1	20
-	25	SPACE & PROVISIONS	–	-	-	-	-					-	26	SPACE & PROVISIONS	–	-	-
-	27	SPACE & PROVISIONS	–	-	-			-	-			-	28	SPACE & PROVISIONS	–	-	-
-	29	SPACE & PROVISIONS	–	-	-					-	-	-	30	SPACE & PROVISIONS	–	-	-
						3.3	0.3	0.8	0.1	1.1	2.2						
		CONNECTED LOAD =	7.8	KVA		3.6		0.9		3.3							

MAIN BREAKER 60 AMPS

DEMAND LOAD = 7.8 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 25,000 AMPS SYMMETRICAL

LOCATION ELEC. RM 146 4

WIRING SCHEDULE: PANEL LP1A

480 / 277 VOLTS | 3 PHASE 4 WIRE | 100 AMP MAINS | SURFACE MOUNTED

CIRCUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	KVA / Ø AØ		BØ		CØ		CIRCUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - MECH RM (VIA LSP1A)	#12-3/4"C	1	20	0.4	0.2					2	2	LTG - TELE/DATA 106	#12-3/4"C	1	20
3	3	LTG - STORAGE (VIA LSP1A)	#12-3/4"C	1	20			2.3					4	SPARE		1	20
5	5	LTG - 1ST FLOOR CORRIDORS (VIA LSP1A)	#12-3/4"C	1	20					1.1			6	SPARE		1	20
7	7	LTG - EXTERIOR LTG (VIA LSP1A)	#12-3/4"C	1	20								8	SPARE		1	20
9	9	LTG - EXTERIOR LTG (VIA LSP1A)	#12-3/4"C	1	20			1.1					10	SPARE		1	20
11	11	LTG - EXTERIOR LTG (VIA LSP1A)	#12-3/4"C	1	20								12	SPARE		1	20
	13	SPARE		1	20								14	SPARE		1	20
	15	SPARE		1	20								16	SPARE		1	20
	17	SPARE		1	20								18	SPARE		1	20
	19	SPARE		1	20								20	SPARE		1	20
	21	SPARE		1	20								22	SPARE		1	20
	23	SPARE		1	20								24	SPARE		1	20
	25	SPARE		1	20								26	SPARE		1	20
	27	SPARE		1	20								28	SPARE		1	20
	29	SPARE		1	20								30	SPARE		1	20
						0.4	0.2	3.4	0.0	1.1	0.0						
		CONNECTED LOAD =	5.1	KVA		0.6		3.4		1.1							

MAIN BREAKER 100 AMPS

DEMAND LOAD = 5.1 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 25,000 AMPS SYMMETRICAL

LOCATION ELEC. RM 146 4

SCHEDULE OF DIMMER PANEL LDP2								
277 VOLTS		3 PHASE 4 WIRE		50A MLO		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	VESTIBULE 201	DOWNLIGHTS	1	DIM	CFL	4500	184	–
2	VESTIBULE 201	DOWNLIGHTS	2	DIM	CFL	4500	276	–
3	RECEPTION 202	DOWNLIGHTS	3	DIM	CFL	4500	184	–
4	RECEPTION 202	ACCENT LIGHTS	4	DIM	CFL	4500	322	–
5	—	SPARE	5	DIM	—	4500	–	–
6	NORTH CONCOURSE	LINEAR	6	DIM	FLUORESCENT	4500	2800	–
7	NORTH CONCOURSE	LINEAR	7	DIM	FLUORESCENT	4500	3080	–
8	NORTH CONCOURSE	LINEAR	8	DIM	FLUORESCENT	4500	2520	–
9	NORTH CONCOURSE	ACCENT LIGHTS	9	DIM	LED	4500	205	–
10	NORTH CONCOURSE	WALLWASHERS - WOODEN BOX	10	DIM	FLUORESCENT	4500	1600	–
11	WEST LOBBY 260	DOWNLIGHTS	11	DIM	FLUORESCENT	4500	322	–
12	HALL OF FAME 255	DOWNLIGHTS	12	DIM	CFL	4500	348	–
13	HALL OF FAME 255	MEDIA WALL - NORTH	14	DIM	LED	4500	102	–
14	HALL OF FAME 255	MEDIA WALL - SOUTH	15	DIM	LED	4500	102	–
15	—	SPARE	16	DIM	—	4500	–	–
16	—	SPARE	16	DIM	—	4500	–	–
17	—	SPARE	17	DIM	—	4500	–	–
18	—	SPARE	18	DIM	—	4500	–	–
19	—	SPARE	19	DIM	—	4500	–	–
20	—	SPARE	20	DIM	—	4500	–	–
21	—	SPARE	21	DIM	—	4500	–	–
22	—	SPARE	22	DIM	—	4500	–	–
23	—	SPARE	23	DIM	—	4500	–	–
24	—	SPARE	24	DIM	—	4500	–	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 12.05 KVA
DEMAND LOAD = 12.05 KVA
MIN AIC RATING = 25,000 AMPS SYM
LOCATION

SCHEDULE OF DIMMER PANEL ELDP2								
277 VOLTS		3 PHASE 4 WIRE		50A MLO		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	VESTIBULE 201	DOWNLIGHTS	1	DIM	CFL	4500	92	–
2	VESTIBULE 201	DOWNLIGHTS	2	DIM	CFL	4500	92	–
3	RECEPTION 202	DOWNLIGHTS	3	DIM	CFL	4500	92	–
4	NORTH CONCOURSE	LINEAR	4	DIM	FLUORESCENT	4500	840	–
5	NORTH CONCOURSE	LINEAR	5	DIM	FLUORESCENT	4500	1400	–
6	NORTH CONCOURSE	LINEAR	6	DIM	FLUORESCENT	4500	1400	–
7	HALL OF FAME 225	COVE	7	DIM	FLUORESCENT	4500	165	–
8	—	SPARE	11	DIM	—	4500	–	–
9	—	SPARE	11	DIM	—	4500	–	–
10	—	SPARE	11	DIM	—	4500	–	–
11	—	SPARE	11	DIM	—	4500	–	–
12	—	SPARE	12	DIM	—	4500	–	–
13	—	SPARE	13	DIM	—	4500	–	–
14	—	SPARE	14	DIM	—	4500	–	–
15	—	SPARE	15	DIM	—	4500	–	–
16	—	SPARE	16	DIM	—	4500	–	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 4.08 KVA
DEMAND LOAD = 4.08 KVA
MIN AIC RATING = 25,000 AMPS SYM
LOCATION

SCHEDULE OF DIMMER PANEL LDP1								
277 VOLTS		3 PHASE 4 WIRE		50A MLO		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	PRESS RM 127	LINEAR FLUORESCENTS	1	DIM	FLUORESCENT	4500	900	–
2	PRESS RM 127	WALL GRAZER	2	DIM	FLUORESCENT	4500	118	–
3	PRESS RM 127	FUTURE VIDEO SPOTLIGHTS	3	DIM	FLUORESCENT	4500	450	–
4	PRODUCTION 129	FLUORESCENT TROFFERS	4	DIM	FLUORESCENT	4500	272	–
5	–	SPARE	5	DIM	–	4500	–	–
6	–	SPARE	6	DIM	–	4500	–	–
7	–	SPARE	7	DIM	–	4500	–	–
8	–	SPARE	8	DIM	–	4500	–	–

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 1.74 KVA
DEMAND LOAD = 1.74 KVA
MIN AIC RATING = 25,000 AMPS SYM
LOCATION

Updated Panelboard Schedules:

For Panel LSP4 I edited circuits 1-19 odd and I decreased the load that the original MEP firm calculated. I sized the wire larger due to voltage drop on the conductors. The cutsheet for the sports light fixture does not give a load for the shutter motor so I gave it an arbitrary load of 150 kW because the existing panelboards have a load of 150 kW for shutter control. Panel LSP4A's circuit numbering is counterintuitive as multiple relays are on the same circuit, so the sports lighting fixtures on Panel LSP4A are designated by the relay number.

My lighting designs didn't need the amount of lights or circuits that were previously designed. So there are panelboards that have spares where previous circuits existed. I added load for each of these circuit breakers at 65% of the ampacity rating. The panelboards' demand factors were set to 1 because most or all of the loads are lighting, which is a continuous load. It is an added safety factor as well. Panel LSP4A AND PANEL ELSP4 are both "FEED-THRU" so I assume that means that a main circuit breaker is not needed. Also, panels LDP4, LDP2, ELDP2, and LDP1 are MLO so a main circuit breaker is not needed. Most of the lighting dimming and switching panels do not yet have a location, so I will assume that panels LSP4A, ELSP4, LDP4, LDP2, ELDP2, AND LDP1 will be fed from panels in the same room because on the lighting control riser diagram, the panels are shown fed from panels on the same floor. Please see attached drawing in the appendix for reference to the Lighting Control Riser Diagram.

The following tables show my calculations for the new lighting circuits as well as panelboard sizing. Following these tables are the updated panelboards. The short circuit current rating from the Square D catalog for main lug interiors is 65,000 A. For Branch circuit short circuit ratings for breakers 1-3 poles and 15-60A is 35,000 A for EGB.

Reception		
	Recessed	Pendant
kW	53	39
Voltage	277	277
Input Current	0.191	0.17
VA/Fixture	52.907	47.09
# of Fixtures	13	16
Total VA	687.791	753.44
VA/Circuit	3545.6	3545.6
Fixtures/Circuit	67.01571	75.29412
Voltage	480	
Voltage Drop	0.10%	
Load in A	5.203	
length in feet	32	
Copper Conductor	#12	
Ground	#12	
AC 3PH 60Hz		
75C		
Aluminum Conduit		
Single cccs		

Court		
	Widelite	
kW	1000	
Voltage	277	
Input Current	4.7	4.7
VA/Fixture	1301.9	
# of Fixtures	20	20
Total VA	26038	
VA/Circuit	3545.6	
Fixtures/Circuit	2.723404	
Voltage	480	208
Voltage Drop	4.10%	3.90%
Load in A	94	94
length in feet	100	100
Copper Conductor	#10	#6
Ground	#12	#12
AC 3PH 60Hz		
75C		
Aluminum Conduit		
Single cccs		

EXTERIOR		
	Recessed	Pole
kW	53	40
Voltage	277	277
Input Current	0.191	0.160433
VA/Fixture	52.907	44.44
# of Fixtures	36	17
Total VA	1904.652	755.48
VA/Circuit	3545.6	3545.6
Fixtures/Circuit	67.01571	79.78398
PF		0.9
Voltage	480	
Voltage Drop	0.10%	
Load in A	9.603365	2.727365
length in feet	32	
Copper Conductor	#12	
Ground	#12	
AC 3PH 60Hz		
75C		
Aluminum Conduit		
Single cccs		

PRESS ROOM		
	Recessed	Wallwasher
kW	53	53
Voltage	277	277
Input Current	0.191	0.191
VA/Fixture	52.907	52.907
# of Fixtures	12	6
Total VA	634.884	317.442
VA/Circuit	3545.6	3545.6
Fixtures/Circuit	67.01571	67.01570681
Voltage	480	
Voltage Drop	0.10%	
Load in A	3.438	
length in feet	32	
Copper Conductor	#12	
Ground	#12	
AC 3PH 60Hz		
75C		
Aluminum Conduit		
Single cccs		

Note: Existing Circuits are Single Pole 20A Breakers(Max 16 Amps)
Note: Lighting circuits are derated for continuous load and breaker

	KVA	VOLTAGE	VOLTAGE	FLA	FLA	FEEDER SIZE		Ground		Main	MLO	busbar	Conduit	fed from	Length	Volt Drop (%)	
LSP4	86.418	480		103.9		#2		#6		110		225	1-1/4	LSP2	212.4	1.6	
LSP4A	35.82	480	208	43.1	99.4	#8	#3	#10	#8	-		100	3/4	LSP4	2.0	0	0.1
ELSP4	30.366	480	208	36.5	84.3	#8	#4	#10	#8	-		100	3/4	LSP4	4.0	0	0.1
LDP4	67.235	480		80.9		#4		#8		-	90	100	1	ELSP4	2.0	0	
EP4	113.1	480		136.0		#1/0		#6		150		225	1-1/2	EP2	212.4	1.4	
LP4	439.15	480		528.2		(2) #300		#4		300		400	2-1/2	SWB	186.3	0.6	
EP2	155.94	480		187.6		#3/0		#6		200		225	2	EP1	104.0	0.6	
LP2	221.67	480		266.6		300		#4		300		400	2-1/2	SWB	104.0	0.6	
EP1A	86.1	480		103.6		#2		#6		125		225	1-1/4	EP1	176.0	1.3	
LP1A	92.6	480		111.4		#2		#6		125		225	1-1/4	SWB	176.0	1.4	
LDP2	46.869	480		56.4		#6		#8		-	70	100	1	ELSP2	2.0	0	
ELDP2	33.239	480		40.0		#8		#10		-	50	100	3/4	LDP2	2.0	0	
LDP1	18.776	480		22.6		#10		#10		-	30	100	3/4	ELSP1	4.0	0	

NOTE:

THE FOLLOWING IS THE FORMULA FOR CALCULATING FLA IN A 3 PHASE SYSTEM

FLA = KVA/VOLTAGE/3^.5

PANELS LSP4A AND ELSP4 ARE "FEED-THRU" DUAL VOLTAGE LIGHTING SWITCHING PANELS SO TWO FEEDERS GO TO PANELBOARD FOR 208V & 480V

ALSO, PANELS DO NOT HAVE MCB

Updated Panelboards:

SCHEDULE OF LIGHTING SWITCHING PANEL LSP4							
277/480 VOLTS		3PHASE 4 WIRE	110A MCB / 225A BUS		SURFACE MOUNTED		
RELAY NUMBER	CIRCUIT NUMBER	LOCATION	NORMAL/ EMERG.	RELAY & CIRCUIT BREAKER CAPACITY (AMPS)	CIRCUIT LOAD (WATTS)	WIRE/ CONDUIT	NOTES
1	1	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
2	3	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
3	5	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
4	7	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
5	9	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
6	11	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
7	13	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
8	15	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
9	17	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
10	19	SPORTS COURT FLOODLIGHTING	N/E	20	2160	#10-3/4"C + #12 G	-
11	21	SPARE	N	20	3601	-	-
12	23	SPARE	N	20	3601	-	-
13	25	SPARE	N	20	3601	-	-
14	27	SPARE	N	20	3601	-	-
15	2	SPARE	N	20	3601	-	-
16	4	SPARE	N	20	3601	-	-
17	6	SPARE	N	20	3601	-	-
18	8	SPARE	N	20	3601	-	-
19	10	SPARE	N	20	3601	-	-
20	12	SPARE	N	20	3601	-	-
21	14	SPARE	N	20	3601	-	-
22	16	SPARE	N	20	3601	-	-
23	18	SPARE	N	20	3601	-	-
24	20	SPARE	N	20	3601	-	-
25	22	SPARE	N	20	3601	-	-
26	24	SPARE	N	20	3601	-	-
27	26	SPARE	N	20	3601	-	-
28	28	SPARE	N	20	3601	-	-

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.
B. TIMECLOCK SCHEDULING SHALL BE COORDINATED WITH FACILITIES AND PROGRAMMED ACCORDINGLY.

CONNECTED LOAD = 86.418 KVA
DEMAND LOAD = 86.418 KVA
MIN AIC RATING = 35,000 AMPS SYM
LOCATION

SCHEDULE OF LIGHTING SWITCHING PANEL LSP4A							
120/277 VOLTS (DUAL VOLTAGE)			FEED-THRU / 100A BUS		SURFACE MOUNTED		
RELAY NUMBER	CIRCUIT NUMBER	LOCATION	NORMAL/ EMERG.	RELAY CAPACITY (AMPS)	CIRCUIT LOAD (WATTS)	WIRE/ CONDUIT	NOTES
1	1	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
2	2	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
3	3	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
4	4	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
5	5	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
6	6	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
7	7	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
8	8	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
9	9	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
10	10	COURT FLOODLIGHTING SHUTTER CONTROL	N/E	20	150	#12-3/4"C + #12 G	-
11	-	SPARE	N	20	1560		-
12	-	SPARE	N	20	1560		-
13	-	SPARE	N	20	1560		-
14	-	SPARE	N	20	1560		-
15	-	SPARE	N	20	1560		-
16	-	SPARE	N	20	1560		-
17	-	SPARE	N	20	1560		-
18	-	SPARE	N	20	1560		-
19	-	SPARE	N	20	1560		-
20	-	SPARE	N	20	1560		-
21	-	SPARE	N	20	1560	-	-
22	-	SPARE	N	20	1560	-	-
23	-	SPARE	N	20	1560	-	-
24	-	SPARE	N	20	1560	-	-
25	-	SPARE	N	20	1560	-	-
26	-	SPARE	N	20	1560	-	-
27	-	SPARE	N	20	1560	-	-
28	-	SPARE	N	20	1560	-	-
29	-	SPARE	N	20	1560	-	-
30	-	SPARE	N	20	1560	-	-
31	-	SPARE	N	20	1560	-	-
32	-	SPARE	N	20	1560	-	-

GENERAL NOTES:

A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD =	35.82	KVA
DEMAND LOAD =	35.82	KVA
MIN AIC RATING =	35,000	AMPS SYM
LOCATION	ELEC 132	

SCHEDULE OF EMERGENCY LIGHTING SWITCHING PANEL ELSP4							
120/277 VOLTS (DUAL VOLTAGE)			FEED-THRU / 100A BUS		SURFACE MOUNTED		
RELAY NUMBER	CIRCUIT NUMBER	LOCATION	NORMAL/ EMERG.	RELAY CAPACITY (AMPS)	CIRCUIT LOAD (WATTS)	WIRE/ CONDUIT	NOTES
1	EP4-1	SPARE	N	20	1560	-	-
2	EP4-3	SPARE	N	20	1560	-	-
3	EP4-3	SPARE	N	20	1560	-	-
4	EP4-5	SPARE	N	20	1560	-	-
5	EP4-5	SPARE	N	20	1560	-	-
6	EP4-7	SPARE	N	20	1560	-	-
7	EP4-9	SPARE	N	20	1560	-	-
8	EP4-11	SPARE	N	20	1560	-	-
9	EP4-11	SPARE	N	20	1560	-	-
10	EP4-13	SPARE	N	20	1560	-	-
11	EP4-13	SPARE	N	20	1560	-	-
12	EP4-15	SPARE	N	20	1560	-	-
13	EP4-15	NORTH VIDEO AREA	N	20	132	#12-3/4"C	-
14	EP4-17	3RD FLOOR LOBBY	N	20	450	#12-3/4"C	-
15	EP4-19	STAIR 7	N	20	384	#12-3/4"C	-
16	EP4-19	STAIR 7	N	20	384	#12-3/4"C	-
17	EP4-21	ROOF LTG	N	20	680	#12-3/4"C	-
18	EP4-17	MECHANICAL ROOM 325	N	20	256	#12-3/4"C	-
19	-	SPARE	N	20	1560	-	-
20	-	SPARE	N	20	1560	-	-
21	-	SPARE	N	20	1560	-	-
22	-	SPARE	N	20	1560	-	-
23	-	SPARE	N	20	1560	-	-
24	-	SPARE	N	20	1560	-	-

GENERAL NOTES:
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD =	30.366	KVA
DEMAND LOAD =	30.366	KVA
MIN AIC RATING =	35,000	AMPS SYM
LOCATION	ELEC 132	

SCHEDULE OF DIMMER PANEL LDP4								
277 VOLTS		3PHASE 4 WIRE		90A MLO / 100A BUS		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	-	SPARE	1	DIM	-	4500	2925	-
2	-	SPARE	2	DIM	-	4500	2925	-
3	-	SPARE	3	DIM	-	4500	2925	-
4	-	SPARE	4	DIM	-	4500	2925	-
5	-	SPARE	5	DIM	-	4500	2925	-
6	-	SPARE	6	DIM	-	4500	2925	-
7	-	SPARE	7	DIM	-	4500	2925	-
8	-	SPARE	8	DIM	-	4500	2925	-
9	-	SPARE	9	DIM	-	4500	2925	-
10	-	SPARE	10	DIM	-	4500	2925	-
11	-	SPARE	11	DIM	-	4500	2925	-
12	-	SPARE	12	DIM	-	4500	2925	-
13	-	SPARE	13	DIM	-	4500	2925	-
14	-	SPARE	14	DIM	-	4500	2925	-
15	-	SPARE	15	DIM	-	4500	2925	-
16	-	SPARE	16	DIM	-	4500	2925	-
17	-	SPARE	17	DIM	-	4500	2925	-
18	SUITE 311	DOWNLIGHTS - MAIN	18	DIM	CFL	4500	116	-
19	SUITE 311	DOWNLIGHTS - FRONT	19	DIM	CFL	4500	58	-
20	SUITE 311	COVE	20	DIM	LED	4500	182	-
21	SUITE 312	DOWNLIGHTS - MAIN	21	DIM	CFL	4500	290	-
22	SUITE 312	DOWNLIGHTS - FRONT	22	DIM	CFL	4500	145	-
23	SUITE 312	COVE	23	DIM	LED	4500	238	-
24	SUITE 313	DOWNLIGHTS - MAIN	24	DIM	CFL	4500	290	-
25	SUITE 313	DOWNLIGHTS - FRONT	25	DIM	CFL	4500	145	-
26	SUITE 313	COVE	26	DIM	LED	4500	238	-
27	SUITE 314	DOWNLIGHTS - MAIN	27	DIM	CFL	4500	116	-
28	SUITE 314	DOWNLIGHTS - FRONT	28	DIM	CFL	4500	58	-
29	SUITE 314	COVE	29	DIM	LED	4500	182	-
30	SUITE 316	DOWNLIGHTS - REAR	30	DIM	CFL	4500	261	-
31	SUITE 316	DOWNLIGHTS - FRONT	31	DIM	CFL	4500	319	-
32	SUITE 316	DOWNLIHGTS - WINDOW	32	DIM	CFL	4500	118	-
33	SUITE 316	REFRESHMENTS	33	DIM	CFL	4500	58	-
34	SUITE 316	LINEAR SLOTS	34	DIM	FLUORESCENT	4500	320	-
35	SUITE 316	COVE	35	DIM	LED	4500	136	-
36	SUITE 317	DOWNLIGHTS	36	DIM	CFL	4500	116	-

37	VIDEO 308	DOWNLIGHTS	37	DIM	CFL	4500	184	-
38	3RD FLOOR CORRIDOR	WALLWASHERS - WOODEN BOX	38	DIM	FLUORESCENT	4500	1152	-
39	MULTIPURPOSE 301	DOWNLIGHTS	39	DIM	CFL	4500	480	-
40	MULTIPURPOSE 302	DOWNLIGHTS - FRONT	40	DIM	CFL	4500	92	-
41	MULTIPURPOSE 303	WALL GRAZER	41	DIM	FLUORESCENT	4500	42	-
42	MULTIPURPOSE 304	ACCENT LIGHTS	42	DIM	CFL	4500	92	-
43	MULTIPURPOSE 305	DECORATIVE PENDANT	43	DIM	LED	4500	60	-
44	RECEPTION 202	DOWNLIGHTS	44	DIM	CFL	4500	322	-
45	-	SPARE	45	DIM	-	4500	2925	-
46	-	SPARE	46	DIM	-	4500	2925	-
47	-	SPARE	47	DIM	-	4500	2925	-
48	-	SPARE	48	DIM	-	4500	2925	-

GENERAL NOTES:

A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD =	67.235	KVA
DEMAND LOAD =	67.235	KVA
MIN AIC RATING =	65,000	AMPS SYM
LOCATION		

WIRING SCHEDULE: PANEL EP4																	
480/277 VOLTS			3 PHASE 4 WIRE					150 AMP MAINS / 225A BUS				SURFACE MOUNTED					
CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	Aϕ		Bϕ		Cϕ		CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP
1	1	SPARE		1	20	3.6	0.5					2	2	LTG - ELEVATOR SHAFT	#12-3/4"C	1	20
3	3	SPARE		1	20			3.6	1			4	4	LTG - 3RD FLOOR EXIT SIGNS	#10-3/4"C	1	20
5	5	SPARE		1	20					3.6	1	6	6	LTG - STAIR 3	#12-3/4"C	1	20
7	7	SPARE		1	20	3.6	2.2					8	8	LTG - SKYBOX RESTROOMS	#12-3/4"C	1	20
9	9	SPARE		1	20			3.6	0.5			10	10	SMOKE DAMPERS	#10-3/4"C	1	20
11	11	SPARE		1	20					3.6	3.6	-	12	SPARE	-	1	20
13	13	SPARE		1	20	3.6	3.6					-	14	SPARE	-	1	20
15	15	SPARE		1	20			3.6	3.6			-	16	SPARE	-	1	20
17	17	LTG - 3RD FLOOR LTG (VIA ELSP4)	#12-3/4"C	1	20					0.5	3.6	-	18	SPARE	-	1	20
19	19	LTG - STAIR 7 (VIA ELSP4)	#12-3/4"C	1	20	0.8	3.6					-	20	SPARE	-	1	20
21	21	LTG - ROOFTOP	#12-3/4"C	1	20			0.7	3.6			-	22	SPARE	-	1	20
-	23	SPARE	-	1	20					3.6	3.6	-	24	SPARE	-	1	20
-	25	SPARE	-	1	20	3.6	3.6					-	26	SPARE	-	1	20
-	27	SPARE	-	1	20			3.6	3.6			-	28	SPARE	-	1	20
-	29	SPARE	-	1	20					3.6	3.6	-	30	SPARE	-	1	20
-	31	SPACE & PROVISIONS	-	1	-	2.8	2.8					-	32	SPACE & PROVISIONS	-	1	-
-	33	SPACE & PROVISIONS	-	1	-			2.8	2.8			-	34	SPACE & PROVISIONS	-	1	-
-	35	SPACE & PROVISIONS	-	1	-					2.8	2.8	-	36	SPACE & PROVISIONS	-	1	-
-	37	SPACE & PROVISIONS	-	1	-	2.8	0.5					38	38	DIMMER PANEL ELDP4	4#8+	3	50
-	39	SPACE & PROVISIONS	-	1	-			2.8	0.5			-	40		#10G-		
-	41	SPACE & PROVISIONS	-	1	-					2.8	0.5	-	42		3/4"C		
						20.8	16.8	20.7	15.6	20.5	18.7						
		CONNECTED LOAD =	113.1	KVA		37.6		36.3		39.2							

MAIN BREAKER 150 AMPS

DEMAND LOAD = 113.1 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 35,000 AMPS SYMMETRICAL

LOCATION ABOVE SKYBOX

WIRING SCHEDULE: PANEL LP4																
480/277 VOLTS			3 PHASE 4 WIRE					300 AMP MAINS / 400 A BUS					SURFACE MOUNTED			
CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	Aϕ		Bϕ		Cϕ		CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	PO
1	1	SPARE	-	1	20	3.6	0.2					2	2	LTG - 3RD FLOOR STORAGE RMS	#12-3/4"C	
3	3	SPARE	-	1	20			3.6	0.4			4	4	LTG - 3RD FLOOR STORAGE & JAN	#12-3/4"C	
5	5	SPARE	-	1	20					3.6	3.6	6	6	SPARE	-	
7	7	SPARE	-	1	20	3.6	3.6					8	8	SPARE	-	
9	9	SPARE	-	1	20			3.6	3.6			10	10	SPARE	-	
11	11	SPARE	-	1	20					3.6	3.6	-	12	SPARE	-	
13	13	SPARE	-	1	20	3.6	3.6					-	14	SPARE	-	
15	15	SPARE	-	1	20			3.6	3.6			-	16	SPARE	-	
17	17	SPARE	-	1	20					3.6	3.6	-	18	SPARE	-	
19	19	SPARE	-	1	20	3.6	3.6					-	20	SPARE	-	
21	21	SPARE	-	1	20			3.6	3.6			-	22	SPARE	-	
23	23	SPARE	-	1	20					3.6	3.6	-	24	SPARE	-	
25	25	LTG - MECH RM 325 (VIA LSP4A)	#12-3/4"C	1	20	1.2	3.6					-	26	SPARE	-	
-	27	SPARE	-	1	20			3.6	3.6			-	28	SPARE	-	
-	29	SPARE	-	1	20					3.6	3.6	-	30	SPARE	-	
32	31	PANEL RP4A (VIA XFMR TRP4A)	3#10+	3	150**	23.3	28.8					32	32	SWITCHING PANEL LSP4	4#2+	
-	33		#6G-					23.3	28.8			-	34		#6G-	
-	35		2"C							21.7	28.8	-	36		1-1/4"C	
37	37	PANEL RP4 (VIA XFMR TRP4A)	3#4/0+	3	225**	40.2	22.4					38	38	DIMMING PANEL LDP4	4#4+	
-	39	(SUB-FEED CIRCUIT BREAKER)	#4G-					37.0	22.4			-	40		#8G-	
-	41		3"C							41.0	22.4	-	42		1"C	
						79.1	65.8	78.3	66.0	80.7	69.2					
		CONNECTED LOAD =	439.2	KVA		144.9		144.3		149.9						
														MAIN BREAKER	300	AM
		DEMAND LOAD =	439.2	KVA												
		MIN AIC RATING =	35,000	AMPS SYMMETRICAL										LOCATION	ABOVE SKYBOX	

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT
** PROVIDE SUB-FEED CIRCUIT BREAKER

WIRING SCHEDULE: PANEL EP2																	
480/277 VOLTS				3 PHASE 4 WIRE					200 AMP MAINS / 225A BUS					SURFACE MOUNTED			
CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	Aϕ		Bϕ		Cϕ		CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP
1	1	LTG - LED RECEPTION RM 125	#12-3/4"C	1	20	1.4	2.2					2	2	LTG - 2ND FLOOR RESTROOMS	#10-3/4"C	1	20
3	3	LTG - CONCOURSE (ELSP2)	#10-3/4"C	1	20			2.5	0.1			4	4	LTG - 2ND FLOOR EXITS	#10-3/4"C	1	20
5	5	LTG - LINK (VIA ELSP2)	#10-3/4"C	1	20					1.2	0.1	6	6	SMOKE DAMPER	#10-3/4"C	1	20
7	7	LTG - UPPER DECK STAIRS (VIA ELSP2)	#10-3/4"C	1	20	1.8						8	8	SPARE		1	20
9	9	LTG - UPPER DECK STAIRS (VIA ELSP2)	#10-3/4"C	1	20			0.9	3.6			10	10	SPARE		1	20
-	11	SPARE		1	20					3.6	3.6	12	12	SPARE		1	20
-	13	SPARE		1	20	3.6	3.6					14	14	SPARE		1	20
-	15	SPARE		1	20			3.6	3.6			16	16	SPARE		1	20
-	17	SPARE		1	20					3.6	3.6	18	18	SPARE		1	20
-	19	SPARE		1	20	3.6	3.6					20	20	SPARE		1	20
-	21	SPARE		1	20			3.6	3.6			22	22	SPARE		1	20
-	23	SPARE		1	20					3.6	3.6	24	24	SPARE		1	20
-	25	SPACE & PROVISIONS	-	1	-	2.8	2.8					26	26	SPACE & PROVISIONS	-	1	20
-	27	SPACE & PROVISIONS	-	1	-			2.8	2.8			28	28	SPACE & PROVISIONS	-	1	20
-	29	SPACE & PROVISIONS	-	1	-					2.8	2.8	30	30	SPACE & PROVISIONS	-	1	20
-	31	SPACE & PROVISIONS	-	1	-	2.8	2.8					32	32	SPACE & PROVISIONS	-	1	20
-	33	SPACE & PROVISIONS	-	1	-			2.8	2.8			34	34	SPACE & PROVISIONS	-	1	20
-	35	SPACE & PROVISIONS	-	1	-					2.8	2.8	36	36	SPACE & PROVISIONS	-	1	20
37	37	PANEL RP2 (VIA XFMR TRP2)	3#1/0+	3	150	10.3	11.1					38	38	DIMMER PANEL ELDP2	4#8+	3	50
-	39	(SUB-FEED CIRCUIT BREAKER)	#6G-					8.2	11.1			40	40		#10G-		
-	41		2"C							6.4	11.1	42	42		3/4"C		
						26.3	26.1	24.4	27.6	24.0	27.6						
		CONNECTED LOAD =	155.9	KVA		52.4		52.0		51.6							

MAIN BREAKER 200 AMPS

DEMAND LOAD = 155.9 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 35,000 AMPS SYMMETRICAL

LOCATION ELECT RM 246

WIRING SCHEDULE: PANEL LP2																
480/277 VOLTS			3 PHASE 4 WIRE						300 AMP MAINS / 400A BUS				SURFACE MOUNTED			
CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	KVA/ϕ Aϕ		Bϕ		Cϕ		CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BRE POLE
1	1	LTG - WEST LOBBY 260 (VIA LSP2)	#12-3/4"C	1	20	0.9	0.7					2	2	LTG - JAN & STORAGE	#12-3/4"C	1
3	3	SPARE	-	1	20			3.6	3.6			4	4	SPARE		1
5	5	LTG - WEST CONCOURSE (VIA LSP2)	#12-3/4"C	1	20					1.1	3.6	6	6	SPARE		1
7	7	SPARE		1	20	3.6	3.6					8	8	SPARE		1
9	9	LTG - HALL OF FAME 225 (VIA LSP2)	#12-3/4"C	1	20			0.3	3.6			10	10	SPARE		1
11	11	LTG - TICKETING 203 (VIA LSP2)	#12-3/4"C	1	20					0.6	3.6	12	12	SPARE		1
13	13	LTG - VESTIBULE 124 (VIA LSP2)	#12-3/4"C	1	20	0.1	3.6					14	14	SPARE		1
	15	SPARE		1	20			3.6	3.6			16	16	SPARE		1
	17	SPARE		1	20					3.6	3.6	18	18	SPARE		1
	19	SPARE		1	20	3.6	3.6					20	20	SPARE		1
	21	SPARE		1	20			3.6	3.6			22	22	SPARE		1
	23	SPARE		1	20					3.6	3.6	24	24	SPARE		1
-	25	SPACE & PROVISIONS	-	1	20	2.8	2.8					26	26	SPACE & PROVISIONS	-	1
-	27	SPACE & PROVISIONS	-	1	20			2.8	2.8			28	28	SPACE & PROVISIONS	-	1
-	29	SPACE & PROVISIONS	-	1	20					2.8	2.8	30	30	SPACE & PROVISIONS	-	1
-	31	SPACE & PROVISIONS	-	1	20	2.8	2.8					32	32	SPACE & PROVISIONS	-	1
-	33	SPACE & PROVISIONS	-	1	20			2.8	2.8			34	34	SPACE & PROVISIONS	-	1
-	35	SPACE & PROVISIONS	-	1	20					2.8	2.8	36	36	SPACE & PROVISIONS	-	1
37	37	PANEL RP2 (VIA XFMR TRP2)		3	150**	26.1	15.6					38	38	DIMMING PANEL LDP2	4#6+	3
-	39	(SUB-FEED CIRCUIT BREAKER)						23.9	15.6			40	40		#8G-	
-	41									22.7	15.6	42	42		1"C	
						39.9	32.7	40.6	35.6	37.2	35.6					
		CONNECTED LOAD =	221.7	KVA		72.6		76.2		72.8						

MAIN BREAKER 300 AMPS

DEMAND LOAD = 221.7 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT
** PROVIDE SUB - FEED CIRCUIT BREAKER

MIN AIC RATING = 35,000 AMPS SYMMETRICAL

LOCATION ELECT RM 246

WIRING SCHEDULE: PANEL EP1A																
480/277 VOLTS			3 PHASE 4 WIRE					125 AMP MAINS / 225A BUS					SURFACE MOUNTED			
CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER		KVA/ϕ						CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	B
				POLE	AMP	Aϕ		Bϕ		Cϕ						POI
1	1	LTG - MECHANICAL 147 (VIA LSP1A)	#10-3/4"C	1	20	0.9	0.3					2	2	LTG - ELEC RM 146	#10-3/4"C	1
3	3	LTG - STORAGE RMS (VIA LSP1A)	#10-3/4"C	1	20			0.8	0.1			4	4	LTG - 1ST FLOOR EXITS	#10-3/4"C	1
5	5	LTG - 1ST FLOOR CORRIDORS (VIA LSP1A)	#10-3/4"C	1	20					1.1	2.2	6	6	LTG - 1ST FLOOR RESTROOMS	#10-3/4"C	1
7	7	LTG - EXTERIOR ENTRANCE & PATHWAY	#12-3/4"C	1	20	2.7	3.6					8	8	SPARE	-	1
9	9	SPARE	-	1	20			3.6	3.6			10	10	SPARE	-	1
11	11	SPARE	-	1	20					3.6	3.6	12	12	SPARE	-	1
13	13	SPARE	-	1	20	3.6	3.6					14	14	SPARE	-	1
15	15	SPARE	-	1	20			3.6	3.6			16	16	SPARE	-	1
17	17	SPARE	-	1	20					3.6	3.6	18	18	SPARE	-	1
19	19	SPARE	-	1	20	3.6	3.6					20	20	SPARE	-	1
21	21	SPARE	-	1	20			3.6	3.6			22	22	SPARE	-	1
23	23	SPARE	-	1	20					3.6	3.6	24	24	SPARE	-	1
-	25	SPACE & PROVISIONS	-	1	20	2.8	2.8					26	26	SPACE & PROVISIONS	-	-
-	27	SPACE & PROVISIONS	-	1	20			2.8	2.8			28	28	SPACE & PROVISIONS	-	-
-	29	SPACE & PROVISIONS	-	1	20					2.8	2.8	30	30	SPACE & PROVISIONS	-	-
						13.6	13.9	14.4	13.7	14.7	15.8					
		CONNECTED LOAD =	86.1	KVA		27.5		28.1		30.5						

MAIN BREAKER 125 AMP

DEMAND LOAD = 86.1 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 35,000 AMPS SYMMETRICAL

LOCATION ELECT RM 146

WIRING SCHEDULE: PANEL LP1A																	
480/277 VOLTS			3 PHASE 4 WIRE					125 AMP MAINS / 225A BUS				SURFACE MOUNTED					
CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	BREAKER POLE	BREAKER AMP	KVA/ϕ Aϕ		KVA/ϕ Bϕ		KVA/ϕ Cϕ		CIR-CUIT	POLE	DESCRIPTION	WIRE/ CONDUIT	PO
1	1	LTG - MECH RM (VIA LSP1A)	#12-3/4"C	1	20	0.4	0.2					2	2	LTG - TELE/DATA 106	#12-3/4"C	1
3	3	LTG - STORAGE (VIA LSP1A)	#12-3/4"C	1	20			2.3	3.6			4	4	SPARE		1
5	5	LTG - 1ST FLOOR CORRIDORS (VIA LSP1A)	#12-3/4"C	1	20					1.1	3.6	6	6	SPARE		1
7	7	SPARE		1	20	3.6	3.6					8	8	SPARE		1
9	9	LTG - EXTERIOR LTG (VIA LSP1A)	#12-3/4"C	1	20			1.1	3.6			10	10	SPARE		1
11	11	LTG - EXTERIOR LTG (VIA LSP1A)	#12-3/4"C	1	20					1.1	3.6	12	12	SPARE		1
	13	SPARE		1	20	3.6	3.6					14	14	SPARE		1
	15	SPARE		1	20			3.6	3.6			16	16	SPARE		1
	17	SPARE		1	20					3.6	3.6	18	18	SPARE		1
	19	SPARE		1	20	3.6	3.6					20	20	SPARE		1
	21	SPARE		1	20			3.6	3.6			22	22	SPARE		1
	23	SPARE		1	20					3.6	3.6	24	24	SPARE		1
	25	SPARE		1	20	3.6	3.6					26	26	SPARE		1
	27	SPARE		1	20			3.6	3.6			28	28	SPARE		1
	29	SPARE		1	20					3.6	3.6	30	30	SPARE		1
						14.8	14.6	14.2	18	13	18					
		CONNECTED LOAD =	92.6	KVA		29.4		32.2		31						

MAIN BREAKER 125 AMP

DEMAND LOAD = 92.6 KVA

NOTE: PROVIDE SEPARATE NEUTRAL FOR EACH CIRCUIT

MIN AIC RATING = 35,000 AMPS SYMMETRICAL

LOCATION ELECT RM 146

SCHEDULE OF DIMMER PANEL LDP2								
277 VOLTS		3PHASE 4 WIRE		70A MLO / 100A BUS		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	VESTIBULE 201	DOWNLIGHTS	1	DIM	CFL	4500	184	-
2	-	SPARE	2	DIM	-	4500	2925	-
3	RECEPTION 202	DOWNLIGHTS	3	DIM	CFL	4500	184	-
4	RECEPTION 202	ACCENT LIGHTS	4	DIM	CFL	4500	322	-
5	-	SPARE	5	DIM	-	4500	2925	-
6	NORTH CONCOURSE	LINEAR	6	DIM	FLUORESCENT	4500	2800	-
7	NORTH CONCOURSE	LINEAR	7	DIM	FLUORESCENT	4500	3080	-
8	NORTH CONCOURSE	LINEAR	8	DIM	FLUORESCENT	4500	2520	-
9	NORTH CONCOURSE	ACCENT LIGHTS	9	DIM	LED	4500	205	-
10	NORTH CONCOURSE	WALLWASHERS - WOODEN BOX	10	DIM	FLUORESCENT	4500	1600	-
11	WEST LOBBY 260	DOWNLIGHTS	11	DIM	FLUORESCENT	4500	322	-
12	HALL OF FAME 255	DOWNLIGHTS	12	DIM	CFL	4500	348	-
13	HALL OF FAME 255	MEDIA WALL - NORTH	13	DIM	LED	4500	102	-
14	HALL OF FAME 255	MEDIA WALL - SOUTH	14	DIM	LED	4500	102	-
15	-	SPARE	15	DIM	-	4500	2925	-
16	-	SPARE	16	DIM	-	4500	2925	-
17	-	SPARE	17	DIM	-	4500	2925	-
18	-	SPARE	18	DIM	-	4500	2925	-
19	-	SPARE	19	DIM	-	4500	2925	-
20	-	SPARE	20	DIM	-	4500	2925	-
21	-	SPARE	21	DIM	-	4500	2925	-
22	-	SPARE	22	DIM	-	4500	2925	-
23	-	SPARE	23	DIM	-	4500	2925	-
24	-	SPARE	24	DIM	-	4500	2925	-

GENERAL NOTES:

A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD =	46.869	KVA
DEMAND LOAD =	46.869	KVA
		AMPS
MIN AIC RATING =	65,000	SYM
LOCATION		

SCHEDULE OF DIMMER PANEL ELDP2								
277 VOLTS		3PHASE 4 WIRE		50A MLO / 100A BUS		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	VESTIBULE 201	DOWNLIGHTS	1	DIM	CFL	4500	92	-
2	-	SPARE	2	DIM	-	4500	2925	-
3	RECEPTION 202	DOWNLIGHTS	3	DIM	CFL	4500	92	-
4	NORTH CONCOURSE	LINEAR	4	DIM	FLUORESCENT	4500	840	-
5	NORTH CONCOURSE	LINEAR	5	DIM	FLUORESCENT	4500	1400	-
6	NORTH CONCOURSE	LINEAR	6	DIM	FLUORESCENT	4500	1400	-
7	HALL OF FAME 225	COVE	7	DIM	FLUORESCENT	4500	165	-
8	-	SPARE	8	DIM	-	4500	2925	-
9	-	SPARE	9	DIM	-	4500	2925	-
10	-	SPARE	10	DIM	-	4500	2925	-
11	-	SPARE	11	DIM	-	4500	2925	-
12	-	SPARE	12	DIM	-	4500	2925	-
13	-	SPARE	13	DIM	-	4500	2925	-
14	-	SPARE	14	DIM	-	4500	2925	-
15	-	SPARE	15	DIM	-	4500	2925	-
16	-	SPARE	16	DIM	-	4500	2925	-

GENERAL NOTES:

A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.

CONNECTED LOAD = 33.239 KVA
DEMAND LOAD = 33.239 KVA
MIN AIC RATING = 65,000 AMPS SYM
LOCATION

SCHEDULE OF DIMMER PANEL LDP1								
277 VOLTS		3PHASE 4 WIRE		30A MLO / 100A BUS		SURFACE MOUNTED		
DIMMER CIRCUIT NO.	LOCATION	DESCRIPTION	CONTROL ZONE	DIM/ SWITCH	LOAD TYPE	DIMMER CAPACITY (WATTS)	CIRCUIT LOAD (WATTS)	NOTES
1	PRESS RM 127	DOWNLIGHTS & WALLWASHER	1	DIM	LED	4500	954	-
2	-	SPARE	2	DIM	-	4500	2925	-
3	-	SPARE	3	DIM	-	4500	2925	-
4	PRODUCTION 129	FLUORESCENT TROFFERS	4	DIM	FLUORESCENT	4500	272	-
5	-	SPARE	5	DIM	-	4500	2925	-
6	-	SPARE	6	DIM	-	4500	2925	-
7	-	SPARE	7	DIM	-	4500	2925	-
8	-	SPARE	8	DIM	-	4500	2925	-
GENERAL NOTES:								
A. PROVIDE SEPARATE NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT.				CONNECTED LOAD =	18.776	KVA		1.74
				DEMAND LOAD =	18.776	KVA		
				MIN AIC RATING =	65,000	AMPS SYM		
				LOCATION				

Short Circuit Study:

For part of the electrical thesis requirements a short circuit study is required. We are to address a single path through the electrical distribution system. I have chosen to go from the switchboard to panel MCT and then to panel RCT. The breakers go respectively in size from 3000A to 300A to 50A. I found TCC curves from Schneider Electric's website and overlaid them in photoshop to see how they overlap.

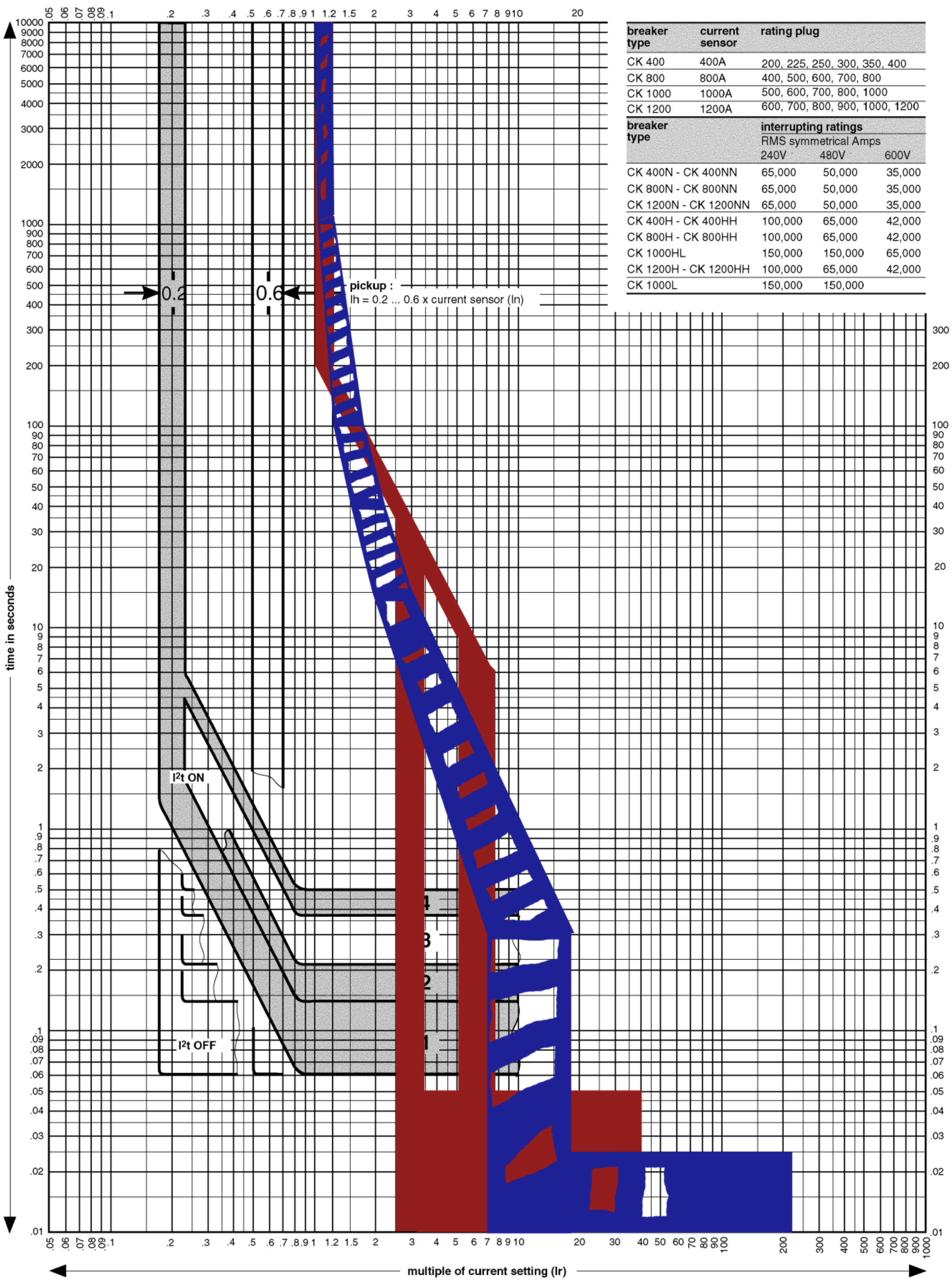
The **grey** outline is the 300A breaker and the **red** is the 3000A breaker. The **blue** is the 50A breaker TCC. As can be seen the breakers cross paths and are not coordinated. The TCC cutsheets are included in the appendix.

molded case circuit breakers
Compact CK

ground fault protection
STR 55UP

breaker type	current sensor	rating plug
CK 400	400A	200, 225, 250, 300, 350, 400
CK 800	800A	400, 500, 600, 700, 800
CK 1000	1000A	500, 600, 700, 800, 1000
CK 1200	1200A	600, 700, 800, 900, 1000, 1200

breaker type	interrupting ratings RMS symmetrical Amps 240V	480V	600V
CK 400N - CK 400NN	65,000	50,000	35,000
CK 800N - CK 800NN	65,000	50,000	35,000
CK 1200N - CK 1200NN	65,000	50,000	35,000
CK 400H - CK 400HH	100,000	65,000	42,000
CK 800H - CK 800HH	100,000	65,000	42,000
CK 1000HL	150,000	150,000	65,000
CK 1200H - CK 1200HH	100,000	65,000	42,000
CK 1000L	150,000	150,000	



MERLIN GERIN

july 94

Short Circuit Calculations:

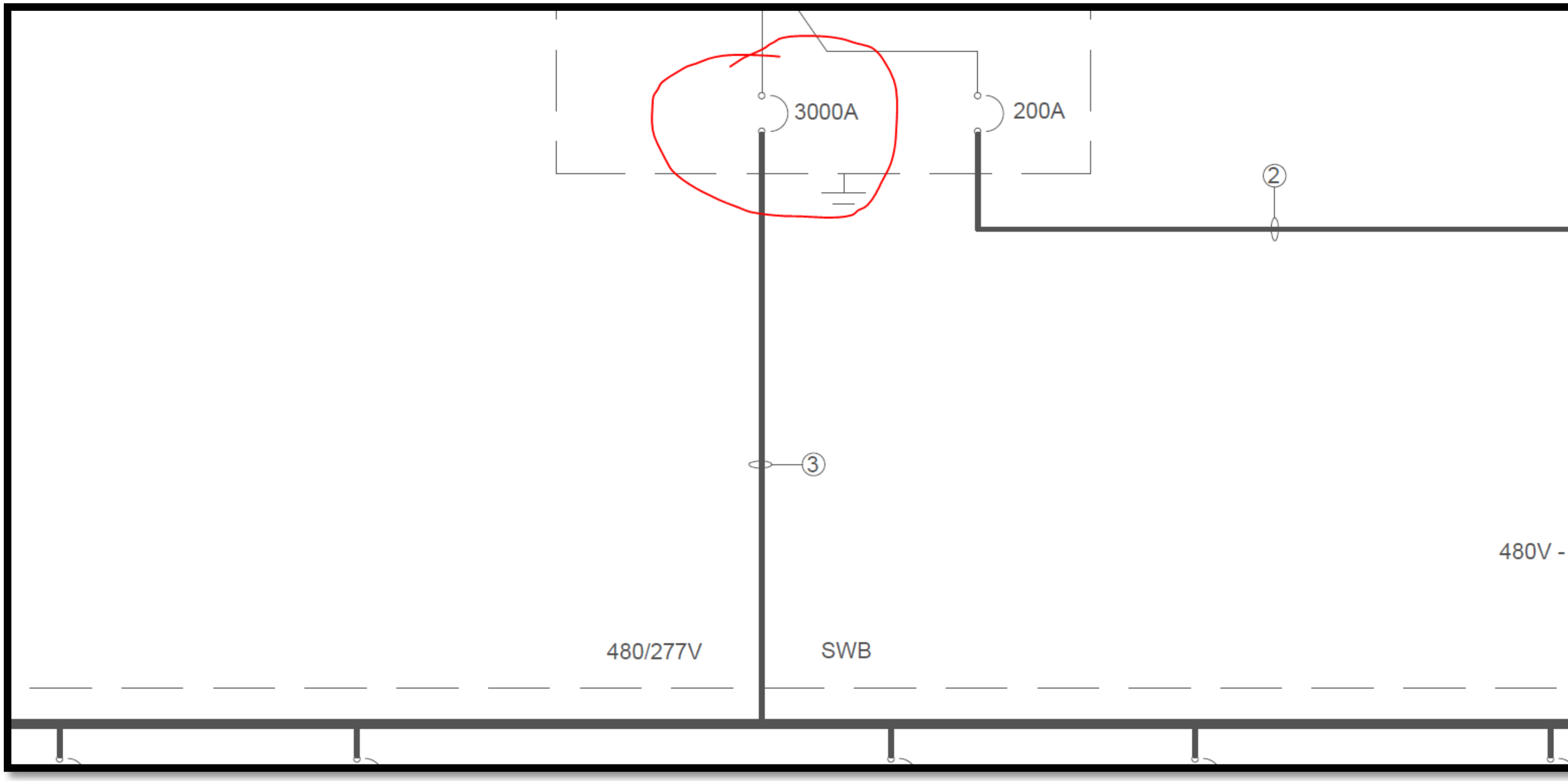
For the short-circuit calculations the wire is THWN, and the utility short circuit kVA is 100000 and the system kVA is 3000. The conduit is aluminum. Panel MCT is 220' away from the switchboard outside. The following are the calculations and an image of the single line.

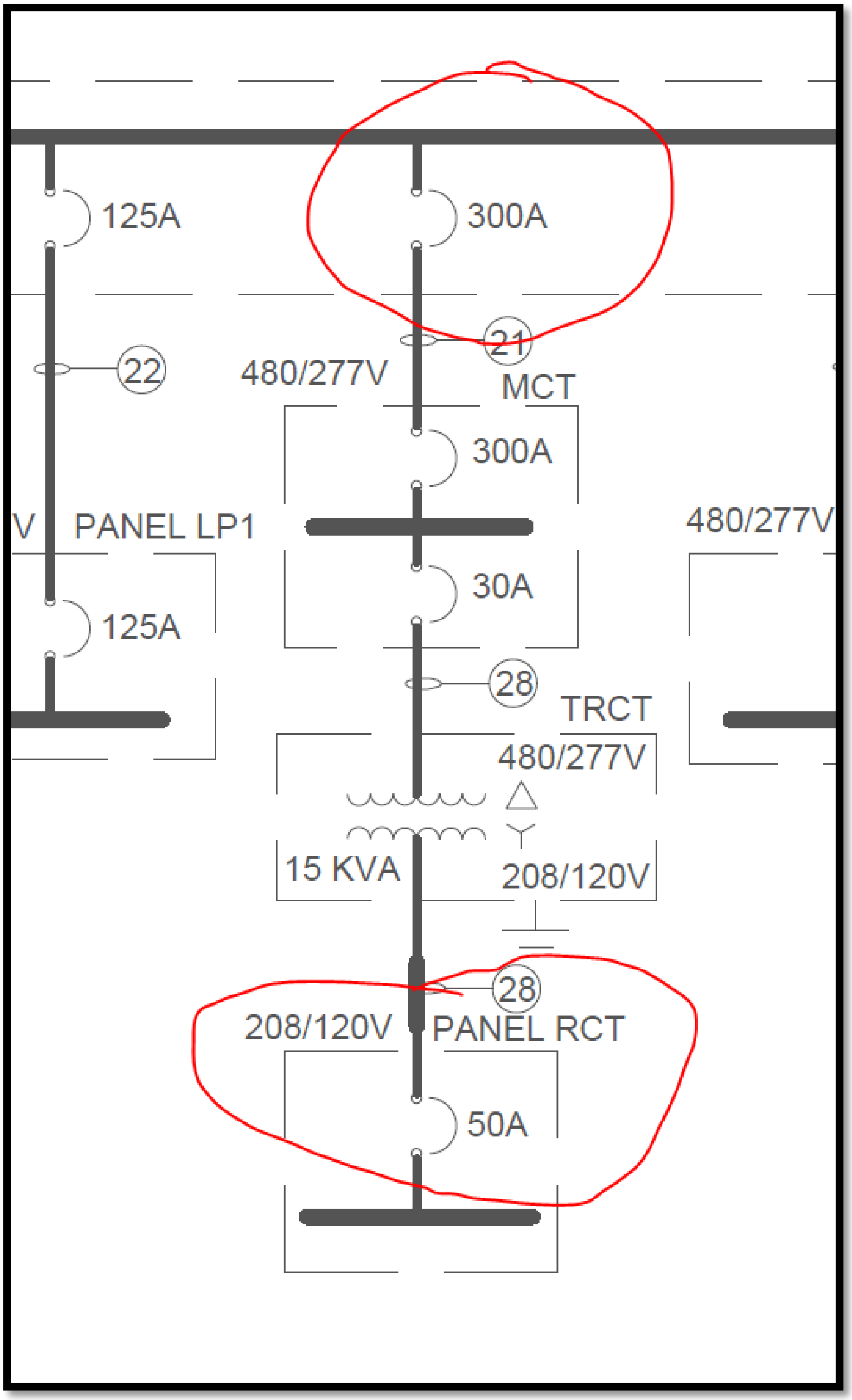
System KVA	Utility Kva
3000	100000

Utility
X = BASE KVA/UTILITY S. C. KVA = .03

Panel Bkr	Base KVA	Voltage	Wire	Length	Sets	XL table	R table	XL calc	R calc	∑XL calc	∑R calc	Z	Isc
SWB 300A bkr	3000	480	#500	10	11	3.03	2.44	0.002755	0.002218	0.035866	0.028883	0.046050	78361.37
MCT 300A bkr	3000	480	#350	220	1	3.11	3.33	0.684200	0.732600	8.908854	9.539063	13.052256	276.4691
RCT 50A bkr	3000	208	#10	5	1	3.71	101.8	0.018550	0.509000	1.286289	35.294933	35.318364	235.7813

Equation for Z	((∑X)^2+(∑R)^2)^.5
Equation for Isc	base KVA/sqrt(3)/kV/Z
Equation for XL & R calc	(Length/1000*(XL or R)*1/# of sets)
Equation for XL(p.u) & R (p.u.)	(XL or R calc) * base KVA/1000/kV^2


3000A
200A
2
3
480V -
480/277V
SWB


125A
300A
22
21
480/277V
MCT
300A
V
PANEL LP1
480/277V
30A
125A
28
TRCT
480/277V
15 KVA
208/120V
28
208/120V
PANEL RCT
50A

Emergency Generator Analysis:

Introduction:

For the first electrical depth topic I did an emergency generator system cost analysis. I took the existing system and found the loads and costs. Then I came up with three new system costs based on generator size, breaker size, and panel load size. Once I found the three different loads, I came up with pricing for the new systems.

Hypothesis:

For the cost analysis, my hypothesis was that calculating the system needs based on panelboard loads would be the least expensive. I figured that the generators would be sized the largest with the largest factor for safety. The individual loads would not be quite as large and therefore would be cheaper.

Method:

As I have said before I calculated the needs of the emergency generator system based on the generator size, feeder size, and the panelboard size. The existing system has three generators, and to lower costs I have designed a system using two generators. The following is a breakdown of the loads and costs.

The RS Means 2010 Electrical Cost Data was used. A diesel-engine-driven generator set was used that includes the battery, charger, muffler, automatic transfer switch & day tank.

Generator Sizing:

The existing system uses three 150 kW generators and I would like to compare the cost of two 250 kW generators.

RS MEANS ELECTRICAL COST DATA 2010 PACKAGED GENERATOR ASSEMBLIES												
				Daily	Labor		2010 Base Costs					
	Amount	Size	Crew	Output	Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P	System Total
Existing	3	150	R3	0.26	76.92	Ea.	43500	3725	530	47755	54000	162000
Redesign	2	250	R3	0.23	86.96	Ea.	57500	4200	600	62300	70000	140000

The cheaper solution appears to be a redesign with two 250 kW generators.

Circuit Breaker Sizing:

The loads go to two separate buildings. With a two generator emergency system, the larger of the two building loads will need to be accounted for. By the table below, the generator will need to handle roughly 500 kW due to sizing the generator so that loads are 80% of the generator size.

Circuit Breaker Sizes							
BUILDING		CB SIZE	TAG	VOLTAGE	AMPS	KVA	kW
TC	ATS 2	3P-125A	17	480	125	103.92	83.13844
TC	ATS 4	3P-100A	19	480	100	83.14	66.51075
TA	ATS 1	3P-125A	17	480	125	103.92	83.13844
TA	ATS 3	3P-100A	19	480	100	83.14	66.51075
TA	ATS 5A	3P-150A	15	480	150	124.71	99.76613
TA	ATS 5B	3P-150A	15	480	150	124.71	99.76613
TA	JOCKEY	3P-60A	13	480	60	49.88	39.90645
						TC TOTAL	149.65
Design Size = 538x1.25=673kW						TA TOTAL	389.09

RS MEANS ELECTRICAL COST DATA 2010 PACKAGED GENERATOR ASSEMBLIES												
				Daily	Labor		2010 Base Costs					
	Amount	Size	Crew	Output	Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P	System Total
Existing	3	150	R3	0.26	76.92	Ea.	43500	3725	530	47755	54000	$162000
Redesign	2	350	R3	0.2	100	Ea.	70000	4825	690	75515	85000	$170000

It appears that the existing system of three generators is the cheaper solution by about $8000.

The final method of calculating a cost analysis will be to calculate the loads on the panels that are fed through the ATSs. I have broken the panels down by Towson Center and Towson Arena.

Panelboard Load Sizing:

TOWSON ARENA PANEL LOADS				
PANEL	VOLT.	TOTAL	DEMAND	kW
EP1	480	61.5	60.2	48.16
SP1	480	104.2	81	64.8
SE4A	480	114	91.2	72.96
SE4B	480	100.8	80.6	64.48
JOCKEY	480	22.45	22.45	17.9579
TOTAL				268.35

TOWSON CENTER PANEL LOADS				
PANEL	VOLT.	TOTAL	DEMAND	kW
E1	480	12.8	12.8	10.24
S1	480	52	35.8	28.64
TOTAL				38.88

This puts the load for emergency panels at around 307.24. With a size up factor, the total is 384 kW. So two 200 kW generators can service this need.

RS MEANS ELECTRICAL COST DATA 2010 PACKAGED GENERATOR ASSEMBLIES												
				Daily	Labor		2010 Base Costs					
	Amount	Size	Crew	Output	Hours	Unit	Material	Labor	Equipment	Total	Total Incl O&P	System Total
Existing	3	150	R3	0.26	76.92	Ea.	43500	3725	530	47755	54000	162000
Redesign	2	200	R3	0.24	83.3	Ea.	48800	4025	575	53400	60000	120000

It appears that having 2 larger generators to cover the emergency panels' loads is cheaper than the existing 3 backup generator system.

Conclusion:

Based on the results, there are two options that provide a cheaper solution for the emergency generator system. If the system is sized based on the existing generators, having two generators instead of three is cheaper. If the system is sized by the circuit breakers, then having 3 generators at 150kW each is cheaper. Finally is the system is sized for the emergency panel load, then the cheaper solution is to use 2 200kW generators. Sizing the system based on the emergency panels is the cheapest solution, however it may have the least safety in its design.

SKM System Model:

My second electrical depth was creating a SKM model for the electrical distribution system for the Towson Arena. The program allows you to run diagnostics tests on the system once a building model is complete.

It is very easy to calculate demand loads for the system. Once all of the panels, breakers, buses and transformers are set up in the model, a simple calculation will give the demand loads for all of the panels. Load flow and Arc Flash can also be calculated with SKM.

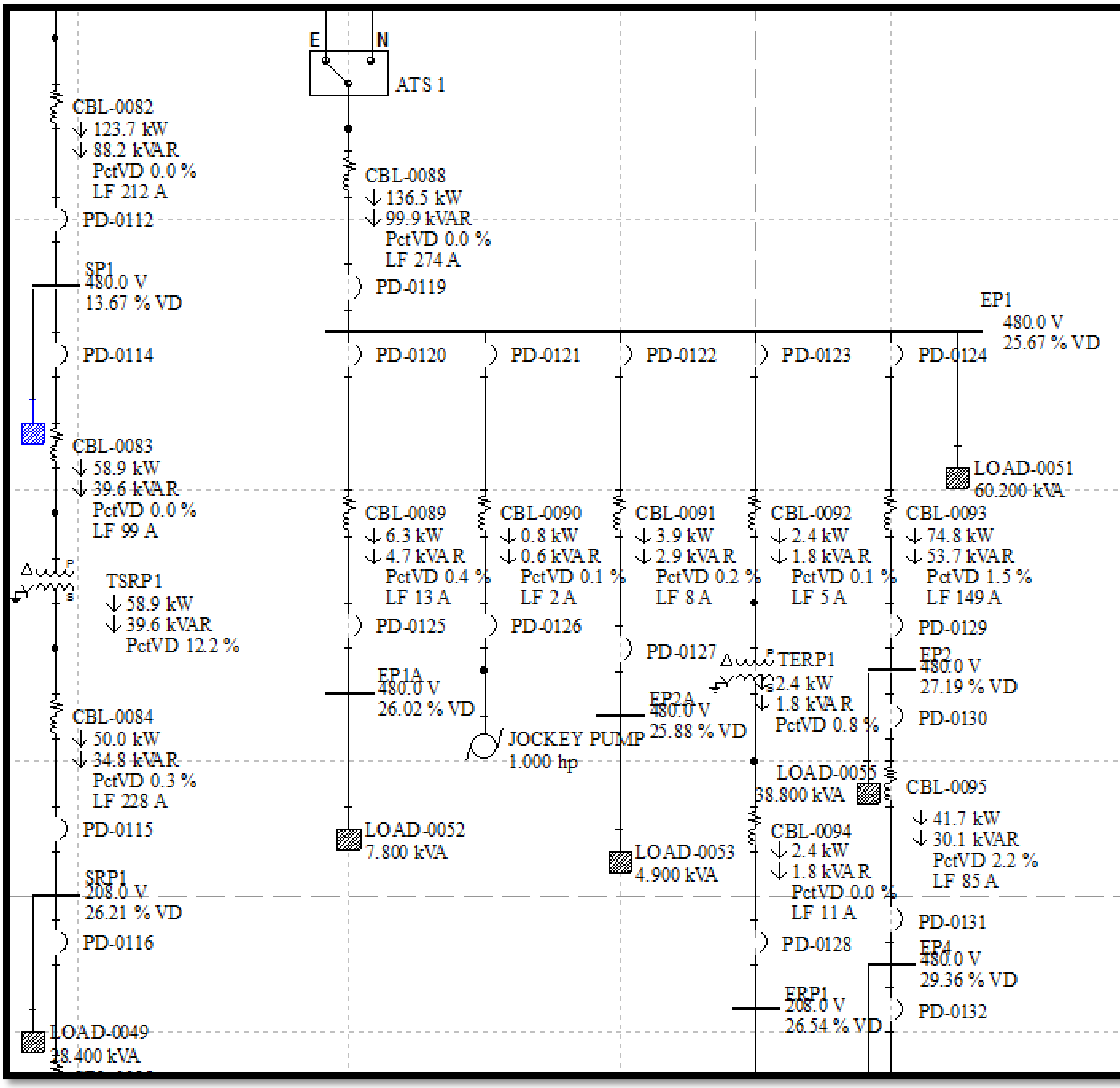
SKM is a very useful tool when calculating the short circuit rating of the system. The short circuit rating is easily calculated, and saves lots of time from hand calculations or even using an excel spreadsheet. The short circuit rating for each panel is labeled right beside it in the model. With short circuit rating calculations, SKM can also give time current curves for circuit breakers in the system.

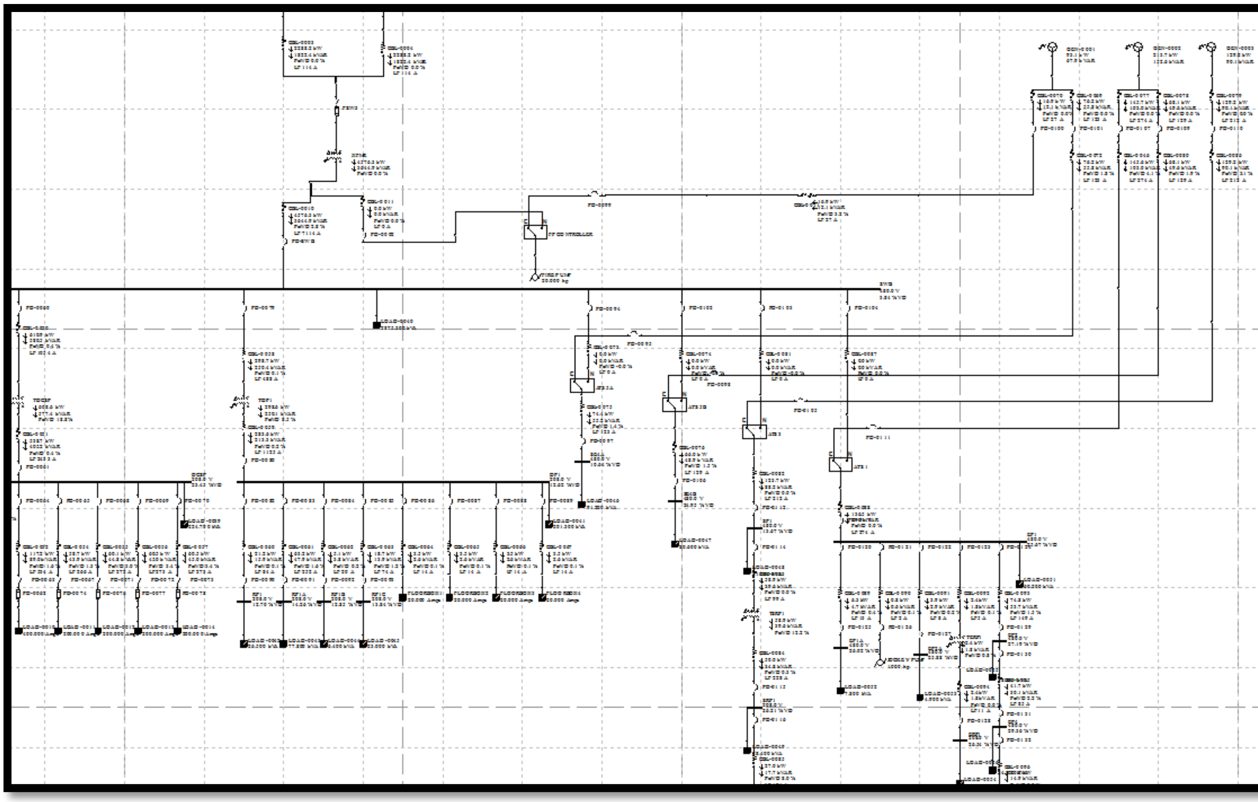
Voltage drop is another reason why SKM is such a useful tool. After the model is complete, voltage drop is easily calculated for each panel, transformer and cable that connects loads. The voltage drop on each device is clearly labeled to the side.

The user can choose from a multitude of cable, transformer, breaker, fuses, ATSs, and many other equipment in SKM. There is a library for the chooser to select specifically, exactly which equipment should be used in the system model.

SKM can be very problematic to a novice user. The model is very sensitive to the slightest malfunctions of a connection or incompatible equipment. If one part of the system model is built incorrectly, none of the analyses will run. Another drawback is the time that it takes to complete the model. A lot of time is spent tweaking every finite detail to make the system correct. In the end the user saves time with the quickness of the calculations. There is a limitation to the number of connections and equipment that can be used in the trial/student version. Only 100 electrical devices can be created within one model, so this can be a burden if a model is created for a large system.

In the end SKM is a very useful and time saving tool for electrical engineers. The information is calculated accurately and reliably once a model is correctly made. The calculations can be transferred into several different file types and formats. The user can use their discretion for the best way to view each bit of information. The following are images from the SKM model I created showing panels, breakers, pumps, ATSs, transformers and their respective loads.


ATS 1
E
N
CBL-0082
123.7 kW
88.2 kVAR
PctVD 0.0 %
LF 212 A
PD-0112
SP1
480.0 V
13.67 % VD
PD-0114
CBL-0083
58.9 kW
39.6 kVAR
PctVD 0.0 %
LF 99 A
TSRP1
58.9 kW
39.6 kVAR
PctVD 12.2 %
CBL-0084
50.0 kW
34.8 kVAR
PctVD 0.3 %
LF 228 A
PD-0115
SRP1
208.0 V
26.21 % VD
PD-0116
LOAD-0049
38.400 kVA
CBL-0088
136.5 kW
99.9 kVAR
PctVD 0.0 %
LF 274 A
PD-0119
EP1
480.0 V
25.67 % VD
PD-0120
PD-0121
PD-0122
PD-0123
PD-0124
LOAD-0051
60.200 kVA
CBL-0089
6.3 kW
4.7 kVAR
PctVD 0.4 %
LF 13 A
CBL-0090
0.8 kW
0.6 kVAR
PctVD 0.1 %
LF 2 A
CBL-0091
3.9 kW
2.9 kVAR
PctVD 0.2 %
LF 8 A
CBL-0092
2.4 kW
1.8 kVAR
PctVD 0.1 %
LF 5 A
CBL-0093
74.8 kW
53.7 kVAR
PctVD 1.5 %
LF 149 A
PD-0125
PD-0126
PD-0127
PD-0129
EP1A
480.0 V
26.02 % VD
JOCKEY PUMP
1.000 hp
EP2A
480.0 V
25.88 % VD
TERP1
2.4 kW
1.8 kVAR
PctVD 0.8 %
EP2
480.0 V
27.19 % VD
PD-0130
LOAD-0052
7.800 kVA
LOAD-0053
4.900 kVA
LOAD-0055
38.800 kVA
CBL-0095
41.7 kW
30.1 kVAR
PctVD 2.2 %
LF 85 A
CBL-0094
2.4 kW
1.8 kVAR
PctVD 0.0 %
LF 11 A
PD-0128
PD-0131
EP4
480.0 V
29.36 % VD
ERP1
208.0 V
26.54 % VD
PD-0132



Acoustic Breadth:

For my acoustical breadth I studied the acoustical characteristics of the court area. The court's primary purpose is for sporting events, but it can also be used as a concert hall or ceremony space. In my calculations I show the requirements for each space and suggestions for the best design.

The court's dimensions are 187'x137'x74'. I chose to analyze the space with the method of calculating Reverberation time. Depending on the use of the space, different reverberation times are desired. Wallace Sabine originally used reverberation time, and identified reverberation with the time it took for the sound of a room to decrease by 60 dB(4).

In Egan's book on Architectural Acoustics there is a figure that gives the designed reverberation times for multiple occupancies, which can be seen in the figure below. I decided to set the court space to be used for a multipurpose auditorium and Dance and Rock concerts. The desired reverberation time for a multipurpose auditorium is 1.4-1.9s and 0.8-1.3s for rock concerts.

The court space has painted walls and wood floors above concrete. There is also a steel truss system at the top of the space with metal deck above that. Seating also covers a large area of the court, and it has different absorptive values depending on if the seats are full or empty.

The following information and tables display the design criteria for calculating reverberation time. The equation is displayed, and my calculations are also visible.

T = (0.05)*Volume/a

The following equation takes a constant multiplied by the volume divided by the average of the sabins at 500 and 1000 hertz. I took the area of the interior of the court and found the corresponding sabin level for all the materials. Once I found the average sabins for 500 and 1000 hertz and the volume of the court I could find the reverberation time. The following figure shows my calculations:

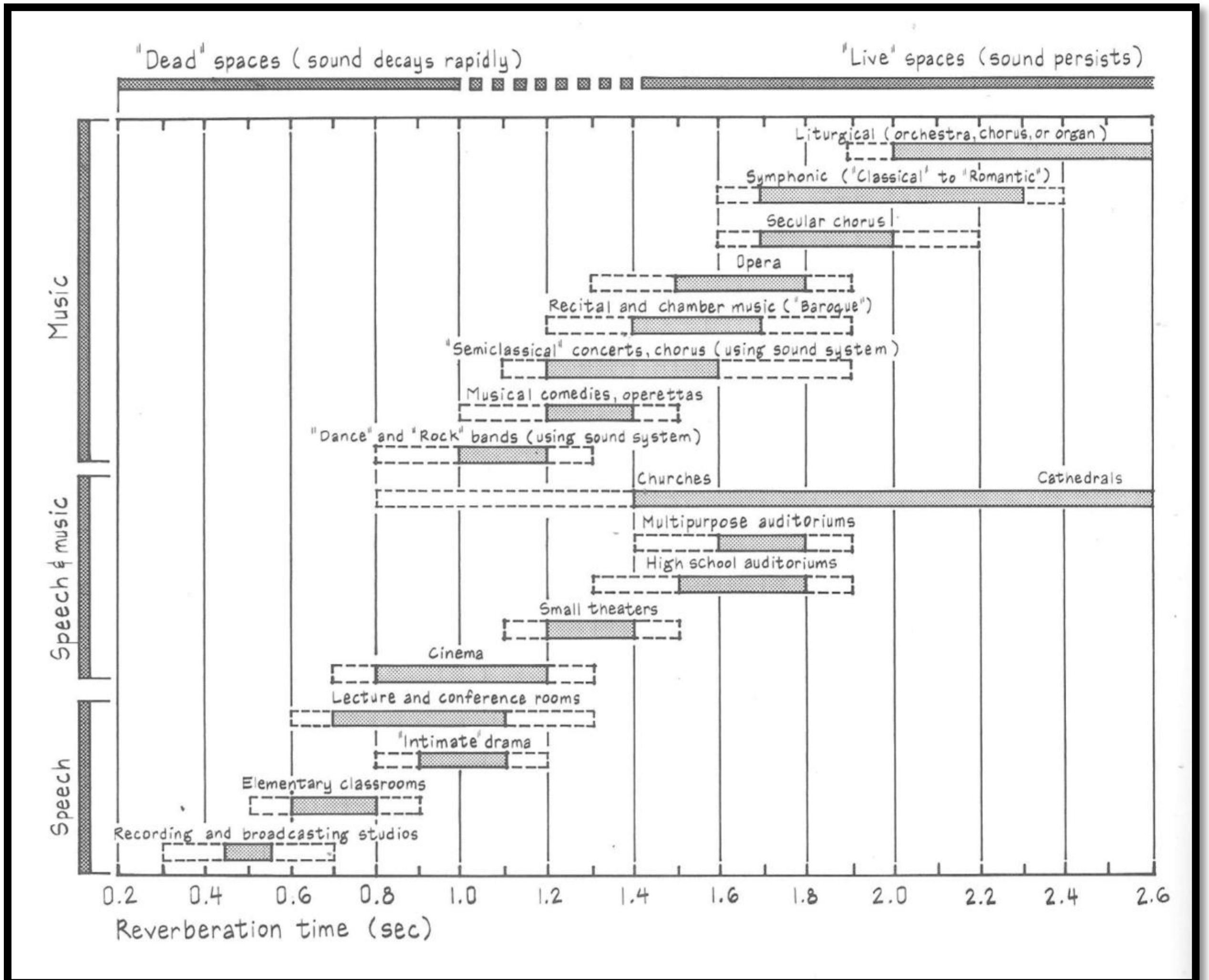


Figure: Reverberation Times from Egan

Location	Finish	Length	Width	Area	Material	500 Sabins	Sabin*ft2	1000 Sabins	S*ft2
Wall	paint	642	61	39162	conc. Blk painted	0.06	2349.72	0.07	2741.34
Floor	wood	187	134	25058	wood parquet on conc.	0.07	1754.06	0.06	1503.48
long trus		10	134	1340	steel	0.1	134	0.1	134
lat trus		4	187	748	steel	0.1	74.8	0.1	74.8
scrbd		5	256	1280	linoleum	0.03	38.4	0.03	38.4
mtl deck				22970	1.5" Acoustic Deck	0.79	18146.3	1.01	23199.7
Upper Deck Seating	unoccupied seats	464	24	11136	chair	0.22	2449.92	0.39	4343.04
Lower Tier Seating	unoccupied seats	496	42	20832	chair	0.22	4583.04	0.39	8124.48
Audience Upper	upholstered seats	464	24	11136	seated person	0.8	8908.8	0.94	10467.84
Audience Lower	upholstered seats	496	42	20832	seated person	0.8	16665.6	0.94	19582.08
						Total	55104.64	Total	70209.16

Figure: Sabin Calculations

Finally I calculated the reverberation time which can be seen in the figure below. The court with no spectators had a reverberation time of 2.19s and 1.44s with the audience. With the audience filling up the space, the reverberation time is ideal as a multipurpose auditorium. For example a graduation would fill up the arena and meet the suggested criteria. However, for a rock concert the reverberation time should be lowered even further.

Attaching acoustical panels to the top of the arena below the steel truss system, the echo could be reduced significantly. Using a highly absorptive material, 15000 square feet could lower the reverberation time to 1.14 seconds. This is right in the range of 0.8-1.3 for rock concerts. This would be a relatively easy alteration by running the acoustical material the length of the arena. With a length of 187’, 80 strips would cover the 15000 square feet needed to drop the reverberation time. A smaller amount of acoustical material could get the reverberation time to split the two criteria at 1.35 seconds. Only 4000 square feet of the acoustical material would be needed which would be 22 stips at 187 feet long. This is however assuming that the arena is nearly full of occupants, but having removable acoustical strips would be a good solution. The catwalk would be an easy way to mount this material.

Glazing Breadth:

The Court space is circumscribed by a clerestory at the top of the space. This allows light and heat in and is susceptible to higher heat losses than a regular wall as well. I did an analysis of several different types of glazing and how the cooling load is affected during the course of a year.

I created a model in revit for the court. The court space is 187’ x 137’ x 74’. I used the same wall types and window types as the architect’s model only my model was dumbed down for simplicity reasons. I used one space with exterior walls, and included the clerestory around the top of the court with five different types of glass. Using the five different types of glass I calculated solar gain sensible in Btu/hr, glass transmission sensible in Btu/hr, and total cooling load in tons. Please see the appendix for specific calculation sheets from Trace that gives the loads for each glass type. Below is a table of my results from my Trace model.

The five glass types that I used in Trace are 5mm single low iron, single clear ¼”, double clear ¼”, 3mm Double Low-E(e2 = 0.1) Clear 6mm Air, and 3mm Double Low-E(e2 = 0.04) Clear 13mm Air. The Low(e2) means that two of the glass panes are coated with the shading material that helps to block out sunlight(5). The U-factors for the glass types decrease with the previous list. So as the U-factor decreases(Btu/hr/F/ft^2), the amount of heat that is transferred through the material also decreases. So a higher U-factor for the glass meant more heat was being transferred. The shading coefficient of the glass also followed this trend of decreasing from the previous list. Once again as the shading coefficient decreases, less light is allowed through and therefore less heat as well.

In trace I set the occupancy to sports arena, and it automatically calculated the amount of air required. I also included the lighting for the space. My results verified that the glass with a higher U-factor and shading coefficient had the larger total cooling load. The 5mm Single Low Iron had a total cooling load in tons of 240.4 while the 3mm Double Low-E(e2=0.04) Clear 13mm Air had a total cooling load of 220.8 tons.

This translates into a difference of 20 tons of cooling. A ton of cooling load is 12,000 Btu/hr(6). It is also the amount of heat removed that would melt 2000 lbs of ice in 24 hours. A lot of energy can be saved over the course of a year by using the Low-E glass.

Trace Designation	U-Factor	Shading Coefficient	Solar Gain Sensible Btu/hr	Glass Transmission Sensible Btu/hr	Total Cooling Load ton
5mm Single Low Iron	1.037	1.04	311,753	75,628	240.4
Single Clear ¼”	0.95	0.95	292,987	67,750	238.4
Double Clear ¼”	0.6	0.82	261,496	43,312	233.7
3mm Double Low-E (e2=.1) Clear 6mm Air	0.432	0.69	179,578	31,711	225.7
3mm Double Low-E (e2=.04) Clear 13mm Air	0.295	0.5	131,021	21,685	220.8

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Appendix: