Landon Roberts
Lighting/Electrical Option
5/16/08
Advisor: Dr. Houser and Mr. Dannerth

The Anne and Michael Armstrong Medical Education Building

Illustration courtesy of Ballinger

Johns Hopkins University School of Medicine
Final Report

The Anne and Michael Armstrong Medical Education Building

Johns Hopkins School of Medicine

Project Team

Owner	Johns Hopkins University
Architect	Ballinger
Structural	Rummel Klepper & Kahl
MEP	Ross Infrastructure, Inc.
Lighting Designer	The Lighting Practice
General Contractor	Barton Malow Company

Building Stats

Size	110,000 SF.
Levels	4
Delivery Method	Design-Bid-Build
Construction Dates	June 2007 - June 2009

Architecture

Southwest glass curtain wall full height facade

Four story ellipsoidal atrium

Four college lounges on second floor

Large cafe and auditoriums on first floor

Lighting

Recessed 32W triple tube round and square compact fluorescent downlights in major circulation spaces

Recessed and pendant high output T5 linear fluorescent fixtures in work spaces.

Occupancy sensor, photocell, astronomical time clock and wall switch combinations in spaces with daylighting.

Structural

3-1/4" lightweight concrete system on 3" deep, 20 gage galvanized composite steel deck.

Roof slab to be 4-1/2" normal weight concrete 3" deep 18 gage galvanized metal deck.

Skylight roof to be 1-1/2" deep, 20 gage galvanized metal deck.

5" normal weight concrete foundation reinforced with 6X6-W2.9XW2.9 WWF

Electrical

13200V at 1500kVA service from adjacent pump house building to 480Y/277V, 3Φ 4W transformer

300kW/375kVA 480Y/277V emergency generator

Mechanical

Primarily a VAV Reheat System with hot water reheating with a constant system exception in the anatomy labs

(3) 45,000 CFM, 781.5 MBH air handling units on penthouse level

Landon K. Roberts
Lighting/Electrical Option | http://www.engr.psu.edu/ae/thesis/portfolios/2008/lkr116

Table of Contents

Executive Summary

The new Armstrong Medical Education Building on the John Hopkins University medical campus is a modern fusion of cutting edge technology and a multi-purpose facility to provide for every need of the student throughout the course of the day. Within the four walls of this 26,000 feet footprint, 66 feet high, four storey building lies faculty offices, full showering and bathroom facilities, classrooms, conference rooms, a café and lounges all connected to a large atrium in the center of the building.

This report will specifically focus on a lighting and electrical redesign. The lighting redesign will consider four spaces: the auditorium, an anatomy laboratory, a central atrium space as well as the south façade and plaza. The electrical redesign will cover a branch circuit analysis, protective device coordination study, a motor control center design as well as an analysis of a central transformer versus a distributed transformer design. It will also cover the electrical impact of the lighting redesign in the four spaces that were analyzed. This report also includes an exploration in the structural design and mechanical designs that will be impacted by the lighting redesign.

The work done unto this point has given me an opportunity to better understand and appreciate the collaborative efforts between the various professions in the building industry. In the case of this project the integration of the lighting, electrical, structural and mechanical design efforts are paramount to end at the optimal finished product.

Project Background

The Armstrong Medical Education Building is located on the John Hopkins University medical campus in Baltimore, Maryland. Beginning construction in the fall of 2007, the building will be a modern fusion of cutting edge medical and educational technology and a multi-purpose facility to provide for every need of the student throughout the course of the day. Within the four walls of this 26,000 feet footprint, 66 feet high, four storey building lies faculty offices, full showering and bathroom facilities, classrooms, conference rooms, a café and lounges all connected to a large atrium in the center of the building.

This state of the art facility on the medical campus was designed by Ballinger Architects with the lighting designed by the Lighting Practice. The MEP work was done by Ross Infrastructure, Inc. One of the key features of the Armstrong building are the four lounges on the third floor that provide a place for students to relax, store belongings and interact with students in other years in the medical program. The largest space in the building is a three storey atrium in the center of the building with a large roof skylight. On the south side of the building is a full height glass curtain wall that, when partnered with the large roof skylight above the atrium, allows a considerable amount of daylight to penetrate into the building. The rest of the façade of the building consists of brick.

Upon completion at the end of 2009, this building will become the new home of the John Hopkins' medical program. It will give all of the students a hub to interact and learn from eachother as well as a comfortable, hi-tech facility to learn in.

Building Statistics

GENERAL STATISTICS

Building Name: Anne and Michael Armstrong Medical Education Building

Location and Site: 1504 E. Jefferson Street
Baltimore, Maryland
21231

Building Occupant Name: The Johns Hopkins University School of Medicine

Size: 110,000 Sq. Ft.

Number of Stories Above Grade: 4 stories and 2 mechanical floors on the roof

Dates of Construction: June 2007 – June 2009

Project Delivery Method: Design – Bid – Build

PRIMARY PROJECT TEAM

Building Owner:	The Johns Hopkins University
Architect:	Ballinger http://www.ballinger-ae.com/
Structural Engineer:	Ballinger http://www.ballinger-ae.com/
MEP:	Ross Infrastructure, Inc. http://www.rossinf.com/
Civil Engineers:	Rummell Klepper & Kahl http://www.rkkengineers.com/
General Contractor:	Barton Malow Company http://www.bmco.com
Lighting Designer:	The Lighting Practice http://thelightingpractice.com/
Audio Visual:	Shen Milsom & Wilke, Inc. http://www.smwinc.com/
Landscape:	Mahan Rykiel www.mahanrykiel.com/

ARCHITECTURE

The Johns Hopkins Medical Education Building is very unique for its kind. The building is meant to house the medical students mainly for their first two years before their curriculum gets hospital-intensive so everything they need is found inside. From cafés and lounges to lockers to large lecture halls, everything can be found without leaving the building.

The exterior shell of the building mainly consists of brick with stone to accentuate the L-shape of the building and other architectural highlights on the façade. Facing the southwest a huge glass curtain wall opens up a full-story atrium to the exterior landscape and allows daylight to penetrate a large portion of the building.

On the ground floor there are two main lecture halls and a café for students and faculty as well as office space. At the bottom of the atrium there is an open lounge for students to gather, study and relax.

The second floor consists of several lounges that will be places for students to gather, store their belongings in lockers and to relax in. The idea here was to give the students a chance to mingle with other classes in order to gain insight on their future courses in the program. It also has a more public lounge for students along the glass curtain wall looking out onto the landscape.

The third and fourth floors all consist of labs, reading rooms and other classrooms for the students as well as a smaller lecture hall.

The roof has two levels that house the three air handling units for the building as well as a sixteen foot corridor within the air handling units for maintenance.

Building Codes/Standards:	International Building Code 2003 ASHRAE Standard 90.1 Baltimore City Building, Fire and Related Codes 2003
Zoning:	Local Zoning Laws of the City of Baltimore, Maryland

Building Envelope:

The exterior walls of the Medical Education Building primarily consists of a brick veneer cavity attached to a steel stud framing system. The first floor to the building consists of an aluminum curtain wall storefront system with 1 inch insulating glass units. Above the main entrance extrudes a similar aluminum curtain wall with 1 inch insulating glass units similar to the first floor but extruding out from the building. Supporting this three story cantilever are six large columns to match the color of the façade and to provide cover for building occupants.

The main entry to the building has two sets of sliding glass doors underneath a large canopy creating a vestibule to better control the change in temperature in the building during harsh climates.

The roof consists of a roofing membrane system on top of rigid insulation on top of a roof concrete slab. A cast stone ledge encompasses the roof.

PRIMARY ENGINEERING SYSTEMS

LIGHTING SYSTEM

The primary type of lamp used throughout the Anne and Michael Armstrong Medical Education Building is the linear and compact fluorescent lamp to minimize energy usage and to meet the design criteria. The majority of the circulation space and classroom space consists of compact fluorescent linear fluorescent downlights and wallwashers. The first floor auditorium, full height atrium and exterior promenade below the second floor also use metal halide fixtures along with fluorescent fixtures to achieve higher illuminance levels throughout the larger spaces. Each classroom space will have a Lutron Grafik Eye lighting dimming system integrated into the audio visual equipment.

The full height glass curtain wall along the southwest exterior facade of the building emits a large amount of natural daylight to penetrate far into the building. The large skylight on top of the atrium also adds a considerable amount of natural daylight into the building interior. The central circulation space, student group rooms and central meeting rooms are impacted the most from the daylight. These spaces have elaborate sensor and switch combination systems to minimize the use of electricity and to maximize the lighting levels in the various spaces.

ELECTRICAL SYSTEM

The Armstrong Medical Education Building consists of a radial system to power the building tapping power from the campus distribution system. The service comes from a 13.2kV transformer behind the adjacent pump house northeast of the building. The power enters the building in the Normal Electric room E116 to power the main switchboard. The main switchboard has 6 switches that distribute 480Y/277V power and 1 switch that distributes 280Y/120V power to a low voltage distribution panel. Two of the 480Y/277V lines connect to the emergency power. A 300KW 480Y/277V emergency generator is located on the northwest end of the site.

The secondary voltage system for the Medical Education Building is 480Y/277 volts, 3 phase, 4 wire. This system serves the majority of the lighting and mechanical loads. There is also a 480 volt, 208Y/120 volt, 3 phase, 4 wire transformer serving the low voltage distribution panel. This distribution panel feeds most of the receptacle loads in the building from an 800A busway. It also provide power to LCD screens, vending machines and projector equipment throughout the building.

STRUCTURAL SYSTEM

The foundation is a 5", normal weight slab on grade reinforced with a 6x6 W2.9xW2.9 welded wire fabric located 2" below the top of the slab. The floor structural systems are 3-1/4" lightweight concrete systems on 3" deep 18 gage galvanized metal decking. The roof slab is a 4-1/2" normal weight concrete system on a 3" deep 18 gage galvanized metal decking.

The floor slabs on each floor are supported mainly by beams ranging from W14 to W21. The second floor beams are slightly larger along the glass curtain wall to support the southwest promenade. There is an extra line of W16x 26 beams as well as extra W21 beams to support the extra load.

The skylight roof will be a 1-1/2" deep, 20 gage galvanized metal deck supported by a system of W12X14 and W16X36 beams and girders with a W36X260 across the middle of the skylight.

MECHANICAL SYSTEM

The mechanical system in the building is a VAV Reheat system with hot water reheating except in the anatomy labs where there is a constant system. There are (3) 45,000 CFM Air handling units on the roof. A large insulated return air plenum is also integrated into the skylight structure above the central atrium space.

FIRE PROTECTION SYSTEM

The building has a fully sprinklered design on all levels allowing 250 GPM hose stream. The automatic fire pump is located in the fire pump room, room 123, on the first floor. It is capable of supplying 750 gallons per minute with 75 head psi. The majority of the structure including the ceilings, floors, structural elements, elevator shafts and stairwells are rated at 2 hours.

TRANSPORTATION SYSTEM

There are three stairwells and three elevators that reach every interior floor within the building. The three elevators are located all on the west side of the building. The stairwell and elevator closest to the north end of the building reach every floor of the building including the roof. The central staircase is along the east side of the central atrium. The last staircase is on the southeast side of the building.

TELECOMMUNICATIONS SYSTEM

The Medical Education Building consists of a large audiovisual system integrated throughout the building. Throughout the classrooms and meeting rooms are interactive whiteboards combined with projectors. The anatomy lab consists of touchscreen plasma screen TV stations throughout the space. The auditorium consists of one interactive whiteboard on each half of the space and a large permanent projection screen with speakers behind them.

Lighting Depth

Preface

The Armstrong Medical Education Building is designed to cater to every need of the medical student throughout the course of the day. The lighting design will work in unison with the architecture to create a comfortable atmosphere to optimize student performance as well as compliment the architecture to increase the functionality of each space.

Four main spaces will be analyzed that are critical spaces in the building. Three of the spaces are inside of the building which are the auditorium, the anatomy laboratory and the atrium. The last space is the exterior south façade and courtyard. This analysis will include lighting plans and details of the architecture and lighting of necessary elements in the design, lighting controls, code requirements, luminaire details and light level calculations.

Auditorium

The Auditorium is the largest classroom space in the Armstrong building. With a seating capacity of 350 people, the space can be split in half to make two separate spaces each with 175 seats. The floor gradually lowers from the first floor level four feet down to the front of the room. Although this space has minimal daylight, it utilizes a Lutron GRX-4116 controls system to give the room the ability to serve its various functions.

Compact fluorescent and linear fluorescent downlighting sources are recessed in the ceiling above the seating areas. The side walls are washed with compact fluorescent downlights to provide a more spacious feeling in the space and also to highlight the finished wood acoustical panels throughout most of the room. The lighting in both sides are controlled from both the podium and entrance to the room.

Auditorium Design Criteria

Appearance of Space and Luminaires. [IMPORTANT]
The arrangement and relationship of the luminaires to the layout of the auditorium is important in order to create a uniform level of light on the seating. It will also be important to give an overhead guide to flow throughout the space above the aisles.

Color Appearance and Color Contrast. [IMPORTANT]
The importance of color along the ceiling and perimeter walls is important to enhance the wood finishes. It is also important for performing educational tasks.

Direct Glare. [VERY IMPORTANT]
This is very important in order for people to pay attention and see the front of the auditorium. Discomfort glare, overhead glare, reflected glare and disability glare are very important to address in the space to avoid visual issues in the space.

Illuminance (Horizontal). [VERY IMPORTANT]
The illuminance levels are very important on the horizontal task plane in the space to adequately supply the appropriate levels for tasks to be performed. The task plane in the space will be at 30 inches. A minimum of 10 footcandles is recommended by IESNA standards.

Illuminance (Vertical). [IMPORTANT]
The illuminance levels are very important on the vertical task plane in the space to adequately supply the appropriate levels along the front wall for chalkboard/whiteboards. It should also be uniform in order to avoid distractions. A minimum of 3 footcandles is recommended by The IESNA standards.

Light Distribution on Surfaces. [IMPORTANT]
The luminance ratios in the space should be uniform to avoid distractions and to open the space. Ceiling and wall luminance ratios should not exceed a 3:1 ratio but should be visibly different to avoid monotonousness in the space.

Light Distribution on Task Plane (Uniformly). [VERY IMPORTANT]
Non-uniform levels will be distracting and uncomfortable and will hinder the occupant from performing tasks well. Task illuminance levels should be 1.5 to 3 times higher than the immediate surroundings (aisles and walkways) to direct the attention of the occupant to the task plane.

Auditorium Design Criteria

Luminaire Noise. [IMPORTANT]
Noise from the luminaires (and HVAC equipment) is very distracting especially in a quiet space meant for presentations and lectures.

Luminances of Room Surfaces. [VERY IMPORTANT]
The space should include direct and diffuse light to the occupants to increase comfort and satisfaction to avoid shadows and dark spots.

Modeling of Faces or Objects. [IMPORTANT]
The space is designed to focus the attention to the front of the room. Most uses of the space will involve a speaker at the front of the room where the attention will be on so shadows especially on the face should be avoided.

Points of Interest. [IMPORTANT]
The front of the room is the most important part of the room and the illuminance levels should be higher here. There should also be a focus on the sides where a podium would stand in case the luminaires are switched off and the speaker uses the projector.

Reflected Glare. [VERY IMPORTANT]
Glare in this space should be avoided to ensure optimal task performance and comfort and clarity for the occupants. It is important to provide illuminance from the sides of the tasks to avoid glare.

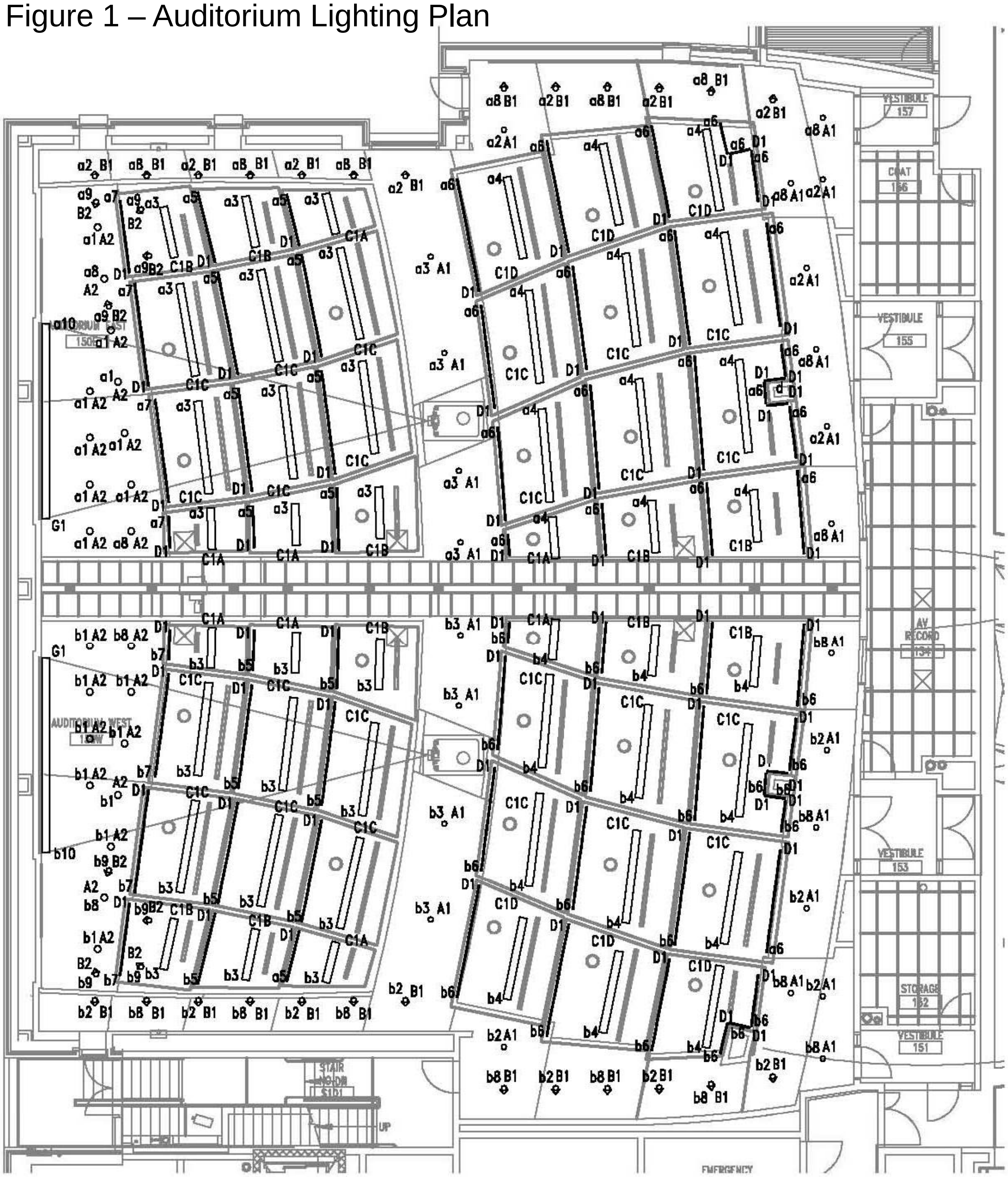
Source/Task/Eye Geometry. [VERY IMPORTANT]
The angles between the light source, the task plane and the occupant are very important in this space. Improper placement of luminaires can cause discomfort and distractions to the occupant.

Surface Characteristics. [IMPORTANT]
Surface materials and reflectances are important to increase ambient light in the room and decrease contrast from the fixtures and their backgrounds. The surfaces should be mainly a matte or satin finish to avoid glare. There is also wood finishes along the side walls to help decrease reverberations in the space.

System Control and Flexibility. [VERY IMPORTANT]
The multi-functionality of the space requires various light levels to accommodate the occupants. Lower light levels will be needed for projector-screen use and high levels will be needed for presentations and lectures using the front chalkboard/whiteboard. Dimming might also be used to lower the light levels in the space for projector-use or digital presentations.

Auditorium Lighting Plan

Figure 1 – Auditorium Lighting Plan

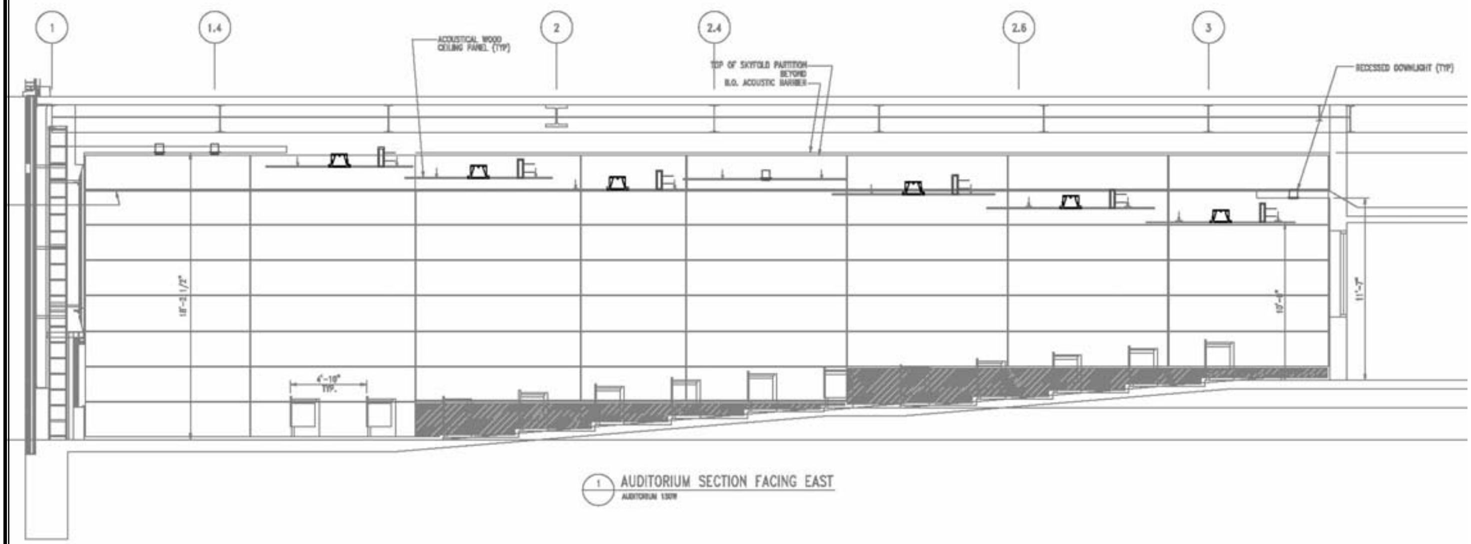


1/8"=1'-0" 1 FIRST FLOOR AUDITORIUM LIGHTING PLAN

TASK ILLUMINANCE LEVELS – PRESENTATION SETTING

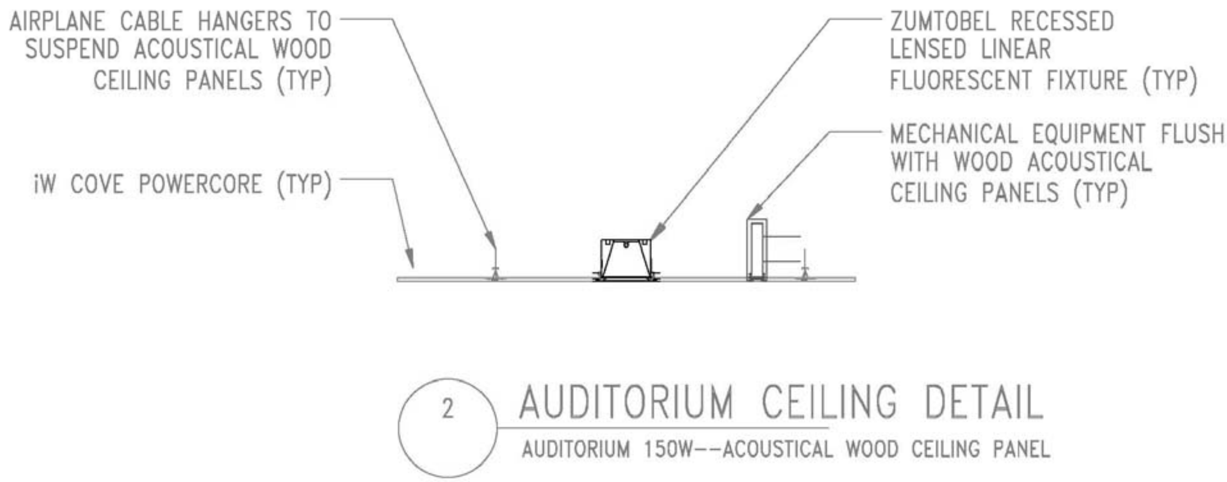
Auditorium Section

Figure 2 – Auditorium section.



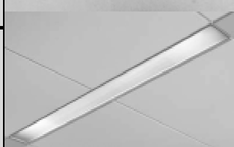
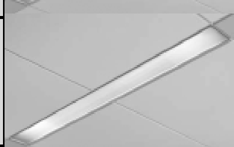
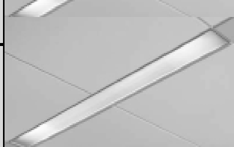
Auditorium Section Detail

Figure 3 – Auditorium Detail



Schedules

Figure 4 – Auditorium Luminaire Schedule

LUMINAIRE SCHEDULE						
FIXTURE TAG		WATTAGE	CATALOG NO.	LAMPS TYPE	BALLAST/ XFMR TYPE	TOTAL WATTAGE
A1		42	P927-Z-DM	PL-T- 42W-830-4P-ALTO	FDB-T442-277-1-S	1008
A2		84	P942-Z-DM2	PL-T- 42W-830-4P-ALTO	FDB-T442-277-2-S	1224
B1		26	S5L6113-D2-6113L-MC	PL-T-26W-830-4P-ALTO	FDB-T426-277-1	208
B2		52	S5D7204-D2-7202W-MC	PL-T-26W-830-4P-ALTO	FDB-T426-277-2	324
C1A		28	RL-I-MPO-64-1285-DE120	F28T5-830-ALTO	ECO-T528-277-1	264
C1B		35	RL-I-MPO-65-1285-DE120	F35T5-830-ALTO	ECO-T528-277-2	380
C1C		63	RL-I-MPO-64-1285-DE120 and RL-I-MPO-65-1285-DE120	F28T5-830-ALTO And F35T5-830-ALTO	(2) ECO-T528-277-1	660
C1D		52	RL-I-MPO-64-1285-DE120	F28T5-830-ALTO	(2) ECO-T528-277-2	142
D1		15	iW-COVE	WARM LED	-	6615

TOTAL WATTAGE = **7265.7 W**
SQUARE FEET = **10097 SF**
WATT/SFT = **1.39 W/SF**
ASHRAE STANDARD 90.1 = **1.4W/SF**

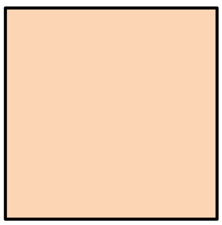
Schedules

Figure 5 – Auditorium Luminaire Light Loss Factors

LIGHT LOSS FACTORS								
TYPE	MAINTENANCE CATEGORY	ENVIRONMENT CLEANLINESS	CLEANING CYCLE	LLD	LDD	RSDD	BF	LLF
A1	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
A2	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
B1	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
B2	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
C1A	V	CLEAN	12MO.	0.93	0.87	0.97	1	0.78
C1B	V	CLEAN	12MO.	0.93	0.87	0.97	1	0.78
C1C	V	CLEAN	12MO.	0.93	0.87	0.97	1	0.78
C1D	V	CLEAN	12MO.	0.93	0.87	0.97	1	0.78
D1	V	CLEAN	12MO.	0.9	0.87	0.97	0.95	0.72

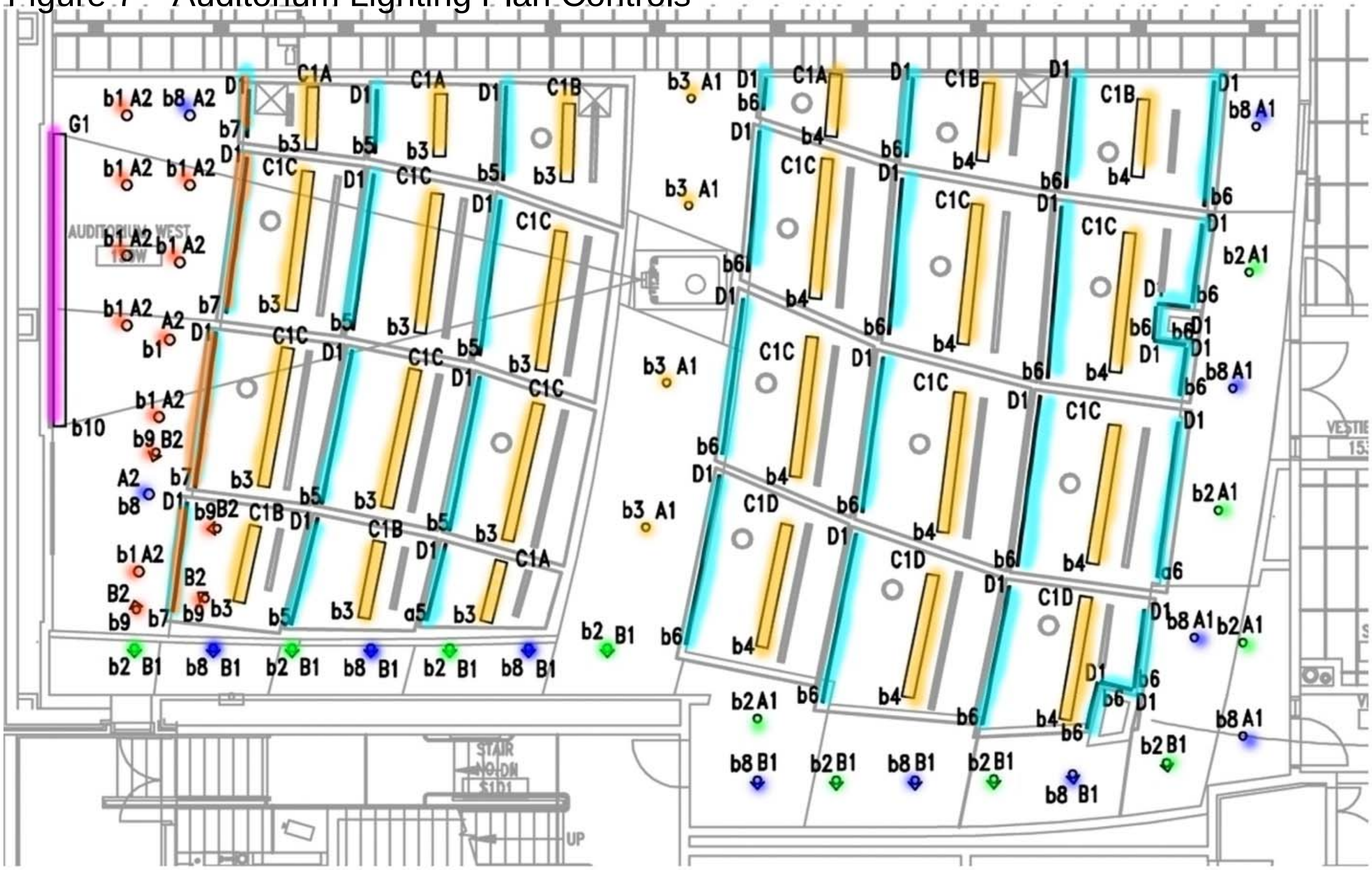
Materials

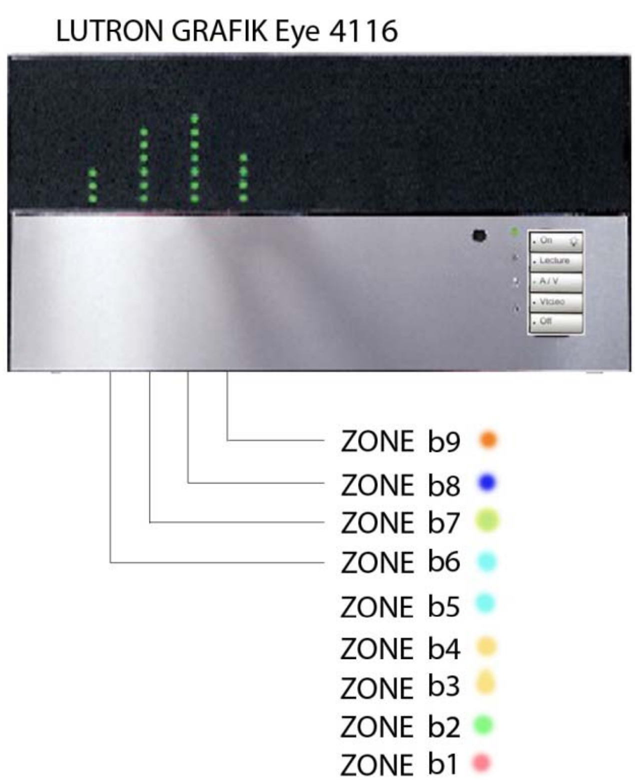
Figure 6 – Auditorium Materials

	Material	Location	Reflectance
	Acoustical Wood Panel	Ceiling	0.3
	Paint	Wall, Ceiling	0.65
	Wood Panels	Wall	0.3
	Broad Loom Carpet	Floor	0.3

Auditorium Controls

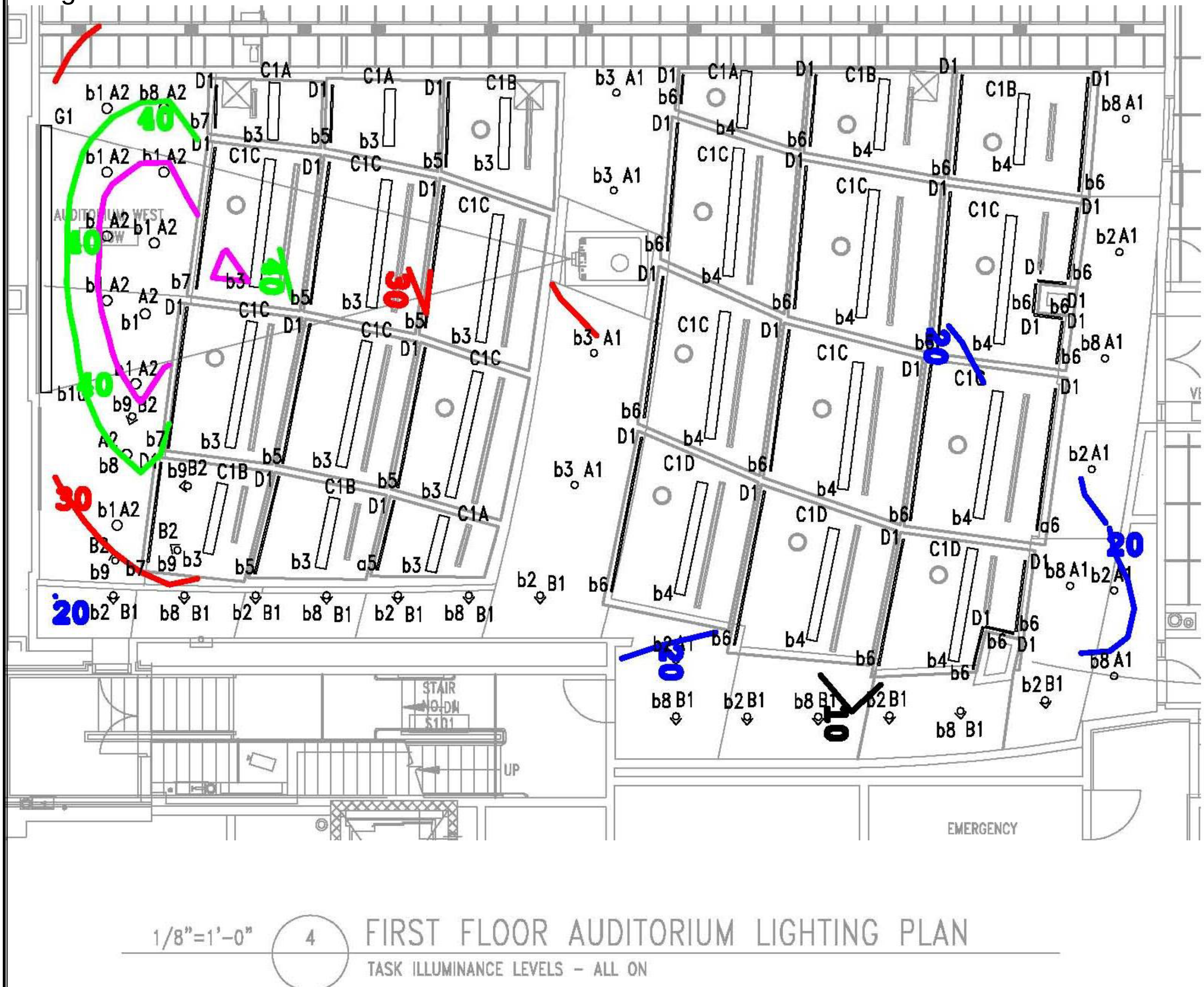
Figure 7 – Auditorium Lighting Plan Controls





Auditorium Illuminance Floor Levels

Figure 8 – Auditorium Calculations



Average Front Stage Illuminance Level: **37.43 FC**

Auditorium Illuminance Task Levels

Figure 8.1 – Auditorium Calculations

1/8"=1'-0" (3) FIRST FLOOR AUDITORIUM LIGHTING PLAN

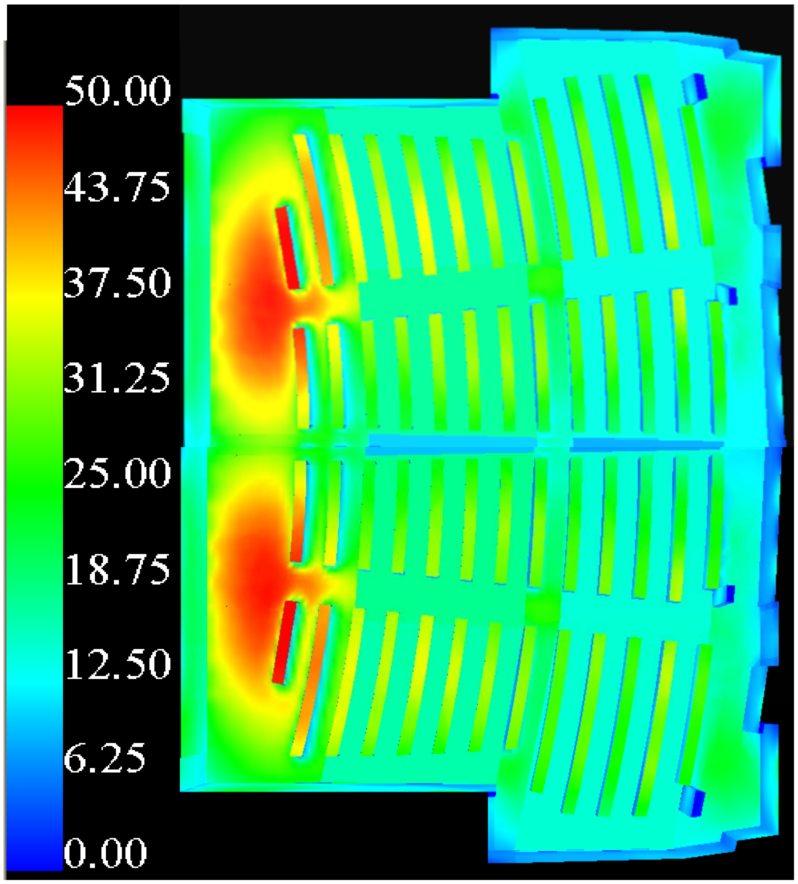
TASK ILLUMINANCE LEVELS – ALL ON

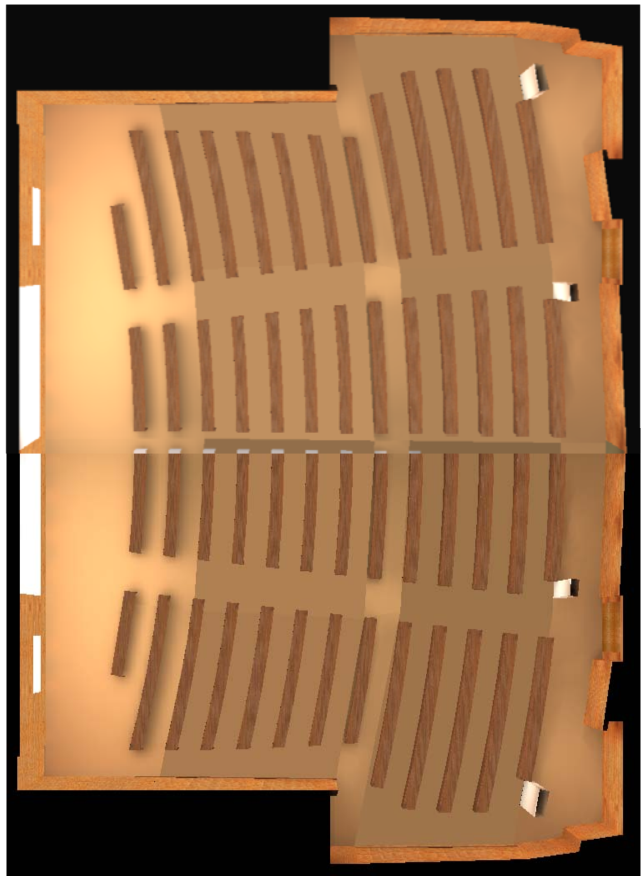
Average Task Plane Illuminance Level (2.5 feet) : **30.72 FC**

IESNA recommended illuminance level : **30 FC**

Auditorium Illuminance Levels

Figure 8.3 – Auditorium Calculations



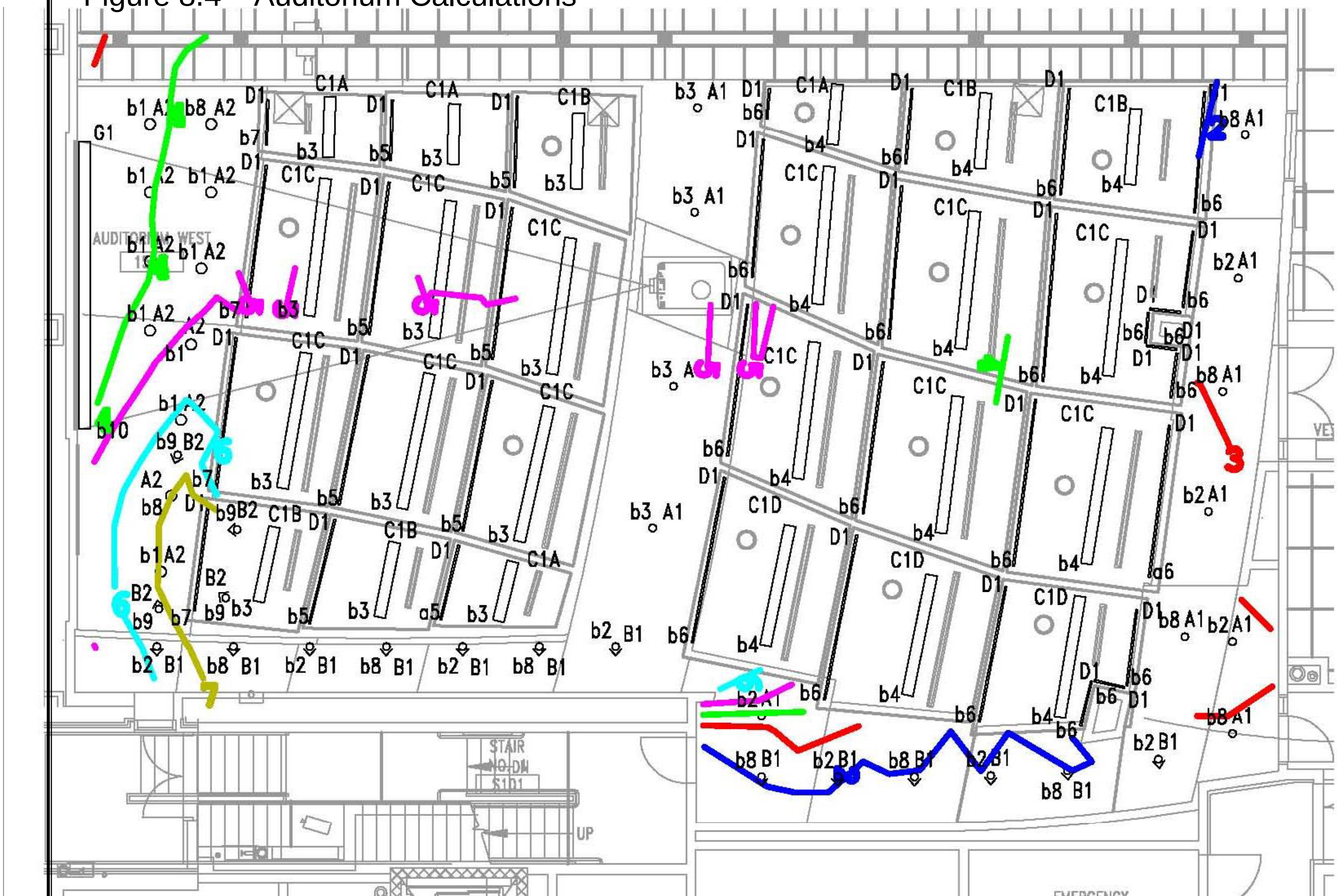


Average Task Plane Illuminance Level (2.5 feet) : **30.72 FC**

Average Illuminance Level at the front of the room : **37.12 FC**

Auditorium Illuminance Floor Levels – AV Presentations

Figure 8.4 – Auditorium Calculations



1/8"=1'-0" 2 FIRST FLOOR AUDITORIUM LIGHTING PLAN

FLOOR ILLUMINANCE LEVELS – PRESENTATION SETTING

Average Front Stage Illuminance Level: **5.12 FC**

Average Floor Illuminance Level: **4.21 FC**

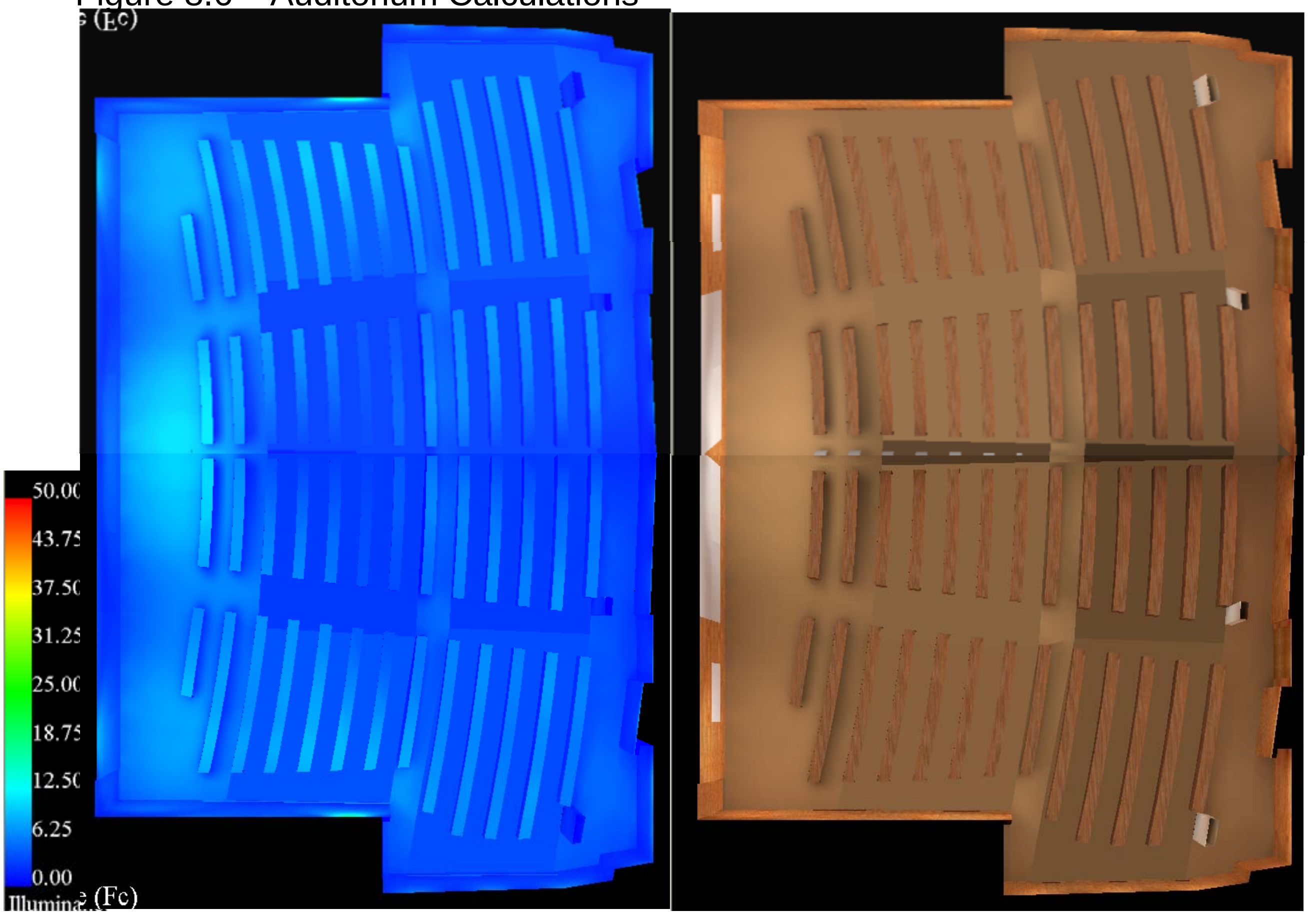
Auditorium Illuminance Task Levels – AV Presentations

Figure 8.5 – Auditorium Calculations

Average Task Illuminance Level: **6.26 FC**

Auditorium Illuminance Levels for Presentations

Figure 8.6 – Auditorium Calculations



Average Task Plane Illuminance Level (2.5 feet) : **6.26 FC**

Figure 9.1 – Auditorium Images

Auditorium 11x17

Figure 9.2 – Auditorium Images

Auditorium 11x17

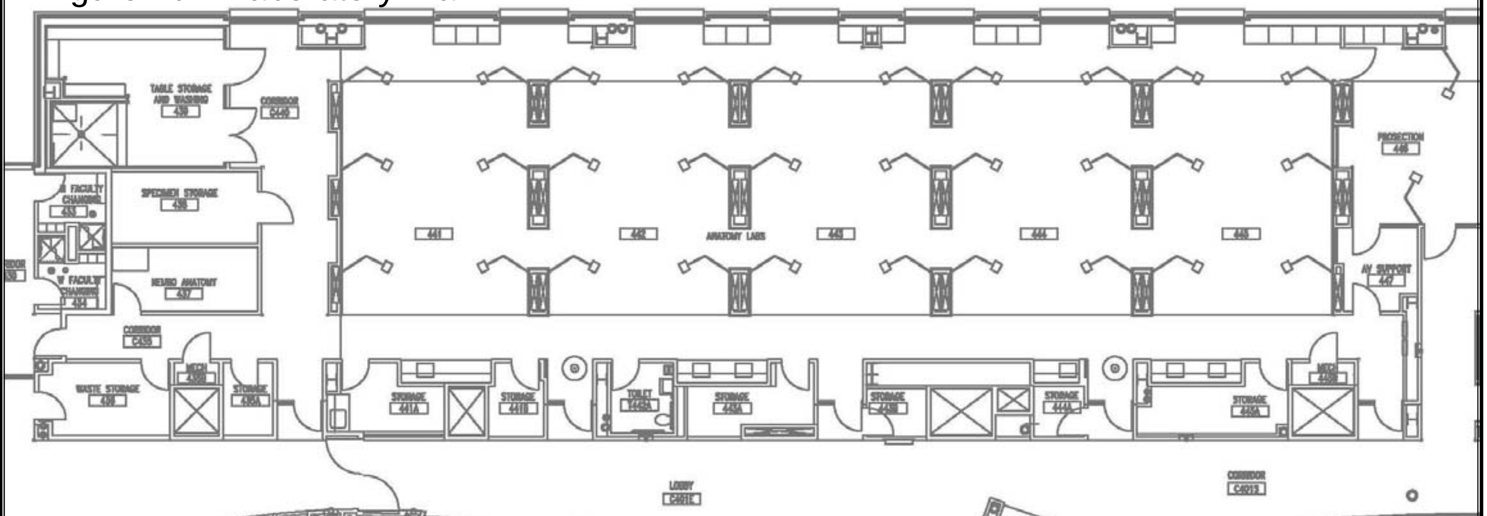
Figure 9.3 – Auditorium Images

Auditorium Design Evaluation

The redesign of the Auditorium successfully adheres to the criteria set forth in the IESNA standards as well as the power density criteria of ASHRAE 90.1. The overall lighting design enhances the wood finish so as not to clutter the space with too much visual distraction but subtly bring forth the existing architectural features in the space. To give a visual distinction between the floating ceiling and the room , LED technology was utilized to continue to reinforce the flow of the floating ceiling as the space gradually increases in height as the path of the eye continues towards the front of the room. The side fixtures bring the materials in the wall out to the viewer’s attention.

Anatomy Laboratory

Figure 10 – Laboratory Plan



On the fourth floor of the Armstrong building is a large anatomy laboratory with state of the art technology for the medical students. Divided into five main areas by large rectangular columns, the laboratory has 25 work stations.

The anatomy laboratory uses recessed fluorescent fixtures in the work areas to provide light levels on each station task plane as well as a state of the art LED surgical fixture to provide optimal levels for punctilious functions in station areas. There are also compact fluorescent downlights around the perimeter of the room to open up the space and give it more visual interest.

Anatomy Lab Design Criteria

Appearance of Space and Luminaires. [IMPORTANT]
The layout of the space with the different examination tables and flat screen TVs need higher light levels then the walkways between the different stations.

Color Appearance and Color Contrast. [VERY IMPORTANT]
Luminaires with higher CRI values should be used to see color better and distinguish between color while occupants are using anatomy stations.

Daylighting Integration and Control. [IMPORTANT]
The space is located on the eastside of the building so there will be a large amount of light entering in the morning hours. Daylighting controls should be used to compliment the daylight with electric lighting to ensure optimal light levels throughout the day and to minimize energy use.

Direct Glare. [VERY IMPORTANT]
It is very important not to have direct glare during anatomy labs. Visual clarity is very important in this space and direct glare will be very uncomfortable and distracting.

Illuminance (Horizontal). [VERY IMPORTANT]
It is very important to have appropriate light levels along the task plane. A minimum of 50 footcandles is recommended in this space.

Illuminance (Vertical). [VERY IMPORTANT]
It is very important to have appropriate vertical light levels for facial recognition. A minimum of 30 footcandles is recommended in this space.

Light Distribution on Surfaces. [IMPORTANT]
Light levels at stations should be higher than the light levels along the periphery and in the walkways between stations to direct attention to the stations.

Light Distribution on Task Plan (Uniformly). [VERY IMPORTANT]
Uniform lighting along task plane is essential for performing critical tasks along stations that require visual detail. There should not be any shadow around work station.

Anatomy Lab Design Criteria

Luminances of Room Surfaces. [IMPORTANT]
An average of 30-100 candela per square meter are recommended for wall luminance levels in a workspace to increase brightness along the periphery of the room.

Modeling of Faces or Objects. [VERY IMPORTANT]
The depth and shape of objects are important in this space to see and be able to perform necessary tasks at stations throughout the space in order to see the small details.

Points of Interest. [VERY IMPORTANT]
The stations and TVs are the points of interest in the space and should have higher illuminance levels than the walkways between the stations.

Reflected Glare. [VERY IMPORTANT]
Glare should be avoided to minimize distraction and discomfort in the space. The daylight and electric lighting both could hinder the tasks being performed. Reflected glare from the TV screens also needs to be avoided in order that the students can easily see the screen.

Shadows. [IMPORTANT]
Shadows should be avoided in this space due to the important visual tasks being performed at the stations throughout the room.

Source/Task/Eye Geometry. [VERY IMPORTANT]
Due to the importance of the visibility of the tasks being performed, the sources should not interfere with the vision of the occupants.

Anatomy Laboratory “Space within a Space” concept

Figure 11 – Laboratory Section

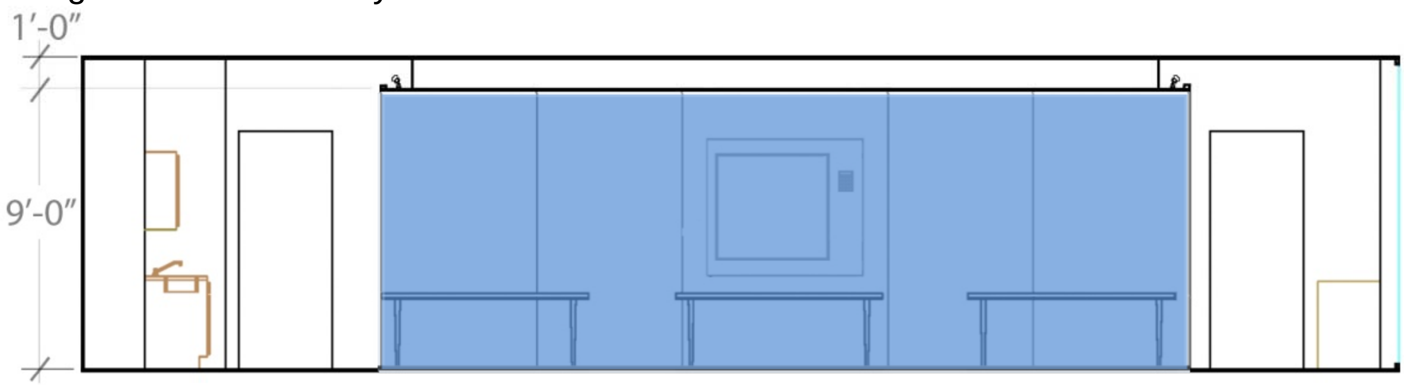
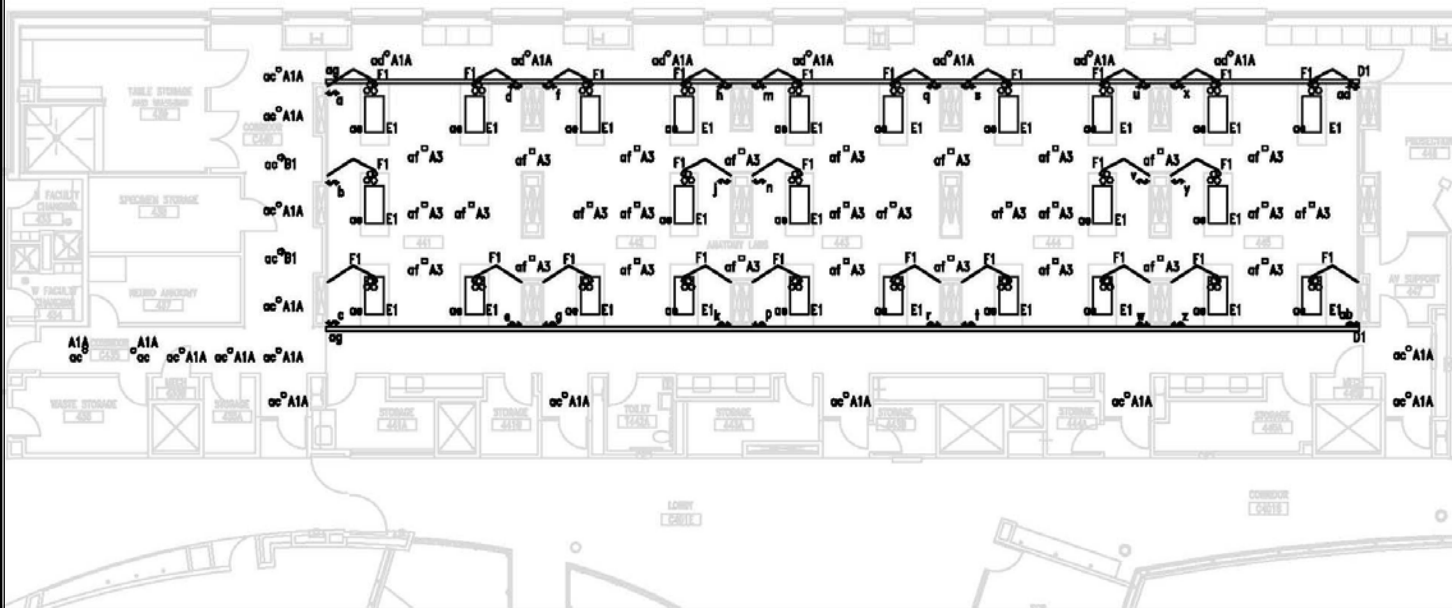


Figure 12 – Isometric

Anatomy Lab Lighting Plan

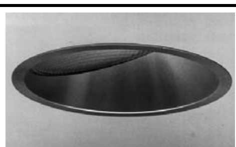
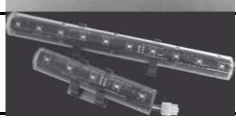
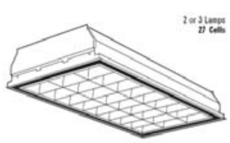
Figure 13 – Laboratory Lighting Plan



1/16"=1'-0" 1 FOURTH FLOOR REFLECTED CEILING PLAN

Schedules

Figure 14 – Laboratory Luminaire Schedule

LUMINAIRE SCHEDULE						
FIXTURE TAG		WATTAGE	CATALOG NO.	LAMPS TYPE	BALLAST/ XFMR TYPE	TOTAL WATTAGE
A1A		26	P927-Z-DM	PL-T- 26W-830-4P-ALTO	FDB-T426-277-1-S	598
A3		32	H8632P32	PL-T- 32W-830-4P-ALTO	FDB-T432-277-1-S	896
B1		26	S5L6113-D2-6113L-MC	PL-T-26W-830-4P-ALTO	FDB-T426-277-1	52
D1		15	iW-COVE	WARM LED	-	3270
E1		62	2PMO-G-A-2-32-27LD-277-GEBIS	F32T8-830-ALTO	INCLUDED	1550
F1		166	iLED 3 SURGICAL 1409964	LED	-	4150*

TOTAL WATTAGE = **6366 W***
SQUARE FEET = **4759 SF**
WATT/SFT = **1.34 W/SF**

ASHRAE STANDARD 90.1 = **1.4W/SF**

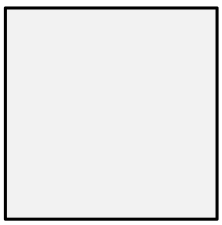
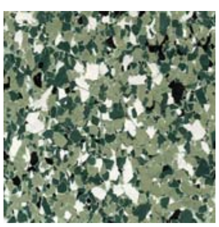
***NOT INCLUDED IN THE TOTAL WATTAGE IS THE F1 FIXTURE BECAUSE OF IESNA 805.5.1 EXCEPTION 1.**

Schedules

Figure 15 – Laboratory Luminaire Light Loss Factors

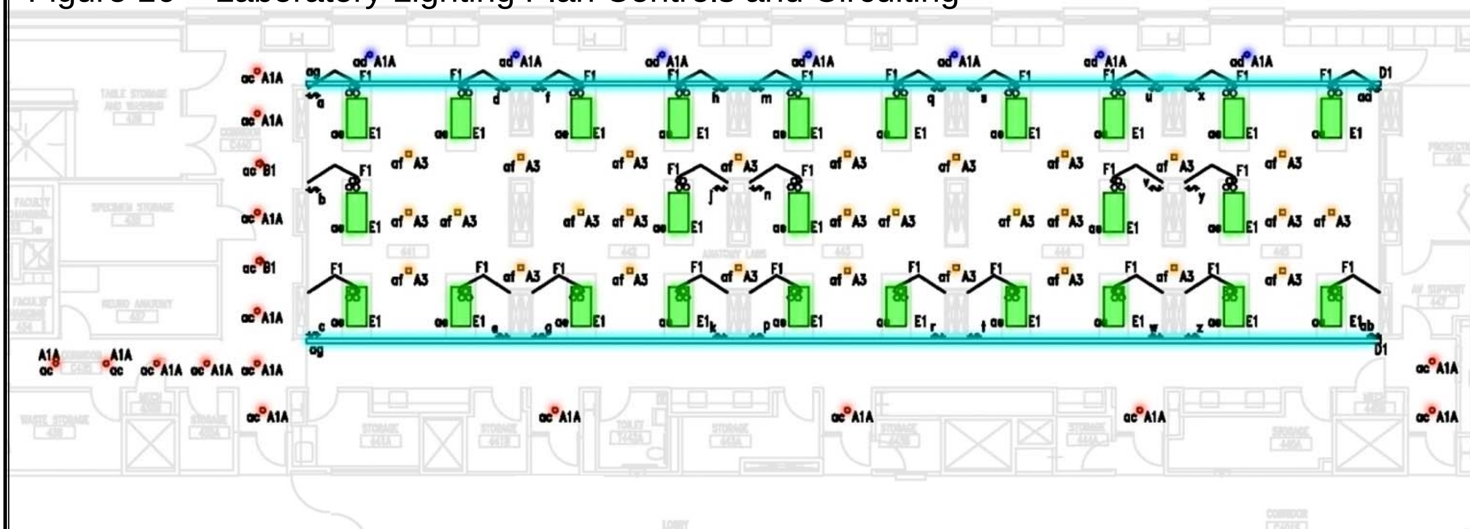
LIGHT LOSS FACTORS								
TYPE	MAINTENANCE CATEGORY	ENVIRONMENT CLEANLINESS	CLEANING CYCLE	LLD	LDD	RSDD	BF	LLF
A1A	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
A3	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
B1	IV	CLEAN	12MO.	0.85	0.88	0.97	0.98	0.71
E1	IV	CLEAN	12MO.	0.96	0.98	0.98	0.95	0.88
F1	IV	CLEAN	12MO.	0.96	0.98	0.98	0.95	0.88

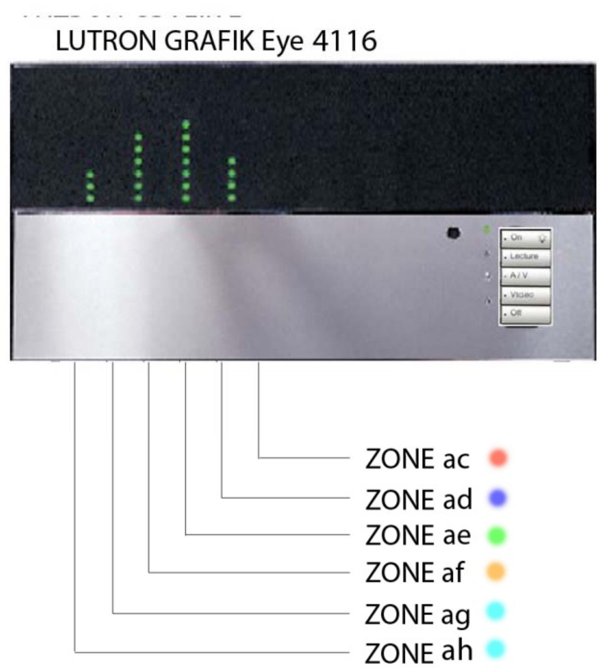
Materials

	Material	Location	Reflectance
	Acoustical Ceiling Tile	Ceiling	0.6
	Paint	Wall Ceiling	0.65
	Epoxy Coated Concrete	Floor	0.4
	Epoxy Coated Concrete	Floor	0.4

Anatomy Lab Lighting Controls Plan

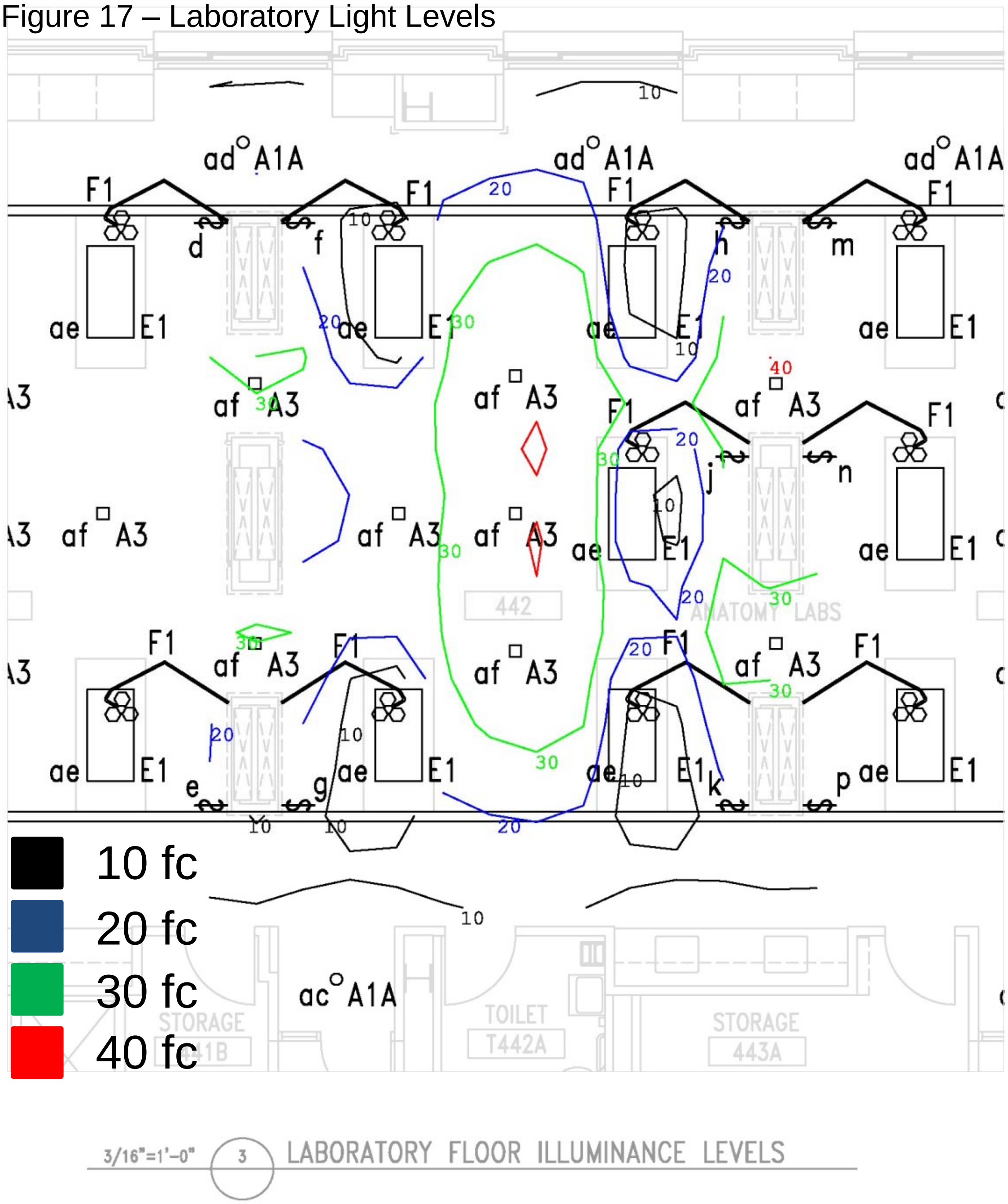
Figure 16 – Laboratory Lighting Plan Controls and Circuiting





Anatomy Laboratory Floor Illuminance Levels without daylight

Figure 17 – Laboratory Light Levels

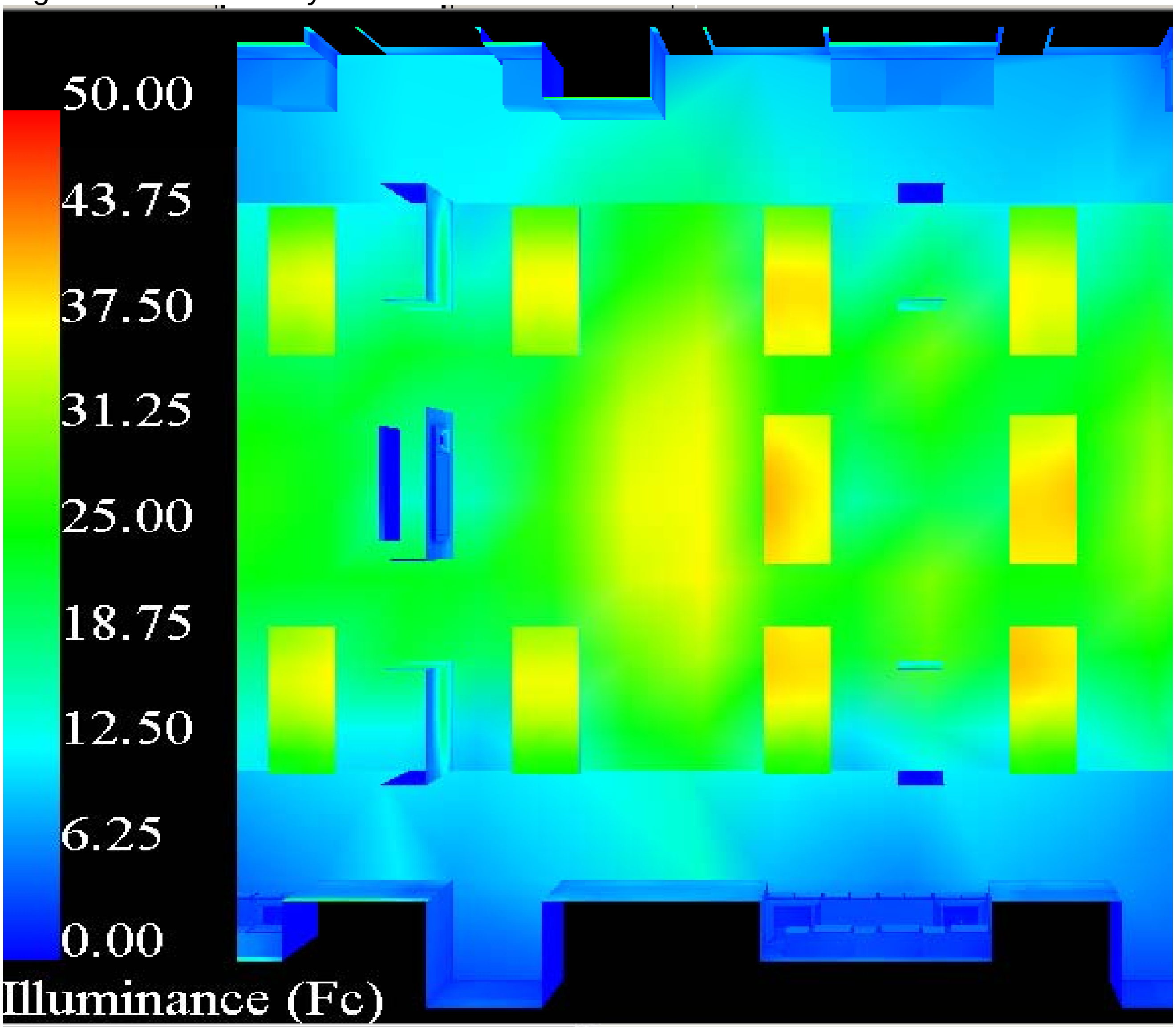


Average Floor Illuminance Level in perimeter walkway: **20.73 FC**

Recommended Illuminance Level: **10 FC**

Anatomy Laboratory Illuminance Levels without daylight

Figure 18 – Laboratory Illuminance Levels



Average Task Illuminance Level (2.5 feet) : **33.51 FC***

IESNA Recommended Classroom Task Illuminance Level : **30 FC**

IESNA Recommended Lab Task Illuminance Level : **50 FC***

***** The low calculated illuminance levels are to meet classroom illuminance levels. To reach 50 FC, separately controlled and adjustable LED surgical fixtures are utilized (TRUMPF iLED 3).

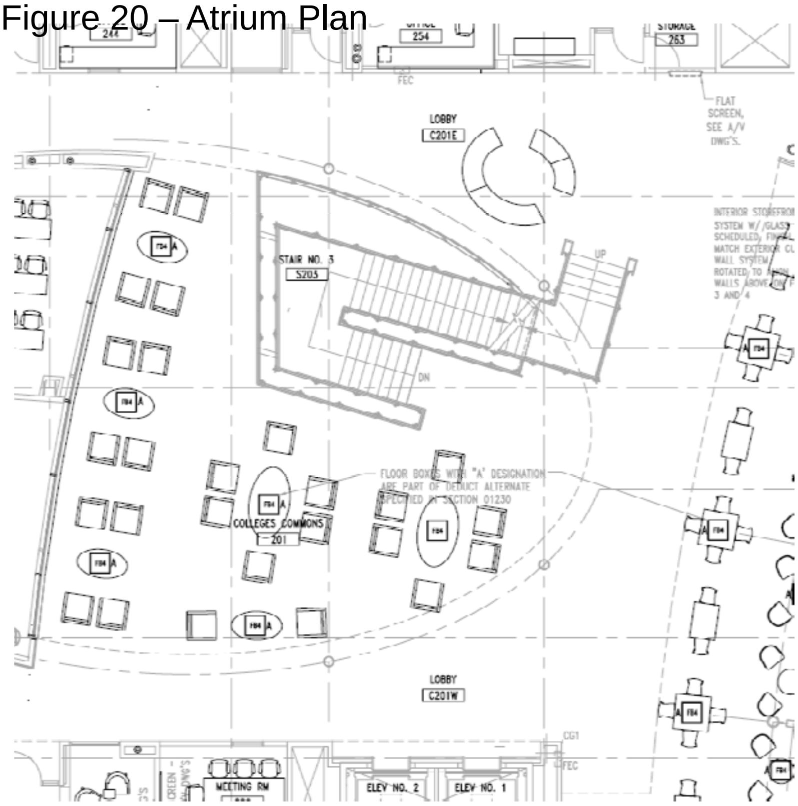
11x17 image

Anatomy Laboratory Design Evaluation

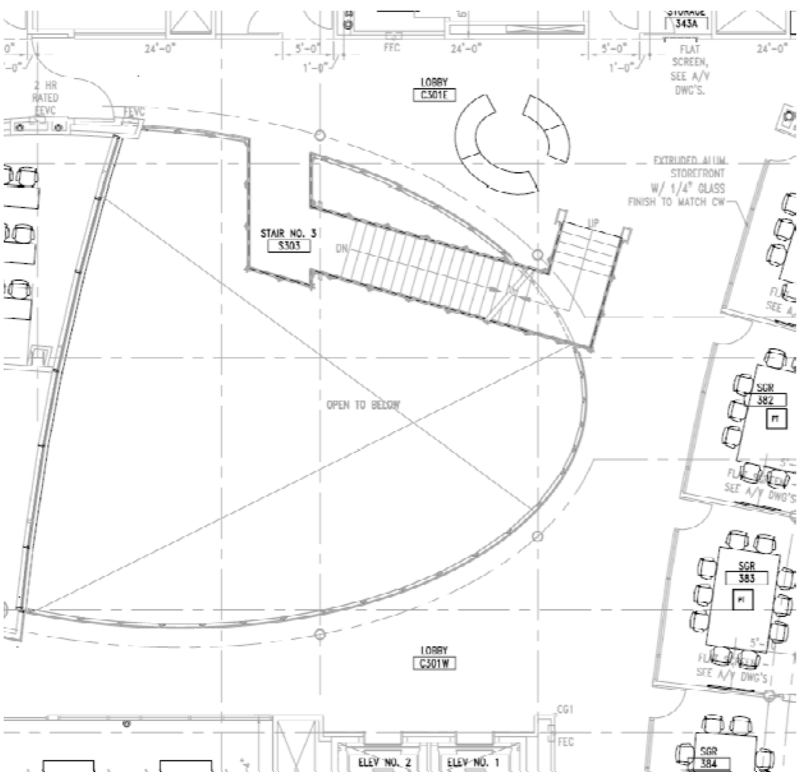
The redesign of the Anatomy Laboratory successfully adheres to the criteria set forth in the IESNA standards as well as the power density criteria of ASHRAE 90.1. The overall lighting design strides to keep the attention of the occupants at their stations in the central space in the room. With higher light levels in the center of the laboratory, the occupants have a visual boundary to stay in as they perform tasks requiring scrupulous attention to detail. The new LED surgical lighting technology enhances the hi-tech statement the medical school is trying to make in the medical education field that this facility is the most up-to-date, cutting edge technological building in the field.

Atrium

Figure 20 – Atrium Plan



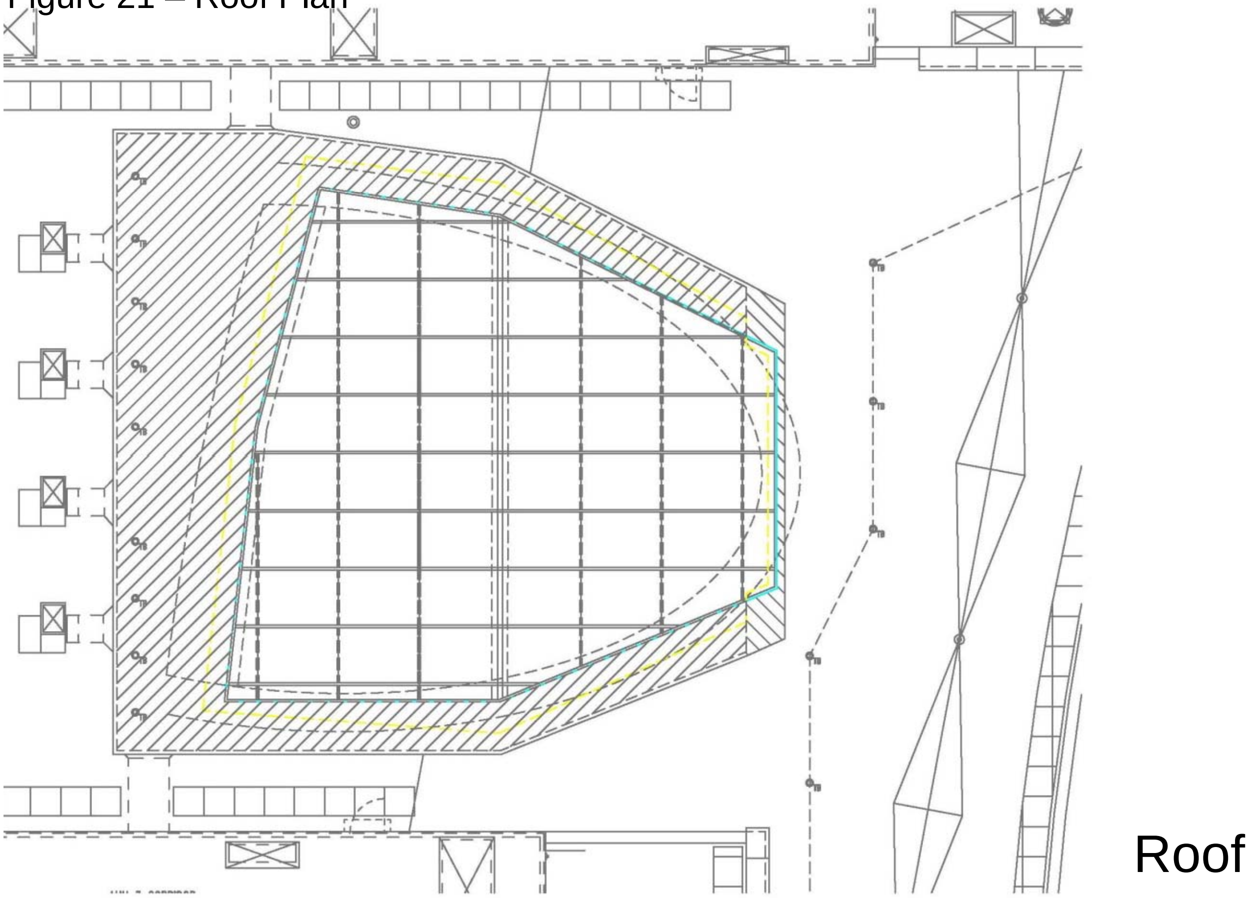
Second Floor



Third & Fourth Floor

Atrium

Figure 21 – Roof Plan



The atrium is the largest space in the building, connecting the occupant from the entrance to their destination within the building. As the central and largest space in the building the atrium is the most commonly visited space. The lighting should reinforce the dramatic architectural statement it makes within the building.

Most of the first floor is separated from the atrium and creates more of a separate space to the atrium. The design should emphasize the vast space of the atrium and also provide a comfortable and enjoysble experience for the building occupant to travel through it. The stairwell also could be emphasized because of its central location within the atrium by giving it a vertical element to reinforce the height of the atrium.

The glass curtain wall also creates an illusion of a larger atrium space. The meeting rooms adjacent to the glass curtain wall and next to the atrium add to the lighting into the space from the skylight and southwest exterior glass curtain wall.

Atrium Design Criteria

Daylighting Integration and Control. [VERY IMPORTANT]
Daylight directly penetrates the space from the roof glass ceiling and through the glass curtain wall on the first and second floor. It also can come through the student group rooms lining the glass curtain wall on the third and fourth floor. With the amount of daylight penetrating the space, it will be important to have daylight control in order to keep a comfortable level constant throughout the day.

Direct Glare. [IMPORTANT]
It is important to minimize glare because of the importance of circulation and heavy meeting use of the space.

Illuminance (Horizontal). [VERY IMPORTANT]
Horizontal Illuminance levels are important for safety along the stairwell and atrium edge as well as clearly light the circulation areas of the occupants. The recommended illuminance level should be 10 footcandles.

Light Distribution on Surfaces. [IMPORTANT]
It is important to differentiate the illuminance levels of the different surfaces in the space to keep a visual interest. The recommended ratio between the ceiling and floor is a 3:1 ratio.

Light Distribution on Task Plan (Uniformly). [IMPORTANT]
It is important to have a uniform level of light along the staircase and floor throughout the space to keep it safe.

Light Pollution/Trespass. [VERY IMPORTANT]
It is important not to waste energy by directing light outside of the building through the large glass ceiling or full height glass façade. Reflected lighting should also be minimized to reduce light escaping from the glass.

Atrium Design Criteria

Modeling of Faces or Objects. [IMPORTANT]
The atrium and lobby spaces will be the main circulation spaces in the building where people will meet and relax. It will be important to use multi-directional lighting to improve facial modeling and reflected lighting from the walls helps to fill in facial shadows.

Points of Interest. [IMPORTANT]
The grandoise architectural statement made by the atrium space should be a dominant point of interest because of its central location within the building.

Reflected Glare. [IMPORTANT]
It is important to avoid reflections from the glass skylight as well as the large glass curtain wall along the northern side of the atrium.

Atrium Lighting Plan Floor 2

Atrium LP floor 2 – 11x17

Atrium Lighting Plan Floor 3

Atrium LP floor 3 – 11x17

Atrium Lighting Plan Floor 4

Atrium LP floor 4 – 11x17

Atrium Illuminance Levels

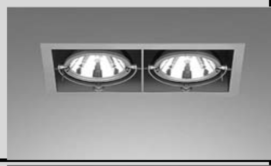
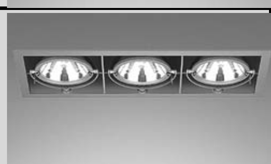
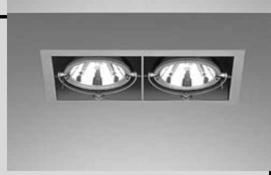
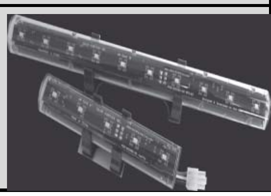
Figure 23– Atrium Illuminance Levels

Average Illuminance Level (2.5 feet) : **FC**

IESNA Recommended Illuminance Level : **10 FC**

Schedules

Figure 24 – Atrium Luminaire Schedule

LUMINAIRE SCHEDULE						
Fixture Tag		Wattage	CATALOG NO.	LAMPS TYPE	BALLAST/ XFMR TYPE	TOTAL WATTAGE
A3		35	H8632P32	PL-T- 32W-830-4P-ALTO	FDB-T432-277-1-S	4550
A4		35	CAR701-QT12F	BC35W-T4-12V	-	1015
A5		70	CAR702-WT12F	BC35W-T4-12V	-	1050
A6		105	CAR703-WT12F	BC35W-T4-12V	-	3150
A7		78	CAR702-T4039F	CDM35-TC-830	RMH-20-E-LF	1716
A8		140	CAR702-T4039F	CDM70-TC-830	RMH-20-E-LF	1540
D1		15	iW-COVE	WARM LED	-	11700

TOTAL WATTAGE = **19086 W**
SQUARE FEET = **27784 SF**
WATT/SFT = **0.58 W/SF**
ASHRAE STANDARD 90.1 = **0.6 W/SF**

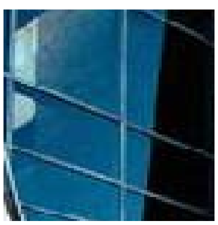
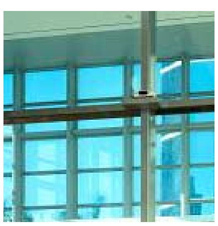
Schedules

Figure 25– Atrium Luminaire Light Loss Factors

LIGHT LOSS FACTORS								
TYPE	MAINTENANCE CATEGORY	ENVIRONMENT CLEANLINESS	CLEANING CYCLE	LLD	LDD	RSDD	BF	LLF
A4	VI	CLEAN	12MO.	1	0.88	0.97	1	0.85
A5	VI	CLEAN	12MO.	1	0.88	0.97	1	0.85
A6	VI	CLEAN	12MO.	1	0.88	0.97	1	0.85
A7	VI	CLEAN	12MO.	1	0.88	0.97	1	0.85
A8	VI	CLEAN	12MO.	1	0.88	0.97	1	0.85

Materials

	Material	Location	Reflectance
	Acoustical Ceiling Tile	Ceiling	0.6
	Wood Panels	Wall	0.3
	Bambu Tile	Floor	0.3

	Material	Location	Transmittance
	VRE2-67 Glass	Wall	0.67
	VE1-2M Glass	Wall	0.70

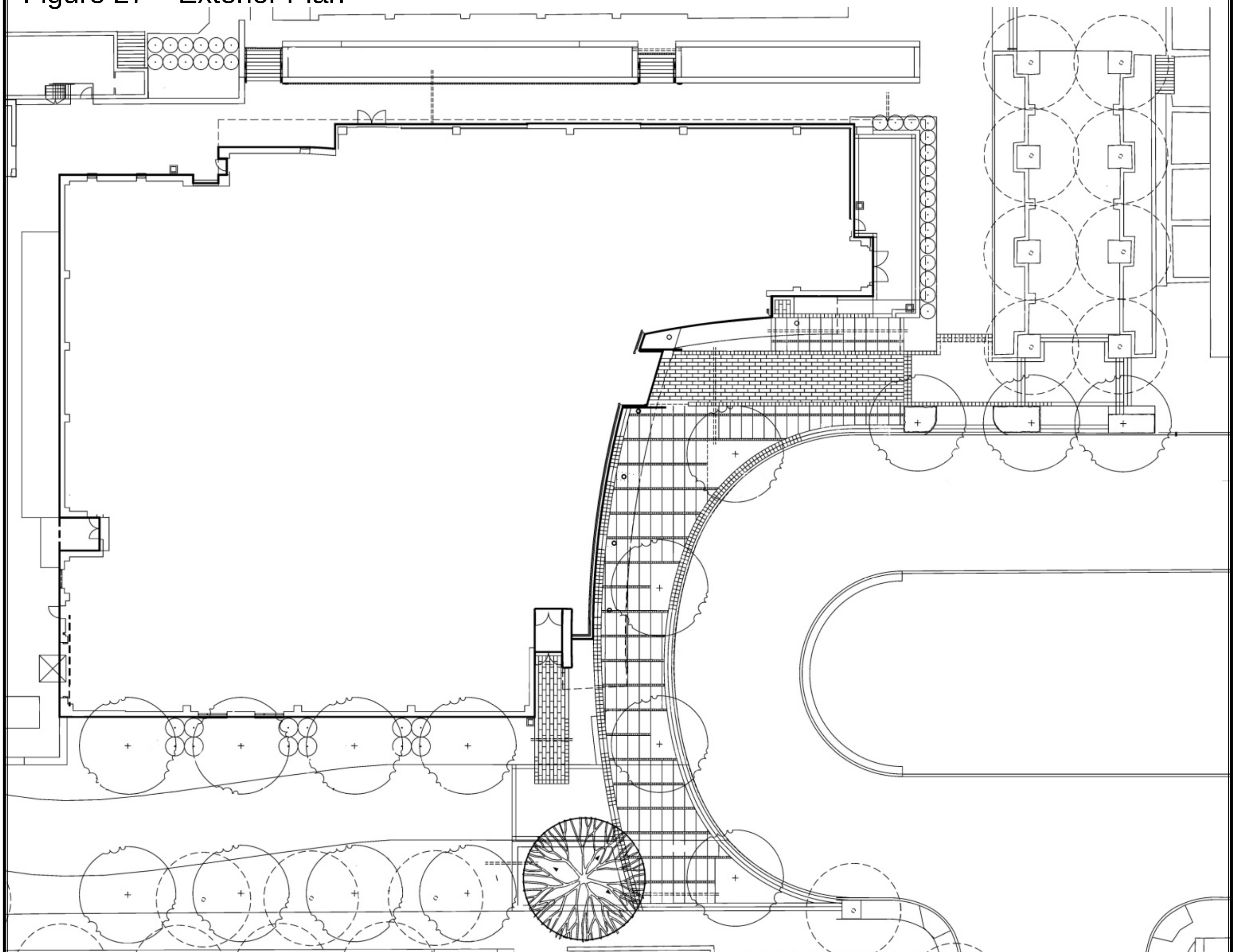
Daylighting 11 x 17

Atrium Design Evaluation

The redesign of the Central Atrium successfully adheres to the criteria set forth in the IESNA standards as well as the power density criteria of ASHRAE 90.1. The overall lighting design boldens the architectural features of the atrium from the surrounding circulation space. The architectural curve that forms the atrium is emphasized by the orientation of the direct lighting that provides light for the center of the atrium as well as the LED cove to articulate the shape of the atrium. The general lighting in the circulation space gently radiates out from the central point of the atrium to reinforce the centrality of the atrium.

Exterior Plaza

Figure 27 – Exterior Plan



The main entrance to the Medical Education Building will be from the southern plaza. The façade along the southern façade of the building will be the main architectural feature of the façade, consisting of a full height glass curtain wall made from aluminum and green tinted low-e glass. The main criteria the design is aiming for here is safety and facial rendering. To make up for the narrow landscape around the building the lighting uses trees to help disperse the lighting but does not bring out any of the architectural elements in the space. The main focus on the exterior is the indirect lighting on the exterior canopy along the southern side of the building as well as the LED bollards along the transportation route on the southwest side of the building.

Exterior Plaza Design Criteria

Appearance of Space and Luminaires. [IMPORTANT]
The luminaires should provide directional cues to the building entrances and distribute light downward and evenly on the walking paths. The design of the fixtures must adhere to the overall modern design of the building

Color Appearance & Color Contrast. [IMPORTANT]
The color rendering is important to create the appropriate mood in the outdoor space.

Daylighting Integration and Control. [VERY IMPORTANT]
Daylighting controls are very important for fixtures outside to minimize energy use during the day.

Direct Glare. [VERY IMPORTANT]
Direct glare should be strictly avoided to maintain safety in the area at night. The contrast between the dark surroundings and a very bright source are very uncomfortable and can hinder visibility in the area.

Illuminance (Horizontal). [VERY IMPORTANT]
The illuminance on the ground is very important for people to be able to safely move around the building and to the building entrance. IESNA standards require 5 footcandles at the building entrance and 0.5 footcandles on pedestrian pathways.

Illuminance (Vertical). [IMPORTANT]
Vertical illuminance is important in this space for good facial modeling and safety around the perimeter of the building. IESNA standards require 3 footcandles at the building entrance and 0.5 footcandles on pedestrian pathways.

Intrinsic Material Characteristics. [SOMEWHAT IMPORTANT]
The exterior materials of the building façade such as the glass curtain wall and brick as well as the canopy over the southwest promenade can be used to highlight the building and create points of interest along the façade. Uplight should be avoided to prevent direct light from entering the atmosphere.

Light Distribution on Task Plans (Uniformly). [VERY IMPORTANT]
Uniform lighting along walkways and surroundings should be addressed to improve security in the vicinity of the building. Shadows should be avoided as much as possible around the walkways.

Exterior Plaza Design Criteria

Light Pollution/Trespass. [VERY IMPORTANT]
Ideally it would be advantageous to avoid luminaires with light directed above 90 degrees to keep direct light from entering into the atmosphere.

Modeling of Faces or Objects. [VERY IMPORTANT]
Lighting levels on faces and objects is very important for safety around the building.

Peripheral Detection. [IMPORTANT]
Lighting levels along the periphery of the walkways are important to safety.

Points of Interest. [IMPORTANT]
Architectural elements of the building such as the entrance and the glass façade are important for aesthetics and for directing pedestrians.

Reflected Glare. [IMPORTANT]
Reflections in the glass along the first floor should be avoided to prevent discomfort.

Shadows. [VERY IMPORTANT]
Shadows should be prevented to allow for pedestrian comfort and safety around the exterior of the building.

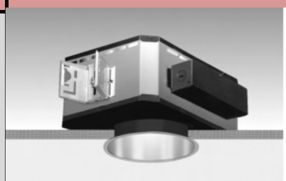
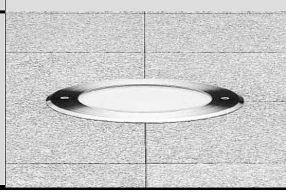
Sparkle/Desirable Reflected Highlights. [IMPORTANT]
Surrounding trees can be used to help distribute a diffuse indirect light to the surrounding area.

Exterior Plaza Design Criteria

EXTERIOR LP 11X17

Schedules

Figure 29 – Atrium Luminaire Schedule

LUMINAIRE SCHEDULE						
Fixture Tag		Wattage	Catalog No.	Lamps Type	Ballast/ XFMR Type	TOTAL WATTAGE
A1B		32	P926-Z-DM	PL-T- 26W-830-4P-ALTO	FDB-T426-277-1-S	254
H1		39	33359-HIT-TC-CE-35W-GU6.5-ECG	CDM-20-TC-830	RMH-35-K	312
J1		32	2027P	PL-T-26W-830-4P-ALTO	FDB-T426-277-1-S	768
K1		20	8703P	PL-C-13W-830-4P-ALTO	FDB-1643-277-1	380

TOTAL WATTAGE = **1714 W**
SQUARE FEET = **10,662 SF**
WATT/SFT = **0.16 W/SF**
ASHRAE STANDARD 90.1 = **0.2 W/SF**

Schedules

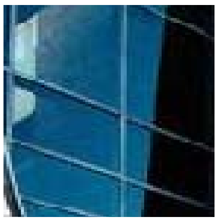
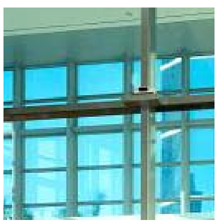
Figure 30 – Atrium Luminaire Light Loss Factors

LIGHT LOSS FACTORS							
TYPE	MAINTENANCE CATEGORY	ENVIRONMENT CLEANLINESS	CLEANING CYCLE	LLD	LDD	BF	LLF
A1B	IV	CLEAN	12MO.	0.85	0.88	0.98	0.73
H1	V	DIRTY	12MO.	0.82	0.88	1	0.72
J1	VI	DIRTY	12MO.	0.85	0.74	0.97	0.61
L1	VI	DIRTY	12MO.	0.85	0.74	0.9	0.57

Materials

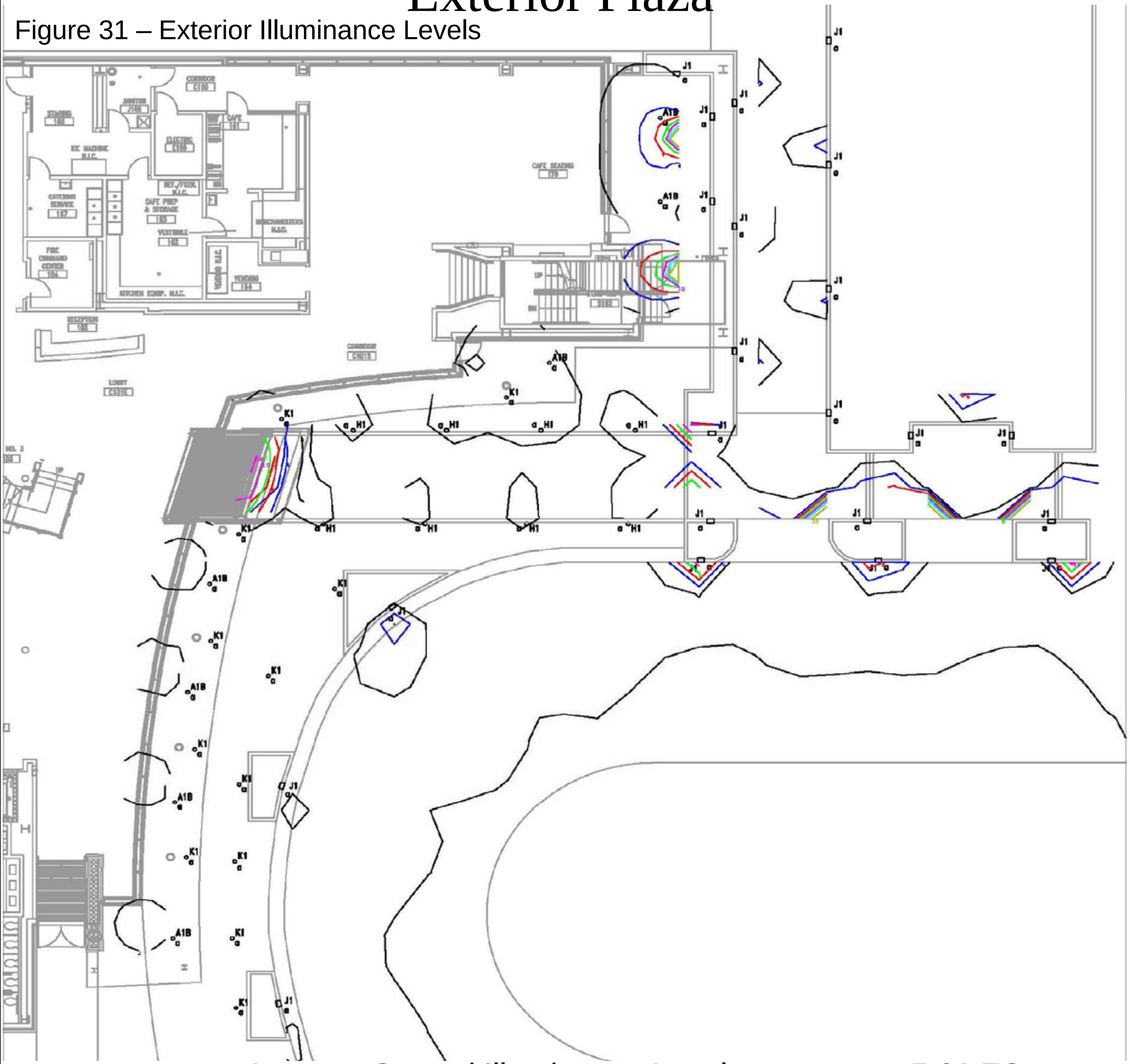
	Material	Location	Reflectance
	Aluminum Curtain Wall	Façade	0.6
	Brick	Façade	0.6
	Bluestone	Stone	0.25
	Quartzite	Stone	0.3
	Concrete	Ground	0.65

Materials

	Material	Location	Transmittance
	VRE2-67 Glass	Wall	0.67
	VE1-2M Glass	First floor wall	0.70

Exterior Plaza

Figure 31 – Exterior Illuminance Levels



Average Ground Illuminance Level at entrance: **5.61 FC**

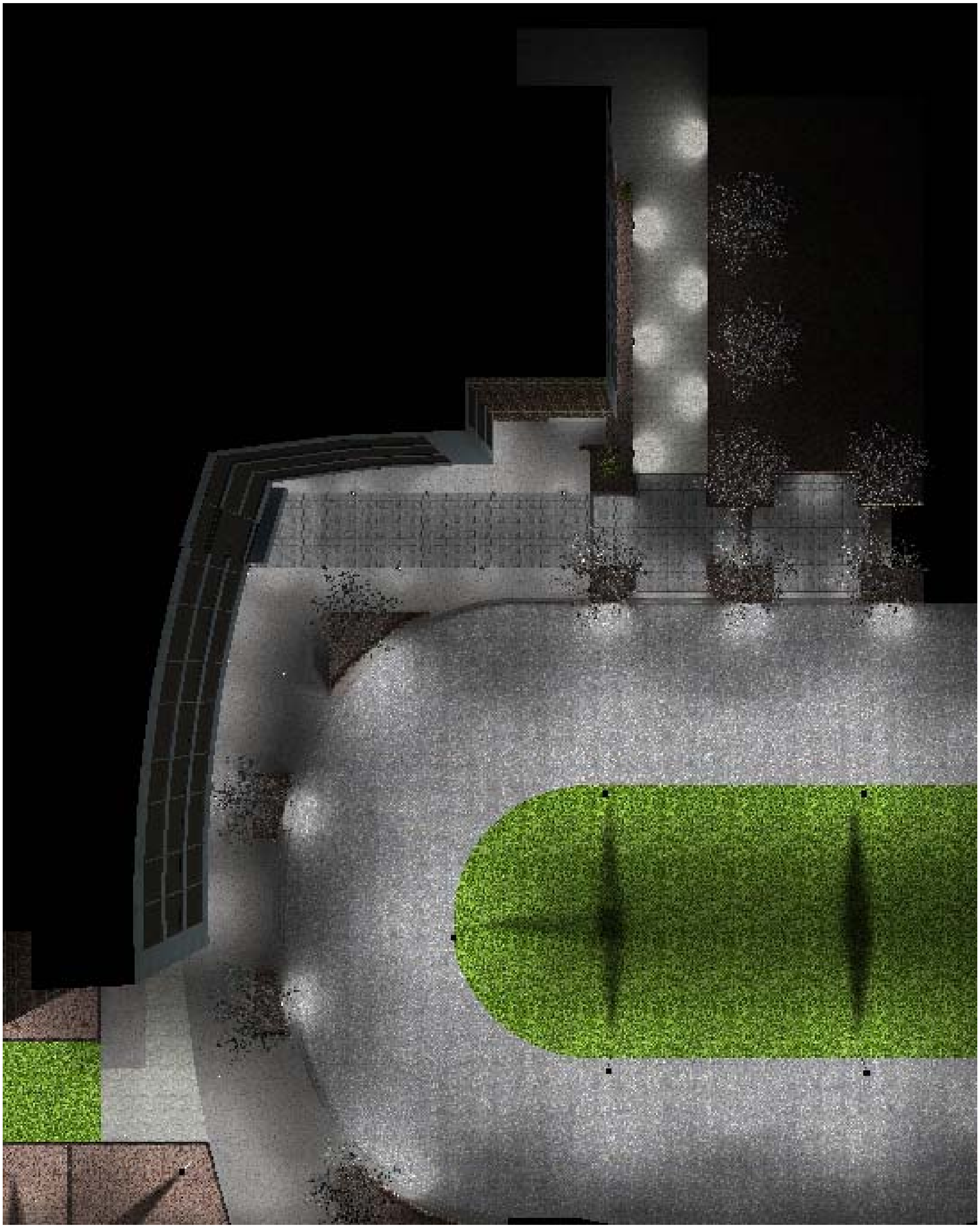
Average Ground Illuminance Level on pedestrian walkways: **1.81 FC**

Recommended Illuminance Level at entrance: **5 FC**

Recommended Illuminance Level on pedestrian walkways: **0.5 FC**

Exterior Plaza

Figure 32 – Exterior Image



Exterior Plaza

Money shots 11x17

Exterior Plaza

Money shots 11x17

Exterior Plaza

Money shots 11x17

Exterior Plaza Design Evaluation

The redesign of the exterior plaza successfully adheres to the criteria set forth in the IESNA standards as well as the power density criteria of ASHRAE 90.1. The overall lighting design compliments the existing architecture and landscape architecture to provide a joined effort to visually lead the viewer through the space and either towards or away from main entrance to the building. Just as the architectural elements of the building work with the landscape architecture and the lighting, so does the light coming down from the building, the lighting glowing upward and the light spreading horizontally from bollards toward the main entrance.

Electrical Depth

Electrical Coordination to the Lighting Redesign

Introduction

The effects of the lighting redesign covered in the Lighting Depth section of this report impact the electrical design. The following is the documentation of the effects on the electrical design specifically on the lighting panels that contained the lighting circuits in the auditorium, anatomy laboratory, atrium and exterior façade.

The gray highlighted circuits are the effected circuits and the red highlighted circuits are the new circuits that contain the lighting for the new design. The panelboards were not changed significantly due to the similar lighting loads to the original design. Therefore, minimal adjustment was needed on the new lighting design.

Electrical Coordination to the Lighting Redesign

Auditorium

The existing lighting design for the auditorium is connected to Dimming panel GP-1 which is then connected to lighting panel LP-1. The total load on the lighting panel was increased from 12,000KVA to 14,250KVA but did not require an increase in panelboard size.

The proposed redesign of the lighting will reuse both the GP-1 dimming panel as well as the LP-1 Lighting Panelboard. The dimming panel will be controlled by a Lutron Grafik Eye 4116. Control diagrams and circuiting are on the following page.

Figure 34 – Auditorium Lighting Plan and Controls

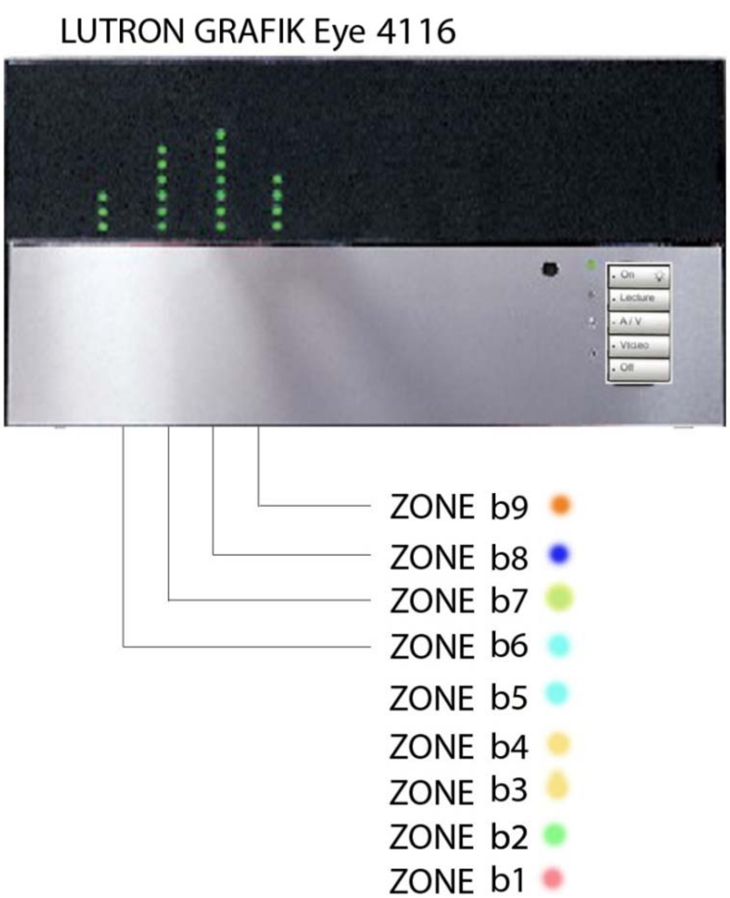


Figure 35 – Auditorium Dimming Panel Schedule

DIMMING PANEL SCHEDULE

VOLTAGE	480				TAG					TYPE PANEL		
MOUNTING	SURFACE									C/B MIN AIC	FEED	
SIZE/TYPE BUS					LOCATION					OPTIONS/ACCESSRS		
SIZE/TYPE MAINS										REMARKS		
LOAD DESCRIPTION	**ZONE**	**LOAD WATTS**	**C/B SIZE**	**POS NO**	**A PH**	**B PH**	**C PH**	**POS NO**	**C/B SIZE**	**LOAD WATTS**	**ZONE**	**LOAD DESCRIPTION**
FLUORESCENT (A2)	a1	1251		1	*			2		1251	b1	FLUORESCENT (A2)
FLUORESCENT (A1 AND B1)	a2	264		3		*		4		264	b2	FLUORESCENT (A1 AND B1)
FLUORESCENT (A1, C1A, C1B, C1C)	a3	896		5			*	6		896	b3	FLUORESCENT (A1, C1A, C1B, C1C)
FLUORESCENT (C1A, C1B, C1C, C1D)	a4	835		7	*			8		835	b4	FLUORESCENT (C1A, C1B, C1C, C1D)
LEDS (D1)	a5	1230		9		*		10		1230	b5	LEDS (D1)
LEDS (D1)	a6	1230		11			*	12		1230	b6	LEDS (D1)
LEDS (D1)	a7	465		13	*			14		465	b7	LEDS (D1)
FLUORESCENT (A1 AND B1)	a8	584		15		*		16		584	b8	FLUORESCENT (A1 AND B1)
FLUORESCENT (B2)	a9	232		17			*	18		232	b9	FLUORESCENT (B2)
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHAS	5102.0		B PHASE						4156.0	C PHASE	4716.0
TOTAL CONNECTED LOAD (WATTS)		13974.0								DEMAND LOAD		12576.6

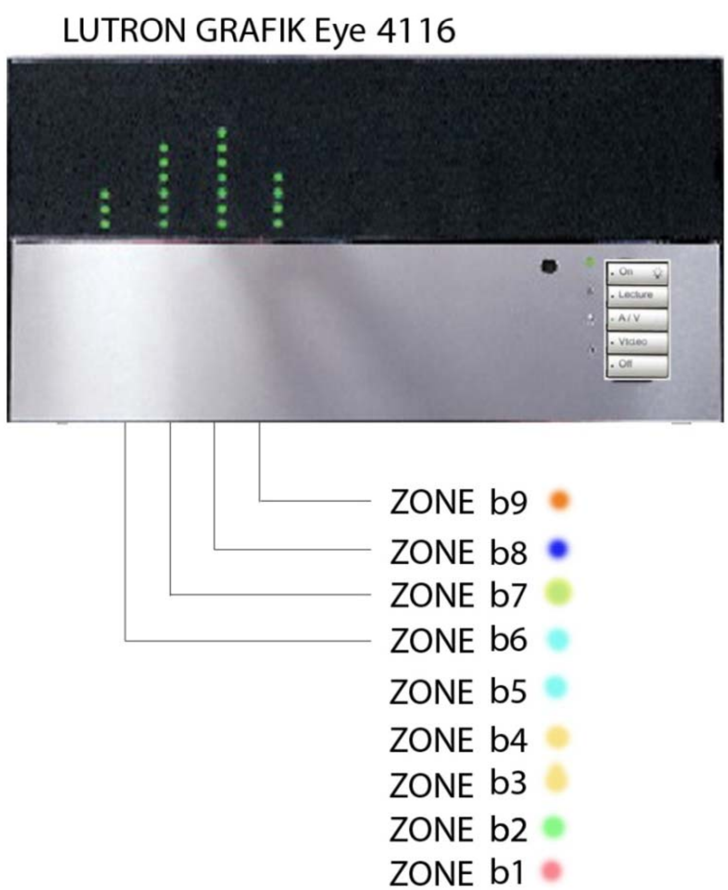


Figure 36.1 – Existing First Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE 480Y/277V, 3PH, 4W
MOUNTING SURFACE
SIZE/TYPE BUS 100A COPPER
SIZE/TYPE MAINS 100A MLO MCB

PANEL TAG LP-1
PANEL LOCATION E116

TYPE PANEL
C/B MIN AIC FEED
OPTIONS/ACCESSRS
REMARKS

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C101N,S,E,W,105	FLOOR ONE	2204	20/1	1	*			2	20/1	864	FLOOR ONE	102W
C101S,W,102W	FLOOR ONE	2178	20/1	3		*		4	20/1	2316	FLOOR ONE	154,160,161,170
152,156,162-164,D165,J166,167	FLOOR ONE	878	20/1	5			*	6	20/1	1857	FLOOR ONE	C110,C110A,C111
109,112-D115,J117,T118,121-124	FLOOR ONE	1336	20/1	7	*			8	20/1	1521	FLOOR ONE	T106,T107
EXTERIOR		224	20/1	9		*		10	20/1	1110		EXTERIOR
EXTERIOR		360	20/1	11			*	12	20/1	849		EXTERIOR
SPARE			20/1	13	*			14	20/1			SPARE
SPARE			20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	30/3	4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	21		*		22		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	23			*	24		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	9925.0		B PHASE						9828.0	C PHASE	7944.0
TOTAL CONNECTED LOAD (WATTS)		27697.0									DEMAND LOAD	24927.3

Figure 36.2 – New First Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE 480Y/277V, 3PH, 4W
MOUNTING SURFACE
SIZE/TYPE BUS 100A COPPER
SIZE/TYPE MAINS 100A MLO MCB

PANEL TAG LP-1
PANEL LOCATION E116

TYPE PANEL
C/B MIN AIC FEED
OPTIONS/ACCESSRS
REMARKS

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C101N,S,E,W,105	FLOOR ONE	2204	20/1	1	*			2	20/1	864	FLOOR ONE	102W
C101S,W,102W	FLOOR ONE	2178	20/1	3		*		4	20/1	2316	FLOOR ONE	154,160,161,170
152,156,162-164,D165,J166,167	FLOOR ONE	878	20/1	5			*	6	20/1	1857	FLOOR ONE	C110,C110A,C111
109,112-D115,J117,T118,121-124	FLOOR ONE	1336	20/1	7	*			8	20/1	1521	FLOOR ONE	T106,T107
EXTERIOR		224	20/1	9		*		10	20/1	1110		EXTERIOR
EXTERIOR		360	20/1	11			*	12	20/1	849		EXTERIOR
SPARE			20/1	13	*			14	20/1			SPARE
SPARE			20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	30/3	4750	A/V ROOM 154	PANEL GP-1
SPARE			20/1	21		*		22		4750	A/V ROOM 154	PANEL GP-1
SPARE			20/1	23			*	24		4750	A/V ROOM 154	PANEL GP-1
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	10675.0		B PHASE						10578.0	C PHASE	8694.0
TOTAL CONNECTED LOAD (WATTS)		29947.0									DEMAND LOAD	26952.3

Laboratory

The existing lighting design for the Anatomy Laboratory is found on the LP-4 lighting panelboard with the exception of the surgical fixtures on panel RP-4S.

The proposed redesign of the lighting will reuse both the LP-4 lighting panelboard as well as the RP-4S Electrical Panelboard. A Lutron Grafik Eye 4116 is included in the redesign to balance the electric lighting with the daylight from the eastern side of the building.

Please refer to the following lighting control diagrams and panelboard layouts for more detailed control diagrams and circuiting.

Figure 37 – Laboratory Lighting Plan and Controls

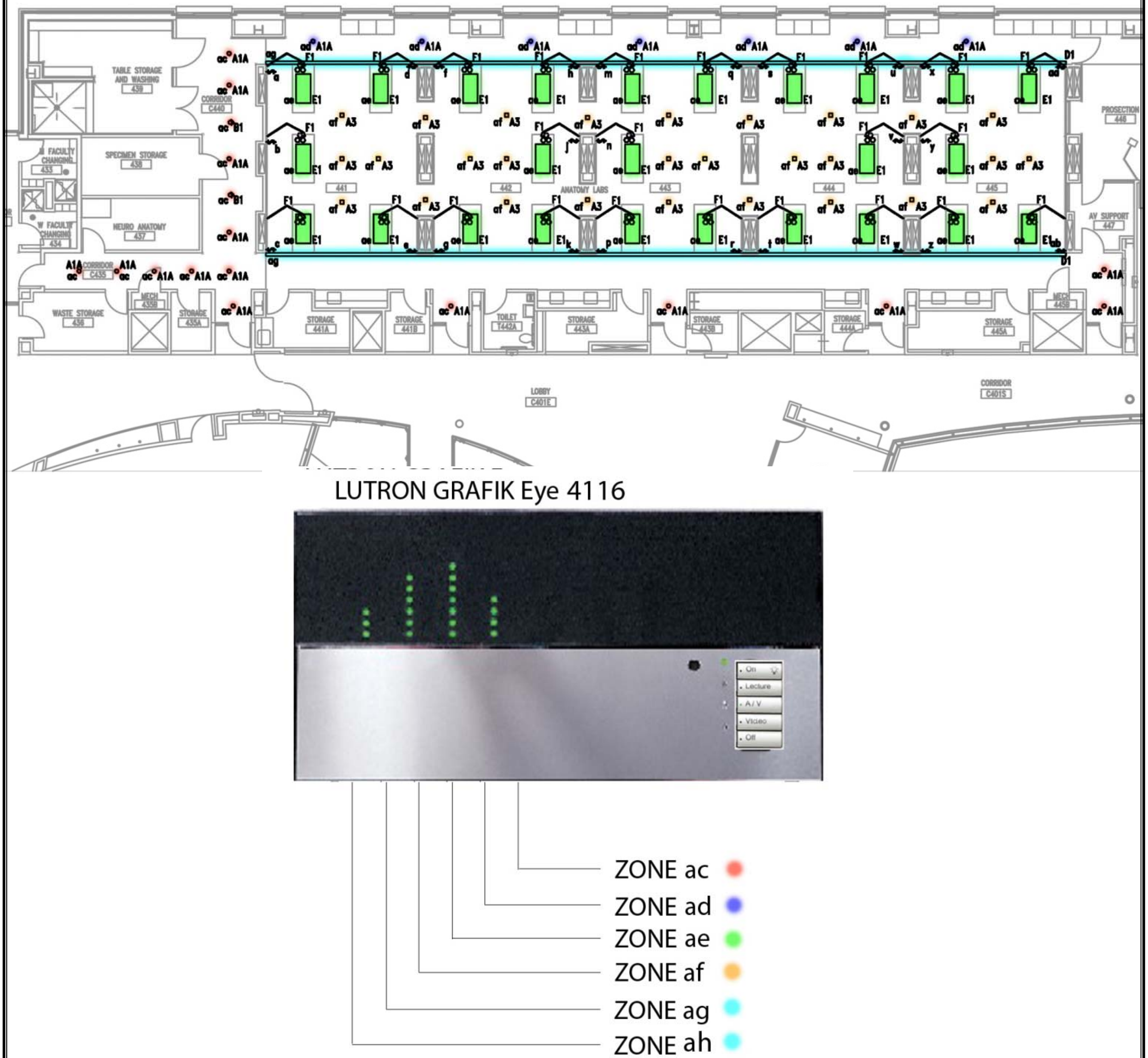


Figure 38.1 – Existing Fourth Floor Lighting Panel

PANEL SCHEDULE												
VOLTAGE	480Y/277V, 3PH, 4W			PANEL TAG	LP-4				TYPE PANEL			
MOUNTING	SURFACE			PANEL LOCATION	E422				C/B MIN	AIC		FEED
SIZE/TYPE BUS	100A COPPER								OPTIONS/ACCESSRS			
SIZE/TYPE MAINS	90A MLO MCB								REMARKS			
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C401N,S,E,W,C430	FLOOR FOUR	1224	20/1	1	*			2	20/1	2326	FLOOR FOUR	C401N,S,E,W
C401N,S,E,W,C430	FLOOR FOUR	1440	20/1	3		*		4	20/1	720	FLOOR FOUR	481-485
C440,437	FLOOR FOUR	1062	20/1	5			*	6	20/1	2040	FLOOR FOUR	441
442	FLOOR FOUR	2040	20/1	7	*			8	20/1	2040	FLOOR FOUR	443
444	FLOOR FOUR	2040	20/1	9		*		10	20/1	2040	FLOOR FOUR	445
446	FLOOR FOUR	1128	20/1	11			*	12	20/1	1620	FLOOR FOUR	441A,B,442A,B,444A,445A,447
427,428,431,A,B,432,A,B	FLOOR FOUR	2713	20/1	13	*			14	20/1	2664	FLOOR FOUR	T424,T425,D423,J421,411,403
481,482,483,484,485	FLOOR FOUR	720	20/1	15		*		16	20/1	1596	FLOOR FOUR	410
402	FLOOR FOUR	1902	20/1	17			*	18	20/1	1080	FLOOR FOUR	426
420	FLOOR FOUR	1476	20/1	19	*			20	20/1			SPARE
SPARE			20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	14483.0		B PHASE						8556.0	C PHASE	8832.0
TOTAL CONNECTED LOAD (WATTS)		31871.0									DEMAND LOAD	28683.9

Figure 38.2 – New Fourth Floor Lighting Panel

PANEL SCHEDULE												
VOLTAGE	480Y/277V, 3PH, 4W			PANEL TAG	LP-4				TYPE PANEL			
MOUNTING	SURFACE			PANEL LOCATION	E422				C/B MIN	AIC		FEED
SIZE/TYPE BUS	100A COPPER								OPTIONS/ACCESSRS			
SIZE/TYPE MAINS	90A MLO MCB								REMARKS			
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
FLUORESCENT (A3,A4)	FLOOR FOUR	1688	20/1	1	*			2	20/1	1500	FLOOR FOUR	LEDS (D1)
HALOGEN (A5,A6)	FLOOR FOUR	1300	20/1	3		*		4	20/1	720	FLOOR FOUR	481-485
C440,437	FLOOR FOUR	1062	20/1	5			*	6	20/1	792	FLOOR FOUR	FLOURESCENT (A1A, B1)
446	FLOOR FOUR	0	20/1	7	*			8	20/1	1008	FLOOR FOUR	FLUORESCENT (A3)
LEDS (D1)	FLOOR FOUR	1650	20/1	9		*		10	20/1	1650	FLOOR FOUR	LEDS (D1)
FLUORESCENT (E1)	FLOOR FOUR	1550	20/1	11			*	12	20/1	1620	FLOOR FOUR	441A,B,442A,B,444A,445A,447
427,428,431,A,B,432,A,B	FLOOR FOUR	2713	20/1	13	*			14	20/1	2664	FLOOR FOUR	T424,T425,D423,J421,411,403
481,482,483,484,485	FLOOR FOUR	720	20/1	15		*		16	20/1	1596	FLOOR FOUR	410
402	FLOOR FOUR	1902	20/1	17			*	18	20/1	1080	FLOOR FOUR	426
420	FLOOR FOUR	1476	20/1	19	*			20	20/1			SPARE
METAL HALIDE (A8)	FLOOR FOUR	1540	20/1	21		*		22	20/1	1500	FLOOR FOUR	LEDS (D1)
SPARE			20/1	23			*	24	20/1	1500	FLOOR FOUR	LEDS (D1)
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	11049.0		B PHASE						10676.0	C PHASE	9506.0
TOTAL CONNECTED LOAD (WATTS)		31231.0									DEMAND LOAD	28107.9

Figure 39.1 – Existing Fourth Floor Electrical Panel

PANEL SCHEDULE

VOLTAGE		PANEL TAG RP-4S	TYPE PANEL
MOUNTING		PANEL LOCATION E422	C/B MIN AIC FEED
SIZE/TYPE BUS			OPTIONS/ACCESSRS
SIZE/TYPE MAINS			REMARKS

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
442 EQUIPMENT BOOM	LABORATORY	800	20/1	1	*			2	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	3		*		4	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	5			*	6	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	7	*			8	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	9		*		10	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	11			*	12	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 SURGICAL LIGHTS	LABORATORY	1000	20/1	13	*			14	20/1	1000	LABORATORY	443 SURGICAL LIGHTS
442,442a RECPT	LABORATORY	1000	20/1	15		*		16	20/1	1000	LABORATORY	443,444 LCD SCREENS
444 EQUIPMENT BOOM	LABORATORY	800	20/1	17			*	18	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	19	*			20	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	21		*		22	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	23			*	24	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	25	*			26	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	27		*		28	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 SURGICAL LIGHTS	LABORATORY	1000	20/1	29			*	30	20/1	1000	LABORATORY	445 SURGICAL LIGHTS
444,443A,444,445A,RECEPT	LABORATORY	1000	20/1	31	*			32	20/1	1000	LABORATORY	445,446 LCD SCREENS
446 EQUIPMENT BOOM	LABORATORY	800	20/1	33		*		34	20/1	800		446,447,C401 RECPT
446 EQUIPMENT BOOM	LABORATORY	800	20/1	35			*	36	20/1	800		470 RECS AND SHADES
446 SURGICAL LIGHTS	LABORATORY	400	20/1	37	*			38	20/1	400		470 PROJECTOR AND RECS
C401 RECEPTACLES		800	20/1	39		*		40	20/1	800		470 RECS AND SHADES
C401 RECEPTACLES		800	20/1	41			*	42	20/1	800		481 FLOOR BOX AND RECPT
SUB-TOTAL	A PHASE	11200.0		B PHASE						11600.0	C PHASE	11600.0
TOTAL CONNECTED LOAD (WATTS)		34400.0									DEMAND LOAD	30960.0

Figure 39.2 – New Fourth Floor Electrical Panel

PANEL SCHEDULE

VOLTAGE	208, 3P, 4W	PANEL TAG RP-4S	TYPE PANEL
MOUNTING	SURFACE	PANEL LOCATION E422	C/B MIN AIC FEED
SIZE/TYPE BUS	225 A COPPER		OPTIONS/ACCESSRS
SIZE/TYPE MAINS	225 A MLO		REMARKS

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
442 EQUIPMENT BOOM	LABORATORY	800	20/1	1	*			2	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	3		*		4	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	5			*	6	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	7	*			8	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	9		*		10	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 EQUIPMENT BOOM	LABORATORY	800	20/1	11			*	12	20/1	800	LABORATORY	443 EQUIPMENT BOOM
442 SURGICAL LIGHTS	LABORATORY	830	20/1	13	*			14	20/1	830	LABORATORY	443 SURGICAL LIGHTS
442,442a RECPT	LABORATORY	1000	20/1	15		*		16	20/1	1000	LABORATORY	443,444 LCD SCREENS
444 EQUIPMENT BOOM	LABORATORY	800	20/1	17			*	18	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	19	*			20	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	21		*		22	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	23			*	24	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	25	*			26	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 EQUIPMENT BOOM	LABORATORY	800	20/1	27		*		28	20/1	800	LABORATORY	445 EQUIPMENT BOOM
444 SURGICAL LIGHTS	LABORATORY	830	20/1	29			*	30	20/1	830	LABORATORY	445 SURGICAL LIGHTS
444,443A,444,445A,RECEPT	LABORATORY	1000	20/1	31	*			32	20/1	1000	LABORATORY	445,446 LCD SCREENS
446 EQUIPMENT BOOM	LABORATORY	800	20/1	33		*		34	20/1	800		446,447,C401 RECPT
446 EQUIPMENT BOOM	LABORATORY	800	20/1	35			*	36	20/1	800		470 RECS AND SHADES
446 SURGICAL LIGHTS	LABORATORY	400	20/1	37	*			38	20/1	400		470 PROJECTOR AND RECS
C401 RECEPTACLES		800	20/1	39		*		40	20/1	800		470 RECS AND SHADES
C401 RECEPTACLES		800	20/1	41			*	42	20/1	800		481 FLOOR BOX AND RECPT
SUB-TOTAL	A PHASE	10860.0		B PHASE						11600.0	C PHASE	11260.0
TOTAL CONNECTED LOAD (WATTS)		33720.0									DEMAND LOAD	30348.0

Atrium

The existing lighting design for the Atrium is found on the LP-1, LP-2, LP-3 and LP-4 lighting panelboards each with three circuits dedicated to atrium and circulation space lighting.

The proposed redesign of the lighting will reuse all of these panelboards. The circuits are divided into the general circulation lighting , atrium lighting and LED cove lighting and had minimal effects on the panelboard loads.

Please refer to the following lighting plan and panelboard layouts for more details on circuits and their loads on the panelboards.

Atrium LP 11x17 floor 2

Atrium LP 11x17 floor 3

Atrium LP 11x17 floor 4

Figure 41.1 – Existing Second Floor Lighting Panel

PANEL SCHEDULE												
VOLTAGE	480Y/277V, 3P, 4W			TAG				LP-2		TYPE PANEL		
MOUNTING	SURFACE									C/B MIN	AIC	FEED
SIZE/TYPE BUS	100A COPPER			PANEL LOCATION				E222		OPTIONS/ACCESSRS		
SIZE/TYPE MAINS	90A MCB									REMARKS		
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C201N,S,E,W	FLOOR TWO	972	20/1	1	*			2	20/1	1764	FLOOR TWO	C201N,S,E,W
C201N,S,E,W	FLOOR TWO	1668	20/1	3		*		4	20/1	720	FLOOR TWO	C201
240,240B,250	FLOOR TWO	2472	20/1	5			*	6	20/1	1020	FLOOR TWO	270
260	FLOOR TWO	2532	20/1	7	*			8	20/1	720	FLOOR TWO	C201N
241-244,251-254,261,263	FLOOR TWO	582	20/1	9		*		10	20/1	1498	FLOOR TWO	230-237
J221,D223,T224,T225	FLOOR TWO	1680	20/1	11			*	12	20/1	1598	FLOOR TWO	202,202A,202B-204, 206-209,211-215
210	FLOOR TWO	1308	20/1	13	*			14	20/1	1206	FLOOR TWO	205
226	FLOOR TWO	1080	20/1	15		*		16	20/1	1236	FLOOR TWO	220
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	20/1			SPARE
SPARE			20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SPARE			20/1	31	*			32	20/1			SPARE
SPARE			20/1	33		*		34	20/1			SPARE
SPARE			20/1	35			*	36	20/1			SPARE
SPARE			20/1	37	*			38	20/1			SPARE
SPARE			20/1	39		*		40	20/1			SPARE
SPARE			20/1	41			*	42	20/1			SPARE
SUB-TOTAL	A PHASE	8502.0		B PHASE						6784.0	C PHASE	6770.0
TOTAL CONNECTED LOAD (WATTS)		22056.0									DEMAND LOAD	19850.4

Figure 41.2 – New Second Floor Lighting Panel

PANEL SCHEDULE												
VOLTAGE	480Y/277V, 3P, 4W			TAG				LP-2		TYPE PANEL		
MOUNTING	SURFACE									C/B MIN	AIC	FEED
SIZE/TYPE BUS	100A COPPER			PANEL LOCATION				E222		OPTIONS/ACCESSRS		
SIZE/TYPE MAINS	90A MCB									REMARKS		
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C201N,S,E,W - a	FLOOR TWO	1085	20/1	1	*			2	20/1	1327	FLOOR TWO	C201N,S,E,W - b
C201N,S,E,W - c	FLOOR TWO	1554	20/1	3		*		4	20/1	2400	FLOOR TWO	C201 - d - LEDs
240,240B,250	FLOOR TWO	2472	20/1	5			*	6	20/1	1020	FLOOR TWO	270
260	FLOOR TWO	2532	20/1	7	*			8	20/1			SPARE
241-244,251-254,261,263	FLOOR TWO	582	20/1	9		*		10	20/1	1498	FLOOR TWO	230-237
J221,D223,T224,T225	FLOOR TWO	1680	20/1	11			*	12	20/1	1598	FLOOR TWO	202,202A,202B-204, 206-209,211-215
210	FLOOR TWO	1308	20/1	13	*			14	20/1	1206	FLOOR TWO	205
226	FLOOR TWO	1080	20/1	15		*		16	20/1	1236	FLOOR TWO	220
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	20/1			SPARE
SPARE			20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SPARE			20/1	31	*			32	20/1			SPARE
SPARE			20/1	33		*		34	20/1			SPARE
SPARE			20/1	35			*	36	20/1			SPARE
SPARE			20/1	37	*			38	20/1			SPARE
SPARE			20/1	39		*		40	20/1			SPARE
SPARE			20/1	41			*	42	20/1			SPARE
SUB-TOTAL	A PHASE	7458.0		B PHASE						8350.0	C PHASE	6770.0
TOTAL CONNECTED LOAD (WATTS)		22578.0									DEMAND LOAD	20320.2

Figure 42.1 – Existing Third Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE	480Y/277V, 3P, 4W	TAG LP-3	TYPE PANEL	
MOUNTING	SURFACE		C/B MIN AIC	FEED
SIZE/TYPE BUS	100A COPPER	PANEL LOCATION E322	OPTIONS/ACCESSRS	
SIZE/TYPE MAINS	90A MCB		REMARKS	

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C301N,S,E,W	FLOOR THREE	1368	20/1	1	*			2	20/1	2408	FLOOR THREE	C301N,S,E,W
C301N,S,E,W	FLOOR THREE	1728	20/1	3		*		4	20/1	1752	FLOOR THREE	327,331-338
J321,D323,T324,T325	FLOOR THREE	1680	20/1	5			*	6	20/1	2364	FLOOR THREE	341,341A,341B,342,342A,342B
343,343B,343C,344,344A	FLOOR THREE	2370	20/1	7	*			8	20/1	2202	FLOOR THREE	345,345A,370
381-385	FLOOR THREE	720	20/1	9		*		10	20/1	720	FLOOR THREE	381-385
305F,306,307,309,310,310A-314	FLOOR THREE	1296	20/1	11			*	12	20/1	2556	FLOOR THREE	305,305B,305C,305E,308
326	FLOOR THREE	1080	20/1	13	*			14	20/1	1332	FLOOR THREE	320
314	FLOOR THREE	720	20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	20/1			SPARE
SPARE			20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SPARE			20/1	31	*			32	20/1			SPARE
SPARE			20/1	33		*		34	20/1			SPARE
SPARE			20/1	35			*	36	20/1			SPARE
SPARE			20/1	37	*			38	20/1			SPARE
SPARE			20/1	39		*		40	20/1			SPARE
SPARE			20/1	41			*	42	20/1			SPARE
SUB-TOTAL	A PHASE	10760.0	B PHASE							5640.0	C PHASE	7896.0
TOTAL CONNECTED LOAD (WATTS)		24296.0									DEMAND LOAD	21866.4

Figure 42.2 – New Third Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE	480Y/277V, 3P, 4W	TAG LP-3	TYPE PANEL	
MOUNTING	SURFACE		C/B MIN AIC	FEED
SIZE/TYPE BUS	100A COPPER	PANEL LOCATION E322	OPTIONS/ACCESSRS	
SIZE/TYPE MAINS	90A MCB		REMARKS	

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C301N,S,E,W - b	FLOOR THREE	1327	20/1	1	*			2	20/1	1554	FLOOR THREE	C301N,S,E,W
C301N,S,E,W	FLOOR THREE	1765	20/1	3		*		4	20/1	1752	FLOOR THREE	327,331-338
J321,D323,T324,T325	FLOOR THREE	1680	20/1	5			*	6	20/1	2364	FLOOR THREE	341,341A,341B,342,342A,342B
343,343B,343C,344,344A	FLOOR THREE	2370	20/1	7	*			8	20/1	2202	FLOOR THREE	345,345A,370
381-385	FLOOR THREE	720	20/1	9		*		10	20/1	720	FLOOR THREE	381-385
305F,306,307,309,310,310A-314	FLOOR THREE	1296	20/1	11			*	12	20/1	2556	FLOOR THREE	305,305B,305C,305E,308
326	FLOOR THREE	1080	20/1	13	*			14	20/1	1332	FLOOR THREE	320
314	FLOOR THREE	720	20/1	15		*		16	20/1	2600	FLOOR THREE	C301N,S,E,W - d
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	20/1			SPARE
SPARE			20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SPARE			20/1	31	*			32	20/1			SPARE
SPARE			20/1	33		*		34	20/1			SPARE
SPARE			20/1	35			*	36	20/1			SPARE
SPARE			20/1	37	*			38	20/1			SPARE
SPARE			20/1	39		*		40	20/1			SPARE
SPARE			20/1	41			*	42	20/1			SPARE
SUB-TOTAL	A PHASE	9865.0	B PHASE							8277.0	C PHASE	7896.0
TOTAL CONNECTED LOAD (WATTS)		26038.0									DEMAND LOAD	23434.2

Figure 43.1 – Existing Fourth Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE	480Y/277V, 3PH, 4W	PANEL TAG	LP-4	TYPE PANEL	
MOUNTING	SURFACE	PANEL LOCATION	E422	C/B MIN AIC	FEED
SIZE/TYPE BUS	100A COPPER			OPTIONS/ACCESSRS	
SIZE/TYPE MAINS	90A MLO MCB			REMARKS	

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C401N,S,E,W,C430	FLOOR FOUR	1224	20/1	1	*			2	20/1	2326	FLOOR FOUR	C401N,S,E,W
C401N,S,E,W,C430	FLOOR FOUR	1440	20/1	3		*		4	20/1	720	FLOOR FOUR	481-485
C440,437	FLOOR FOUR	1062	20/1	5			*	6	20/1	2040	FLOOR FOUR	441
442	FLOOR FOUR	2040	20/1	7	*			8	20/1	2040	FLOOR FOUR	443
444	FLOOR FOUR	2040	20/1	9		*		10	20/1	2040	FLOOR FOUR	445
446	FLOOR FOUR	1128	20/1	11			*	12	20/1	1620	FLOOR FOUR	441A,B,442A,B,444A,445A,447
427,428,431,A,B,432,A,B	FLOOR FOUR	2713	20/1	13	*			14	20/1	2664	FLOOR FOUR	T424,T425,D423,J421,411,403
481,482,483,484,485	FLOOR FOUR	720	20/1	15		*		16	20/1	1596	FLOOR FOUR	410
402	FLOOR FOUR	1902	20/1	17			*	18	20/1	1080	FLOOR FOUR	426
420	FLOOR FOUR	1476	20/1	19	*			20	20/1			SPARE
SPARE			20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	14483.0		B PHASE						8556.0	C PHASE	8832.0
TOTAL CONNECTED LOAD (WATTS)		31871.0									DEMAND LOAD	28683.9

Figure 43.2 – New Fourth Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE	480Y/277V, 3PH, 4W	PANEL TAG	LP-4	TYPE PANEL	
MOUNTING	SURFACE	PANEL LOCATION	E422	C/B MIN AIC	FEED
SIZE/TYPE BUS	100A COPPER			OPTIONS/ACCESSRS	
SIZE/TYPE MAINS	90A MLO MCB			REMARKS	

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C401N,S,E,W,C430 - b	FLOOR FOUR	1327	20/1	1	*			2	20/1	1554	FLOOR FOUR	C401N,S,E,W - c
C401N,S,E,W,C430 - a	FLOOR FOUR	1785	20/1	3		*		4	20/1	720	FLOOR FOUR	481-485
C440,437	FLOOR FOUR	1062	20/1	5			*	6	20/1	2040	FLOOR FOUR	441
442	FLOOR FOUR	2040	20/1	7	*			8	20/1	2040	FLOOR FOUR	443
444	FLOOR FOUR	2040	20/1	9		*		10	20/1	2040	FLOOR FOUR	445
446	FLOOR FOUR	1128	20/1	11			*	12	20/1	1620	FLOOR FOUR	441A,B,442A,B,444A,445A,447
427,428,431,A,B,432,A,B	FLOOR FOUR	2713	20/1	13	*			14	20/1	2664	FLOOR FOUR	T424,T425,D423,J421,411,403
481,482,483,484,485	FLOOR FOUR	720	20/1	15		*		16	20/1	1596	FLOOR FOUR	410
402	FLOOR FOUR	1902	20/1	17			*	18	20/1	1080	FLOOR FOUR	426
420	FLOOR FOUR	1476	20/1	19	*			20	20/1			SPARE
C401N,S,E,W - d	FLOOR FOUR	2600	20/1	21		*		22	20/1			SPARE
SPARE			20/1	23			*	24	20/1			SPARE
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	13814.0		B PHASE						11501.0	C PHASE	8832.0
TOTAL CONNECTED LOAD (WATTS)		34147.0									DEMAND LOAD	30732.3

Figure 44.1 – Existing First Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE	480Y/277V, 3PH, 4W	PANEL TAG LP-1	TYPE PANEL
MOUNTING	SURFACE	PANEL LOCATION E116	C/B MIN AIC FEED
SIZE/TYPE BUS	100A COPPER		OPTIONS/ACCESSRS
SIZE/TYPE MAINS	100A MLO MCB		REMARKS

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C101N,S,E,W,105	FLOOR ONE	2204	20/1	1	*			2	20/1	864	FLOOR ONE	102W
C101S,W,102W	FLOOR ONE	2178	20/1	3		*		4	20/1	2316	FLOOR ONE	154,160,161,170
152,156,162-164,D165,J166,167	FLOOR ONE	878	20/1	5			*	6	20/1	1857	FLOOR ONE	C110,C110A,C111
109,112-D115,J117,T118,121-124	FLOOR ONE	1336	20/1	7	*			8	20/1	1521	FLOOR ONE	T106,T107
EXTERIOR		224	20/1	9		*		10	20/1	1110		EXTERIOR
EXTERIOR		360	20/1	11			*	12	20/1	849		EXTERIOR
SPARE			20/1	13	*			14	20/1			SPARE
SPARE			20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	30/3	4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	21		*		22		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	23			*	24		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	9925.0		B PHASE						9828.0	C PHASE	7944.0
TOTAL CONNECTED LOAD (WATTS)		27697.0									DEMAND LOAD	24927.3

Figure 44.2 – New First Floor Lighting Panel

PANEL SCHEDULE

VOLTAGE	480Y/277V, 3PH, 4W	PANEL TAG LP-1	TYPE PANEL
MOUNTING	SURFACE	PANEL LOCATION E116	C/B MIN AIC FEED
SIZE/TYPE BUS	100A COPPER		OPTIONS/ACCESSRS
SIZE/TYPE MAINS	100A MLO MCB		REMARKS

LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C101N,S,E,W,105	FLOOR ONE	2204	20/1	1	*			2	20/1	864	FLOOR ONE	102W
C101S,W,102W	FLOOR ONE	2178	20/1	3		*		4	20/1	2316	FLOOR ONE	154,160,161,170
152,156,162-164,D165,J166,167	FLOOR ONE	878	20/1	5			*	6	20/1	1857	FLOOR ONE	C110,C110A,C111
109,112-D115,J117,T118,121-124	FLOOR ONE	1336	20/1	7	*			8	20/1	1521	FLOOR ONE	T106,T107
EXTERIOR		224	20/1	9		*		10	20/1	1110		EXTERIOR
EXTERIOR		360	20/1	11			*	12	20/1	849		EXTERIOR
SPARE			20/1	13	*			14	20/1			SPARE
SPARE			20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	30/3	4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	21		*		22		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	23			*	24		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	9925.0		B PHASE						9828.0	C PHASE	7944.0
TOTAL CONNECTED LOAD (WATTS)		27697.0									DEMAND LOAD	24927.3

Exterior Plaza

The existing lighting design for the Plaza on the south side of the building is all located on the LP-1 lighting panelboard with three circuits dedicated to atrium and circulation space lighting. The proposed redesign of the lighting will reuse lighting panel LP-1.

Please refer to the following lighting plan and panelboard layouts for more details on circuits and their loads on the panelboards.

Figure 46.1 – Existing First Floor Lighting Panel

PANEL SCHEDULE												
VOLTAGE	480Y/277V, 3PH, 4W			PANEL TAG	LP-1					TYPE PANEL		
MOUNTING	SURFACE			PANEL LOCATION	E116					C/B MIN	AIC	FEED
SIZE/TYPE BUS	100A COPPER									OPTIONS/ACCESSRS		
SIZE/TYPE MAINS	100A MLO MCB									REMARKS		
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C101N,S,E,W,105	FLOOR ONE	2204	20/1	1	*			2	20/1	864	FLOOR ONE	102W
C101S,W,102W	FLOOR ONE	2178	20/1	3		*		4	20/1	2316	FLOOR ONE	154,160,161,170
152,156,162-164,D165,J166,167	FLOOR ONE	878	20/1	5			*	6	20/1	1857	FLOOR ONE	C110,C110A,C111
109,112-D115,J117,T118,121-124	FLOOR ONE	1336	20/1	7	*			8	20/1	1521	FLOOR ONE	T106,T107
EXTERIOR		224	20/1	9		*		10	20/1	1110		EXTERIOR
EXTERIOR		360	20/1	11			*	12	20/1	849		EXTERIOR
SPARE			20/1	13	*			14	20/1			SPARE
SPARE			20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	30/3	4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	21		*		22		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	23			*	24		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	9925.0		B PHASE						9828.0	C PHASE	7944.0
TOTAL CONNECTED LOAD (WATTS)		27697.0									DEMAND LOAD	24927.3

Figure 46.2 – New First Floor Lighting Panel

PANEL SCHEDULE												
VOLTAGE	480Y/277V, 3PH, 4W			PANEL TAG	LP-1					TYPE PANEL		
MOUNTING	SURFACE			PANEL LOCATION	E116					C/B MIN	AIC	FEED
SIZE/TYPE BUS	100A COPPER									OPTIONS/ACCESSRS		
SIZE/TYPE MAINS	100A MLO MCB									REMARKS		
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
C101N,S,E,W,105	FLOOR ONE	2204	20/1	1	*			2	20/1	864	FLOOR ONE	102W
C101S,W,102W	FLOOR ONE	2178	20/1	3		*		4	20/1	2316	FLOOR ONE	154,160,161,170
152,156,162-164,D165,J166,167	FLOOR ONE	878	20/1	5			*	6	20/1	1857	FLOOR ONE	C110,C110A,C111
109,112-D115,J117,T118,121-124	FLOOR ONE	1336	20/1	7	*			8	20/1	1521	FLOOR ONE	T106,T107
EXTERIOR - A1B		280	20/1	9		*		10	20/1	312		EXTERIOR - H1
EXTERIOR - K1		360	20/1	11			*	12	20/1	704		EXTERIOR - J1
SPARE			20/1	13	*			14	20/1			SPARE
SPARE			20/1	15		*		16	20/1			SPARE
SPARE			20/1	17			*	18	20/1			SPARE
SPARE			20/1	19	*			20	30/3	4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	21		*		22		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	23			*	24		4000	A/V ROOM 154	PANEL GP-1
SPARE			20/1	25	*			26	20/1			SPARE
SPARE			20/1	27		*		28	20/1			SPARE
SPARE			20/1	29			*	30	20/1			SPARE
SUB-TOTAL	A PHASE	9925.0		B PHASE						9086.0	C PHASE	7799.0
TOTAL CONNECTED LOAD (WATTS)		26810.0									DEMAND LOAD	24129.0

MOTOR CONTROL CENTER DESIGN

Introduction

This study analyzes the consolidation of a mechanical distribution panel located in the Penthouse of the Armstrong Medical Education Building into a Motor Control Center to house all of the 17 motors connected to the curent distribution panel, DP-MECH-1. This analysis includes equipment sizing, protection for these motors as well as a space analysis to place the Motor Control Center in the Penthouse level of the building. Also included is a preliminary cost comparison of both systems.

Motor Control Center Loads

The distribution panel, DP-MECH-1, in the penthouse of the Medical Education Building delivers power to 17 motors needed to run the mechanical systems in the building. Included are three air handling units to operate its heating and air conditioning system. Each unit consists of a 45,000 cfm supply fan and a 26,600 cfm return fan. Corresponding to these fans are a 75 HP and 25 HP motor, respectively. Also included on the mechanical distribution panel are four pump motors and five exhaust fan motors ranging from 2 to 30 HP. Also included in the motor control center is a circuit breaker for the steam condensation pump and another circuit break for the elevator motor. Refer to Figure 47 for more information on the loads and their respective motors on the motor control center.

Motor Starter Sizes

The motor control center is sized by calculating the number and sizes of motors that will be included within it. According to the building specifications, the motor starters will all have NEMA 12 enclosures (equivalent to IEC IP52 enclosure types). NEMA 12 enclosures provide protection from dust, dirt and falling particles as well as liquid damage.

The motor control center is sized by calculating the number and sizes of motors that will be included within it. The ampacity will also need to be calculated to determine the wiring for the whole motor control center. Refer to Figure 47 for Motor Starter Sizes.

Figure 47 – MCC Sizing and Dimensions

MOTOR CONTROL CENTER DESIGN								
MOTOR		HP	AMP RATING	VFD	FRAME SIZE	DIMENSIONS (INCH)		
						WIDTH	HEIGHT	DEPTH
1	EF-1	30	40	MM430	D	10.8	20.5	9.6
2	EF-2	2	3.4	MM420	C	7.3	9.6	7.7
3	EF-3	3	4.8	MM430	C	7.3	9.6	7.7
4	EF-4	3	4.8	MM430	C	7.3	9.6	7.7
5	P-1	25	34	MM430	D	10.8	20.5	9.6
6	P-2	25	34	MM430	D	10.8	20.5	9.6
7	P-3	7.5	11	MM420	C	7.3	9.6	7.7
8	P-4	7.5	11	MM420	C	7.3	9.6	7.7
9	AHU-1	75	96	MM430	F	13.8	33.5	12.6
10	AHU-1	25	34	MM430	D	10.8	20.5	9.6
11	AHU-2	75	96	MM430	F	13.8	33.5	12.6
12	AHU-2	25	34	MM430	D	10.8	20.5	9.6
13	AHU-3	75	96	MM430	F	13.8	33.5	12.6
14	AHU-3	25	34	MM430	D	10.8	20.5	9.6
15	EF-1A	30	40	MM430	D	10.8	20.5	9.6
				CKT BKR				
16	ELEVATOR	75	96					
17	SCP-1	(2) 5	15.2					

Motor Control Center Sizing

The motor control center is sized by calculating the number and sizes of motors that will be included within it. The ampacity will also need to be calculated to determine the wiring for the whole motor control center. Refer to Figure 48 for Ampacity calculations.

Table 48 – MCC Ampacity Calculations

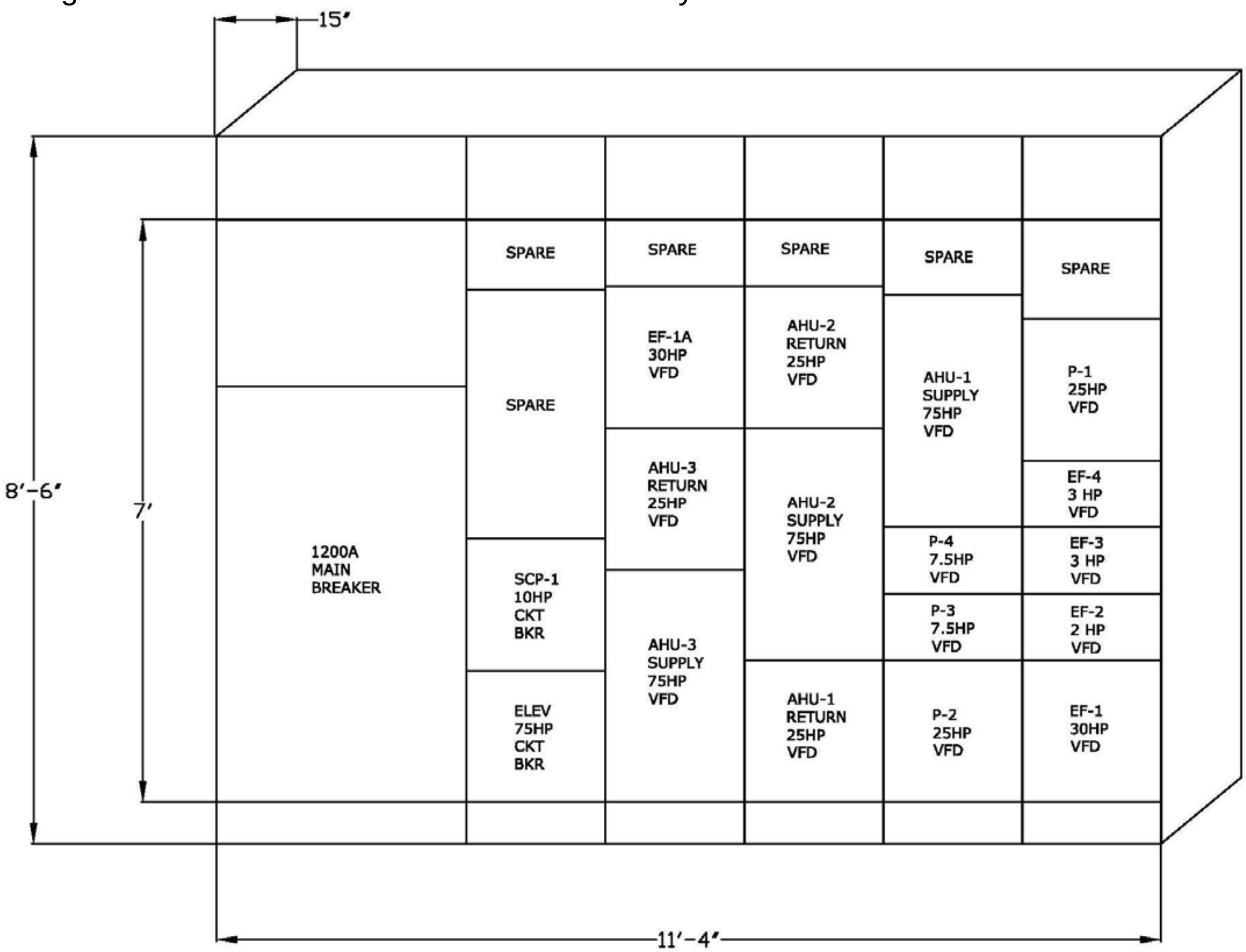
MOTOR CONTROL CENTER SIZING			
MOTOR	FLMA	DEMAND	AMPS
1	40	X 100%	40
2	3.4	X 100%	3.4
3	4.8	X 100%	4.8
4	4.8	X 100%	4.8
5	34	X 100%	34
6	34	X 100%	34
7	11	X 100%	11
8	11	X 100%	11
9	96	**X 125%**	120
10	34	X 100%	34
11	96	X 100%	96
12	34	X 100%	34
13	96	X 100%	96
14	34	X 100%	34
15	40	X 100%	40
16	96	X 100%	96
17	15.2	X 100%	15.2
		TOTAL	708.2

The calculated ampacity for all of the loads in the motor control center is 708.2 amps. The vertical bus in the control center will be a 800 amp bus and it will be braced for 42,000 amps interrupting rating. According to Table NEC 310.16, the wire sizes feeding the motor control center will be (2) sets of 4-500kcmil copper wiring. The maximum OCPD is 250% of the ampacity which is 1770.5 amps. From this it is determined that a 1200 amp circuit breaker is required.

Motor Control Center Design

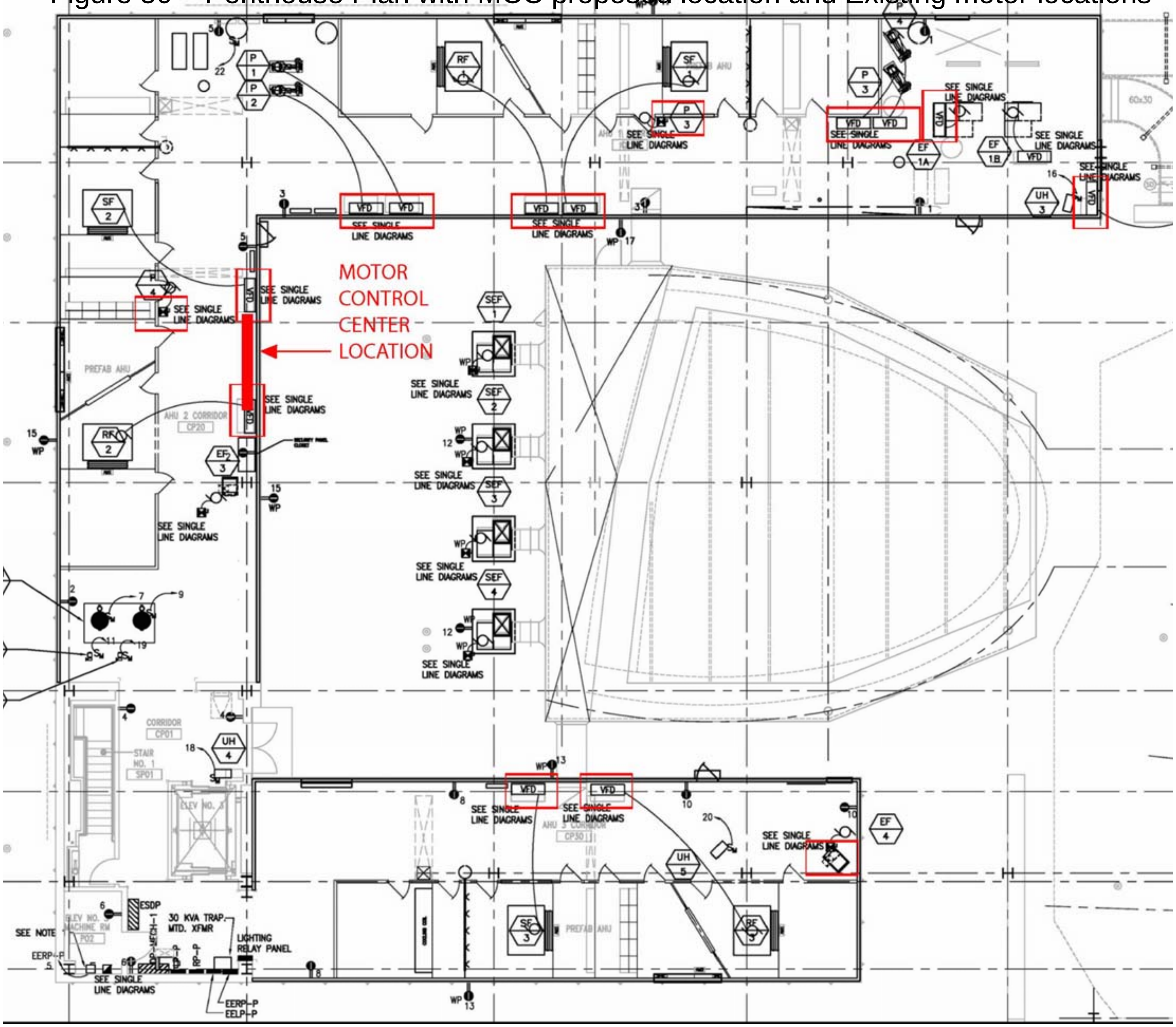
The motor control center has a nominal height of 90 inches with 72 inches of motor control unit space. The other 18 inches is needed for wiring. The depth of the motor control center is 15 inches. With the exception of the 36 inch wide main breaker control center, each section is 20 inches wide. Refer to Figure 49 for more details.

Figure 49 – Motor Control Center Size and Layout



The location of the motor control center will need to be located on the penthouse level to correspond with the location of the loads. Locating it near AHU-2 would be ideal in order to keep it in a central location. Being over 10 feet from the air handling unit, it satisfies the 3.5 foot distance from the nearest grounded surface requirement. It is consolidating all of the outlined variable frequency drives throughout the penthouse and therefore opening up a considerable amount of space. Refer to Figure 50 for location of the motor control center and location of existing motors.

Figure 50 – Penthouse Plan with MCC proposed location and Existing motor locations



Conclusion

The motor control center has a nominal height of 90 inches with 72 inches of motor control unit space. The depth of the motor control center is 15 inches. With the exception of the 36 inch wide main breaker control center, each of the 5 sections are 20 inches wide. The motor control center will supply the motor loads from a 800A bus bar. It is located in a central location in the penthouse in order to be closest to the loads.

CENTRAL VS. DISTRIBUTED TRANSFORMER ANALYSIS

Introduction

The following electrical study compares a portion of the central transformer design of the Armstrong Medical Education Building to a redesign utilizing distributed transformers. This analysis will include transformer sizing, feeder sizing and busway sizing as well as a cost analysis to determine the cost savings with the two options.

Existing System

The electrical design of the Armstrong Medical Education building taps off a 15KV feeder which feeds a 13.2kV, 1500KVA dry type transformer. Secondary voltage for the building is 480Y/277V, 3 phase, 4 wire grounded Wye system. The majority of the lighting and mechanical loads in the building are served at this voltage with the exception of emergency receptacle panels and regular receptacle panels.

The analysis specifically looks at transformer T-1 which provides power to the Low Voltage Distribution Panel, LVDP. This supplies power to the majority of the receptacle panels throughout the building. Figure 51 outlines the current transformers in the building. Refer to Appendix C for existing single-line diagram.

Figure 51 – Transformer Schedule

TRANSFORMER SCHEDULE								
TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE (KVA)	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
T-MEB	13200V,3PH,3W	480Y/277V,3PH,4W	1500	N/A	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	
T-1	480V,3PH,4W.	208Y/120V,3PH,4W	300	DRY TYPE	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-2	480V,3PH,3W.	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-3	480V,3PH,3W.	208Y/120V,3PH,4W	30	DRY TYPE	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	K-14

1. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS

KEY:
A/N=AS NOTED

Transformer Design Considerations

There are several major considerations to take into account when designing a central transformer system compared to a distributed transformer system. The more prominent difference of the two systems is cost. Central transformer designs minimizes equipment costs for transformers throughout the building. Distributed transformer designs do increase the equipment costs but greatly effect the wire costs. With transformers stepping down voltage closer to the panelboards, wire sizes generally decrease and therefore greatly decreasing the cost of the system. The more expensive costs in the electrical designs are the wire costs, running hundreds of dollars per foot of wire.

Another factor when deciding between a central or a distributed transformer design is the space requirements. Central transformers minimize the space that is needed for the transformers. Due to their heat buildup, they need extra space to be able to ventilate properly. Electrical rooms are typically designed to be smaller than they should be an to increase the amount of equipment in the space will only compound the issue.

Distributed Transformer Design

The redesign of the central transformer system to distributed transformers will begin at transformer T-1 and analyze the effects on the system through the low voltage distribution panel, busway and receptacle panels. Feeders, protection and busways will be resized and new transformers will be designed. Figure 52 indicates the part of the electrical system that will be redesigned. Figures 56.1 to 56.8 indicate the location of the new transformers. Refer to Appendix G for transformer information.

Transformer Sizing

Figure 54 outlines the sizing of the distributed transformers throughout the system.

Figure 52 – Existing Single Line Diagram

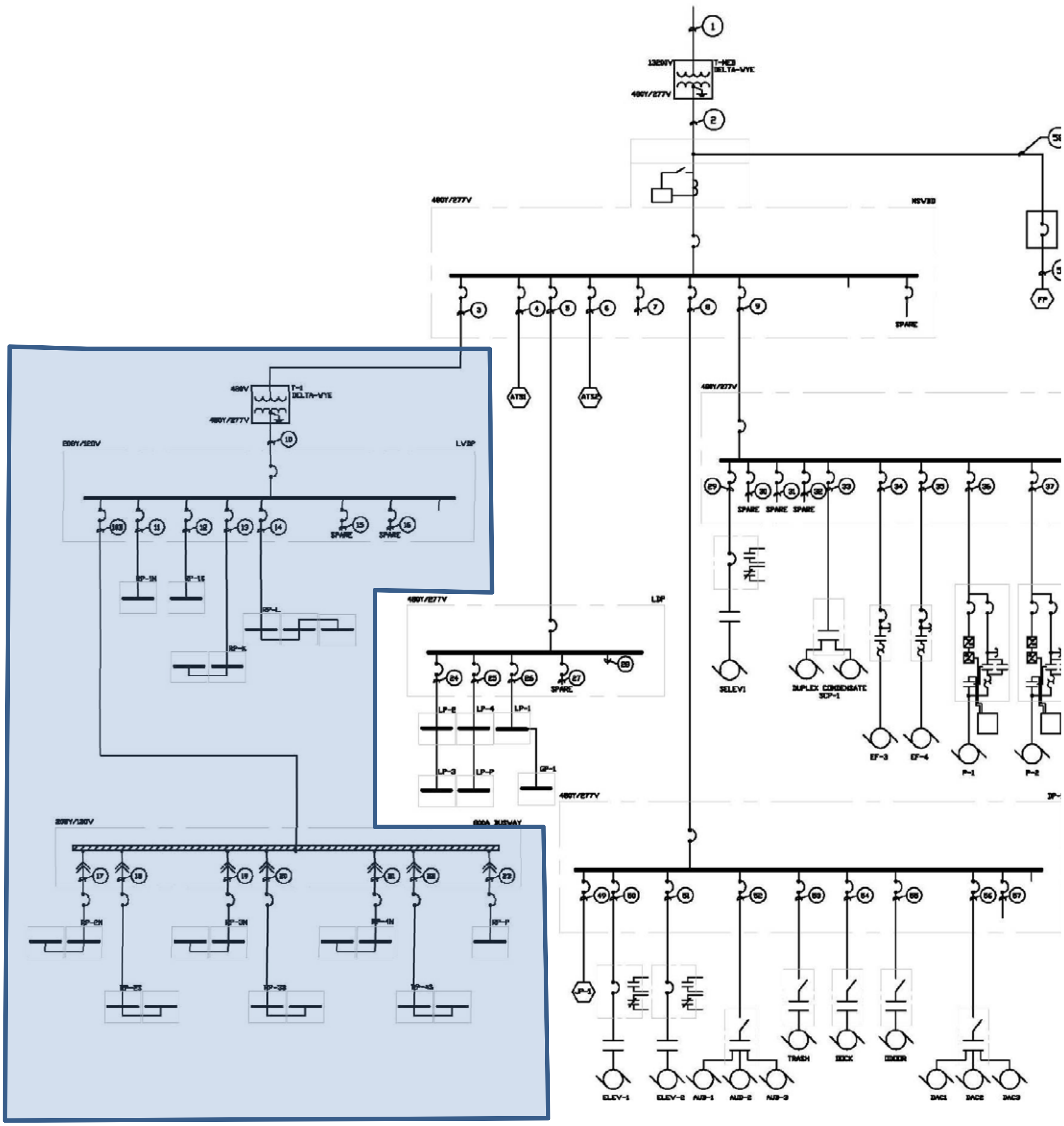
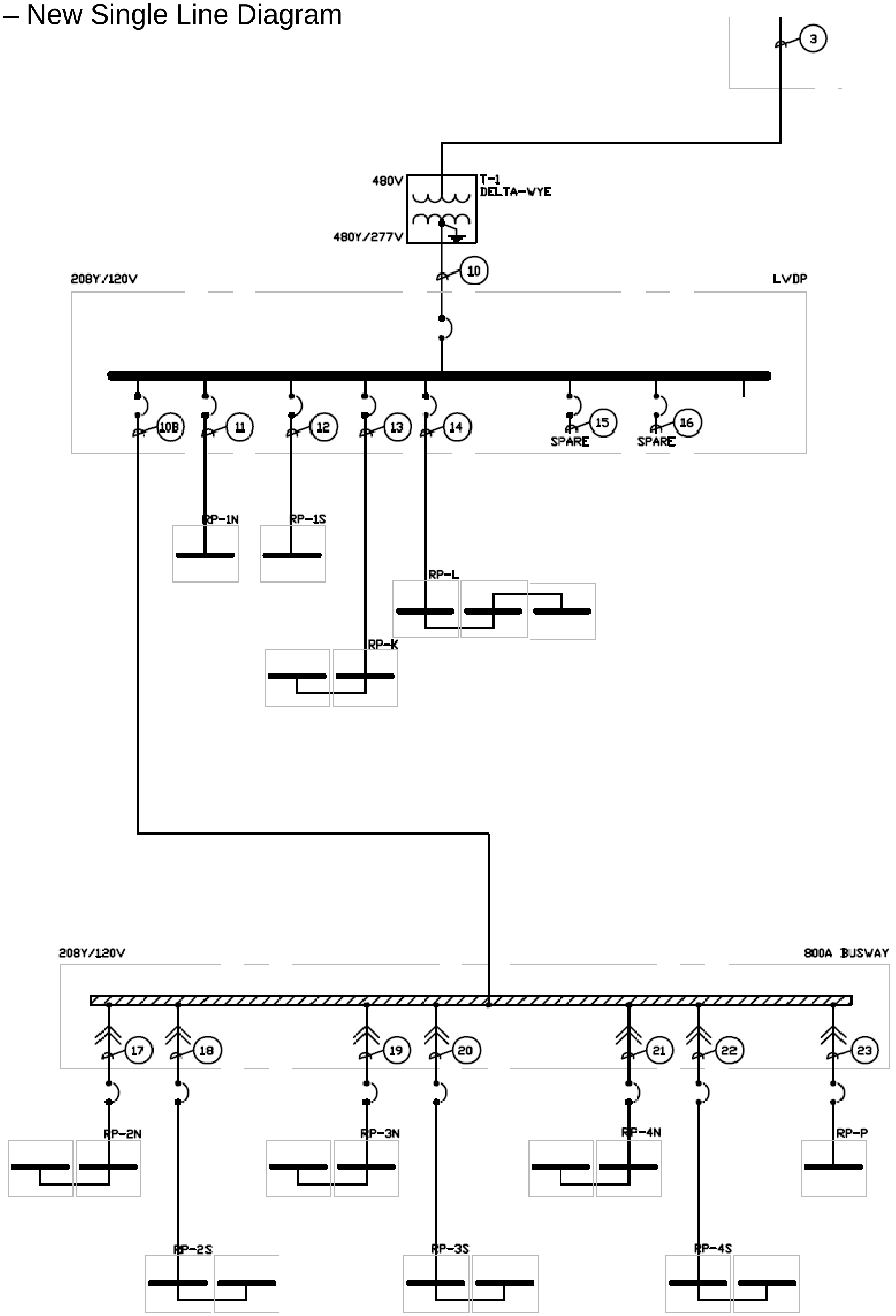


Figure 53 – New Single Line Diagram



Transformer Sizing

The following Figure 54 outlines the sizing of the distributed transformers throughout the system.

Figure 54 – Transformer Sizing

TRANSFORMER SIZING						
TAG	DESIGN LOAD (A)	XFRMR SIZE (kVA)	XFRMR PROTECTION		FEEDER SIZES	
			PRIMARY BKR SIZE (A)	SECONDARY BKR SIZE (A)	PRIMARY	SECONDARY
T-RP-1N	37	15	50	50	4#6, 1#10G, 1-1/4"C	4 #6, 1#10G, 1-1/4"C
T-RP-1S	22	15	50	30	4 #6, 1#10G, 1-1/4"C	4 #10, 1#10G, 1-1/4"C
T-RP-K	43	30	100	60	4 #2, 1 #8G, 1-1/2"C	4 #6, 1 #10G, 1-1/4"C
T-RP-L-HALL	98	45	150	125	4 #2/0, 1 #6G, 2"C	4 #1, 1 #6G, 2"C
T-RP-2N	96	45	150	125	4 #2/0, 1 #6G, 2"C	4 #1, 1 #6G, 2"C
T-RP-2S	79	30	100	100	4 #2, 1 #8G, 1-1/2"C	4 #2, 1#8G, 1-1/2"C
T-RP-3N	110	45	150	150	4 #2/0, 1 #6G, 2"C	4 #2/0, 1 #6G, 2"C
T-RP-3S	147	75	250	200	(2) 4 #1, 1 #4G, 2"C	4 #4/0, 1 #4G, 1-1/4"C
T-RP-4N	93	45	150	125	4 #2/0, 1 #6G, 2"C	4 #1, 1 #6G, 2"C
T-RP-4S	94	45	150	125	4 #2/0, 1 #6G, 2"C	4 #1, 1 #6G, 2"C
T-RP-P	33	15	50	50	4 #6, 1#10G, 1-1/4"C	4 #6, 1#10G, 1-1/4"C
TAG	DESIGN LOAD (A)	BUSWAY SIZE (KVA)	PRIMARY PROTECTION	SECONDARY PROTECTION	PRIMARY	SECONDARY
BUSWAY	279	400	500	400	(2) 250kcmil, #2G, 3"C	(2) #2/0, 1#3G, 1-1/2"C
TAG	DESIGN LOAD (A)	DP SIZE (KVA)	PRIMARY PROTECTION	SECONDARY PROTECTION	PRIMARY	SECONDARY
LVDP	370	500	600	500	(2) 4-350kcmil, #1G, 3"C	(2) 4#4/0, 1#2G, 2-1/2"C

Distributed Transformer Design

The distributed transformer design includes 11 new transformers and a resized busway and low voltage distribution panel. Refer to Figure 55 for a new transformer schedule and Figure 53 for a revised single line diagram.

Figure 55 – New Transformer Schedule

TRANSFORMER SCHEDULE								
TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
T-MEB	13200V,3PH,3W	480Y/277V,3PH,4W	1500	DRY TYPE	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	
T-RP-1N	480V, 3PH, 3W	208Y/120V,3PH,4W	15	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-1S	480V, 3PH, 3W	208Y/120V,3PH,4W	15	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-K	480V, 3PH, 3W	208Y/120V,3PH,4W	30	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
-RP-L-HAL	480V, 3PH, 3W	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-2N	480V, 3PH, 3W	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-2S	480V, 3PH, 3W	208Y/120V,3PH,4W	30	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-3N	480V, 3PH, 3W	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-3S	480V, 3PH, 3W	208Y/120V,3PH,4W	75	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-4N	480V, 3PH, 3W	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-4S	480V, 3PH, 3W	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-RP-P	480V, 3PH, 3W	208Y/120V,3PH,4W	15	DRY TYPE	80 DEGREE C	(2) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-2	480V,3PH,3W.	208Y/120V,3PH,4W	45	DRY TYPE	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	K-14
T-3	480V,3PH,3W.	208Y/120V,3PH,4W	30	DRY TYPE	80 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	K-14

NOTES:
1. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS

KEY:
A/N=AS NOTED

Electrical Room Layout

The following Figures, Figure 56.1 to Figure 56.8 outline the changes to the electrical room layouts to adapt to the new distributed transformer design.

Figure 56.1 – First Floor Electrical Room Transformer Location

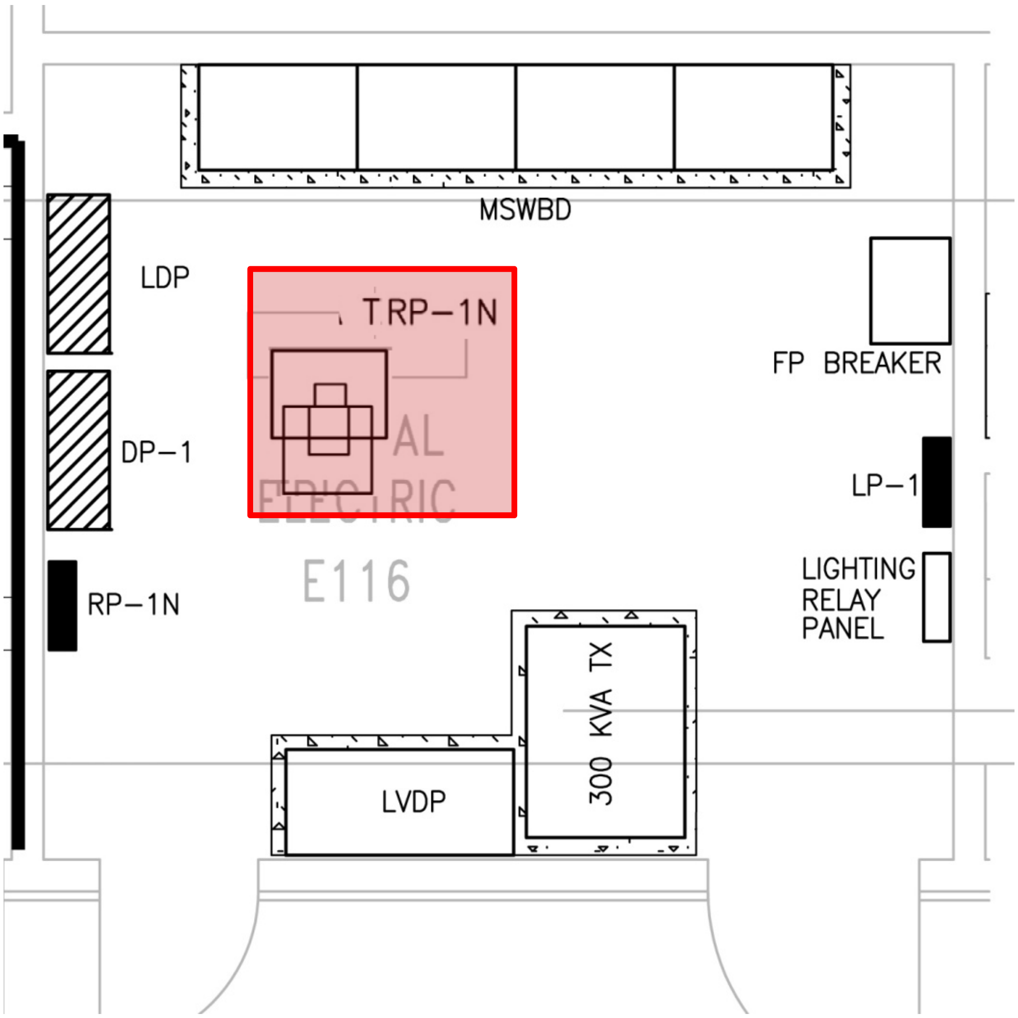


Figure 56.2 – First Floor Electrical Room Transformer Location

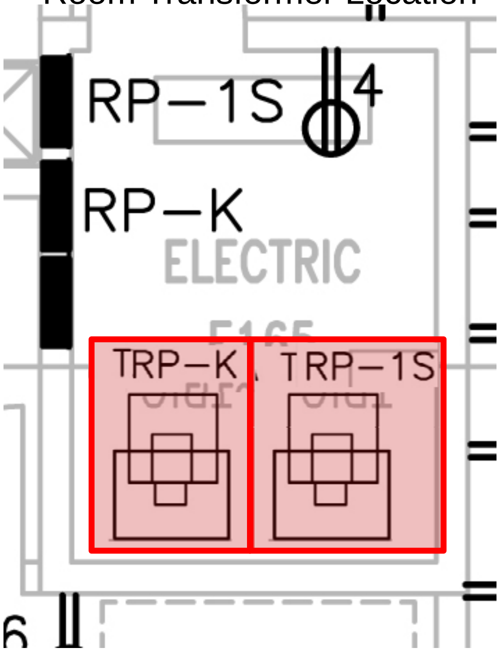


Figure 56.3 – Second Floor Electrical Room Transformer Location

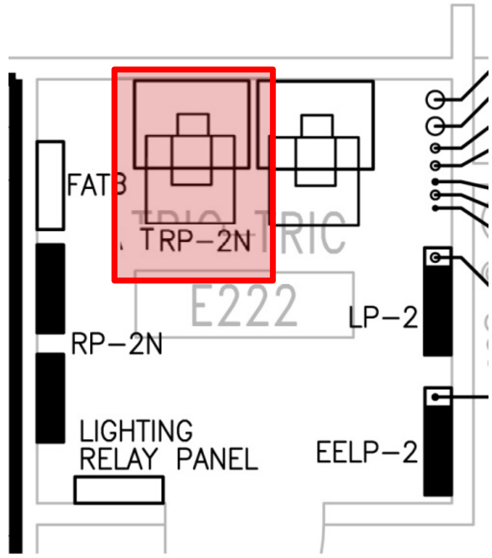


Figure 56.4 – Third Floor Electrical Room Transformer Location

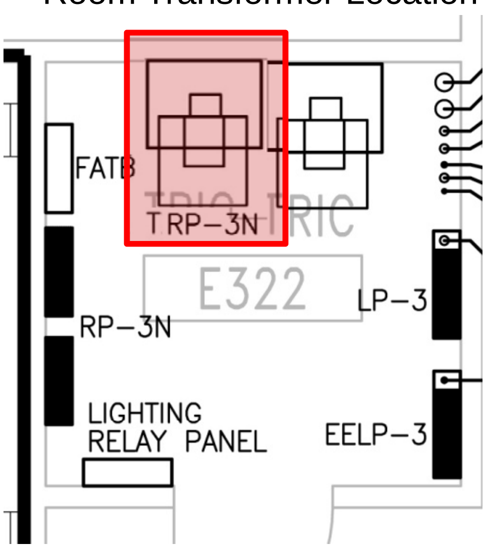


Figure 56.5 – Fourth Floor Electrical Room Transformer Location

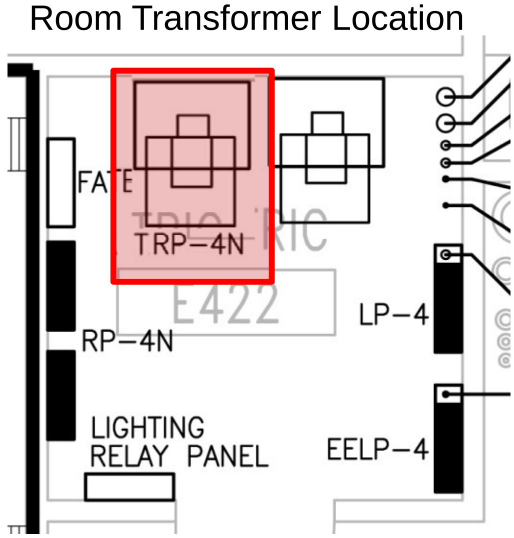


Figure 56.5 – Second Floor Electrical Room Transformer Location

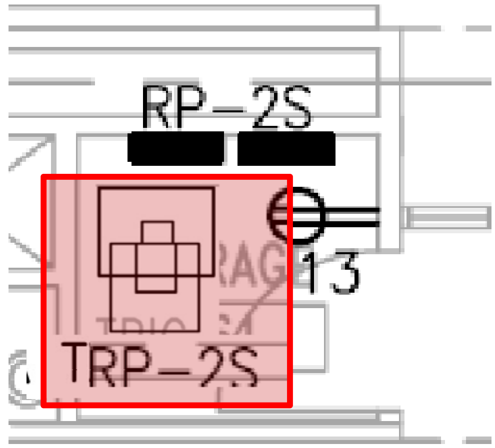


Figure 56.6 – Third Floor Electrical Room Transformer Location

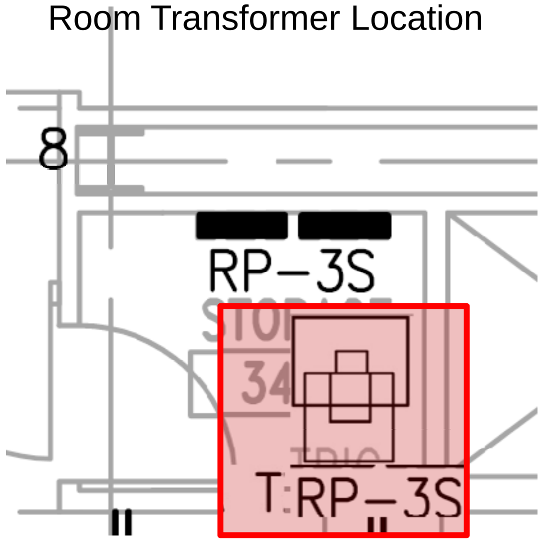


Figure 56.7 – Fourth Floor Electrical Room Transformer Location

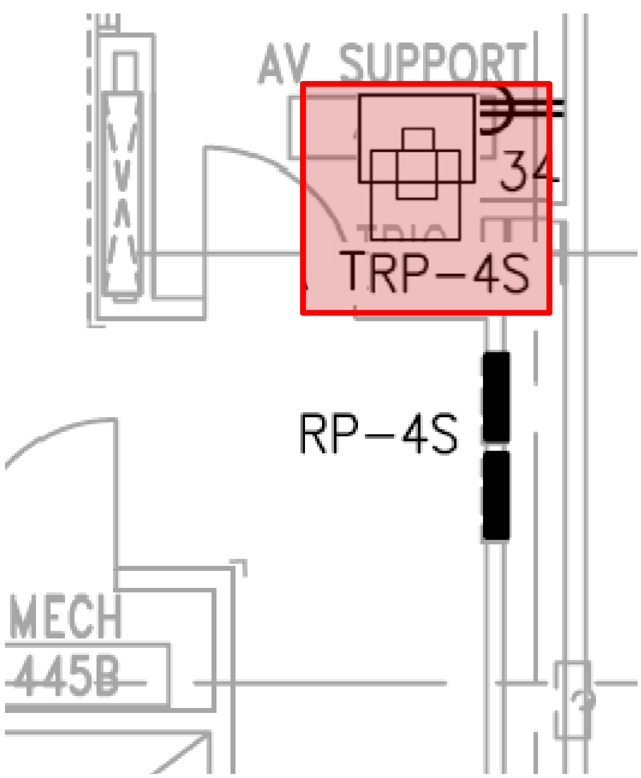
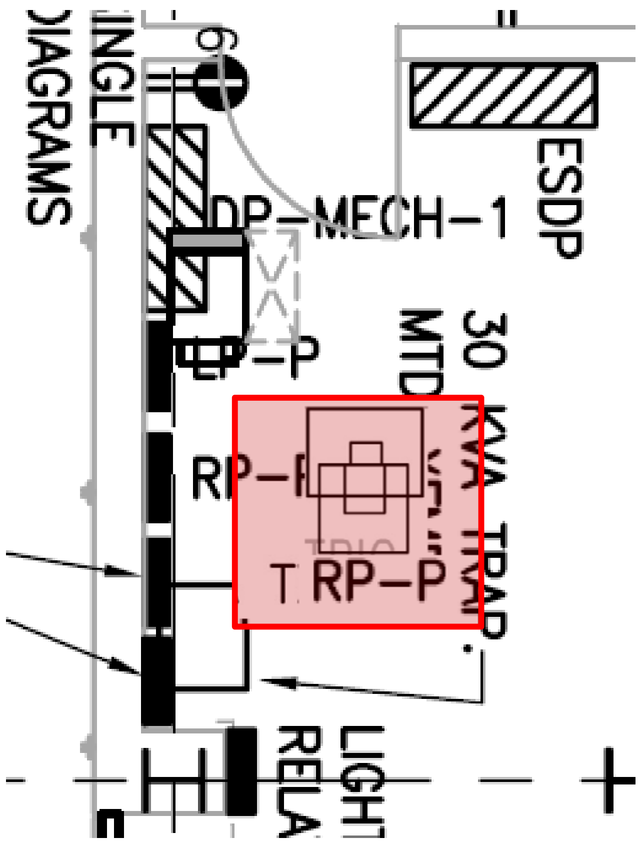


Figure 56.8 – Penthouse Floor Electrical Room Transformer Location



Cost Comparison

The following Figure 57.1 outlines the cost of the current central transformer configuration. Figure 57.2 outlines the changes to the electrical design in terms of cost.

Figure 57.1 – Existing System Costs

EXISTING SYSTEM		
TRANSFORMERS		COST
TAG	SIZE	
T-1	300KVA	$14,365
	SUBTOTAL	$14,365
TRANSFORMER PROTECTION		
SWITCHGEAR BREAKERS		
TAG	SIZE	
T-1	800A	$5,900
RP-1N	250A	$2,175
SPARE	250A	$2,175
SPARE	250A	$2,175
RP-1S	250A	$2,175
RP-K	250A	$2,175
RP-L-HALL	250A	$2,175
RP-2N	250A	$2,175
RP-2S	250A	$2,175
RP-3N	250A	$2,175
RP-3S	250A	$2,175
RP-4N	250A	$2,175
RP-4S	250A	$2,175
RP-P	250A	$2,175
	SUBTOTAL	$34,175
DISTRIBUTION PANEL		
TAG	SIZE	
LVDP	1200A	$5,775
	SUBTOTAL	$5,775
BUSWAY		
TAG	SIZE	
BUSWAY	800A	$331
	SUBTOTAL	$331

Figure 57.2 – New System Costs

PROPOSED TRANSFORMER DESIGN		
TRANSFORMERS		COST
TAG	SIZE	
RP-1N	15A	$2,925
RP-1S	15A	$2,925
RP-K	30A	$3,488
RP-L-HALL	45A	$3,975
RP-2N	45A	$4,300
RP-2S	30A	$3,488
RP-3N	45A	$4,300
RP-3S	75A	$5,510
RP-4N	45A	$4,300
RP-4S	45A	$4,300
RP-P	15A	$2,925
	SUBTOTAL	$42,436
TRANSFORMER PROTECTION		
SWITCHGEAR BREAKERS		
TAG	SIZE	
LVDP	1600A	$6,600
BUSWAY	800A	$5,900
RP-1N	250A	$2,175
SPARE	250A	$2,175
SPARE	250A	$2,175
RP-1S	250A	$2,175
RP-K	250A	$2,175
RP-L-HALL	250A	$2,175
RP-2N	250A	$2,175
RP-2S	250A	$2,175
RP-3N	250A	$2,175
RP-3S	250A	$2,175
RP-4N	250A	$2,175
RP-4S	250A	$2,175
RP-P	250A	$2,175
	SUBTOTAL	$40,775

Figure 57.1 continued

PANELBOARDS				
TAG	SIZE			
RP-1N	225A			$2,025
RP-1S	225A			$2,025
RP-K	225A			$2,025
RP-L-HALL	225A			$2,025
RP-2N	225A			$2,025
RP-2S	225A			$2,025
RP-3N	225A			$2,025
RP-3S	225A			$2,025
RP-4N	225A			$2,025
RP-4S	225A			$2,025
RP-P	225A			$2,025
		SUBTOTAL		$22,275
FEEDER & CIRCUIT				
TAG	WIRE	LENGTH	SIZE	
T-1 PRIMARY	PHASE	30	(2) 3-350kcmil	148500
	GROUND	30	#1	8610
	CONDUIT	30	3"	1350
T-1 SECONDARY	PHASE	5	(3) 4-600kcmil	72000
	GROUND	5	#3/0	2400
	CONDUIT	5	4"	210
RP- 1N	PHASE	10	4-#1/0	13600
	GROUND	10	#6	1380
	CONDUIT	10	2"	180
RP-1S	PHASE	105	4-#1/0	142800
	GROUND	105	#6	14490
	CONDUIT	105	2"	1890
RP-K	PHASE	105	4-#1/0	142800
	GROUND	105	#6	14490
	CONDUIT	105	2"	1890
RP-L-HALL	PHASE	70	4-#3/0	134400
	GROUND	70	#6	9660
	CONDUIT	70	2"	1260
RP-2N	PHASE	75	4-#1/0	102000
	GROUND	75	#6	10350
	CONDUIT	75	2"	1350

Figure 57.2 continued

DISTRIBUTION PANEL				
TAG	SIZE			
LVDP	1200A			$5,775
		SUBTOTAL		$5,775
BUSWAY				
TAG	SIZE			
BUSWAY	400A			$265
		SUBTOTAL		$265
PANELBOARDS				
TAG	SIZE			
RP-1N	225A			$2,025
RP-1S	225A			$2,025
RP-K	225A			$2,025
RP-L-HALL	225A			$2,025
RP-2N	225A			$2,025
RP-2S	225A			$2,025
RP-3N	225A			$2,025
RP-3S	225A			$2,025
RP-4N	225A			$2,025
RP-4S	225A			$2,025
RP-P	225A			$2,025
		SUBTOTAL		$22,275
FEEDER & CIRCUIT				
TAG	WIRE	LENGTH	SIZE	
LVDP PRIMARY	PHASE	30	(3) 3-600kcmil	216000
	GROUND	30	#3/0	6165
	CONDUIT	30	4"	1372.5
BUS PRIMARY	PHASE	10	(2) 4-250kcmil	52800
	GROUND	10	#2	2420
	CONDUIT	10	3"	465
RP- 1N PRIMARY	PHASE	10	4-#6	5560
	GROUND	10	#10	800
	CONDUIT	10	1-1/4"	111.5
RP- 1N SECONDARY	PHASE	5	4-#6	2780
	GROUND	5	#10	400
	CONDUIT	5	1-1/4"	70
RP-1S PRIMARY	PHASE	100	4-#6	55600
	GROUND	100	#10	750
	CONDUIT	100	1-1/4"	1115

Figure 57.1 continued

RP-2S	PHASE	120	4-#1/0	163200
	GROUND	120	#6	16560
	CONDUIT	120	2"	2160
RP-3N	PHASE	95	4-#2/0	152000
	GROUND	95	#6	13110
	CONDUIT	95	2"	1710
RP-3S	PHASE	140	4-#1/0	190400
	GROUND	140	#6	19320
	CONDUIT	140	2"	2520
RP-4N	PHASE	115	4-#1/0	156400
	GROUND	115	#6	15870
	CONDUIT	115	2"	2070
RP-4S	PHASE	160	4-#1/0	217600
	GROUND	160	#6	22080
	CONDUIT	160	2"	2880
RP-P	PHASE	80	4-#1/0	108800
	GROUND	80	#6	11040
	CONDUIT	80	2"	1440
		SUBTOTAL		1924770
EXISTING SYSTEM TOTAL				$2,001,691

Figure 57.2 continued

RP-1S SECONDARY	PHASE	5	4-#6	2780
	GROUND	5	#10	400
	CONDUIT	5	1-1/4"	55.75
RP-K PRIMARY	PHASE	100	4-#2	100000
	GROUND	100	#8	105000
	CONDUIT	100	1-1/2"	1115
RP-K SECONDARY	PHASE	5	4-#6	2780
	GROUND	5	#10	400
	CONDUIT	5	1-1/2"	75
RP-L-HALL PRIMARY	PHASE	65	4-#2/0	92300
	GROUND	65	#6	9035
	CONDUIT	65	2"	1170
RP-L-HALL SECONDARY	PHASE	5	4-#1	5730
	GROUND	5	#6	55.75
	CONDUIT	5	2"	90
RP-2N PRIMARY	PHASE	65	4-#2/0	65000
	GROUND	65	#6	724.75
	CONDUIT	65	2"	1170
RP-2N SECONDARY	PHASE	10	4-#1	11460
	GROUND	10	#6	111.5
	CONDUIT	10	2"	180
RP-2S PRIMARY	PHASE	110	4-#2	110000
	GROUND	110	#8	105000
	CONDUIT	110	1-1/2"	1226.5
RP-2S SECONDARY	PHASE	10	4-#2	10000
	GROUND	10	#8	105000
	CONDUIT	10	1-1/2"	111.5
RP-3N PRIMARY	PHASE	85	4-#2/0	137700
	GROUND	85	#6	947.75
	CONDUIT	85	2"	1530
RP-3N SECONDARY	PHASE	10	4-#2/0	137700
	GROUND	10	#6	111.5
	CONDUIT	10	2"	180
RP-3S PRIMARY	PHASE	130	(2) 4-#1	297960
	GROUND	130	#4	24050
	CONDUIT	130	2"	2340

Figure 57.2 continued

RP-3S SECONDARY	PHASE	10	4-#4/0	20000
	GROUND	10	#4	1850
	CONDUIT	10	1-1/2"	150
RP-4N PRIMARY	PHASE	105	4-#2/0	105000
	GROUND	105	#6	1170.75
	CONDUIT	105	2"	1890
RP-4N SECONDARY	PHASE	10	4-#1	12000
	GROUND	10	#6	111.5
	CONDUIT	10	2"	180
RP-4S PRIMARY	PHASE	150	4-#2/0	150000
	GROUND	150	#6	1672.5
	CONDUIT	150	2"	2700
RP-4S SECONDARY	PHASE	10	4-#1	12000
	GROUND	10	#6	111.5
	CONDUIT	10	2"	180
RP-P PRIMARY	PHASE	70	4-#6	38920
	GROUND	70	#10	5600
	CONDUIT	70	1-1/4"	780.5
RP-P SECONDARY	PHASE	10	4-#6	5560
	GROUND	10	#10	800
	CONDUIT	10	1-1/4"	111.5
		SUBTOTAL		2040687.25
TOTAL				$2,152,213

After analyzing the costs of both systems according to R.S. Means, the Proposed design would cost approximately $150,522.00 more than the current design. The cost adjustments to compensate for mark-up prices as well as inflation were consistent through both estimates.

Although a distributed transformer design utilizes smaller transformers and typically smaller wiring sizes, the cost came out to be higher than the central transformer design.

Conclusions

The concept of distributed transformers typically calls for smaller transformer units as well as smaller feeder and conduit sizes for connecting equipment to the panelboards. Unfortunately, this distributed design layout costs more due to a larger number of panelboards and also because some of the wire sizes remained about the same size. The central transformer design for the Armstrong Medical Education Building is the optimal layout to save money.

Structural Breadth

Structural Breadth

Introduction

The atrium of the Armstrong Medical Education building is the largest space within the building. Every occupant that experiences the interior of this building must interact with the atrium during their duration within the building. As the atrium is the most visited space within the building it also should be the most prominent space. In this breadth study a structural analysis will examine the effects of opening up the second floor to make the atrium a full-height atrium.

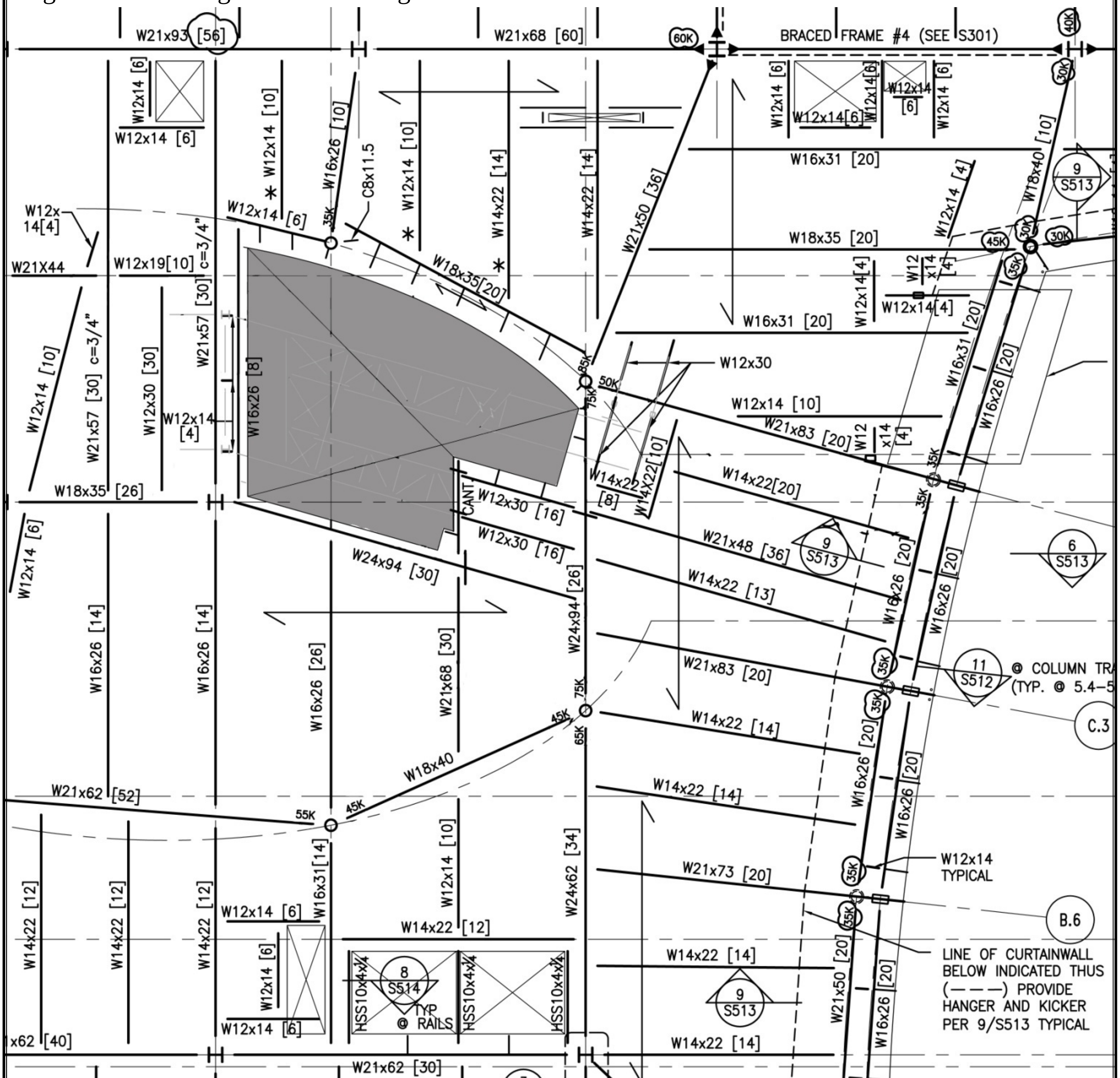
Existing System

The current floor design in the Medical Education building is a composite steel decking flooring with 3-1/4 inch light weight concrete on 3 inch metal decking with ¾ inch studs. According to ASCE 7-05, the controlling load combination for a gravity system will be 1.2D + 1.6L.

The existing structural system on the second floor of the atrium utilizes a W24x68 girder with full moment connections to support composite steel decking on a W21x48 and W14x22 beam from the south and two cantilevered W12x14s on the north to hold the stairwell. The girder is supported at the ends with a shear connection by round HSS columns with a 12.75 inch diameter and ½ inch thickness. This design allows space for the atrium stairwell.

Refer to Figure 58 for the existing structural design.

Figure 58– Existing Structural Design



Design Considerations

The atrium of the Armstrong Medical Education building is the central space within the building that connects every space together. With a large glass skylight on the top and a large glass curtain wall along the north side of the atrium, it makes a powerful architectural statement as it visually connects the building together at a central location. The current design creates a basement feeling to the first floor as it is the only floor disconnected from the atrium. Opening up the first floor to the atrium will increase the natural daylight on the first floor lobby as well as make the lobby a more impressionable space as the first space the building occupant experiences upon entering the main entrance to the building. According to the building specifications, IBC 2003 was utilized to determine a maximum deflection of l/360. The live load was also determined from the building specifications to be 100 psf.

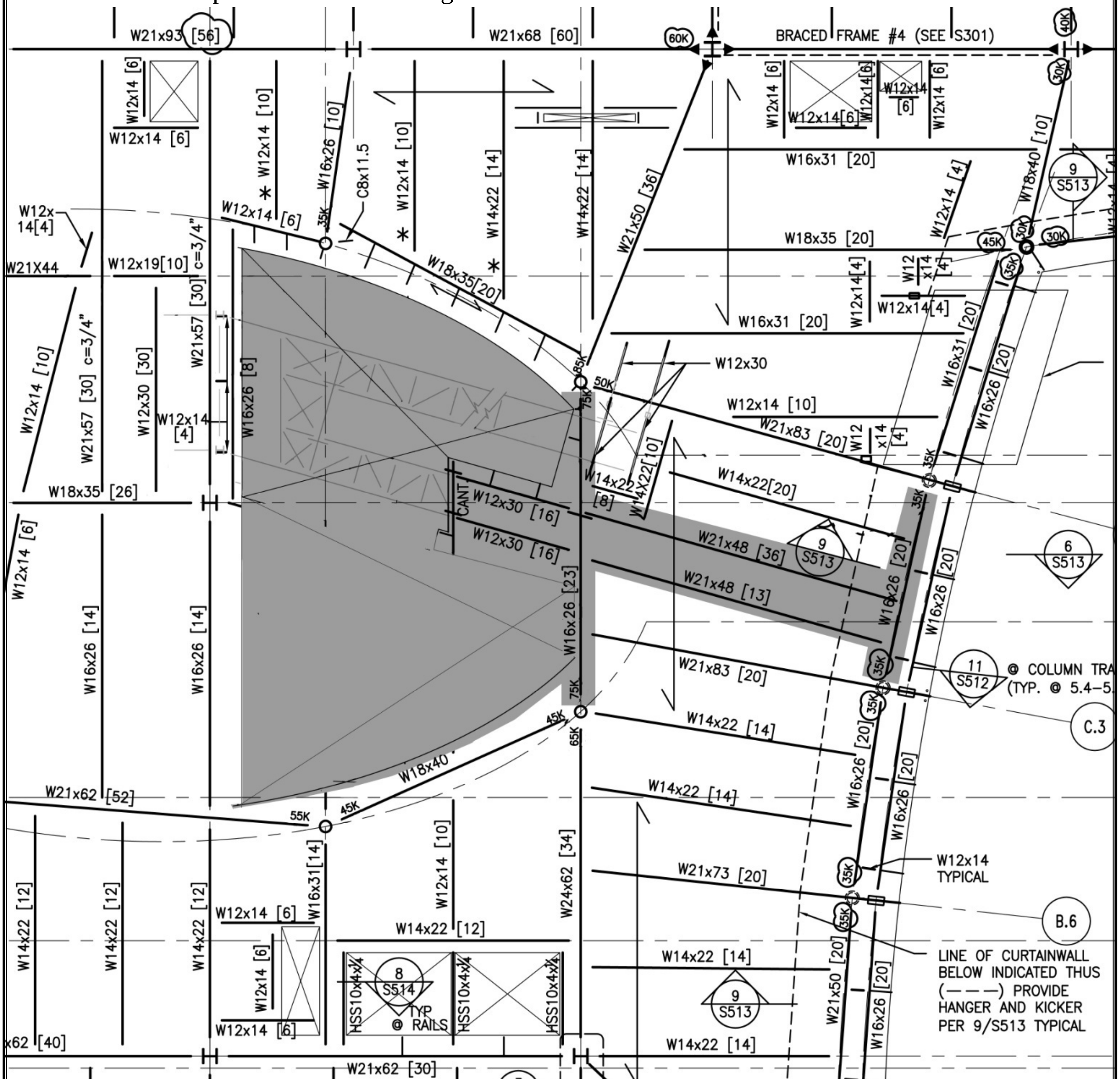
New System

The new design resizes the girder from a W24x68 to a W16x26. The girder downsizing was due to the subtraction of tributary area and dead load on the girder. However, it still needed to take into account the increased W14x22 beam to a W21x48 beam.

The design opens up the second floor until it hits the first floor wall of the auditorium. This creates a walkway around the atrium.

Refer to Figure 59 for further details on the new design. Also refer to Appendix E for calculations of the new structural design.

Table XX.X – Proposed Structural Design



Conclusion

The atrium of the Armstrong Medical Education building is the central space within the building that connects every space together. The opening of the second floor to create a full height atrium gives the whole building a sense of fluidity as every space on every floor is connected to this central, grandiose space. The structural design of the second floor allowed for the opening after a few recalculations of beam and girder sizes. This first floor lobby will now reveal to the occupant immediately upon entering the building how important this building is not only to the education of the future medical field but also to the university as it will become one of the top facilities for medical education in the nation.

Mechanical Breadth

Mechanical Breadth

Introduction

The atrium of the Armstrong Medical Education building is the largest space within the building and therefore will require one of the largest amounts of mechanical loads in the building. In this breadth study a mechanical analysis will examine the effects on the mechanical loads after changing the glass properties of the large glass skylight above the atrium. It will also analyze the loads after opening up the second floor of the atrium to expose the first floor and make the atrium span the full height of the building in correspondence to the structural breadth

Existing System

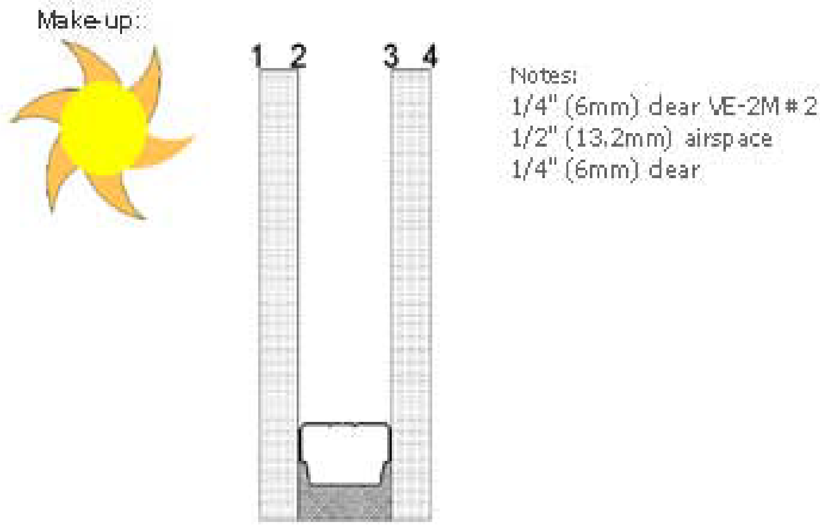
The current mechanical design in the Medical Education building is a recirculating variable air volume reheat system mainly operated by three large air handling units located on the roof of the building. The circulation space is positively pressurized. The atrium is supplied by 6700 CFM on the second floor, 3145 CFM on the third floor and 6120 CFM on the fourth floor. The return air system is a combination return air and exhaust air system located on the north side of the skylight that takes return air to the air handling units and also doubles as a smoke exhaust system in the event of a fire. The existing glass implemented in the skylight design

Design Considerations

The skylight above the central atrium will allow a considerable amount of daylight into the atrium during peak building use. Due to the large amount of direct sunlight penetration into the building, the glass material and properties is essential for occupants to feel comfortable as well as to minimize the mechanical loads on the building. The current glass material is a viracon 1” insulating clear glass called VE1-2M. The current design has a U value of 0.26 BTU/hr*SF*F and a shading coefficient of 0.44.

Mechanical Breadth

Figure 60 – Existing Glass



New System Design

In order to compensate for the considerable amount of daylight penetrating the building, the glass will be changed to have a more favorable shading coefficient (similar to the solar heat gain coefficient) as well as a more favorable U value (transmission loss of heat through the material).

The design considers four types of glass, including the existing glass type, in the current atrium as well as the new atrium proposed under the structural depth of this thesis report which adds space from the first floor.

Figure 61 includes details of the glass types and Figure 62 includes details on the mechanical loads for the different scenarios.

Refer to Appendix F for the detailed Trace results.

Mechanical Breadth

Figure 61 – Glass types

GLASS CHARACTERISTICS			
GLASS TYPE		U-VALUE (BTU/hr*sf*F)	SHADING COEFFICIENT
1	VE1-2M	0.26	0.44
2	VE1-2M + ARGON	0.21	0.43
3	VRE2-67	0.26	0.32
4	VRE2-67+ARGON	0.22	0.32

Figure 62 – Load Results

LOAD RESULTS				
GLASS TYPE		ATRIUM HEIGHT	COOLING LOAD (TON)	HEATING LOAD (BTU/HR)
1	VE1-2M	THREE	25	117,549
	VE1-2M	FOUR	26	118,947
2	VE1-2M+ARGON	THREE	24	115,623
	VE1-2M+ARGON	FOUR	25	117,021
3	VRE2-67	THREE	20	99,503
	VRE2-67	FOUR	21	101,345
4	VRE2-67+ARGON	THREE	20	99,088
	VRE2-67+ARGON	FOUR	21	100,930

CONCLUSION

The current atrium skylight can save a considerable amount of energy by simply changing the properties of the glass. By replacing the current glass with VRE2-67, 5 tons of cooling load will be saved and 17,000 BTU/hr will be saved on the heating load. Argon filled glass also helps to reduce mechanical loads. On average, the cooling loads were reduced by a ton when the same glass was calculated with argon in it. The heating loads also were reduced by an average of 1800 BTU/hr. This shows the considerable differences that occur with different glass types. The VRE2-67 glass with argon filled airspace would be the ideal glass to be used in the skylight.

Final Remarks

Over the past two semesters of studying and redesigning various systems within the Ann and Michael Armstrong Medical Education Building on the John Hopkins University campus, I have gained invaluable insight on the intricacies of building systems and their complex integration into the building as a whole. To have an experience as a student to work with a real building and to have the opportunity to simulate a real life architectural engineering job situation has given me uncanny experience that has culminated with the final work in the thesis process.

The lighting design has been the most enjoyable experience but also the most difficult. To satisfy IESNA standards and meet ASHRAE 90.1 energy requirements while simultaneously fusing creativity and occupant-friendly design turned out to be much more challenging than I had originally expected. To also integrate the human psyche into the design such as for the exterior façade was essential to end at a successful design. To also develop an energy conscious and flexible lighting system for multi-use spaces such as the auditorium was also a challenge in order to ensure a successful design meanwhile still maintaining the aesthetic of the space.

The electrical design was a good study to analyze the cost impact of various system designs. By distributing transformers to specific loads in the building and running 480V through the building as far as possible before stepping down to 208V is a huge cost factor, not simply a design factor. By also consolidating various motors into one motor control center also is another potential solution to consolidating space as well as money.

The mechanical system in the building works closely with the lighting and architecture of the building. By simply altering the glass properties in the central atrium can cause a huge mechanical load to be eliminated. It also is greatly impacted by opening up the atrium to be a full storey atrium that spans all four floors of the building. However, by installing a higher quality glass for the skylight, the mechanical impact from the larger space can be minimized and almost eliminated.

In conclusion, this process has been an arduous but amazing learning experience that has given me a great appreciation for the various professions within the building industry and also shown me the importance of teamwork to optimize system integration throughout the building design.

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WE ARE…PENN STATE!