Duke University Medical School
Duke University School of Nursing

Durham, North Carolina

Final Thesis Report

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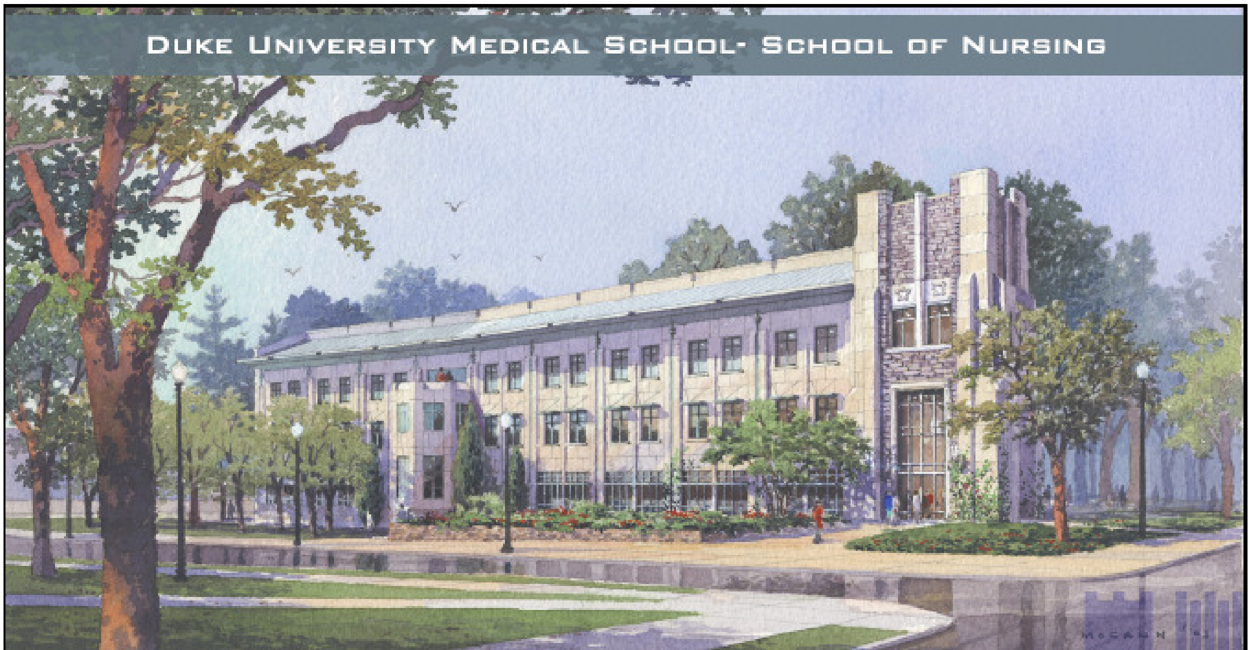
Lighting | Electrical Option
Advisors: Dr. Houser | Dr. Mistrick | Professor Dannerth
Spring 2008

Thesis Link: http://www.engr.psu.edu/thesis/portfolios/2008/nak142

Abstract

Duke University Medical School- School of Nursing



Durham, North Carolina

Building Statistics

Size: 59,610 SF
Levels: 3 & 1 Basement
Construction Dates: 3/2005-8/2006
Building Cost: $14.7M
Delivery Method: Design-Build

Design Team

Owner: Duke University Medical School

Architect: Ayer/Saint/Gross Architects

MEP Engineering: Mueller Associates, Inc.

Structural & Civil: Stewart Engineering Engineering

Landscape Architect: Michael Vergason Landscape Architects

Acoustical Consultant: Shen Milsom & Wilke, Inc.

Lighting

Predominately 277V Linear Flourescents and Compact Flourescents used throughout the building for reduced energy consumption

Daylight integration and controls utilized throughout building where applicable

Double high Cafe has full height glass curtain walls on all three exterior sides

Architecture

The Gothic style "Duke" tower and Duke limestone were incorporated into the design

Double high entry tower vestibule

Wooden Gothic arches incorporated into the double high Cafe DUSON lounge

Electrical

12.47kV campus fed service line ditributed by 408Y/277V and 208Y/120V transformers

1000kVA service entrance transformer

Emergency power fed from an existing 350kW, 480Y/277V diesel engine generator set

Mechanical

235 ton air-cooled chiller provides chilled water to VAV air handling boxes

Structural

Structural steel framing system

6-in to 4-in slab on grade with concrete spread footings and continuous strip footings

Combination of precast concrete panels and limestone used for exterior facade

Nicholas A. Kutchi
Lighting/Electrical Option
http://www.engr.psu.edu/ae/thesis/portfolios/2008/nak142/

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Executive Summary

The Duke University Medical School-Duke University School of Nursing Thesis Project is primarily an in-depth study of redesigning the lighting and electrical systems throughout the building. The report also looks at the design and analysis of multiple systems to potentially improve the quality of the building. Feasibility studies were performed for all the proposed designs based on building energy, cost of construction and operation cost.

An in-depth lighting design study was performed for several areas throughout the building based on IESNA design criteria. The design analysis focused on proper equipment selections and detailed light level calculations to reach the stated lighting design goals while staying within the allowed power densities set forth by ASHRAE 90.1. The four spaces that were redesigned are the Duke Main Tower Entrance Lobby, the Peter | Ginny Nicholas Auditorium | Learning Center, the Café DUSON Student Lounge, and the Champagne Outdoor Courtyard. The main design goal was to tie each unique space together with the lighting being the common thread. The intent for all the spaces was to utilize a simplistic yet aesthetically pleasing design that complements the unique Gothic architecture of the building while maintaining a conducive atmosphere for learning.

An in-depth electrical study verifying panelboard, feeder, and overcurrent protection device sizes for all the redesigned lighting spaces was conducted. In addition a feasibility-cost analysis was conducted for changing all the existing non-energy efficient transformers in the building with energy efficient transformers. The electrical depth also looked at replacing distribution transformers located on each floor with a large central transformer located on one floor, in order to decrease the overall system cost. Significant cost savings are able to be obtained by switching to a central transformer system. Finally, a short circuit analysis was conducted along with an overcurrent protection device coordination study. This coordination study looks at the protection devices along a single feeder to determine if each device will properly trip when overcurrent is detected.

Finally, two breadth topics, mechanical integration and acoustical redesign, were studied to determine their impact on improving the quality of the space. The Mechanical Breadth looked at modifying the mechanical duct system of the café in order to be able to integrate it with proposed lighting system. This integration of systems improved the visual appearance of the space, which equated to the improvement of the architectural integrity of the space. The Acoustical Breadth looked at reducing the reverberation times in the café, since this space is a study lounge and a large social gathering, the amount of noise and the quality of speech in the space are important elements. The breadth concluded that the quality of speech could be improved with the replacement of the fabric on the wrapped wall panels with thicker fabric, at a minimal cost difference.

Introduction | Background

The Duke School of Nursing building offers a new three-story state of the art facility that has helped strengthen the quality and integrity of the School of Nursing at Duke. The building was built on the Duke University Medical Center campus in the Gothic architectural style of Duke. The intent of the building was to unite classroom and laboratory in a standalone facility. Besides offering a wonderful learning environment, the building provides students and faculty with comfortable and interactive common spaces.

Building Overview

General Building Data

Building Name: Duke University Medical School- School of Nursing

Location: Durham, NC

Building Occupant Name: Duke University School of Nursing

Occupancy: Assembly (A-3) and Business
-Includes offices, seminar rooms, classrooms, and café facility

Size: 59,610 Square Feet

Number of Stories: 3 levels above grade and 1 level below grade

Primary Project Team:

***Owner*:**

Duke University Medical School

***Architecture*:**

Ayer/Saint/Gross Architects

Website: http://www.asg-architects.com

Civil and Structural Engineering:

Stewart Engineering

Website: http://stewart-eng.com

MEP and Fire Protection Engineering:

Mueller Associates Inc.

Website: http://www.muellerassoc.com

Landscape Architecture:

Michael Vergason Landscape Architects

Website: http://www.vergason.net

Acoustical Consultant:

Shen Milsom & Wilke, Inc.

Website: http://www.smwinc.com

General Contractor:

Bovis Lend Lease

Website: http://www.bovislendlease.com

Construction Manager:

Bovis Lend Lease

Website: http://www.bovislendlease.com

Dates of Construction: ***Start:***

March of 2005

Completed:

August of 2006

Actual Cost Information: Total Building Cost is $14.7M

Project Delivery Method: Design-Build

Architecture:

The Gothic style "Duke" tower and Duke limestone was incorporated into the design in order to fit into the traditional Duke building style.

Major National Model Codes:

2002 North Carolina State Building Code NCBC with local amendments to the International Code Council, IBC 2000 edition.

Zoning:

The Duke University School of Nursing was built on Duke Property and therefore there were no zoning requirements on this university owned land.

Historical requirements of building or zoning:

There were no historical requirements for this building. However, Duke University has its own building Architectural Style that requires all university buildings to retain the Gothic Duke style.

Building envelope:

The building has two major roof structures. The first is a low slope roof. This roof structure is composed of single ply roof, concrete encased insulation, metal decking, and GWB or Acoustic Ceiling Paneling ceiling. The second roof structure is over the Café. This roof structure is composed of standing seam metal roof, polyiso insulation, plywood, and 5-in exposed wood. The main exterior wall system is made up of precast or limestone panels, 8-in CMU, faced batting insulation, and GWB.

Construction:

Bovis Lend Lease was both the General Contractor and the Construction Manager for the Duke Medical School- Duke University School of Nursing project. The project was delivered by a design-build method for a total building cost of $14.7M. Construction began March 2005 and was completed August 2006. As part of the construction contracts, the building had to be operational for the first day of classes on September 4th, 2006.

Structural:

The Duke University School of Nursing building shell is made up of 8" and 12" CMU walls that are covered by precast limestone panels and in some places Duke stonework. The main structural system is comprised of a structural steel framing that typically create approximate 20'x20' bay sizes. The basement floor is a 6" slab on grade with #3 rebar, spaced 12" OC. Spread. The typical first floor is a 4" slab on grade with 6x6-W2.1xW2.1 reinforcing. The entire second and third floor and the flooring above the basement on the first floor are a 5¼" concrete slab and decking system. Isolated spread footings ranging from 12" to 30" in thickness and 5' to 10' square in plan view in order to support the steel columns throughout the building. Continuous strip footings 12" to 18" thick by 2' wide make up the wall foundations around the building.

Mechanical:

A 235 ton air-cooled chiller located on the roof of the building creates chilled water. This chilled water is pumped throughout the building to VAV air handling boxes. Also, the system was designed to be able to handle phase 2 of this project which is not yet built. This phase 2 was designed with the current building and will be built at a later date when Duke feels the need to expand its Duke University School of Nursing facility.

Electrical:

A 12.47 kV campus fed service line enters a 1000 kVA pad mounted exterior transformer, which then enters the building via an underground duct bank. At this point the service enters a single 2000A switchboard. This switchboard services all the panelboards and motors throughout the building. The main voltage for the entire building is 480Y/277V, except for receptacle loads which are run at 208Y/120V. A 60 kW natural gas generator located in the basement, provides emergency electrical backup for the building.

Lighting:

The lighting compliments the Duke Gothic Architectural Style in the main public areas of the first floor. The fixtures have an elegant Gothic sense while also possessing a modernistic feel. The classrooms and offices for the most part do not reflect an elegant lighting design but rather a functional efficient lighting design. Compact and linear fluorescents, running at 277V, are used throughout the building for reduced energy consumption. Daylight integration and controls are utilized throughout the building when applicable, to also reduce energy consumption via lighting.

Transportation:

There are two passenger elevators for occupants of the building. The elevators go from the central core of first floor to the central core of the third floor. The elevators are both 27 KVA and protected by two 150A shunt-trip circuit breakers.

Telephone/Data:

The telephone and data system is comes form the outside into the first floor Telecommunication Room, RM 1016TC. This telephone and data is then run throughout the first floor and into the other telecommunication rooms on the other floors. Almost every classroom, office, and group gathering areas receive telephone, data, and cable television.

Audio Visual:

The audio visual equipment is run from audio visual closets in the large classrooms/auditorium, the Dean’s office, and the conference rooms. This system includes projectors, automatic projector screens, speakers, and microphones.

Fire Alarm:

The main Fire Alarm Annunciator Panel is located in the main entrance lobby of the tower. The system is composed of room/duct smoke detectors, manual pull stations, strobe lights, heat detectors and door holders. These devices are found throughout the building on all floors.

Lighting Depth

Introduction

The Duke University School of Nursing Building serves students and faculty in the Duke University Medical School and provides them with spaces to learn, research, meet, and relax. The Duke University name carries with it great prestige and grandeur with not only its medical studies and research but also with its architecture. As with all the buildings on campus, the Duke University School of Nursing building is built in the "Duke Gothic" architecture style. The lighting system that is proposed herein will not only compliment the Duke's Gothic style of architecture but also highlight the defining features of the building.

A complete lighting analysis will be conducted for the following four spaces:

1. Duke Tower Entrance Lobby
2. Peter & Ginny Nicholas Auditorium & Learning Center
3. Café DUSON- Student Lounge
4. Champagne Courtyard- Outdoor Patio

The lighting analysis will thoroughly discuss the lighting design for each proposed lighting system, which includes: a complete design criteria survey of pertinent lighting features; light loss factors (LLFs); controls; light level performance data; and power densities. Each proposed lighting space shall be compliant with IESNA lighting requirements as well as ASHRAE 90.1 energy standards.

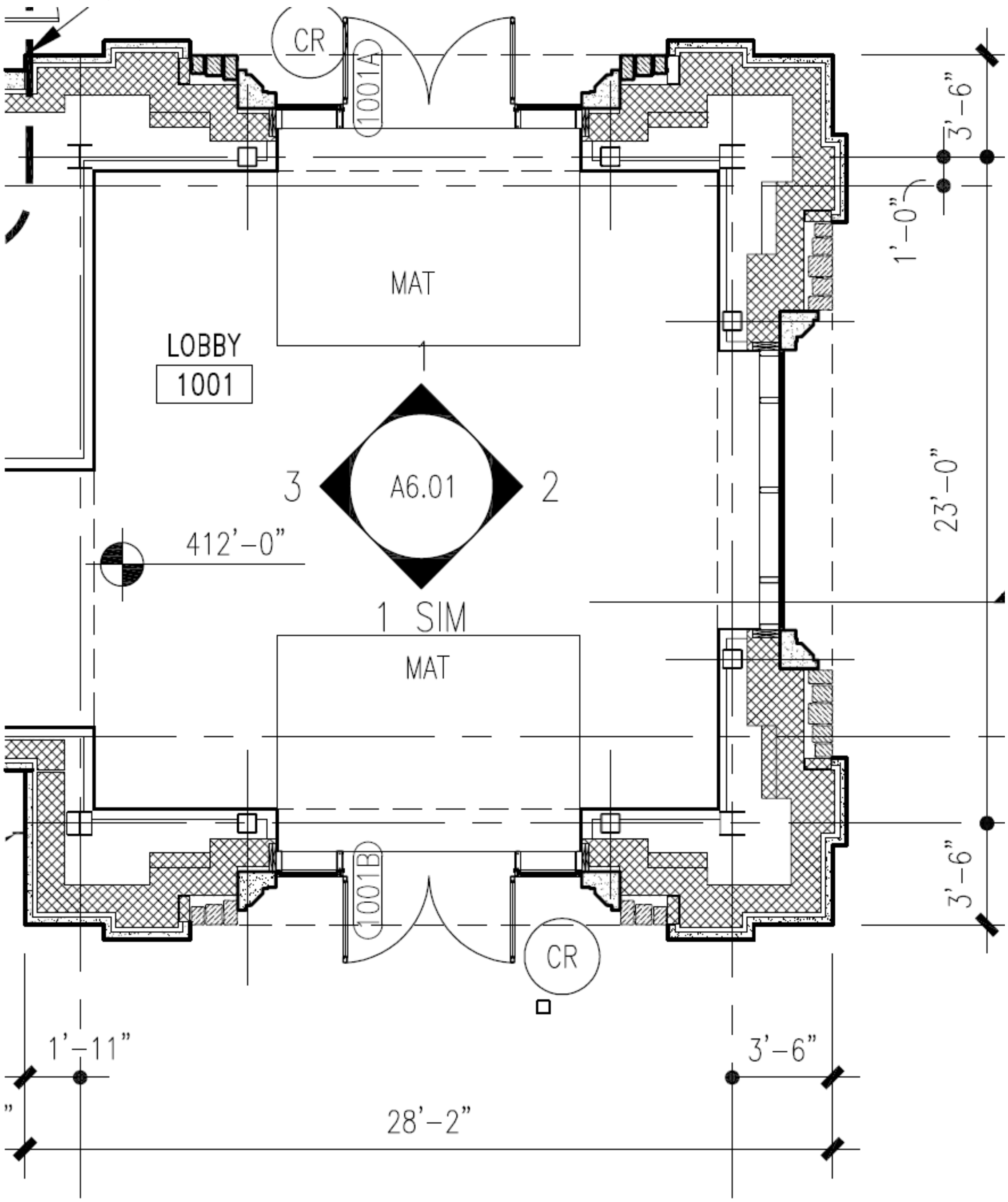
Duke Tower Main Entrance Lobby Overview

This is the main entrance to the building that is located in the prominent tower portion of the building. The floor of this lobby has the Duke University School of Nursing emblem worked into the terrazzo flooring. This could be considered a grand entrance, since it covers an area of approximately 530 SF and is about 26 feet high with three full height glass curtain walls.

*The above are Pre-construction conceptual renderings by ASG

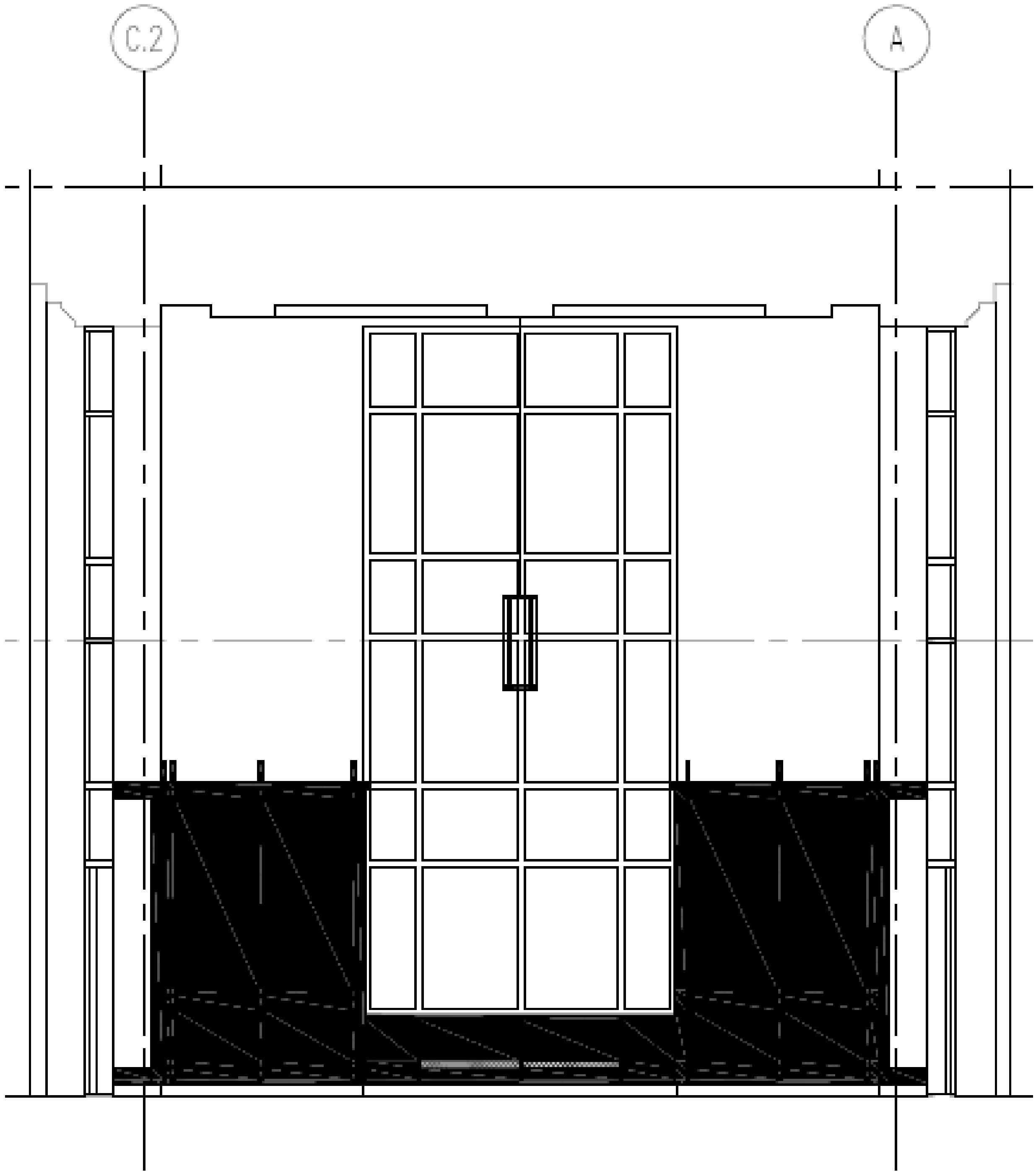
Architectural Plan

Plan:



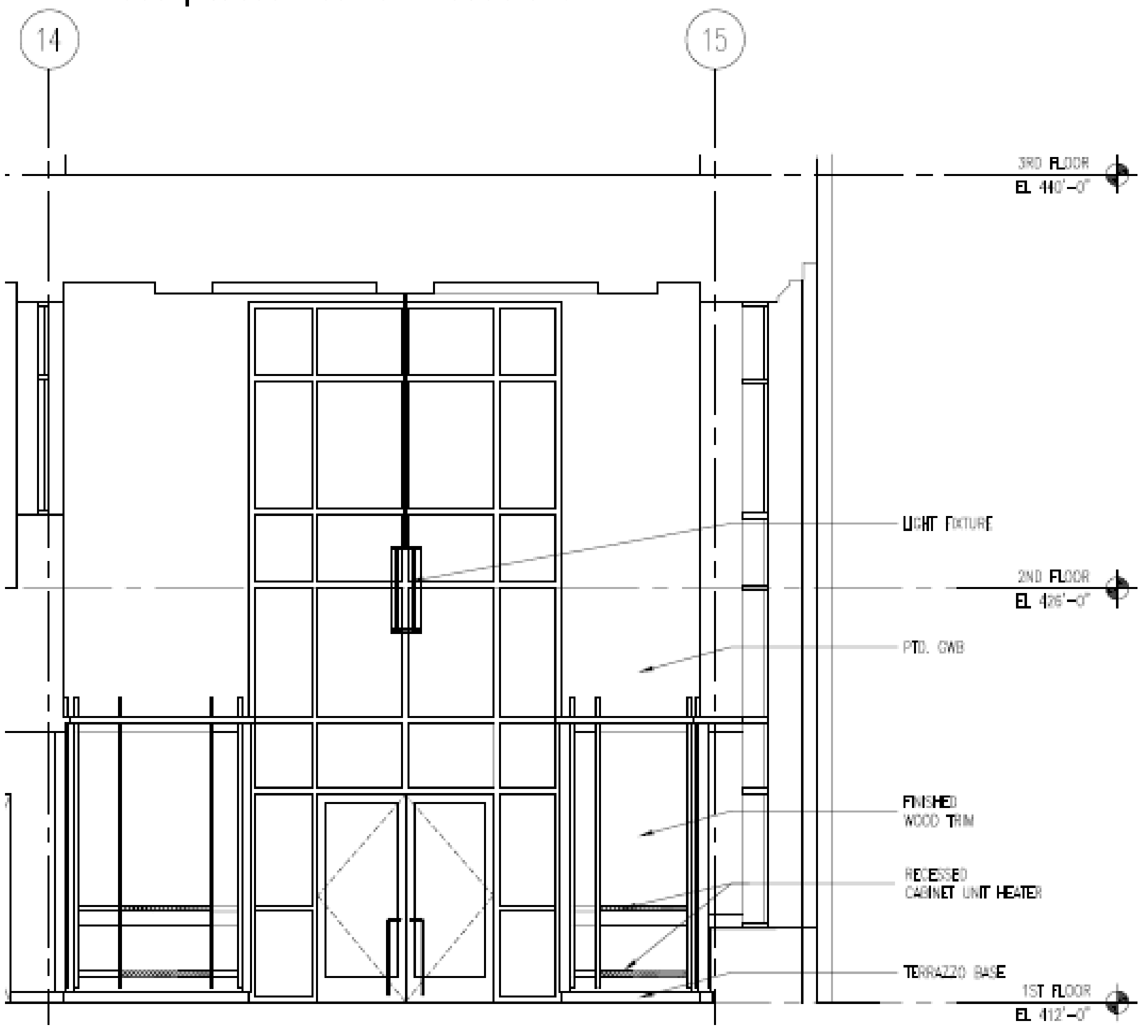
Architectural Interior Elevations

South Interior Elevation:



Architectural Interior Elevations

East | West Interior Elevation:



IESNA Design Criteria

Appearance of Space and Luminaires:

The space needs to appear inviting and carry a sense of grandeur, for this is the main entrance to the lobby. The luminaires should complement the Gothic style of the building, since most of the room is visible through the large glass windows of the tower.

Color Appearance:

The space should have warm color tones, in order for the space to have a warm and inviting feeling to it. Also, the color of the wood paneling will be enhanced by the warm color of light.

Daylight Integration and Controls:

The space is exposed to eastern, southern, and western sunlight by the three double high glass curtain walls. For this reason the use of photocell-controlled sensors or astronomical time clocks should be utilized for control of the fixtures.

Glare:

Direct and reflected glare from the luminaires should be considered to reduce seeing most of the fixtures in the glass and the waxed terrazzo floor.

Light Distribution on Surfaces:

The space should maintain a moderate level of uniform light on the walls of the tower, in order to help provide a sense of spaciousness and grandeur. However, due to the space being 26-ft high, some scalloping may occur if recessed fixtures are used.

Light Distribution on Task Plane:

The space is a major thoroughfare for the building and as a matter of public safety the task plane, the floor, should have some degree of uniformity. However, in order to highlight the School's emblem the center of the floor must be maintained at a higher light level to create the light difference in highlighting. This highlighting will cause the uniformity of the floor to decrease. The decrease in uniformity will not cause a safety hazard.

Luminance of Surfaces:

Being that the space is an entry lobby; the main goal is to lead the occupants to the corridor. By having variable surface luminances this can be achieved.

Points of Interest:

The main point of interest in the space is the Duke University School of Nursing emblem worked into the terrazzo flooring. This emblem should be highlighted with light.

Shadows*:*

Some shadowing is inherent with the sun tracking from east to the west throughout the day.

Surfaces Characteristics*:*

The space has wood wall paneling that, with the proper lighting, will enhance its beautiful characteristics. This wood paneling is contrasted by stark white walls above the wall paneling, and need to be considered so that they are not over lit. Finally, the gray terrazzo flooring needs to be properly lit to limit glare.

IESNA Illuminance Recommendations

Horizontal

Public Spaces	50 lx (5 fc)

Vertical

Public Spaces	IESNA does not recommend a vertical illuminance value for a lobby.

Existing Material Conditions

Surface Materials within the Space:

- Gray Terrazzo flooring
  - Reflectance = 37%
- Painted White GWB Ceiling
  - Reflectance = 80%
- Painted White GWB Walls
  - Reflectance = 80%
- Wood Panel Walls
  - Reflectance = 10%
- Wood Beams Ceiling
  - Reflectance = 10%

Glazing:

- **G-5:** 1" Insulated Glass - Float
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

- **G-4:** 1" Insulated Glass – Laminated (door glass)
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

Luminaire Schedule

Duke Tower Entrance Lobby- Luminaire Schedule								
Type	**Mounting**	**Manufacturer**	**Catalog Number**	**Lamp**	**Input Watts**	**Volts**	**Ballast Catalog Number**	**Fixture Description**
A	Ceiling Recessed	Lightolier	8021-CCLW	(1) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	31	277	Advance VEZ-1T42-M2-BS	6" Direct Downlight Vetical Lamp Electronic Ballast
G	Pendant Chandelier	Custom	Custom	(2) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	58	277	Advance VEZ-2Q26-M2-LD	Custom designed pendant that reflects Gothic Architecture/Style

Lamp Schedule

Duke Tower Entrance Lobby- Lamp Schedule							
Type	**Manufacturer**	**Cat. #**	**Rated Wattage**	**CRI / CCT**	**Rated Life**	**Initial Lumens**	**Assoc. Fixture**
L1	General Electric	F26TBX/SPX30A/4P	26	82 / 3000K	12000	1710	A / G

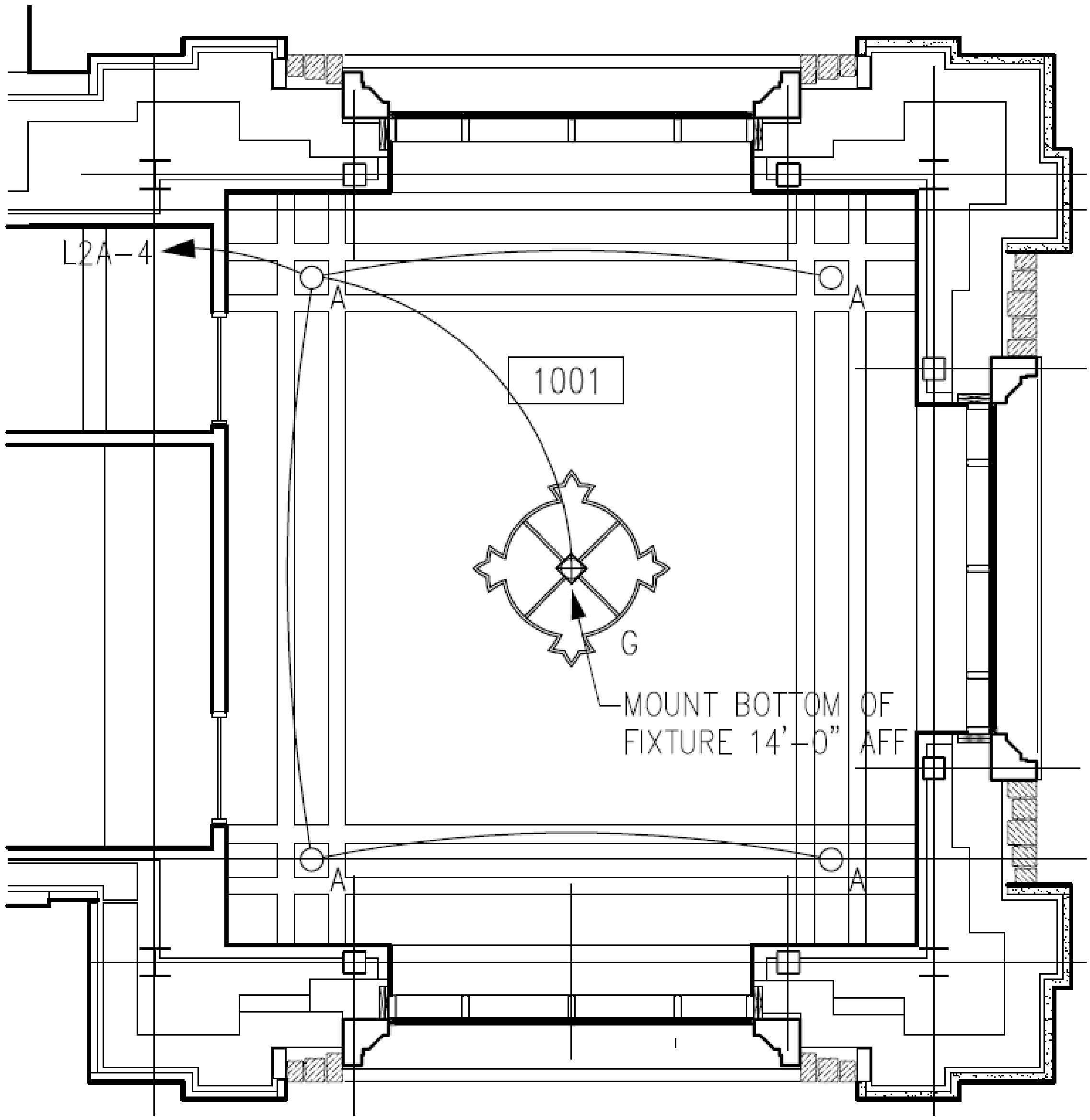
Notes: (1) please refer to Appendix A for all product cut sheets and complete schedules.
(2) Lighting is controlled by an astronomical time clock, which is located in the second floor electrical closet where PNL L2A is located.

Light Loss Factors

Duke Tower Entrance Lobby- Light Loss Factors														
Type	**Fixture Description**	**Lamp**	**Mean Lumens [Initial Lumens]**	**LLD**	**Room Properties (Ft.)**		**RCR**	**Assumptions**	**Expected Dirt Depreciation**	**RSDD**	**LDD**	**BF**	**Total LLF**
A	26W CFL 6" Open Maintenance **Category III** **Direct** Downlight	(1) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	1440 / 1710	**0.842**	Height Length Width Perimeter Area (ft^2)	24 23.5 24 95 564	10.11	Clean 12 Months Cleaning Cycle	12	**0.955**	**0.9**	**1.05**	**0.760**
G	Custom Pendant Chandelier	(2) 26W Triple Tube CFL GE26TBX/SPX30A/4P	1440 / 1710	**0.842**	Height Length Width Perimeter Area (ft^2)	24 23.5 24 95 564	10.11	Clean 12 Month Cleaning Cycle	12	**0.955**	**0.9**	**1.00**	**0.724**

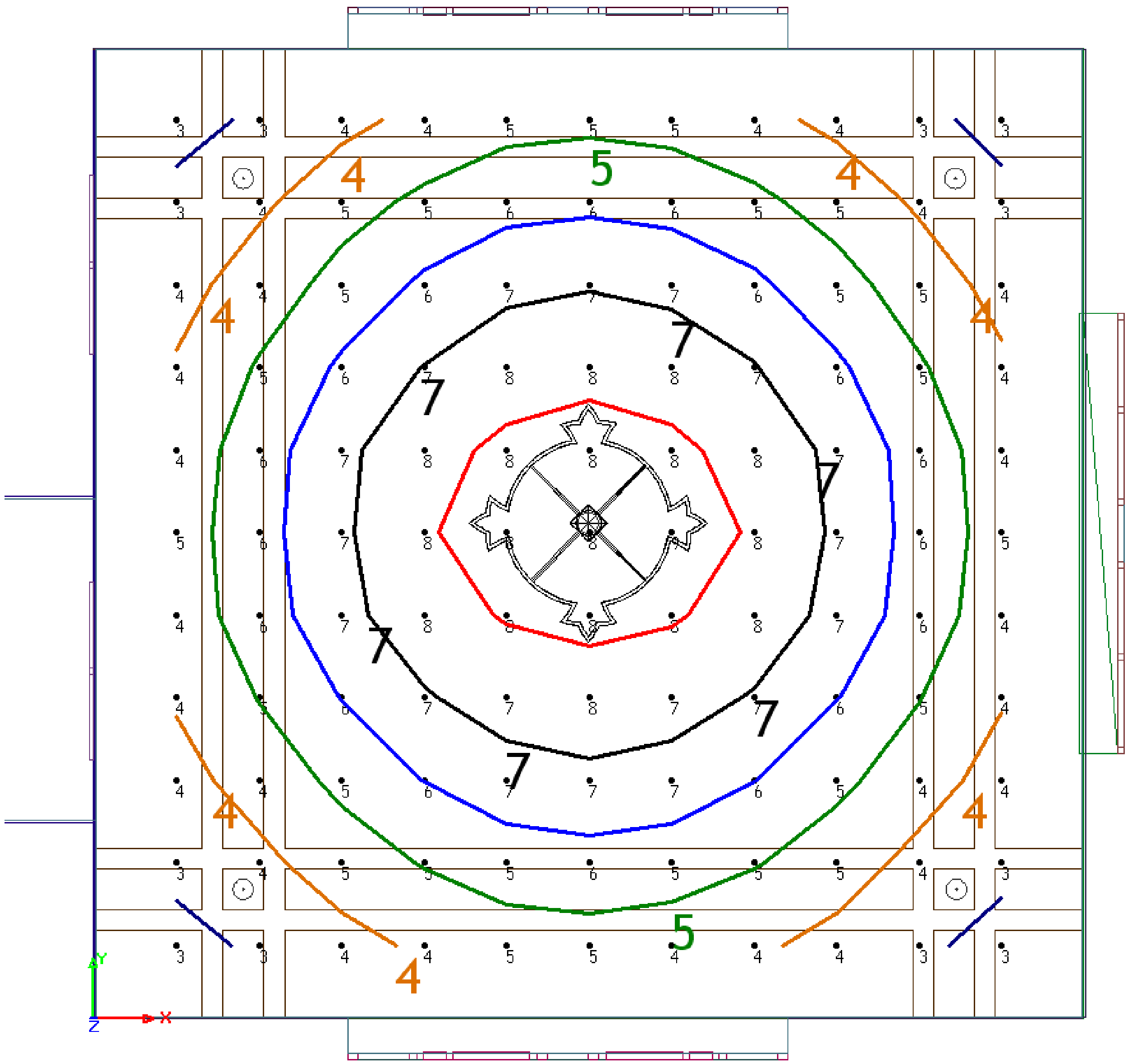
Lighting Plan

Second Floor Lighting Plan (Double High Space):



Note: Please refer to Appendix B for 1/8" = 1'0" Lighting and Circuiting Plan

Illuminance Data

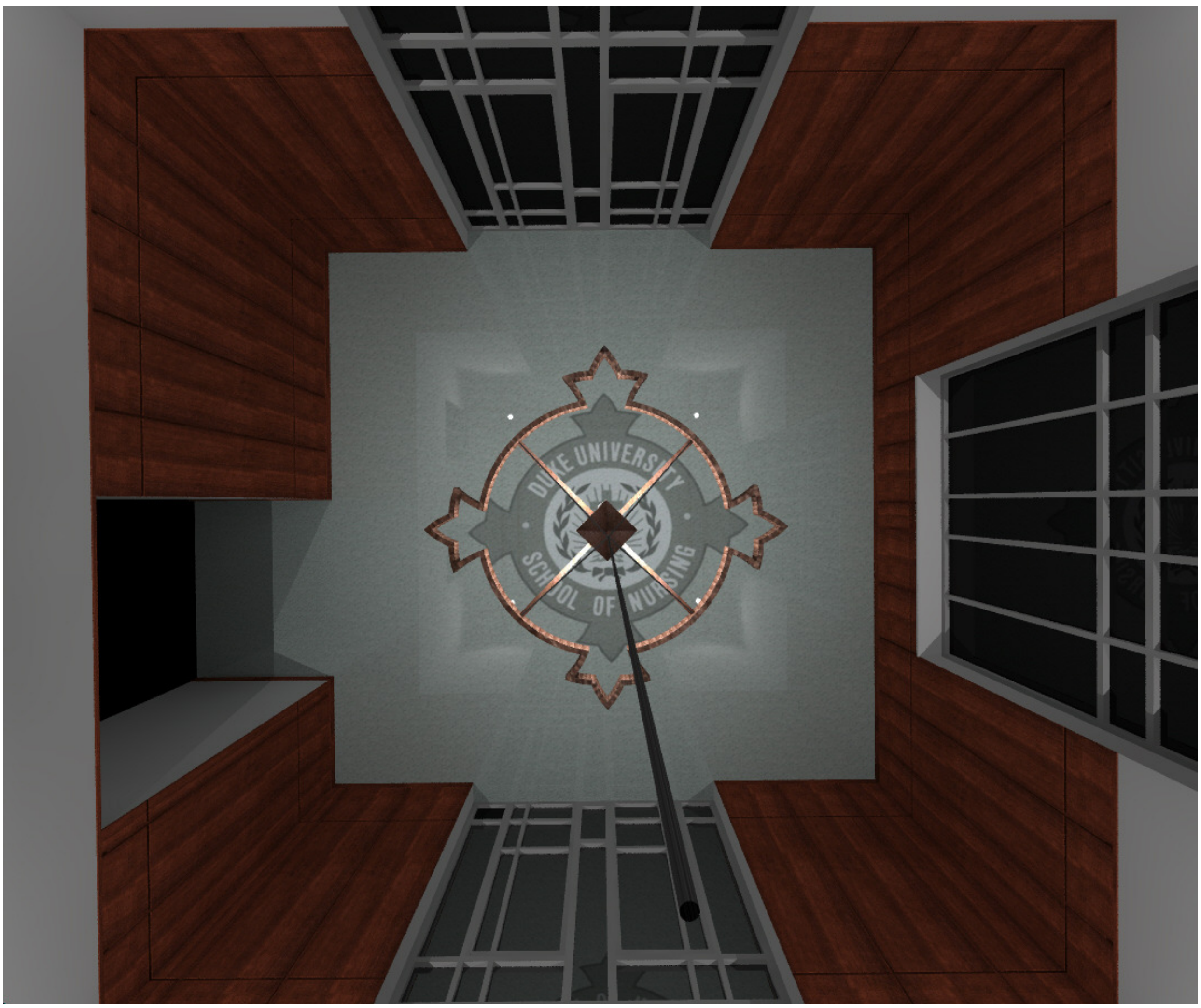


AGI32-v2.0 Statistical Summary

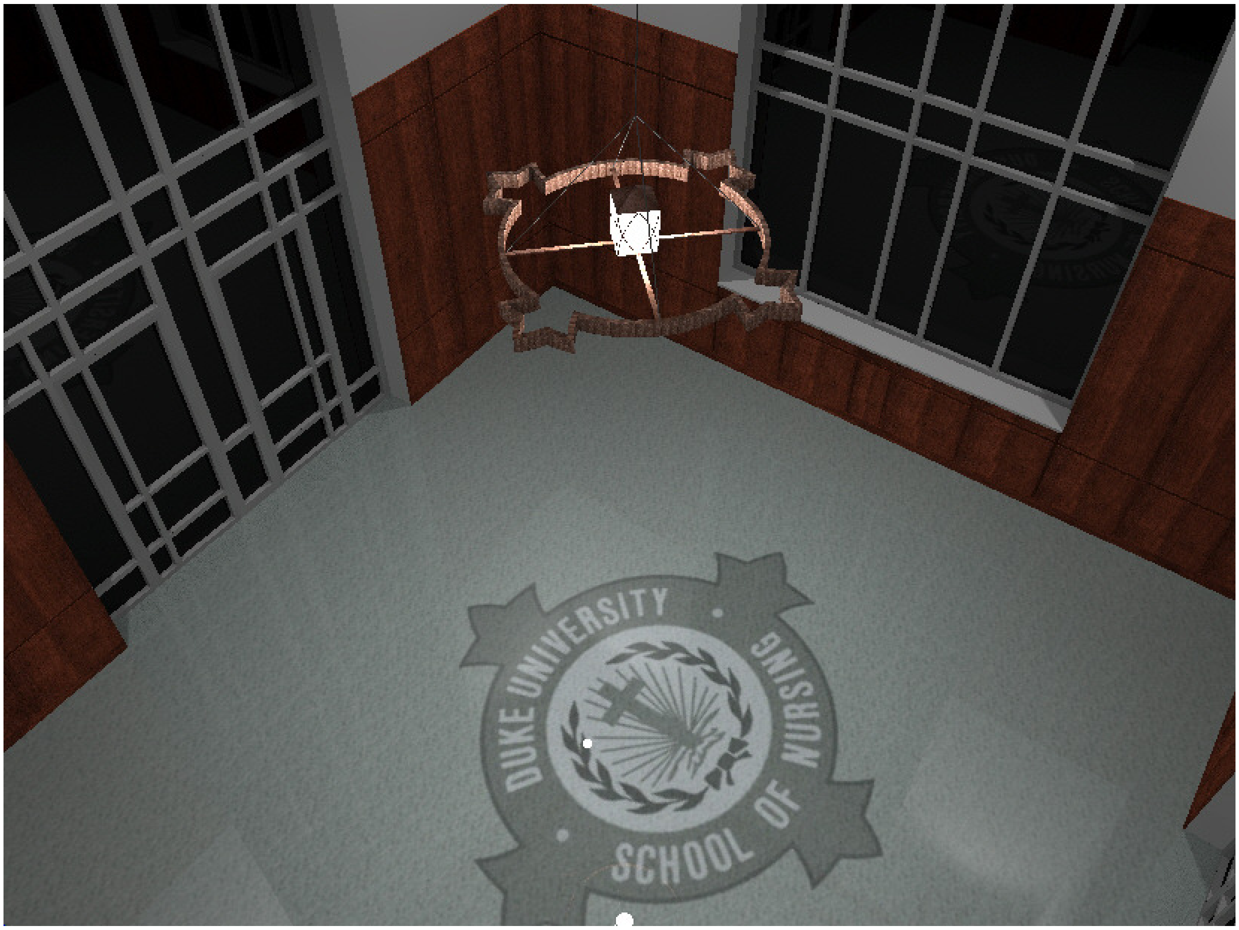
Duke Tower Entrance Lobby- Illuminance Results					
Average Illuminance	Maximum Illuminance	Minimum Illuminance	Avg/Min	Max/Min	Uniform Gradient
5.5	9.0	3.0	1.8	3.0	1.5

Raytraced Renderings

Plan View:



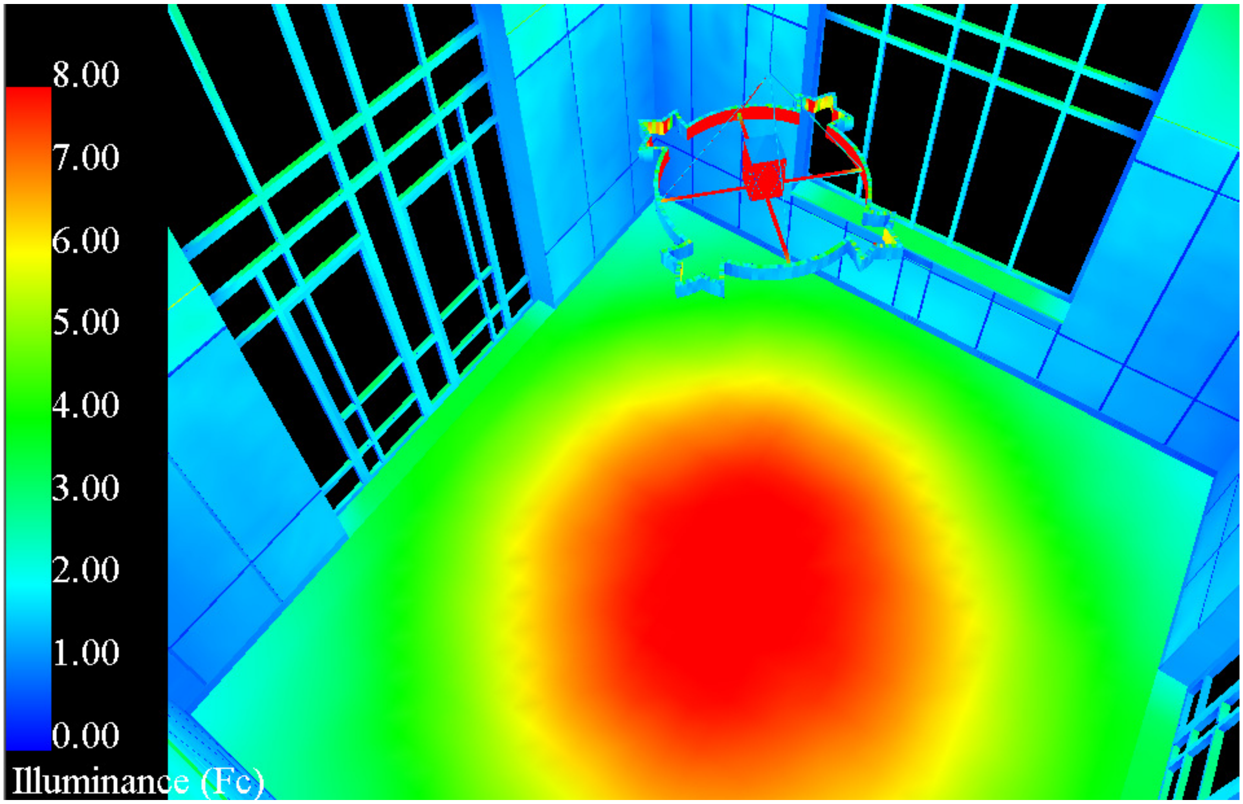
View from Second Floor Windows:



View from First Floor Corridor:

View of the Second Floor Windows and First Floor Corridor:

Pseudo Color Rendering:



Power Density

Duke Tower Entrance Lobby Power Density						
Fixture Type	Fixture Quantity	Fixture Wattage	Total Wattage (W)	Total Area (sf)	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density
A	4	31	124			
			124	564	0.22	1.2
Fixture Type	Fixture Quantity	Fixture Wattage	Total Wattage (W)	Total Area (sf)	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density
G*	1	58	58			
			58	564	0.10	1.0
*Decorative Fixture, Additional 1.0 W/sf						

Evaluation

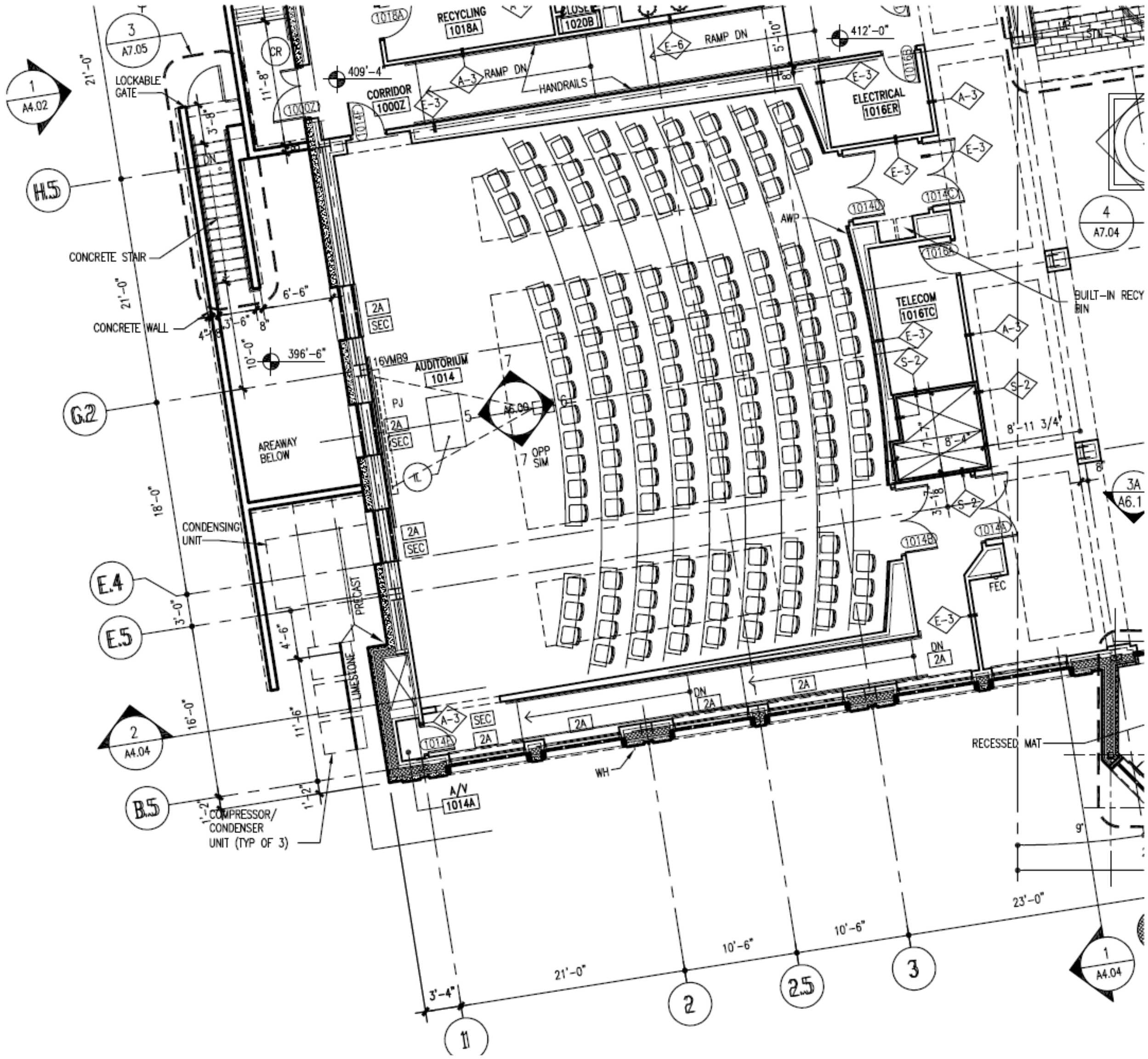
A custom chandelier was created for this space. After studying traditional Gothic architecture and lighting, the design of the central “lantern” surrounded by an outer ring was chosen. The outer ring of the custom chandelier was inspired by the Duke University School of Nursing emblem that it is in fact accenting. The architecture of the ceiling and placement of lights is a design element that was successfully carried out throughout all the redesigned interior spaces. The implemented lighting system satisfies the basic illumination requirements spelled out in the IESNA handbook.

Peter | Ginny Nicholas Auditorium | Learning Center Overview

The Peter | Ginny Nicholas Auditorium | Learning Center is a large auditorium used as a classroom and meeting area. The auditorium has seating for approximately 150 people and covers an area of approximately 2700 SF. The seating and desks are permanent fixtures within the space. The ceiling is a combination of painted GWB and acoustic ceiling tiles. The ceiling is basically one level and bears no resemblance to the other "Gothic" spaces that are being redesigned. Therefore, to tie this space both architecturally and lighting wise with the Lobby and the Café, the ceiling was dropped and a cross pattern of square light coves were implemented.

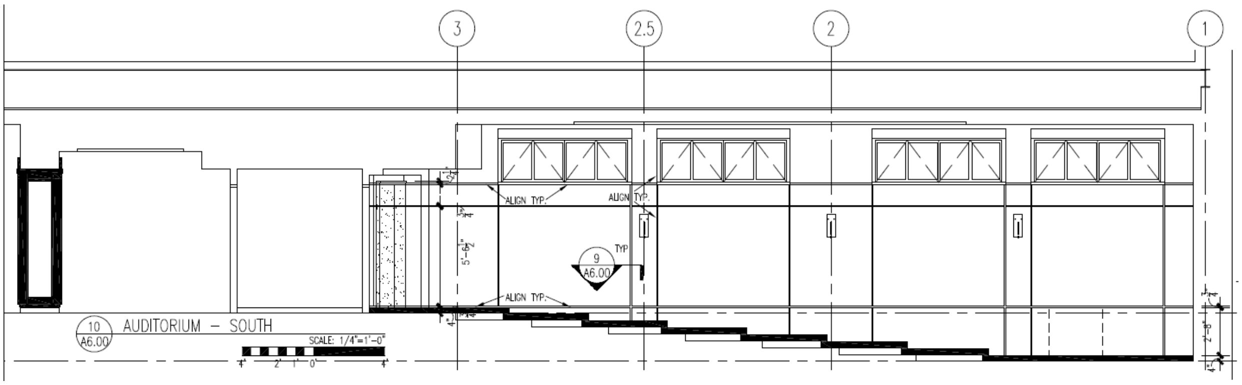
The floor gradually steps down from the back of the room towards the front of the room where the lecturer stands, with a total change of about 3 Ft. This stadium seating effect allows the farthest people in the back to be able to not only see but also hear the lecturer. The back wall curved and composed of fabric wrapped acoustic panels. The auditorium is intended to be a classroom and meeting place, and therefore requires a sense of visual clarity as well as set a studious atmosphere.

Architectural Plan

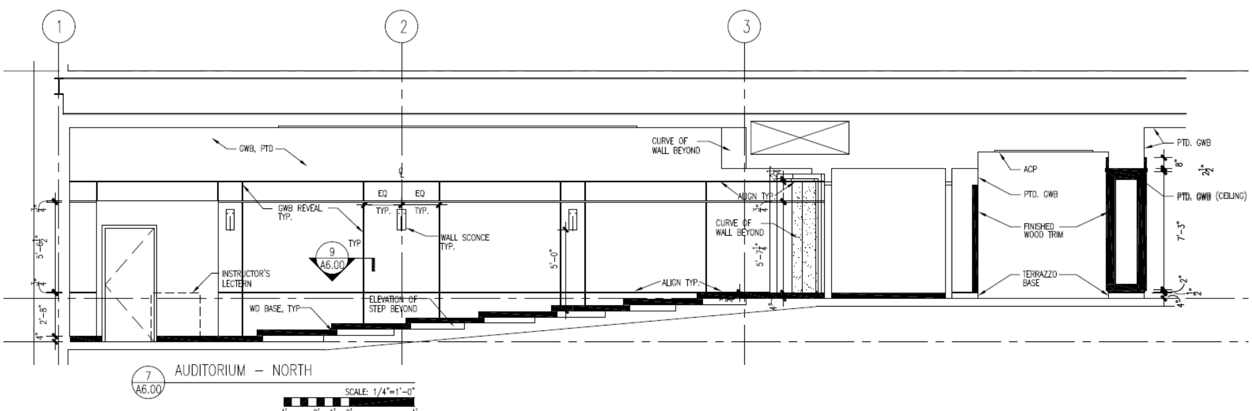


Architectural Interior Elevations

South Interior Elevation:

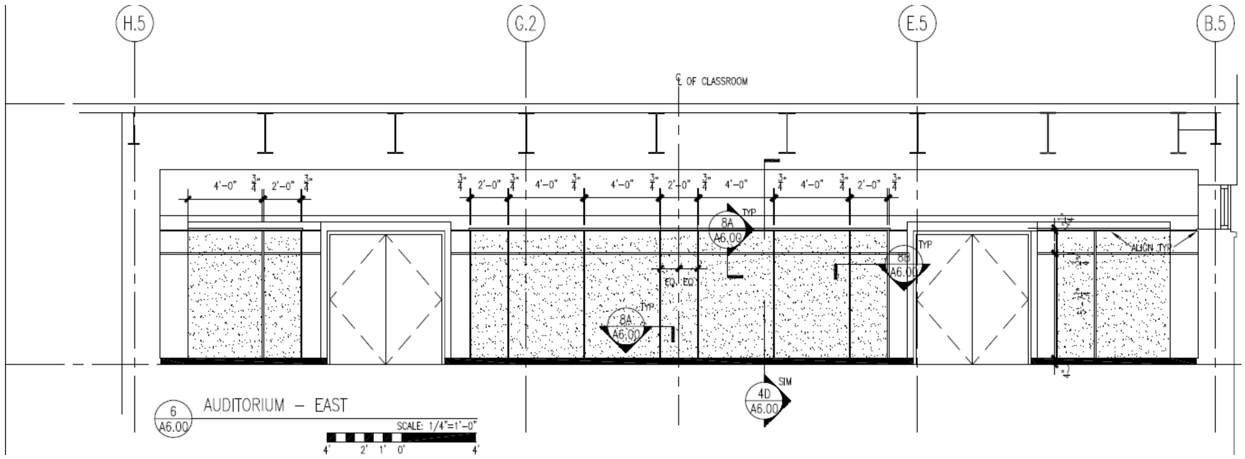


North Interior Elevation:

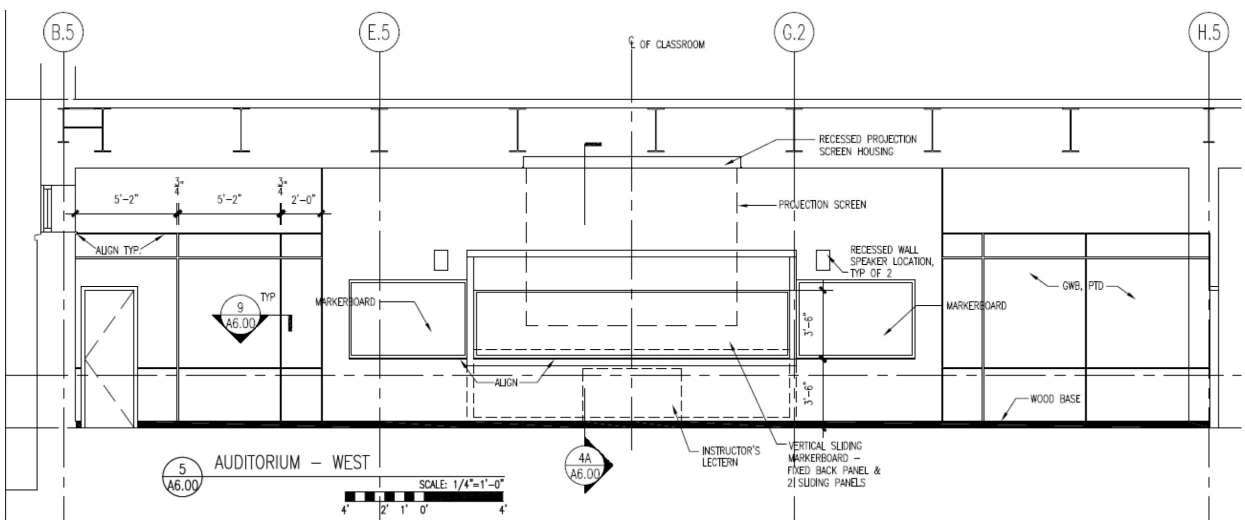


Architectural Interior Elevations (cont.)

East Interior Elevation:



West Interior Elevation:



IESNA Design Criteria

Appearance of Space and Luminaires:

The Peter & Ginny Nicholas Auditorium is intended to provide a studious atmosphere and the feeling of visual clarity, since it is a classroom. The space should also create a feeling of pleasantness to make the classroom an inviting place and a reduced institutional feel to the space. The luminaires in this space should provide a visually pleasing environment while maintaining a clean look.

Color Appearance:

The proper balance of color tone must be achieved to provide the sense of pleasantness while keeping a studious atmosphere and users of the space alert.

Daylight Integration and Controls:

The space has a series of four ribbon windows high on the west wall. This space has a projector and screen used by lectures to show presentations as well as videos. For this reason motorized shading of the windows must be considered for the daylight issues associated with projectors. The space is a classroom and meeting area and therefore requires flexible lighting and shading controls for the variety of activities that go on in this space. A scene selection control system should be used to automatically control shades and lights for a pre program scenario, like a power point presentation or a lecture on the white boards.

Glare:

Direct glare from the luminaires should be considered to ensure that the space maintains a comfortable feel for the occupants. Also, direct glare from the sun should be avoided by installing the appropriate shading and controls for the windows. Reflected glare is also a great concern, especially on the whiteboards.

Light Distribution on Surfaces:

The space should maintain a rather uniform light distribution on the desks. Accent lighting will be used on the podium to draw the audience's attention. Downlighting will be used to on the walkways as a means of showing egress, but also to add some direct light interest in the main indirect lighting system of the coves.

Light Distribution on Task Plane:

Considering the space is a classroom, visual clarity is of great importance. For this visual clarity, the task plane should have a uniform light distribution on it.

Modeling of Faces:

Being that the space is a classroom the point of focus is the professor or whoever is presenting before the class, modeling of faces is an important issue to address. Students who are able to see the eyes and facial expressions of a professor or speaker will naturally have a higher level of focus than if the face cannot be seen as well.

Points of Interest:

The main point of interest is the front of the room, which contains the lecturer, lectern, whiteboards, and projection screen. Therefore, this area must be appropriately lit for all these tasks to create the point of interest or focal point.

Shadows:

Shadows should be avoided except for the shadows created by the furniture.

Surfaces Characteristics:

The space contains a multitude of surfaces with varying characteristics. The main critical surface in this space is the surface of the whiteboards, since these have a high reflectance value to them. The other surfaces include carpeting; fabric wrapped acoustics panels; and painted GWB.

Source Task Eye Geometry:

Source task eye geometry must be considered since the space is a classroom. The location as well as the types of luminaires must be taken into consideration to reduce glare and veiling reflections.

Luminance of Surfaces:

Since the desks in the space are of a darker brown, the luminance ratio of the light color of paper to the dark color of the desks must be considered to achieve proper visual clarity.

- 3:1 Task to Adjacent Background
- 10:1 Task to Non-Adjacent Background

Other Issues:

The floor has a stepping effect to it and therefore this changes the level of the task plane, the desk surface, for every step made. This must be considered in the reading of the horizontal illuminance of the space.

IESNA Illuminance Recommendations

Horizontal

Educational Lecture Hall	300 lx (30 fc)

Vertical

Lecture Hall Whiteboard	30 lx (30 fc)

Existing Material Conditions

Surface Materials within the Space:

- Beige Thin Carpeting
  - Reflectance = 25%
- Painted White GWB Ceiling
  - Reflectance = 85%
- Beige Painted GWB Walls
  - Reflectance = 85%
- Fabric Wrapped Acoustic Wall Panels
  - Reflectance = 38%
- PLAM Wood Desks
  - Reflectance = 13%
- Wood Trim
  - Reflectance = 13%
- Brown Doors
  - Reflectance = 13%
- White Boards
  - Reflectance = 95%
  -

Other Materials within the Space:

- Beige Fabric Covered Chairs

Glazing:

- **G-5:** 1" Insulated Glass - Float
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

Luminaire Schedule

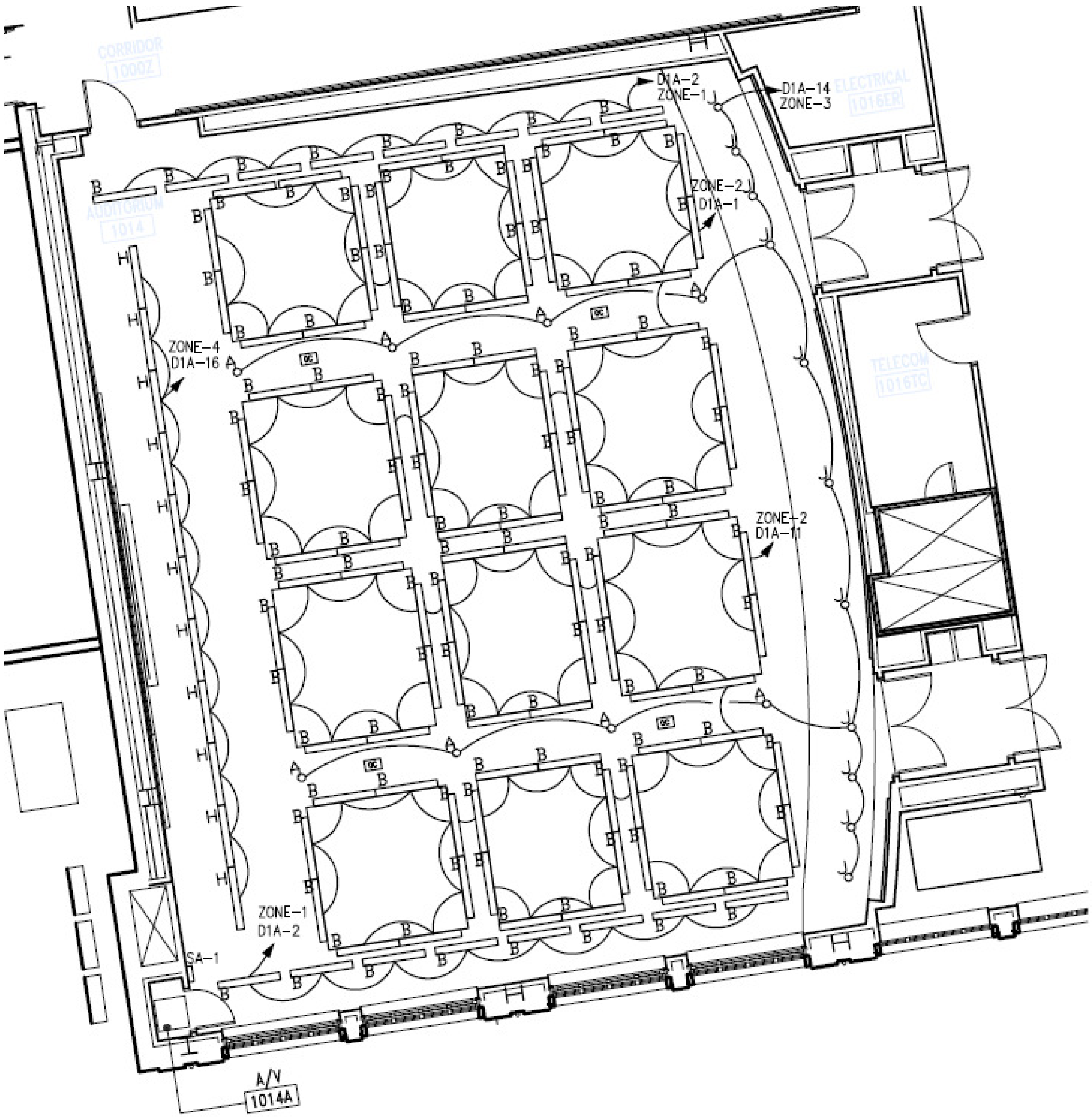
Peter & Ginny Nicholas Auditorium & Learning Center Luminaire Schedule									
Type	Mounting	Manufacturer	Catalog Number	Lamp	Input Watts	Input Amps	Volts	Ballast Catalog Number	Fixture Description
A	Ceiling Recessed	Lightolier	8021-CCLW	(1) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	31	0.11	277	Advance VEZ-1T42-M2-BS	6" Direct Downlight Vetical Lamp Electronic Ballast
B	Surface Cove	Elliptipar	F306-A128-S-00-2-000	(1) 32W T8 GE F32/T8/SPX30/ECO	25	0.1	277	Advance ICN1P32LWSC	4 Ft. Assymetric Cove Electronic Ballast
H	Ceiling Recessed	Lightolier	WMRL143277PS	(1) 32W T8 GE F32/T8/SPX30/ECO	25	0.1	277	Advance IOP2S32LWSC	4 Ft. Linear Wallwasher Electronic Ballast
J	Ceiling Recessed	Lightolier	8021-CCLW	(1) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	31	0.11	277	Advance IOP2S32LWSC	6" Direct Wallwasher Horizontal Lamp Electronic Ballast

Lamp Schedule

Peter & Ginny Nicholas Auditorium & Learning Center Lamp Schedule							
Type	Manufacturer	Cat. #	Rated Wattage	CRI / CCT	Rated Life	Initial Lumens	Assoc. Fixture
L1	General Electric	F26TBX/SPX30A/4P	26	82 / 3000K	12000	1710	A / J
L2	General Electric	F32/T8/SPX30/ECO	32	86 / 3000K	20000	2950	B / H

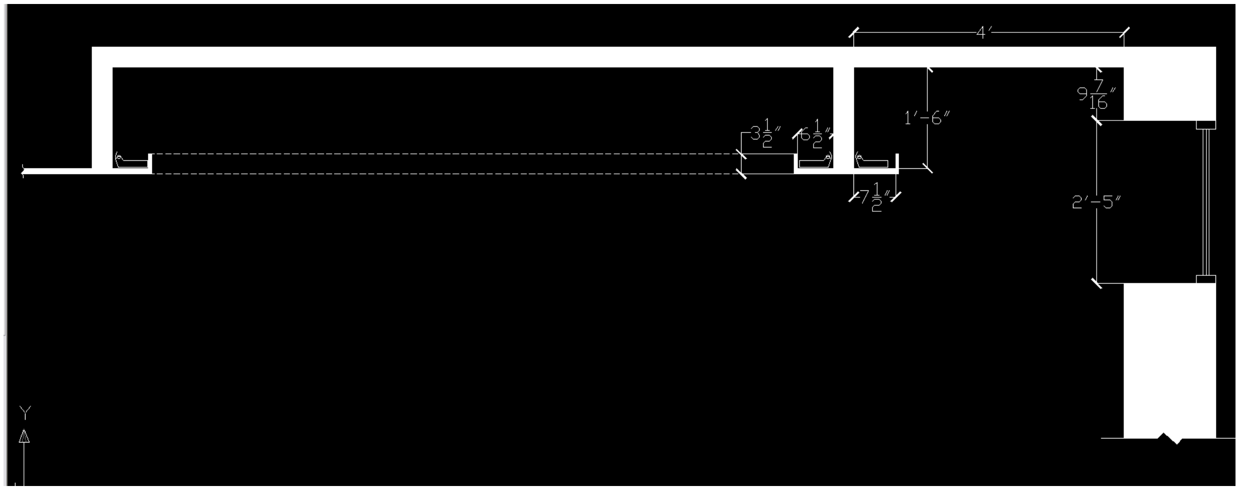
Notes: (1) please refer to Appendix A for all product cut sheets and complete schedules.
(2) Lighting control intent is located in the electrical depth section of this report.

Lighting Plan



Note: Please refer to Appendix B for 1/8" = 1'0" Lighting and Circuiting Plan

Cove Lighting System Detail (typ.)



Light Loss Factors

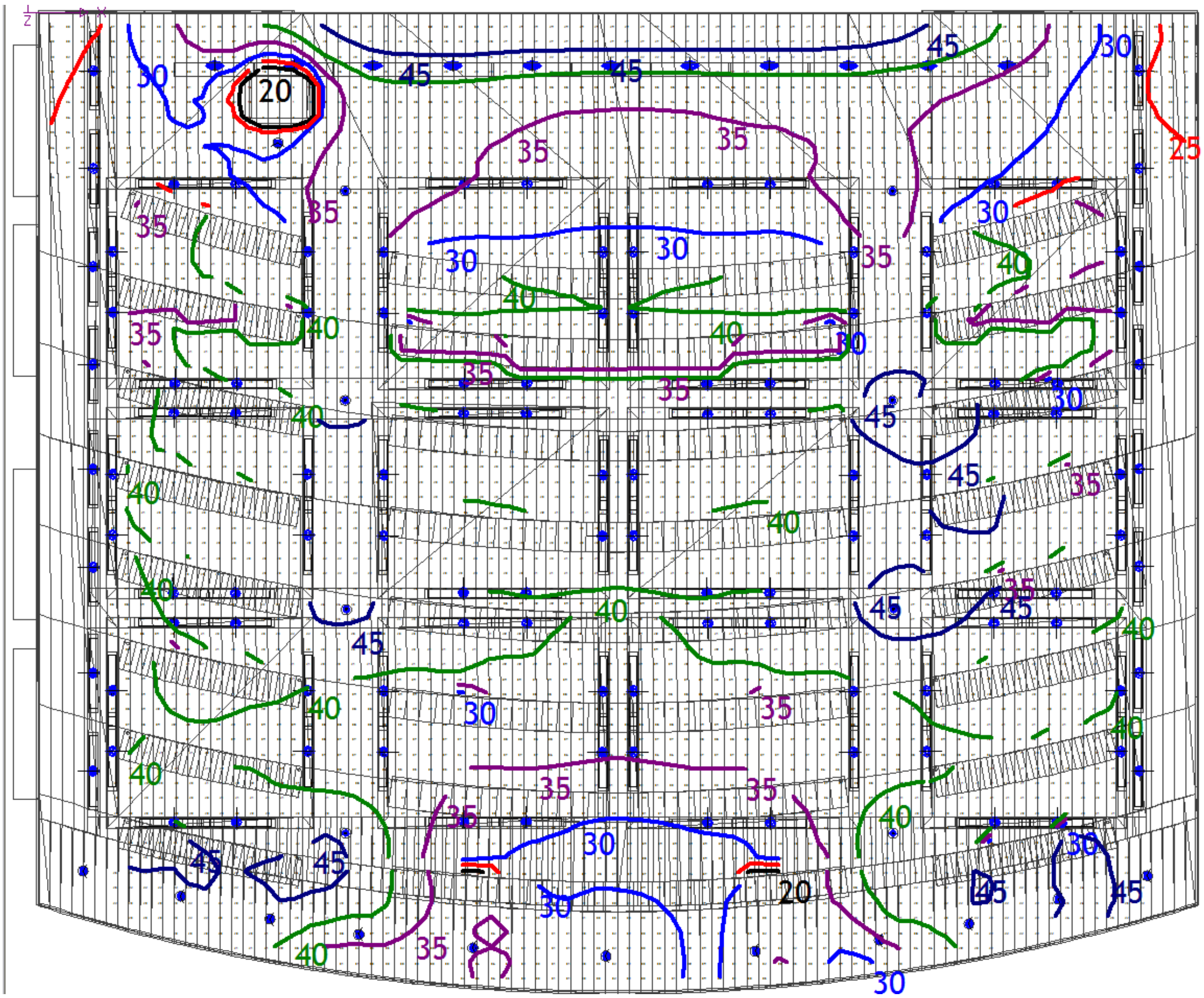
Peter & Ginny Nicholas Auditorium & Learning Center LLF														
Type	Fixture Description	Lamp	Mean Lumens [Initial Lumens]	LLD	Room Properties (Ft.)		RCR	Assumptions	Expected Dirt Depreciation	RSDD	LDD	BF	Total LLF
A	26W CFL 6" Open Maintenance **Category IV** **Direct** Downlight	(1) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	1440 [1710]	0.842	Height / Length / Width / Perimeter / Area (ft²)	11.5 / 46 / 57.33 / 204 / 2704	2.17	Clean 12 Months Cleaning Cycle	12	0.978	0.89	1.05	0.77
B	32W T8 Open top Closed Bottom Maintenance **Category VI** Assymetric Cove **Indirect** Uplight	(1) 32W T8 GE F32/T8/SPX30/ECO	2950 [2800]	1.054	Height / Length / Width / Perimeter / Area (ft²)	11.5 / 46 / 57.33 / 204 / 2704	2.17	Clean 12 Month Cleaning Cycle	12	0.89	0.87	0.73	0.60
H	32W T8 Closed Top Open Bottom Maintenance **Category IV** Linear Wallwasher	(1) 32W T8 GE F32T8/SPX30/ECO	2950 [2800]	1.054	Height / Length / Width / Perimeter / Area (ft²)	11.5 / 46 / 57.33 / 204 / 2704	2.17	Clean 12 Month Cleaning Cycle	12	0.978	0.89	0.73	0.67
J	26W CFL 6" Open Maintenance **Category IV** **Direct** Wallwasher	(1) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	1440 [1710]	0.842	Height / Length / Width / Perimeter / Area (ft²)	11.5 / 46 / 57.33 / 204 / 2704	2.17	Clean 12 Months Cleaning Cycle	12	0.978	0.89	1.05	0.77

Control Scenes

Control Scenes				
Scenes:	**Zone-1**	**Zone-2**	**Zone-3**	**Zone-4**
Projector	OFF	OFF	Dimmed to 20%	OFF
Speaker	1/2 Switched ON	1/2 Switched ON	Dimmed to 50%	All ON
Class/Exam	All ON	All ON	All ON	All ON

Note: Controlled by a Graffic Eye 3000

Illuminance Data



Peter & Ginny Nicholas Auditorium & Learning Center-Illuminance Results					
	Average Illuminance	Maximum Illuminance	Minimum Illuminance	Avg/Min	Max/Min
Floor in Front of Room	33.8	50.0	0.0	--	--
First Row of Desks	40.1	44.0	28.0	1.4	1.6
Second Row of Desks	39.6	45.0	28.0	1.4	1.6
Third Row of Desks	42.7	46.0	34.0	1.3	1.4
Fourth Row of Desks	42.6	46.0	33.0	1.3	1.4
Fifth Row of Desks	41.4	47.0	29.0	1.4	1.6
Sixth Row of Desks	38.4	43.0	31.0	1.2	1.4
Seventh Row of Desks	36.8	46.0	13.0	1.9	2.4
Eighth Row of Desks	38.0	46.0	28.0	1.4	1.6

Note: All desk calculations were taken from the top of the desk, 2.5 ft AFF

Raytraced Renderings

Looking Southeast from Front of Room:

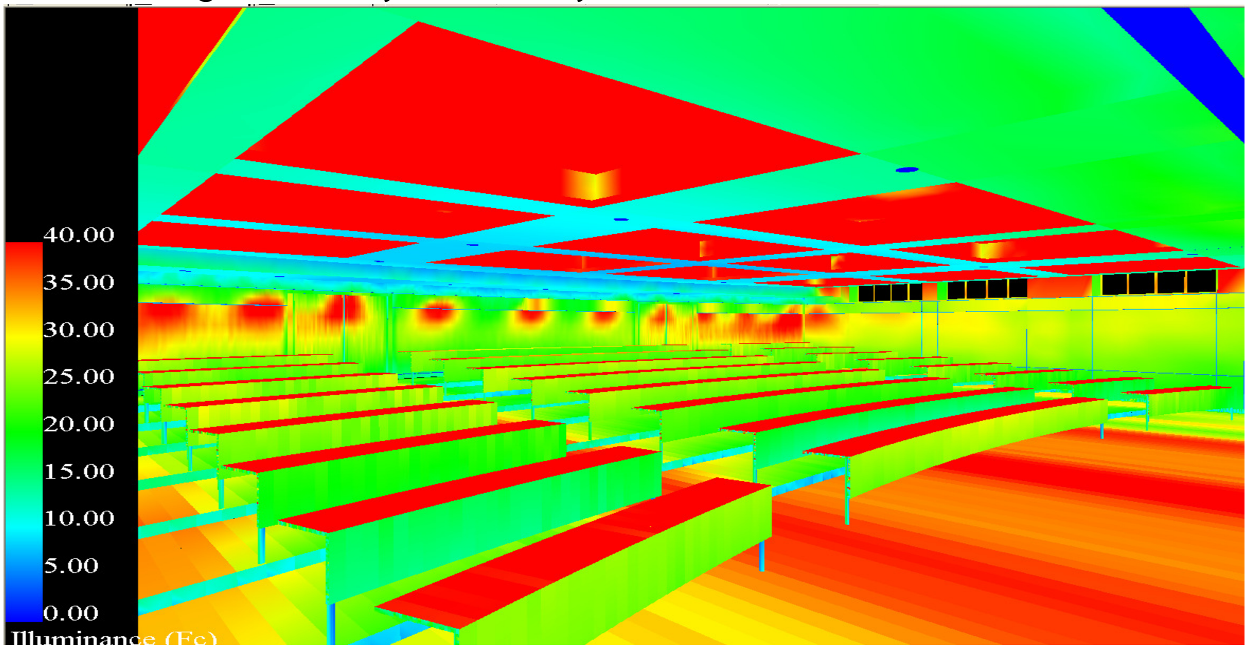
Looking Northeast from Front of Room:

Looking South-Southeast from Back of Room:

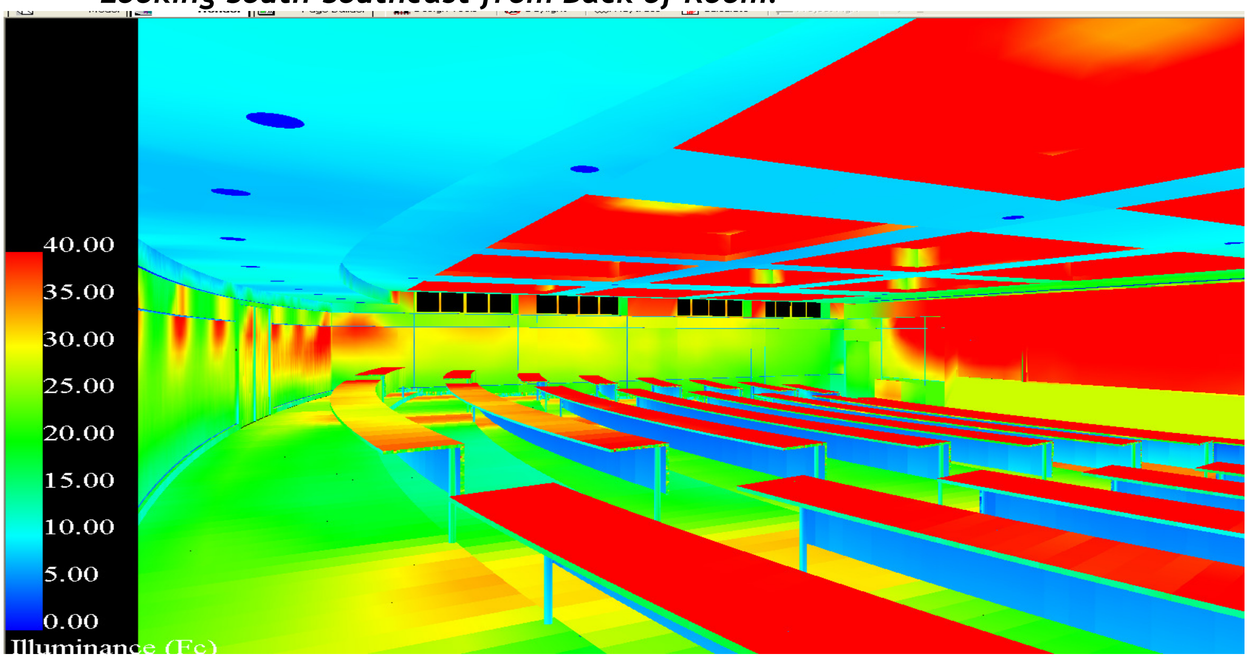
Looking South-Southeast from Back of Room:

Pseudo Color Renderings

Looking Southeast from Front of Room:



Looking South-Southeast from Back of Room:



Power Density

Peter & Ginny Nicholas Auditorium & Learning Center Power Density						
Fixture Type	Fixture Quantity	Fixture Wattage	Total Wattage (W)	Total Area (sf)	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density
A	8	31	248			
B	112	25	2800			
H	11	25	275			
J	11	31	341			
			3664	2704	1.36	1.40

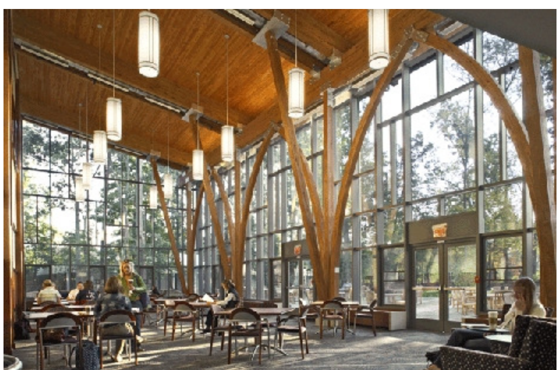
Evaluation

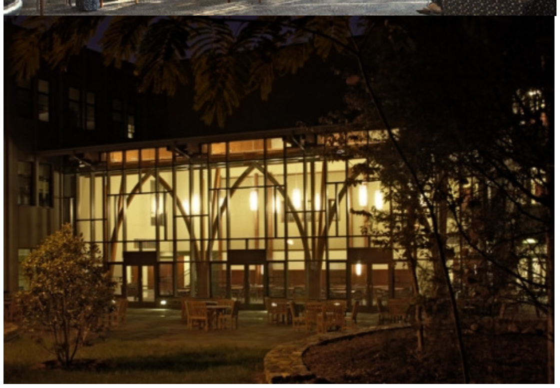
The lighting system that has been implemented meets the basic illumination requirements recommended in the IESNA. The design intent for changing the ceiling was to tie the architectural sense of the lobby together with this space. The cove system provides a clean look to the space as one looks out across the ceiling. The cove lighting system provides the main lighting for the space. However, since the cove lighting system is totally indirect lighting it creates what is known as a cloudy sky effect. This cloudy sky effect was avoided by introducing direct downlight atop the walkways. By placing direct light over the walkways, it increases the level of illumination and thereby providing a natural means of way finding. Finally, the front of the room, mainly the podium and whiteboards, were lit to a higher illuminance. The desired hierarchy of light for the space was successfully achieved.

Café DUSON- Overview

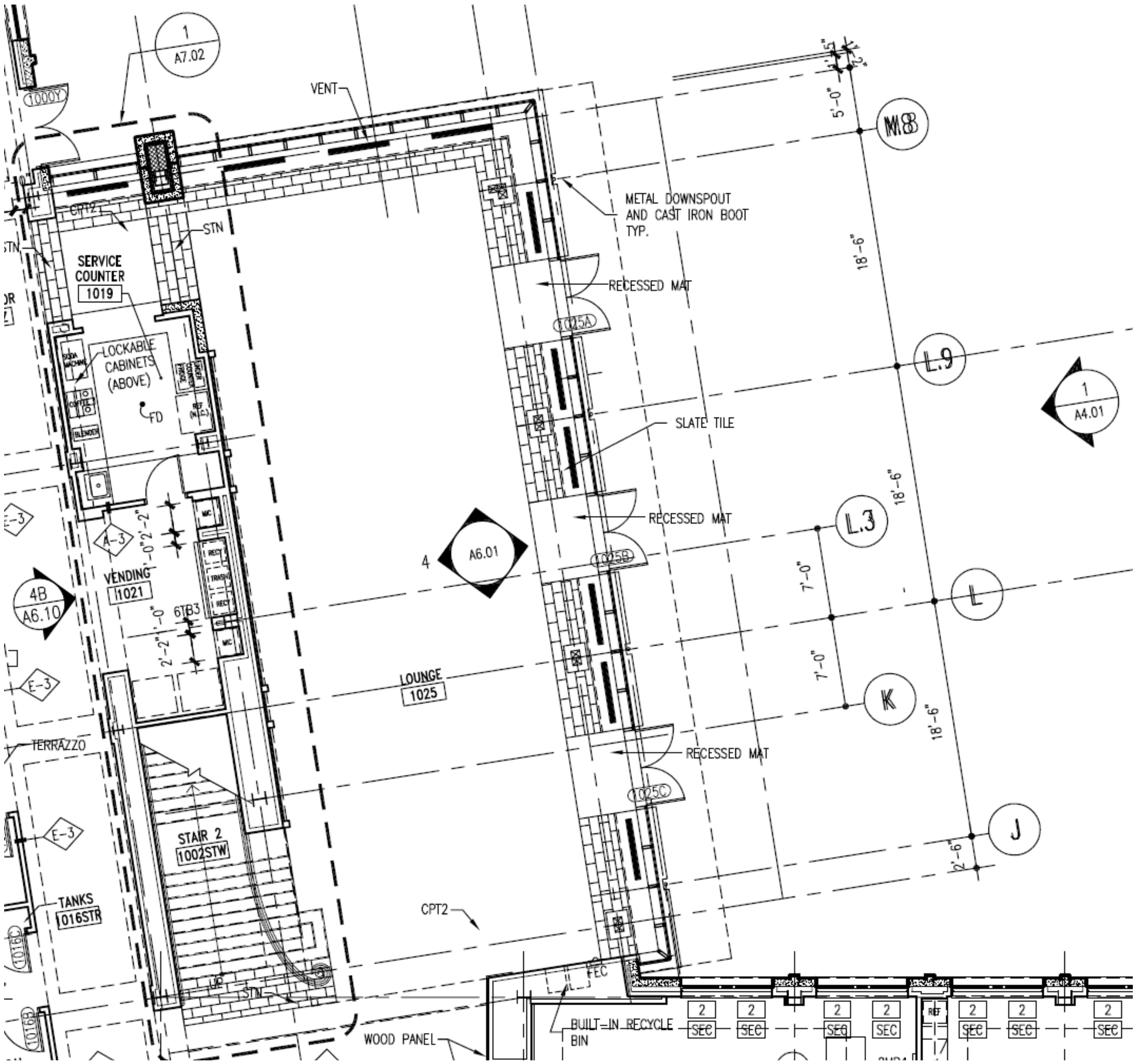
Café DUSON is a study lounge with seating and tables to seat approximately 65 people in an area of about 1850 SF. The café is a double high space with full height windows on the North and Eastern walls. This space also contains large arching roof supports that are large wooden timbers and made to look like Gothic Cathedral arches, which follow the Duke University architectural style. Café DUSON is designed to hold a feeling of relaxation while still having a studious atmosphere.

The lighting design intent for this space was to tie lighting and architectural feel together with the other interior spaces that were redesigned, the lobby and the auditorium. The first lighting goal was to create a clean look as one looks out across the space, just like in the auditorium. The second goal was to bring a sense of Gothic style to the space with a chandelier, the same chandelier from the lobby that also symbolizes the school. The final goal was to integrate part of the lighting into the large beams with the mechanical ducts to help in visually cleaning up the space but also refer back to the lobby and the luminaire locations between the beams.



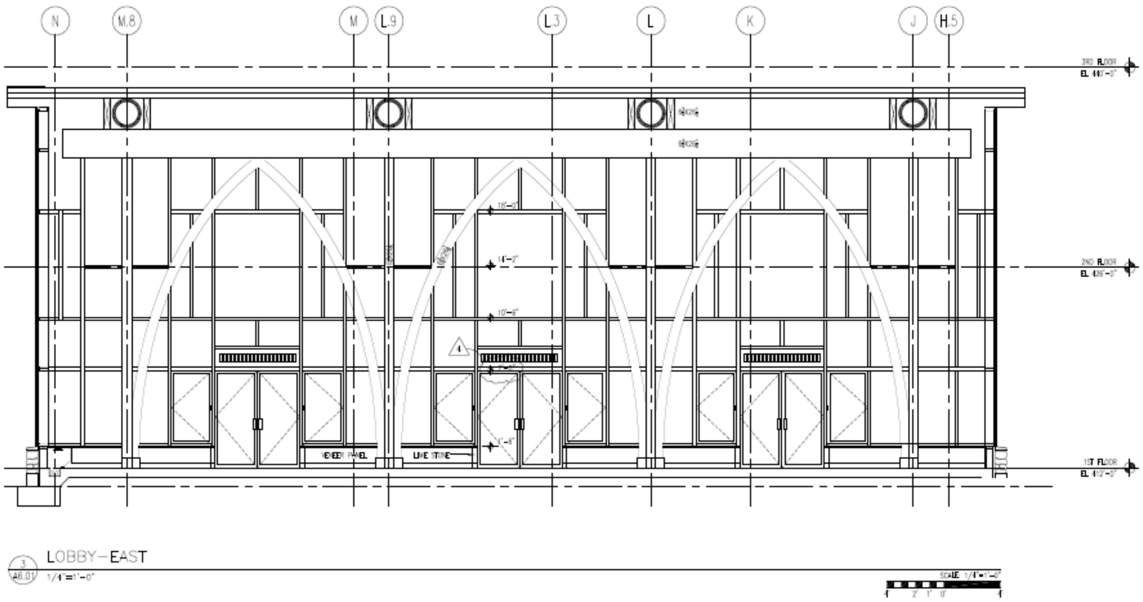



Architectural Plans

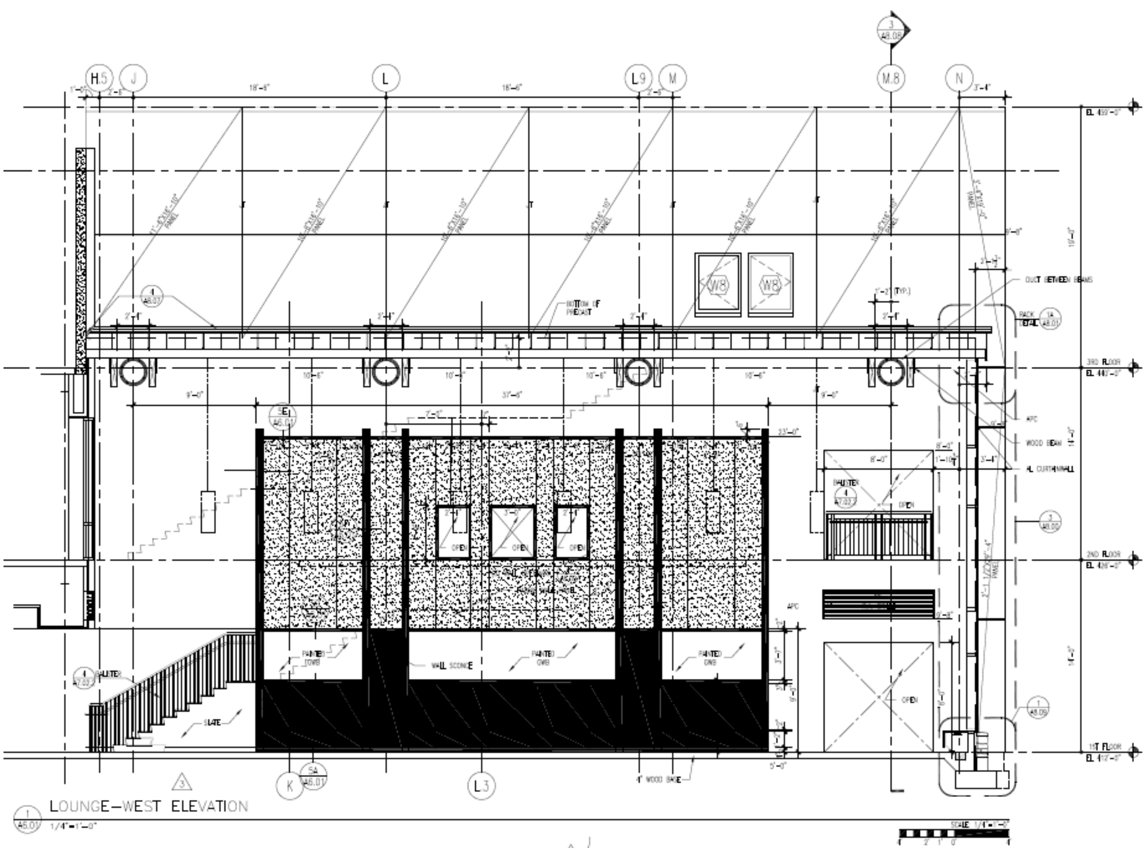


Architectural Interior Elevations

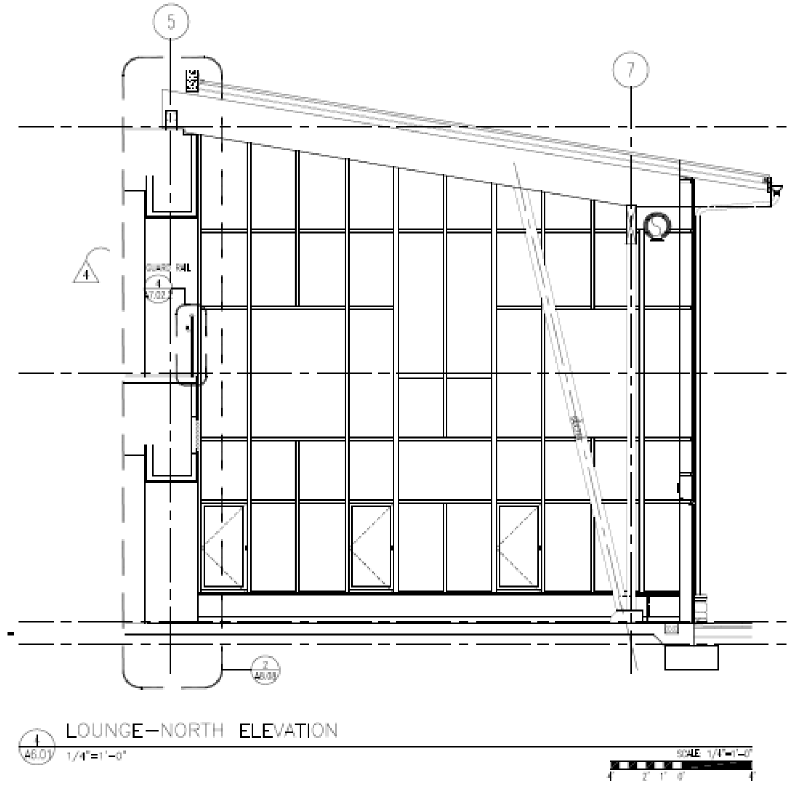
East Interior Elevation:



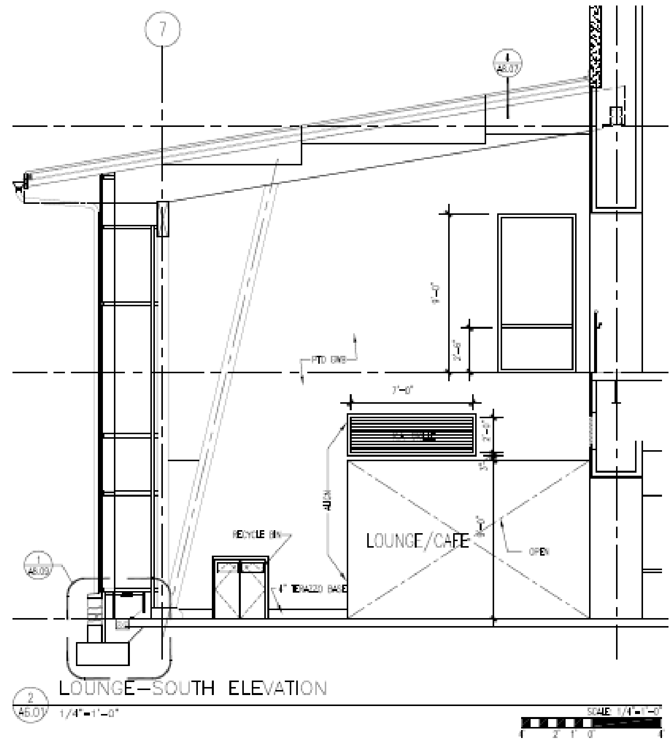
West Interior Elevation:



North Interior Elevation:



South Interior Elevation:


LOUNGE/CAFE
RECYCLE BIN
4" TERRAZZO BASE
OPEN
7'-0"
LOUNGE—SOUTH ELEVATION
1/4"=1'-0"

IESNA Design Criteria

Appearance of Space and Luminaires:

Café DUSON is intended to possess a relaxing atmosphere, where you can relax and take a break from the busy schedule of the day. This space already posses some inherent properties of relaxation with its double high ceiling, natural wood beams, columns, wall paneling and ceiling. Also, the lounge looks out directly onto the courtyard with its gradual curves and the large trees surrounding it. The café also has a modern feel to it with the exposed air ducts and glass and aluminum curtain walls. Therefore, the styles of the luminaries should have a slight modernistic style to them while still holding to the Duke Gothic style. The lighting design intent is to maintain a clean look as you look across the space. For this reason, three chandeliers will be the only fixtures hanging from the ceiling. All the other light fixtures will be incorporated into or hidden by the architecture of the space.

Color Appearance:

The color appearance of the café should have a warm tone to it to enhance the natural tones of the wood throughout the space and maintain the intended feeling of relaxation.

Daylight Integration and Controls:

Café DUSON has glass curtain walls that face North and East. For this reason daylight integration should be utilized to save electrical energy. Also, this space could potentially be used for other events, such as banquets or parties. Therefore, an adjustable control system should be utilized to provide a versatile lighting system.

Direct Glare:

Direct glare from the luminaires is a concern, since the space is intended to have a feeling of comfort and relaxation. Direct sun glare from the easterly glass walls is a concern. However, the large trees that surround the courtyard could potentially diffuse some of the direct glare from the sun on the eastern curtain wall.

Light Distribution on Surfaces:

The space contains a lot of expensive woodwork and should be lit in such a way to bring out its natural beauty. Also, there is a 3-dimensional quality to the wooden arches, beams, and columns that should be expressed. Therefore, portions of the wood should have uniformity while also providing depth with shadows and direct lighting. The arches at night will not be highlighted by light but rather be in silhouette against the wallwashed wall behind it.

Light Distribution on Task Plane:

The task plane should be relatively uniform since there are tables and chairs for studying and working. Also, since this space could potentially have multiple uses, the task plane height could vary but should still maintain a uniform light distribution.

Modeling of Faces:

Modeling of faces is not of great importance. This space is intended for a relaxing work atmosphere, and therefore having a high vertical illuminance on the peoples' faces is actually not recommended.

Points of Interest:

The large wooden arches that look like Gothic cathedral arches and the wooden columns that support the roof system are a well defined point of interest within the space.

Shadows:

Some shadowing is desired to achieve a sense of depth with the large wooden timbers and arches. The desired lighting effect on the arches looking from the exterior is leaving the arches in strong shadows against the uniformly wallwashed wall behind the arches. However, shadows are not desired on the task plane.

Surfaces Characteristics:

The café contains a variety of surface materials. Some of the most prominent materials in the space are natural wood and of course the glass from the curtain walls. The space also contains some acoustic fabric wrapped paneling and white painted GWB.

IESNA Recommended Illuminance

Horizontal

For a lounge	300 lx (30 fc)

Vertical

For a lounge	No recommended illuminance

Café DUSON- Existing Conditions

Surface Materials within the Space:

- Gray Thin Outer Carpeting
  - Reflectance = 29%
- Gray Thin Inner Carpet
  - Reflectance = 35%
- Natural Wood Ceiling
  - Reflectance = 9%
- Natural Wood Timber
  - Reflectance = 13%
- White Painted GWB
  - Reflectance = 88%
- Acoustic Wall Panels
  - Reflectance = 48%
- Natural Wood Wall Panels
  - Reflectance = 13%
- Gray Painted Aluminum Mullions
  - Reflectance = 58%

Glazing:

- **G-5:** 1" Insulated Glass Curtain Wall System of Café DUSON
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

- **G-4:** 1" Insulated Glass – Laminated (door glass)
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

Luminaire Schedule

Café DUSON Student Lounge- Luminaire Schedule									
Type	Mounting	Manufacturer	Catalog Number	Lamp	Input Amps	Input Watts	Volts	Ballast Catalog Number	Fixture Description
C	Ceiling Recessed	Cooper Lighting	M6043S-Q-740-10012P	(1) 100W BD17MED CMH GE CMH100/U/830/MED	1.1	118	277	Advance 71A5337J	Max height 6-in 10-in Direct Downlight Horizontal Lamp Core and Coil Ballast
D	Surface	Elliptipar	F305-T328-S-00-2-000	(1) 54W T5HO GE F54W/T5/830	0.52	62	277	Advance ICN4S5490C2LSG _277	4 ft. Asymmetric Cove Electronic Ballast
F	Semi-Recessed	Elliptipar	M204-0175-T-02-B	(1) 175W ED28 CMH MVR175/SP30/U	0.45	206	277	Advance 71A5543T	18-in Louvered Semi-recessed CMH Wallwasher Coir and Coil Ballast
G	Pendant Chandelier	Custom	Custom	(2) 26W Triple Tube CFL GE F26TBX/SPX30A/4P	0.21	58	277	Advance VEZ-2Q26-M2-LD	Custom designed pendant that reflects Gothic Architecture/Style

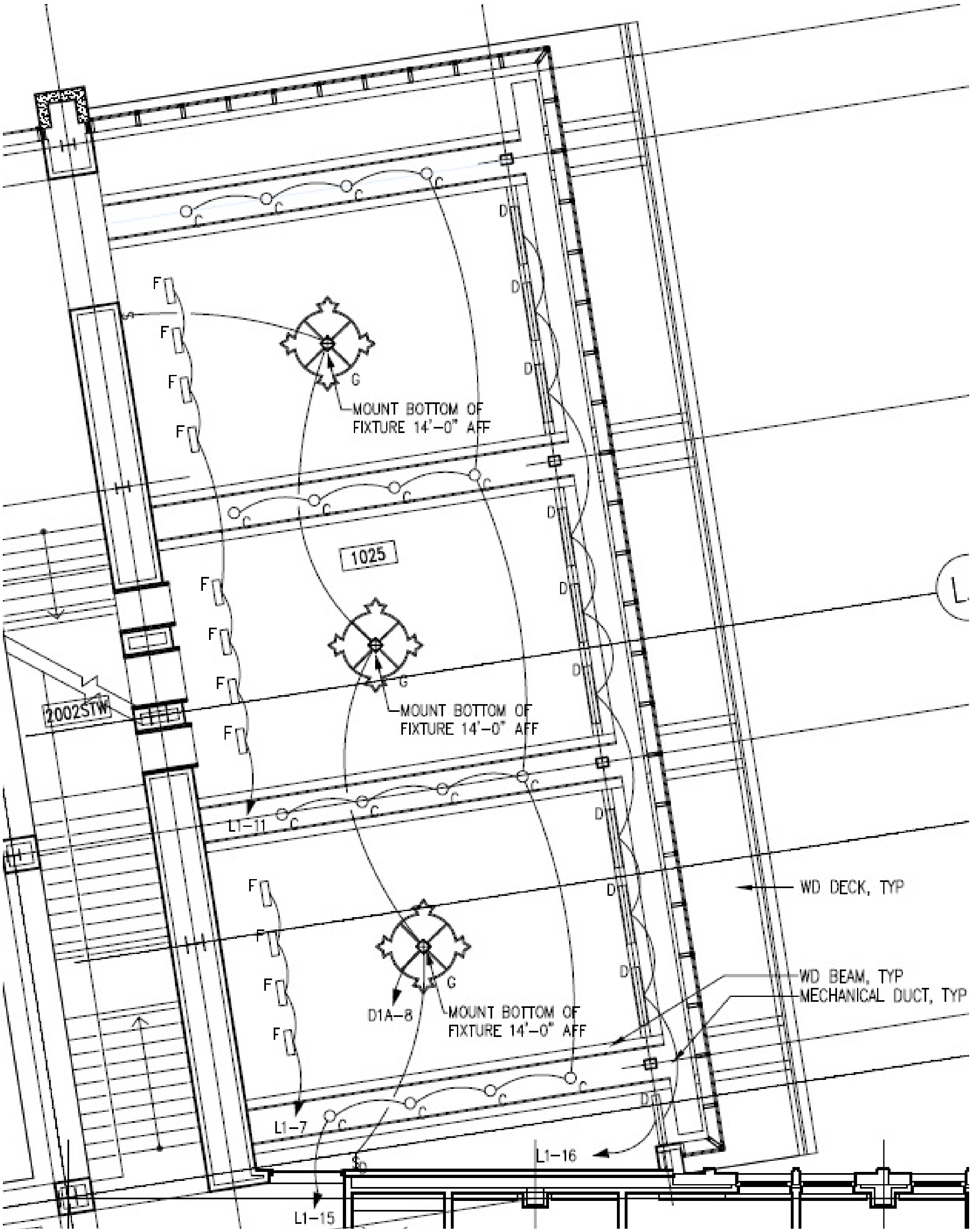
Lamp Schedule

Café DUSON Student Lounge- Lamp Schedule							
Type	Manufacturer	Cat. #	Rated Wattage	CRI / CCT	Rated Life	Initial Lumens	Assoc. Fixture
L1	General Electric	F26TBX/SPX30A/4P	26	82 / 3000K	12000	1710	G
L3	General Electric	CMH100/U/830/MED	100	83 / 3000K	15000	9200	C
L4	General Electric	F54W/T5/830	54	85 / 3000K	20000	5000	D
L5	General Electric	MVR175/SP30/U	175	70 / 3000K	6000	10300	F

Note: (1) All fixture cut sheets are located in the Appendix A

(2) This space is controlled by an astronomical time clock and a wall dimmer

Lighting Plan

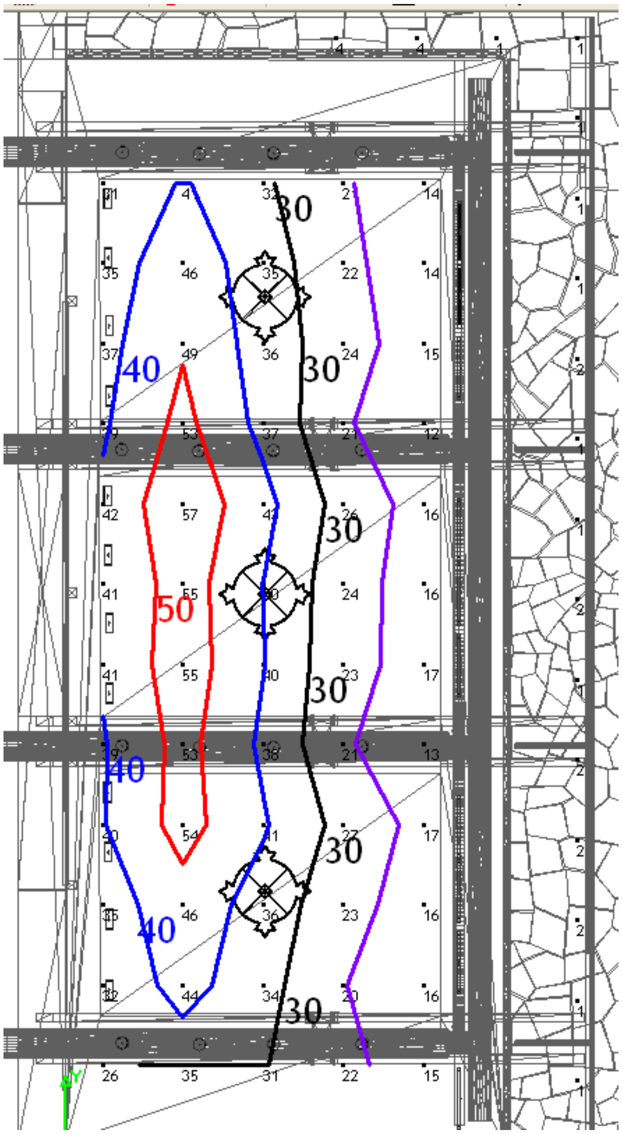


Note: Please refer to Appendix B for 1/8" = 1'0" Lighting and Circuiting Plan

Light Loss Factors

Café DUSON Student Lounge- LLF													
Type	**Fixture Description**	**Lamp**	**Mean Lumens [Initial Lumens]**	**LLD**	**Room Properties (Ft.)**		**RCR**	**Assumptions**	**Expected Dirt Depreciation**	**RSDD**	**LDD**	**BF**	**Total LLF**
C	100W MH Open Maintenance **Category III** **Direct** Downlight	(1) 100W BD17MED CMH GE CMH100/U/830/MED	6400 9200	**0.696**	Height Length Width Perimeter Area (ft^2)	25.5 67 27 190 1843	6.57	Clean 12 Months Cleaning Cycle	12	**0.96**	**0.9**	**1.00**	**0.60**
D	54W T5HO Open top Closed Bottom Maintenance **Category VI** Asymmetric **Indirect** Uplight	(1) 54W T5HO GE F54W/T5/830	4700 5000	**0.940**	Height Length Width Perimeter Area (ft^2)	25.5 67 27 190 1843	6.57	Clean 12 Month Cleaning Cycle	12	**0.87**	**0.86**	**0.99**	**0.70**
F	175W CMH Closed top Louvered Bottom Maintenance **Category IV** Wallwasher **Direct**	(1) 175W ED28 CMH MVR175/SP30/U	6500 10300	**0.631**	Height Length Width Perimeter Area (ft^2)	25.5 67 27 190 1843	6.57	Clean 12 Month Cleaning Cycle	12	**0.96**	**0.89**	**1.00**	**0.54**
G	Custom Pendant Chandelier	(2) 26W Triple Tube CFL GE26TBX/SPX30A/4P	1440 1710	**0.842**	Height Length Width Perimeter Area (ft^2)	25.5 67 27 190 1843	6.57	Clean 12 Month Cleaning Cycle	12	**0.96**	**0.9**	**1.00**	**0.72**

Illuminance Data

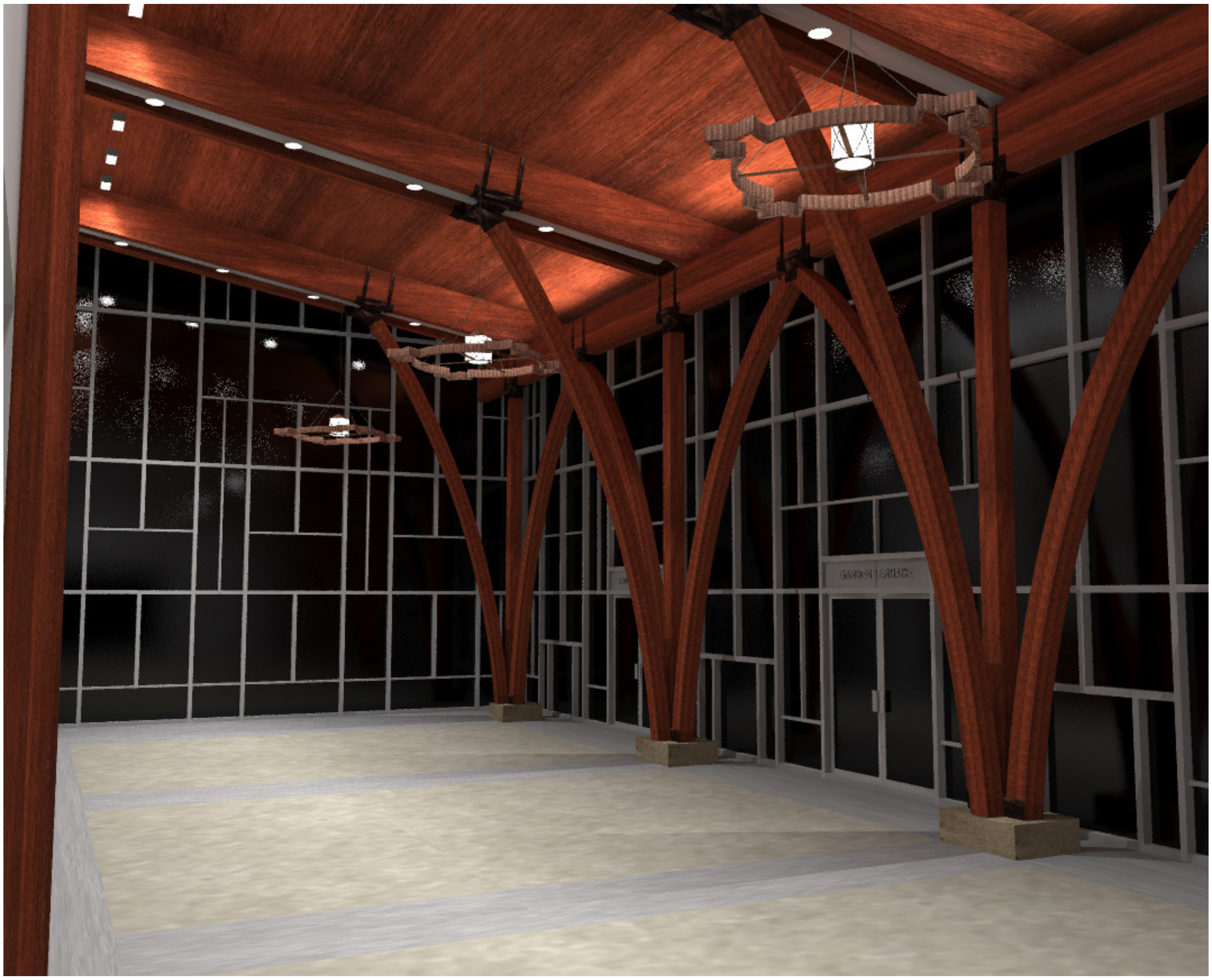


AGI32-v2.0 Statistical Summary

Café DUSON Student Lounge- Illuminance Results					
Average Illuminance	Maximum Illuminance	Minimum Illuminance	Avg/Min	Max/Min	Uniform Gradient
32.2	58.0	12.0	2.7	4.8	1.8

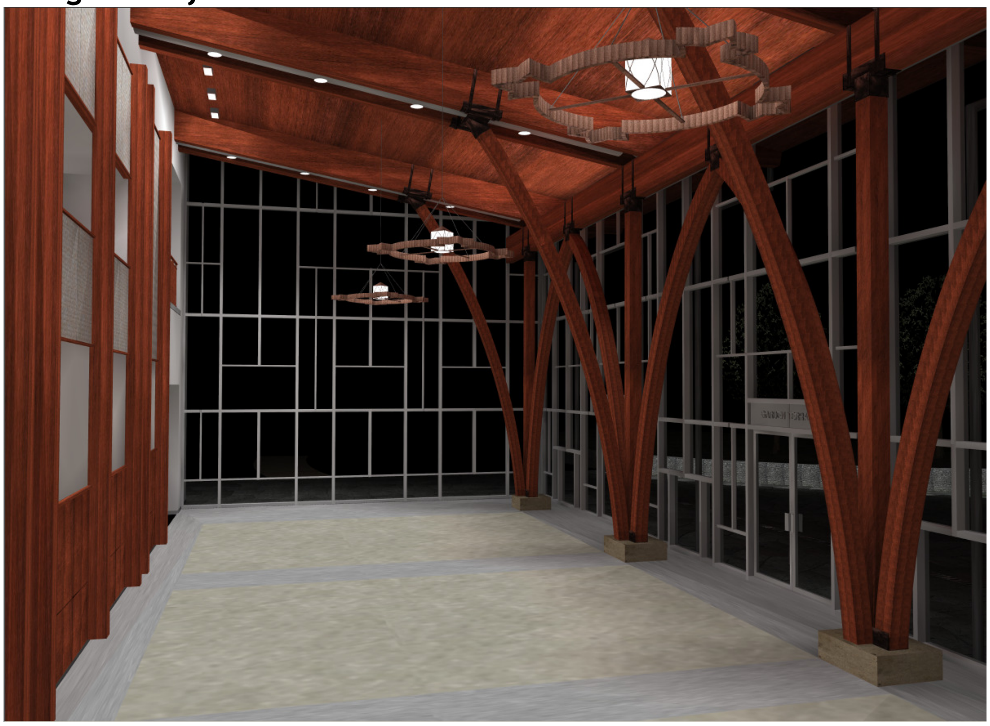
AGI32 Raytraced Renderings

Looking North-Northeast from the Corridor:



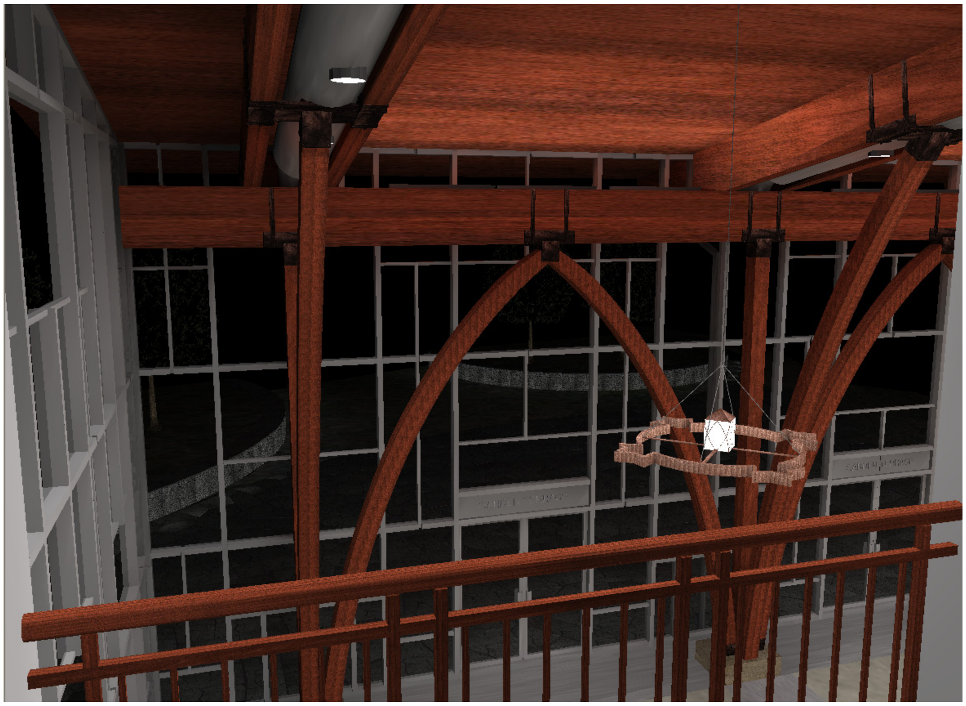
AGI32 Radiosity Renderings

Looking North from the Corridor:

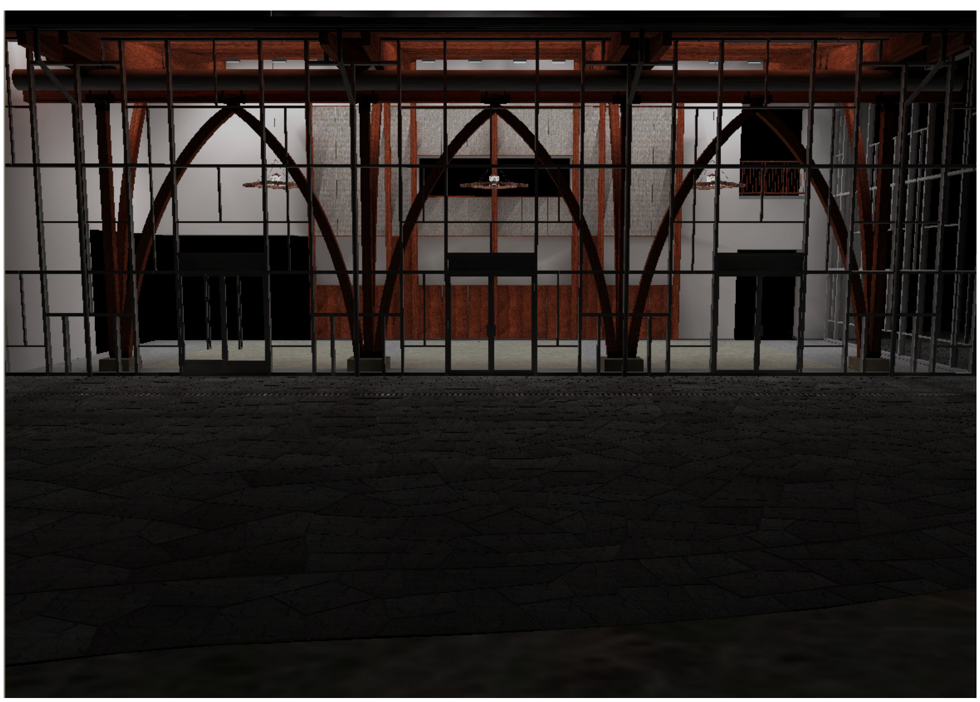


Looking Northeast from the Corridor toward the Courtyard:

Looking East from the Second Floor Corridor:



Looking West from the Courtyard:



Power Density

Café DUSON Student Lounge Power Density						
Fixture Type	Fixture Quantity	Fixture Wattage	Total Wattage (W)	Total Area (sf)	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density
C	12	118	1416			
D	11	62	682			
F	11	206	2266			
			4364	1843	2.30	1.2
Fixture Type	Fixture Quantity	Fixture Wattage	Total Wattage (W)	Total Area (sf)	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density
G*	3	58	174			
			174	1843	0.09	1.0
*Decorative Fixture, Additional 1.0 W/sf						

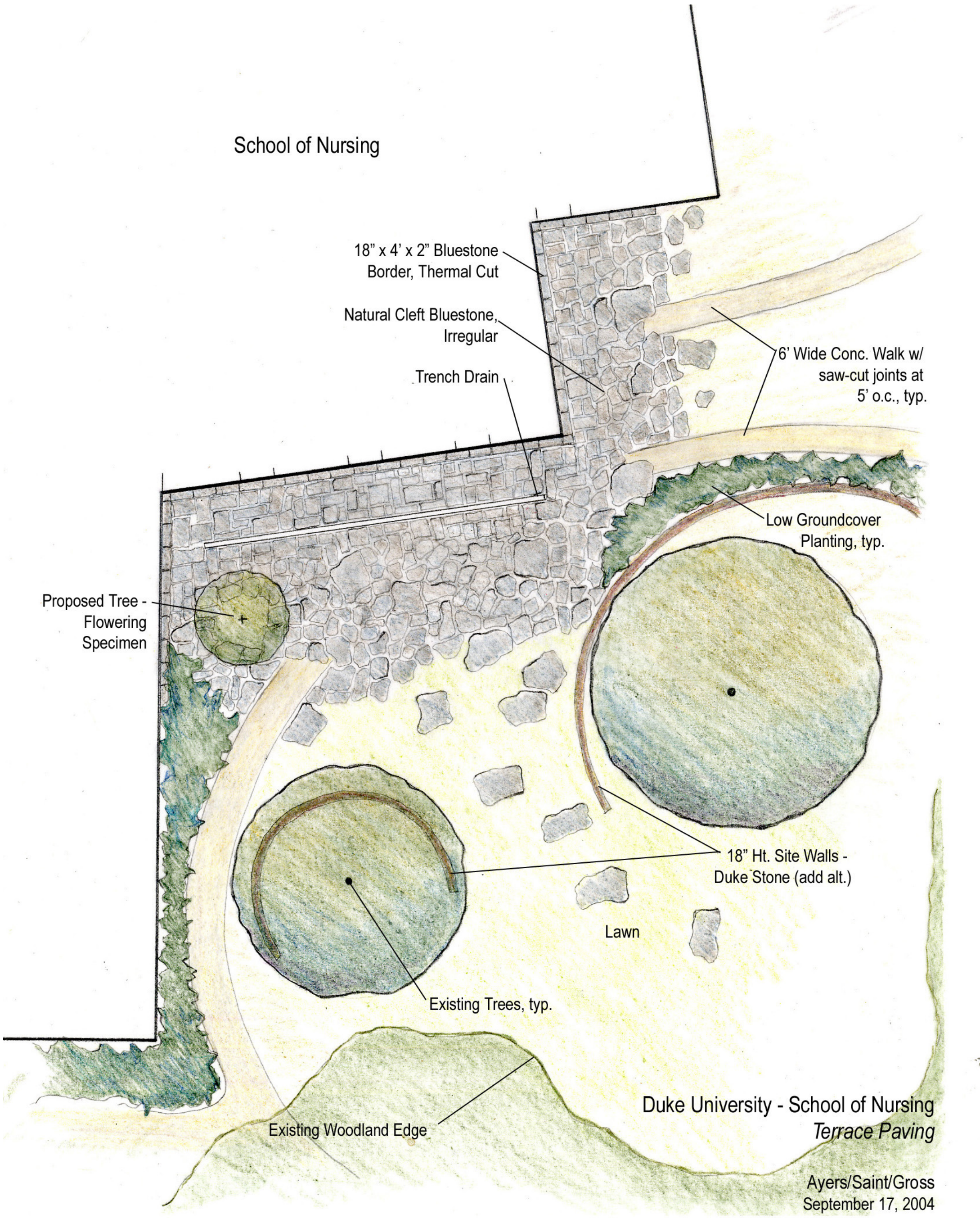
Evaluation

This space is just about on target for the recommended horizontal illuminance. It is currently higher by about 9fc. Since I am 0.26 W/sf above the ASHRAE standard, I will look into changing the ballast for the CMH fixtures. For the final submission I am going to Photoshop the wallwashers to soften the white luminous surface, since in reality you would see a soft metallic glow. After making minor modifications and putting my custom fixture in, I am pleased with the results.

Champagne Outdoor Courtyard Overview

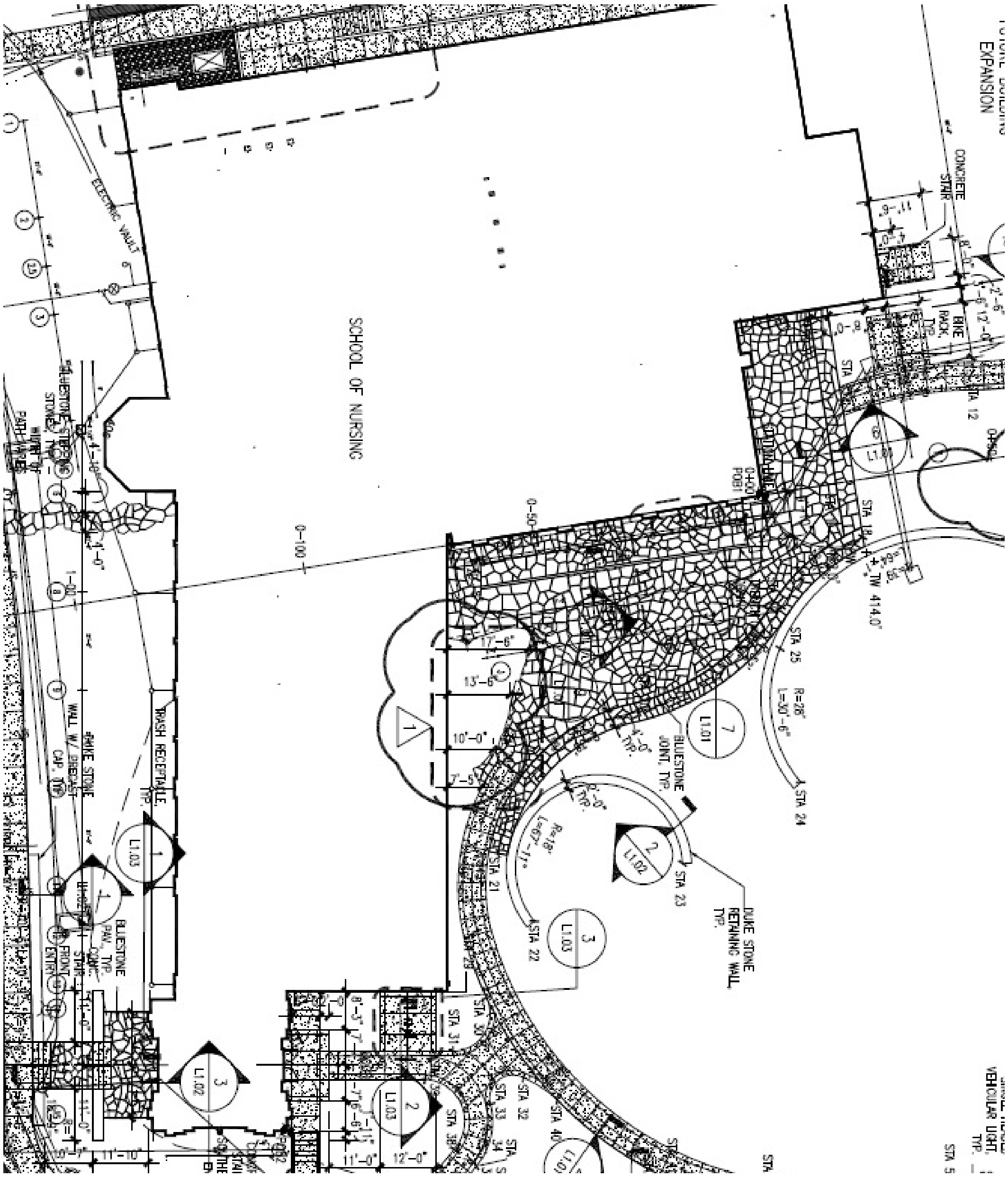
The courtyard is located on the East side of the building and covers an approximate area of 1450 SF. The courtyard serves as the outdoor portion of the Café DUSON lounge. There are tables and benches that seat approximately 54 people. The courtyard is intended to provide a sense of relaxation and comfort, with its gentle curving retaining walls, random natural cleft Bluestone paver pattern, and the incorporation of trees and shrubbery around the courtyard.

Architect's Conceptual Rendering



*The above is a conceptual rendering by ASG

Architectural Plan



Architectural Elevations

The curved retaining walls are rise 2-ft off of the courtyard stone pavers.

IESNA Design Criteria

Appearance of Space and Luminaires:

The courtyard is a space that is intended for people to gather and work or relax. With the knowledge of this intended use, it is critical that the space appear inviting and have a sense of pleasantness. The luminaire styles should accent the Duke University Architectural Style of Gothic Architecture.

Color Appearance:

The color appearance of the courtyard should have a slight warm tone to it. Being that the courtyard is adjacent to and essentially the outdoor portion of the warmly lit Café DUSON, it is critical that the courtyard carry similar characteristics.

Controls:

All the outdoor luminaries within this space should use an astronomical time clock.

Light Distribution on Surfaces:

For public safety, some degree of uniformity must be maintained on the pathways. To create visual interests and bring out the inherent textures of the materials of the space, grazing and other forms of non-uniformity should be used.

Light Distribution on Task Plane:

The courtyard and its walkways are some of the main means of egress from the building and therefore require the walkways and courtyard surface to maintain an illuminance level of 1 lx (0.1 fc) over the entire path of egress.

Modeling of Faces and Objects:

The courtyard is used by occupants of the building as well as passersby therefore face and object recognition is important for security and safety reasons.

Points of Interest:

The trees surrounding the courtyard were an important part of the building, since these trees are original to the site. The architecture of the courtyard retaining walls highlight their existence and give them a sense of importance to the space. For this reason, accenting these trees with light will reinforce this design objective and provide a point of interest. Also, the curved retaining walls that contain the previously mentioned trees are an interesting architectural feature that should also be highlighted for the patrons of the café and passersby to notice.

Shadows:

Shadows should be avoided in the interest of safety and security.

Surfaces Characteristics:

The courtyard has a variety of stonework and trees that should be highlighted to some extent to draw out their natural textures by grazing.

IESNA Illuminance Recommendations

Horizontal

Pathways Away from Building 10 lx (1 fc)

Vertical

Pathways Away from Building 3 lx (0.3 fc)

Existing Material Conditions

Surface Materials within the Space:

- Natural Cleft Bluestone walkway and courtyard
  - Reflectance = 15%
- Duke Stone retaining walls
  - Reflectance = 20%
- Gray Painted Aluminum Mullions
  - Reflectance = 25%

Glazing:

- **G-5:** 1” Insulated Glass Curtain Wall System of Café DUSON
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

- **G-4:** 1” Insulated Glass – Laminated (door glass)
  - U-Value = 0.57
  - Transmittance = 0.55
  - Shading Coefficient = 0.45

Luminaire Schedule

Champagne Outdoor Courtyard- Luminaire Schedule							
Type	Mounting	Manufacturer	Catalog Number	Lamp	Input Watts	Volts	Fixture Description
K	Outdoor In -ground Recessed	Erco	33670	(1) 10W T3 2-Pin G4 Halogen GE Q10T3/CL	10	120	10W Halogen, 120V Outdoor In-ground recessed uplight UL Wet Listed Impact Resistant Cut-off angle 30°

Light Loss Factors

Champagne Outdoor Courtyard- LLF														
Type	Fixture Description	Lamp	Mean Lumens [Initial Lumens]	LLD	Room Properties (Ft.)		RCR	Assumptions	Expected Dirt Depreciation	RSDD	LDD	BF	Total LLF
K	10W T3 Halogen Closed Clear Lens Top Closed Bottom Outdoor in-ground Uplight Maintenance **Category VI**	(1) 10W T3 2-Pin G4 Halogen GE Q10T3/CL	140 [140]	**1.0**	Height	0	1.00	Very Dirty 12 Months Cleaning Cycle	30	**0.94**	**0.64**	**1.00**	**0.602**
					Length	~95							
					Width	~52							
					Perimeter	405							
					Area (ft^2)	3860							

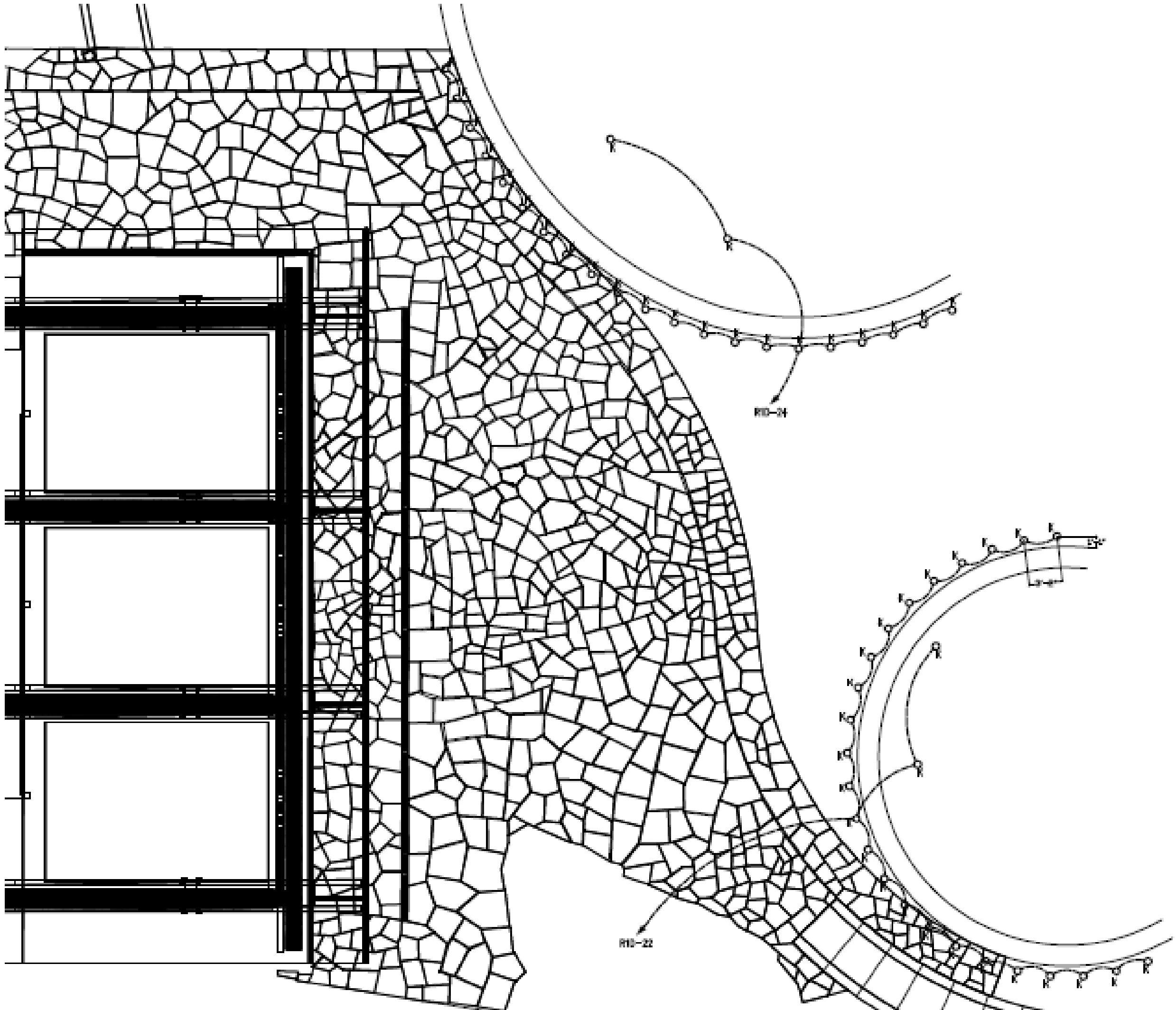
Lamp Schedule

Champagne Outdoor Courtyard- Lamp Schedule							
Type	Manufacturer	Cat. #	Rated Wattage	CRI / CCT	Rated Life	Initial Lumens	Assoc. Fixture
L6	General Electric	Q10T3/CL	10	1.0/2800	2000	140	K

Notes: (1) please refer to Appendix A for all product cut sheets and complete schedules.

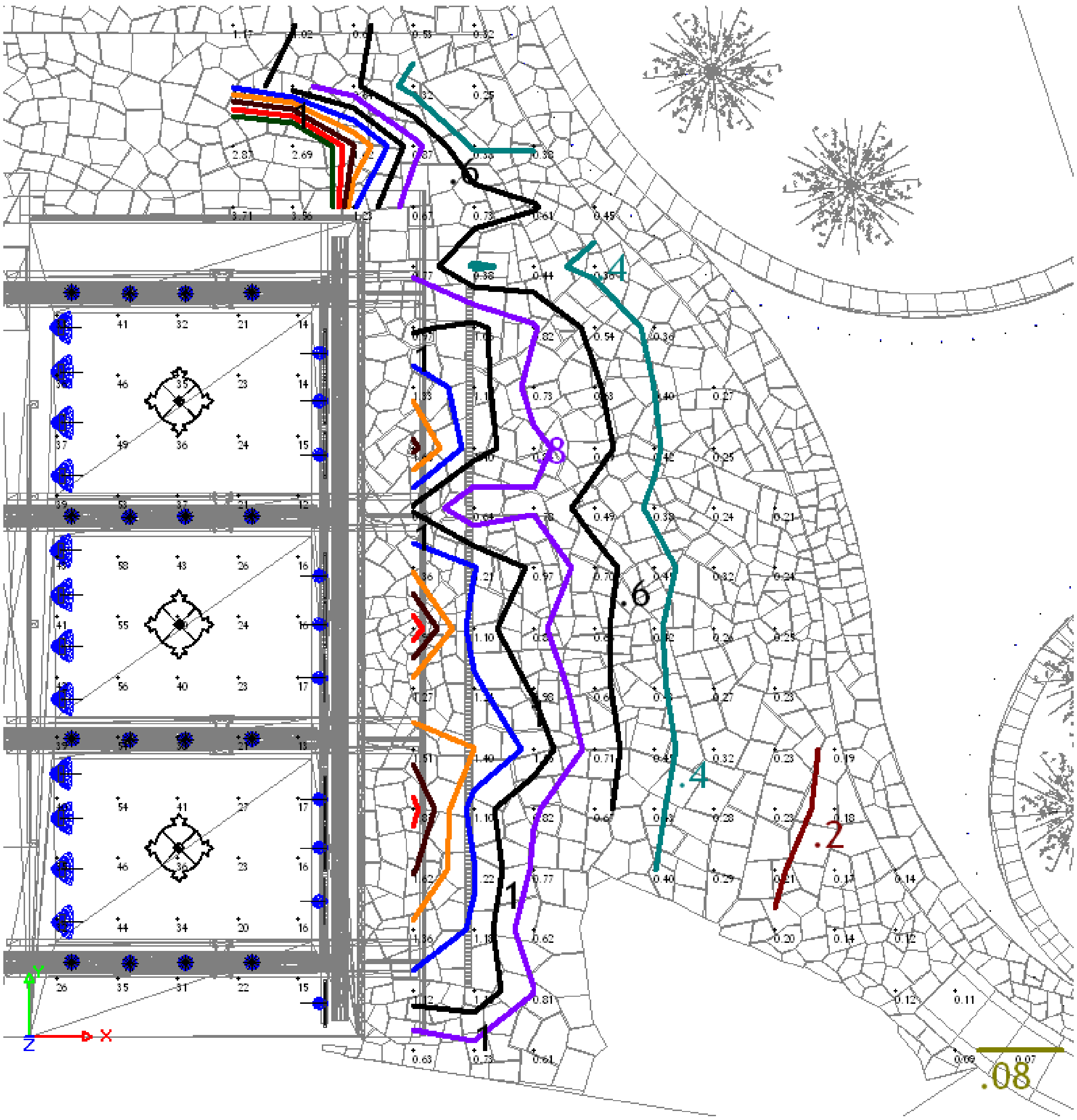
(2) this space will be controlled by an astronomical time clock located in the first floor west AV closet, where PNL R1D is located.

Lighting Plan



Note: Please refer to Appendix B for 1/8" = 1'0" Lighting and Circuiting Plan

Illuminance Data



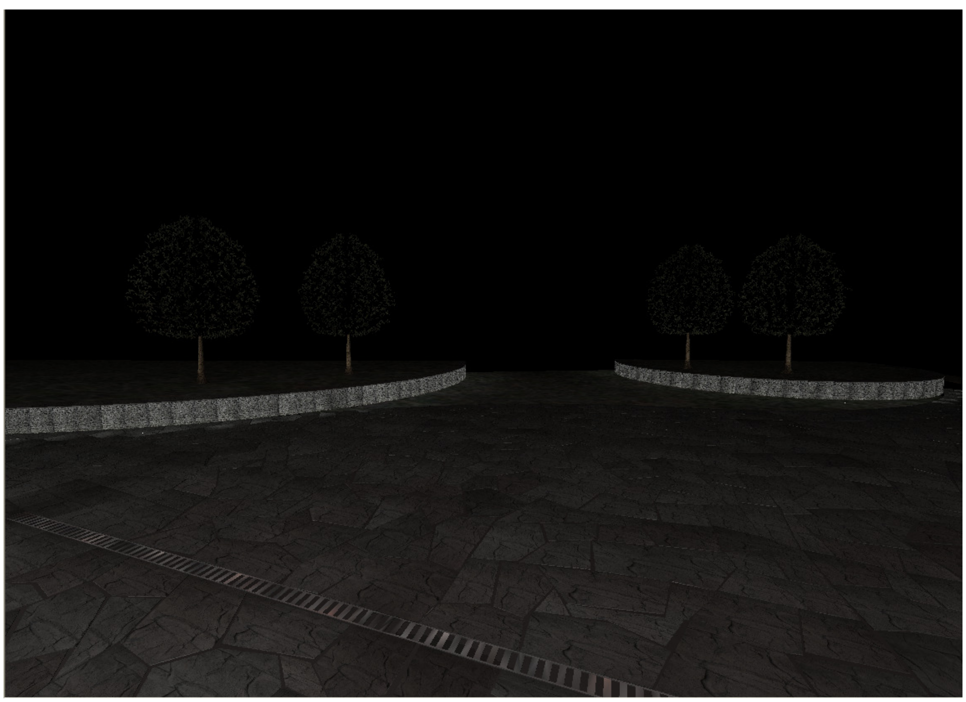
AGI32-v2.0 Statistical Summary

Duke Tower Entrance Lobby- Illuminance Results					
Average Illuminance	Maximum Illuminance	Minimum Illuminance	Avg/Min	Max/Min	Uniform Gradient
0.77	3.70	0.07	11.00	53.00	3.58

Radiosity Renderings

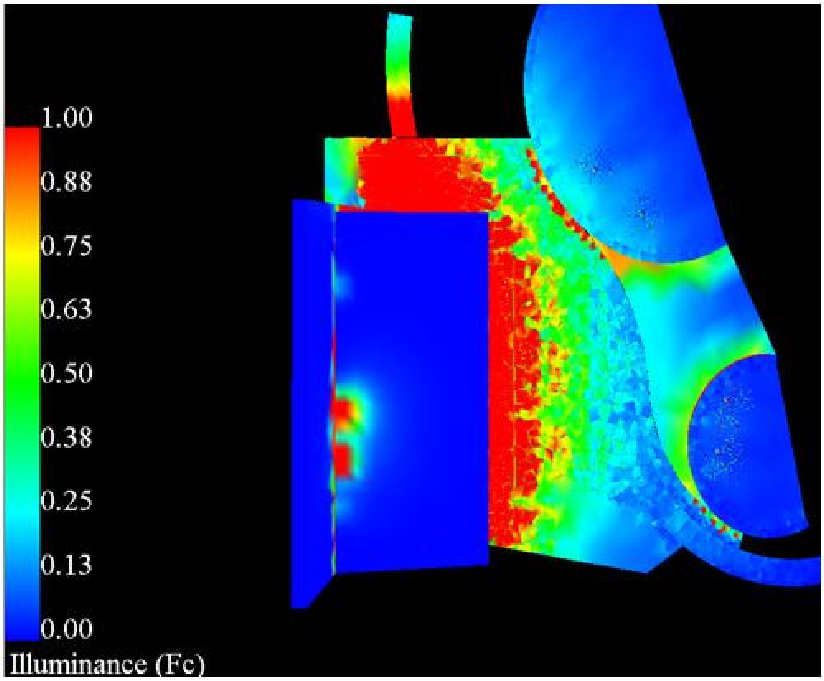
Plan View:

View from Café DUSON East Exterior Doors:

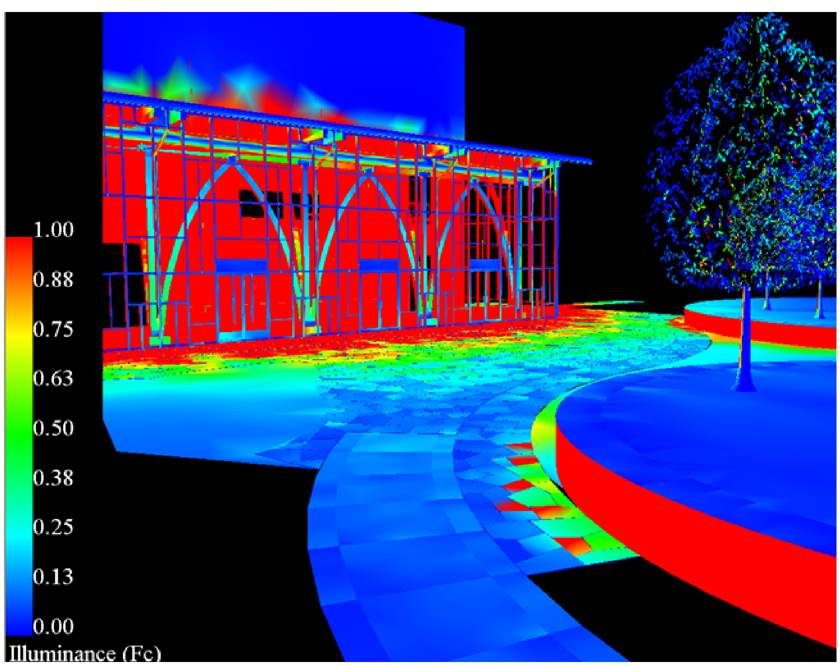


Pseudo Color Renderings

Plan View:



View from South Walkway Looking Northwest:



Power Density

Champagne Outdoor Courtyard Power Density						
Fixture Type	Fixture Quantity	Fixture Wattage	Total Wattage (W)	Total Area (sf)	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density
C	48	10	480			
			480	3859.6	0.12	0.2

Evaluation

The lighting system that has been implemented almost meets the basic illumination requirements recommended in the IESNA. The average horizontal illuminance was 0.77 fc as compared to the recommended value of 1.0 fc. This illuminance was calculated with no other lights on, where in reality there is trespass light on the space from roadway and parking lot lights that were not part of this scope. Therefore I am comfortable saying that this space meets the IESNA recommended illuminance values.

Total Building Power Density for Redesigned Spaces

Power Density Analysis of Redesigned Spaces			
Space	Actual Power Density (W/sf)	ASHRAE 90.1 Allowed Power Density	Percent Difference
Lobby	0.22	1.2	18.3%
Auditorium	1.36	1.4	97.1%
Café	2.30	1.2	191.7%
Courtyard	0.12	0.2	60.0%
Total Percentage of Actual Power Density to Allowed Power Density =			100.0%

The total power density for the entire building meets ASHRAE 90.1 energy standards. All of the spaces except for the Café DUSON meet and exceed the ASHRAE standard. Even though the Café exceeds the allowed power density by 1.1 W/sf the other three spaces combined are 1.1 W/sf below the allowed power density.

Electrical Depth

Introduction

The existing electrical system had to be modified, due to the proposed lighting system detailed in the previous section. The following provides the necessary details that outline the electrical changes that were made in the process of redesigning the lighting system for the four spaces. The panelboards that were affected by the new systems were updated to reflect the changes. The feeders that provide the electricity to these modified panels were checked and resized if necessary. The electrical redesign was done such that it complies with the NEC 2005.

In addition to the electrical redesign of the proposed lighting system a cost analysis of replacing the existing transformers in the building with energy efficient transformers. Also, a second cost analysis was conducted on replacing the existing distributive transformer system with a central transformer system.

Existing System Overview

The Duke University School of Nursing building has a radial distribution system. The 12.47 kV campus loop runs into an outdoor pad mounted 1000 kVA transformer. This transformer is the service entrance to the building and is fed through an underground duct bank and into the main electrical room located in the basement of the building. A 480Y/277V, 2000A switchboard distributes the incoming power to all the main panel boards on each floor. Finally, these main panel boards feed the branch circuits on each respective floor.

The emergency life safety system is fed by a generator located in the basement electrical room of the building. The emergency generator is a 60 kW, 480Y/277V, 3P, 4W packaged engine generator that is fueled by natural gas. The emergency power system uses an automatic transfer switch, which provides power to all the life safety loads. These life safety loads include the fire alarm system, fire pumps, and all the emergency lighting. The luminaires designated as emergency fixtures all contain integral emergency bypass devices, to override switched fixtures. The automatic transfer switch senses a disruption in the primary electrical service and signals the generator engine to start and then transfers the load to the emergency circuits. Once the primary power is restored, the automatic transfer switch transfers the load back to primary power and signals the generator to turn off.

Note: Please refer to Appendix B for a single line diagram of the existing electrical system.

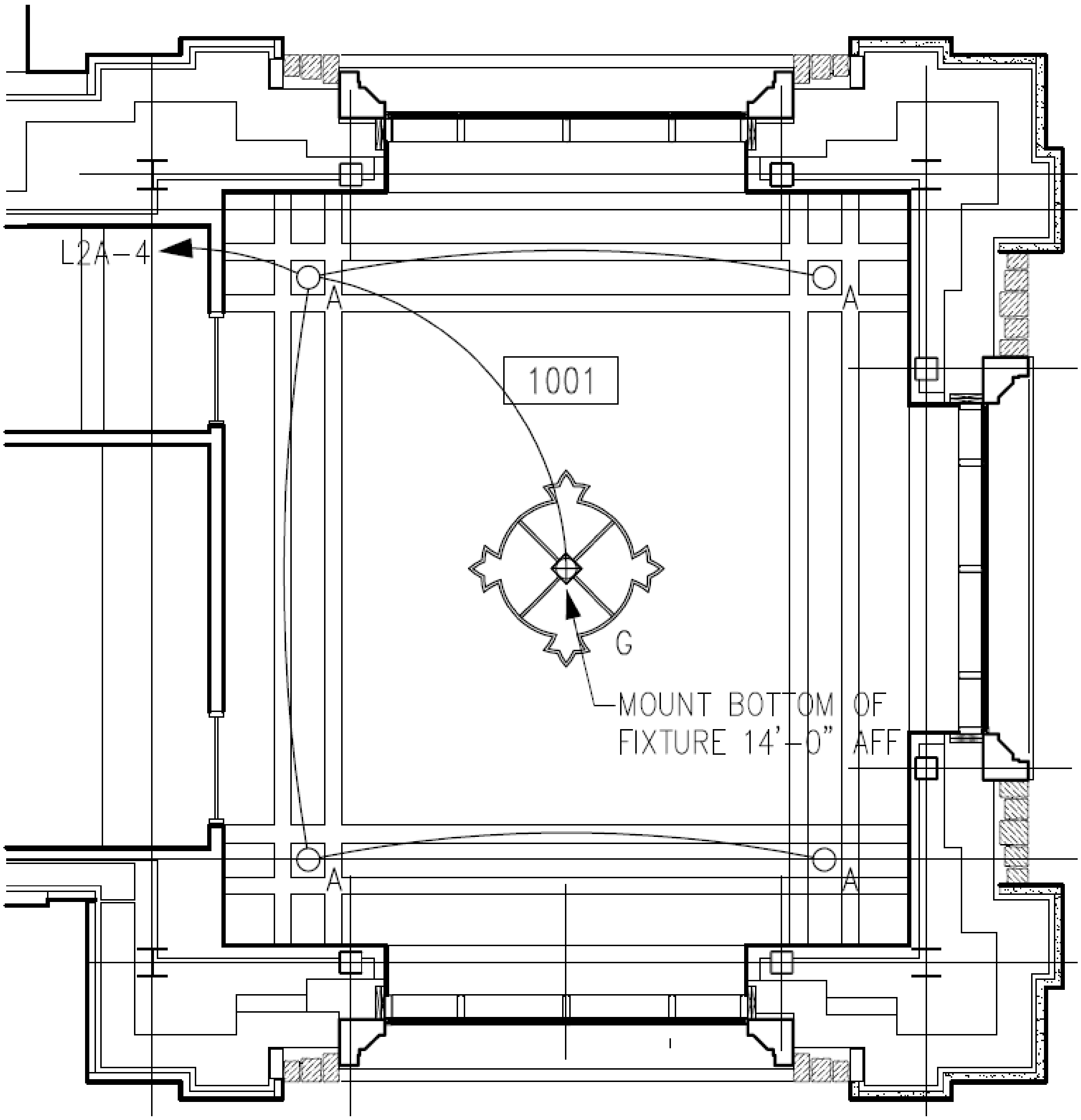
Duke Tower Main Entrance Lobby

The existing lighting design of the double high lobby utilizes circuits on one panelboard located on the second floor, panel L2A. On this panel one circuit, L2A-4, feeds all of the lights in the lobby. The existing lights were compact fluorescent direct downlights recessed in the ceiling and a single pendant fixture mounted 14-ft AFF.

The proposed lighting design will reuse the same circuit on panel L2A. The lighting design is similar to the existing lighting design with recessed compact fluorescent direct downlights and a single compact fluorescent pendant fixture mounted 14-ft AFF. However, the quantity of fixtures and lamping per fixture were changed. This change nearly cut the load on the same circuit by half.

As noted in the Lighting Depth section of this report, this circuit will be controlled by an astronomical time clock. The time clock will be located in the second floor electrical room, where panel L2A is located.

Lighting and Circuiting Plan



Note: Please refer to Appendix B for 1/8" = 1'0" Lighting and Circuiting Plan

Lighting Panels

EXISTING PANEL SCHEDULE

VOLTAGE		480Y/277	TAG						TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING		SURFACE	L2A						C/B MIN AIC			14,000
Bus Rating		60A	LOCATION						PHASES:	3	WIRES:	4
SIZE/TYPE MAINS		MLO	Second Floor Electrical Room						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
Flourescent Ltg.	West Corridor	1500	20	1	*			2	20	400	Corridor Sconces	Flourescent Ltg.
Flourescent Ltg.	East Corridor	400	20	3		*		4	20	300	Lobby 1001	Flourescent Ltg.
Flourescent Ltg.	Stair 2	1000	20	5			*	6	20	1400	Offices, Workrooms	Flourescent Ltg.
Flourescent Ltg.	Skills Lab 2064	2000	20	7	*			8	20	2000	Physical Assesment	Flourescent Ltg.
Flourescent Ltg.	Computer Lab, Restrooms, Work	1400	20	9		*		10	20	1200	Offices	Flourescent Ltg.
Spare	--	--	20	11			*	12	20	--	--	Spare
Spare	--	--	20	13	*			14	20	--	--	Spare
Spare	--	--	20	15		*		16	20	--	--	Spare
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHASE	5900	B PHASE							3300	C PHASE	2400
TOTAL CONNECTED LOAD (WATTS)		11600									DEMAND LOAD	10440

REDESIGNED PANEL SCHEDULE

VOLTAGE		480Y/277	TAG						TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING		SURFACE	L2A						C/B MIN AIC			14,000
Bus Rating		60A	LOCATION						PHASES:	3	WIRES:	4
SIZE/TYPE MAINS		MLO	Second Floor Electrical Room						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
Flourescent Ltg.	West Corridor	1500	20	1	*			2	20	400	Corridor Sconces	Flourescent Ltg.
Flourescent Ltg.	East Corridor	400	20	3		*		4	20	182	Lobby 1001	Flourescent Ltg.
Flourescent Ltg.	Stair 2	1000	20	5			*	6	20	1400	Offices, Workrooms	Flourescent Ltg.
Flourescent Ltg.	Skills Lab 2064	2000	20	7	*			8	20	2000	Physical Assesment	Flourescent Ltg.
Flourescent Ltg.	Computer Lab, Restrooms, Work	1400	20	9		*		10	20	1200	Offices	Flourescent Ltg.
Spare	--	--	20	11			*	12	20	--	--	Spare
Spare	--	--	20	13	*			14	20	--	--	Spare
Spare	--	--	20	15		*		16	20	--	--	Spare
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHASE	5900		B PHASE						3182		C PHASE 2400
TOTAL CONNECTED LOAD (WATTS)		11482									DEMAND	10334

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	L2A	Panel Location:	FIRST FLOOR ELEC ROOM
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	PNL L2A			5900	w	0.80	5900	7375	
2	A				0	w	1.00	0	0	
3	B	PNL L2A			3182	w	0.80	3182	3978	
4	B				0	w	1.00	0	0	
5	C	PNL L2A			2400	w	0.80	2400	3000	
6	C				0	w	1.00	0	0	
7	A				0	w	1.00	0	0	
8	A				0	w	1.00	0	0	
9	B				0	w	1.00	0	0	
10	B				0	w	1.00	0	0	
11	C				0	w	1.00	0	0	
12	C				0	w	1.00	0	0	
13	A				0	w	1.00	0	0	
14	A				0	w	1.00	0	0	
15	B				0	w	1.00	0	0	
16	B				0	w	1.00	0	0	
17	C				0	w	1.00	0	0	
18	C				0	w	1.00	0	0	
19	A				0	w	1.00	0	0	
20	A				0	w	1.00	0	0	
21	B				0	w	1.00	0	0	
22	B				0	w	1.00	0	0	
23	C				0	w	1.00	0	0	
24	C				0	w	1.00	0	0	
25	A				0	w	1.00	0	0	
26	A				0	w	1.00	0	0	
27	B				0	w	1.00	0	0	
28	B				0	w	1.00	0	0	
29	C				0	w	1.00	0	0	
30	C				0	w	1.00	0	0	
31	A				0	w	1.00	0	0	
32	A				0	w	1.00	0	0	
33	B				0	w	1.00	0	0	
34	B				0	w	1.00	0	0	
35	C				0	w	1.00	0	0	
36	C				0	w	1.00	0	0	
37	A				0	w	1.00	0	0	
38	A				0	w	1.00	0	0	
39	B				0	w	1.00	0	0	
40	B				0	w	1.00	0	0	
41	C				0	w	1.00	0	0	
42	C				0	w	1.00	0	0	
PANEL TOTAL								11.5	14.4	Amps= 17.3

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	5.9	7.4	51%	26.6
PHASE TOTAL	B	3.2	4.0	28%	14.4
PHASE TOTAL	C	2.4	3.0	21%	10.8

LOAD CATAGORIES		Connected			Demand				Ver. 1.02
		kW	kVA	DF	kW	kVA	PF		
1	receptacles	0.0	0.0		0.0	0.0			
2	computers	0.0	0.0		0.0	0.0			
3	fluorescent lighting	0.0	0.0		0.0	0.0			
4	HID lighting	0.0	0.0		0.0	0.0			
5	incandescent lighting	0.0	0.0		0.0	0.0			
6	HVAC fans	0.0	0.0		0.0	0.0			
7	heating	0.0	0.0		0.0	0.0			
8	kitchen equipment	0.0	0.0		0.0	0.0			
9	unassigned	11.5	14.4	0.95	10.9	13.6	0.80		
Total Demand Loads					10.9	13.6			
Spare Capacity		20%			2.2	2.7			
Total Design Loads					13.1	16.4	0.80	Amps=	19.7

Redesigned Feeders of Modified Panels

Feeder Sizing Worksheet	
Panelboard Tag	L2A
Panelboard Voltage	480Y/277
Calculated Design Load (kw)	13.1
Calculated Design Load (kva)	16.4
Resultant Power Factor	0.8
Calculated Design Load (amps)	19.7
Feeder Protection Size	20A
Sets	1
Wire Size	
Phase	(3) #12
Neutral	#12
Ground	#12
Conduit Size	3/4"

Based on: Copper Wire, 75 degree C, THWN,
- Copper wire
- 75 degree C THWN insulation
- IMC Conduit
- Maximum 500kcmil wire
- Minimum 3/4" conduit
- 100% neutral

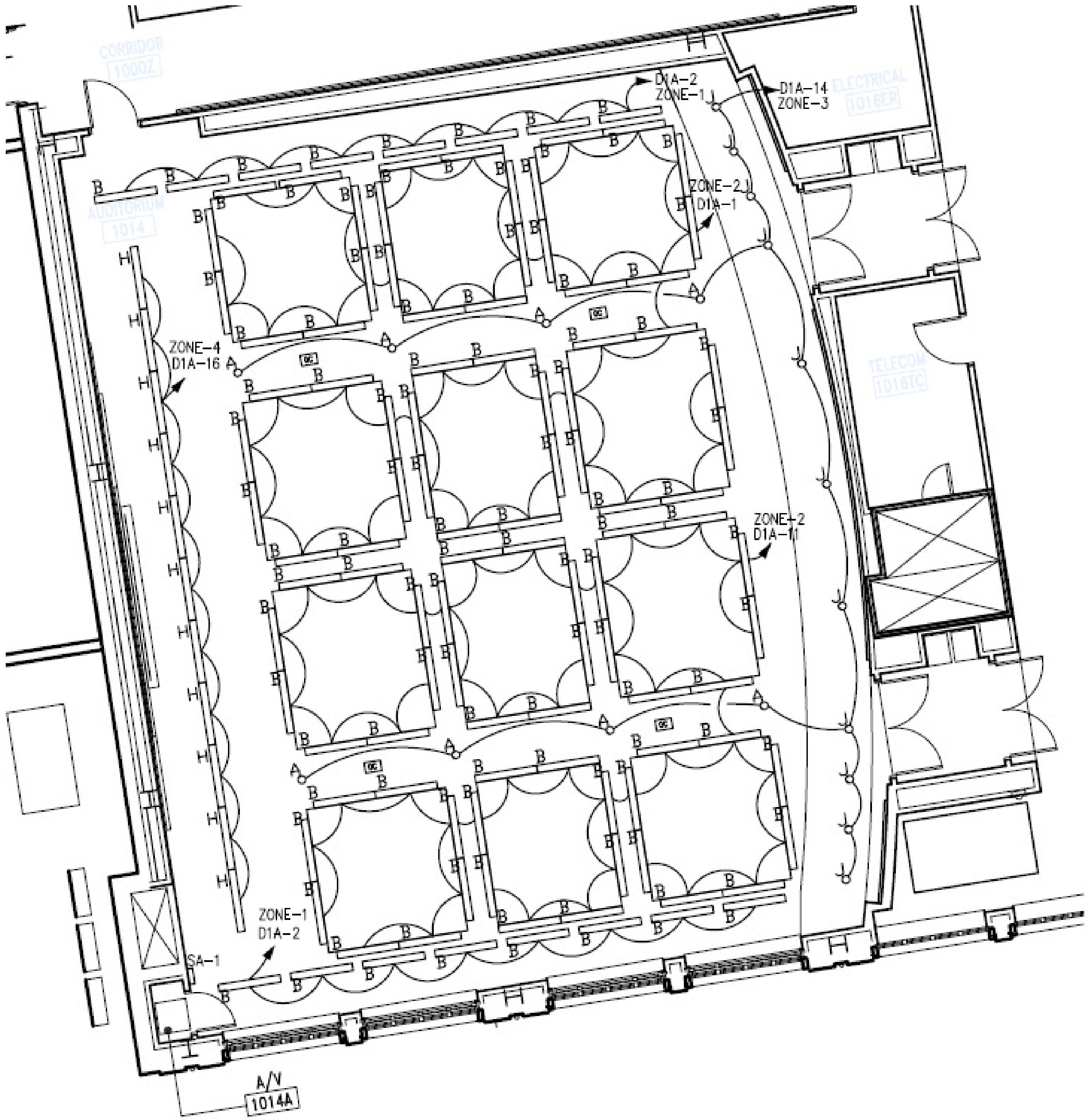
Peter | Ginny Nicholas Auditorium | Learning Center

The existing lighting design of the auditorium utilizes circuits on two panelboards located in the first floor electrical room: panel L1 and panel D1A. On panel L1, two circuits were used for the non-dimmed fluorescent loads in the auditorium: L1-7 and L1-8. On panel D1A, three circuits were used for the dimmed fluorescent loads in the auditorium: D1A-1, D1A-2, and D1A-11. The general lighting design for the space included linear fluorescent direct-indirect pendants as the main light source, compact fluorescent direct downlights, linear fluorescent wallwash board lights, and compact fluorescent wall sconces.

The proposed lighting design will not use panel L1. However, the proposed design will reuse the three previously mentioned circuits from D1A as well as two additional circuits, D1A-14 and D1A-16, which were previously spares. The proposed lighting design utilizes a fluorescent cove lighting system as the main source of light, compact fluorescent direct downlights to highlight the walkways, and linear fluorescent wallwashers to light the white boards.

As noted in the Lighting Depth section of the report, these five circuits will be controlled by a Lutron Graffic Eye 3000, plan tag SA-1. There are four lighting zones that the Lutron Graffic Eye will control. Using these four lighting zones specific lighting scenes will be setup for various activities that will take place within the space. Please refer panelboard D1A and the lighting scene matrix for specific details. This space also utilizes four Lutron LOS-CDT-2000 occupancy sensors were used to turn off the lights when the space is not occupied.

Lighting and Circuiting Plan



Note: Please refer to Appendix B for 1/8” = 1’0” Lighting and Circuiting Plan

Lighting Panels

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING	SURFACE	L1	C/B MIN AIC			14,000
Bus Rating	60A	LOCATION	PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	MLO	First Floor Electrical Room	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
Flourescent Ltg.	West Corridor	1500	20	1	*			2	20	400	West Corridor & Café Sconces	Flourescent Ltg.
Flourescent Ltg.	East Corridor	400	20	3		*		4	20	400	East Corridor	Flourescent Ltg.
Flourescent Ltg.	Classroom 1011	700	20	5			*	6	20	700	Classroom 1009	Flourescent Ltg.
Flourescent Ltg.	Auditorium Sconces	300	20	7	*			8	20	2500	Auditorium- Board Lights/Basement Mech Elect Room	Flourescent Ltg.
Flourescent Ltg.	East Seminar Rooms, Offices	1400	20	9		*		10	20	1000	Restrooms, Seminar, AV Room	Flourescent Ltg.
Spare	--	--	20	11			*	12	20	2500	Exterior- Roadway	Flourescent Ltg.
Flourescent Ltg.	Exterior- Roadway	2500	20	13	*			14	20	--	--	Spare
Spare	--	--	20	15		*		16	20	--	--	Spare
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHASE	7200		B PHASE						3200	C PHASE	3900
TOTAL CONNECTED LOAD (WATTS)		14300									DEMAND I	12870

REDESIGNED PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING	SURFACE	L1	C/B MIN AIC			14,000
Bus Rating	60A	LOCATION	PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	MLO	First Floor Electrical Room	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
Flourescent Ltg.	West Corridor	1500	20	1	*			2	20	346	West Corridor	Flourescent Ltg.
Flourescent Ltg.	East Corridor	400	20	3		*		4	20	400	East Corridor Sconces, Portrait Lights	Flourescent Ltg.
Flourescent Ltg.	Classroom 1011	700	20	5			*	6	20	700	Classroom 1009	Flourescent Ltg.
Ceramic MH Ltg.	Café Wallwashers	824	20	7	*			8	20	500	Basement Mech/	Flourescent Ltg.
Flourescent Ltg.	East Seminar Rooms, Offices	1400	20	9		*		10	20	1000	Restrooms, Seminar, AV Room	Flourescent Ltg.
Ceramic MH Ltg.	Café Wallwashers	1648	20	11			*	12	20	2500	Exterior- Roadway	Flourescent Ltg.
Flourescent Ltg.	Exterior- Roadway	2500	20	13	*			14	20	--	--	Spare
Ceramic MH Ltg.	Café Downlights	1888	20	15		*		16	20	620	Café- Uplights	Flourescent Ltg.
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHASE	5670		B PHASE						5708	C PHASE	5548
TOTAL CONNECTED LOAD (WATTS)		16926									DEMAND LOAD	15233

Lighting Panels (cont.)

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277				TAG					TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE				D1A					C/B MIN AIC		14,000
Bus Rating	60A				LOCATION					PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO				First Floor Electrical Room					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
Dimmed Flourescent Ltg.	Auditorium- Linear Pendants	680	20	1	*			2	20	680	Auditorium- Linear Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study- Linear Pendants	680	20	3		*		4	20	680	Case Study- Linear Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Seminar 2062- Seating	600	20	5			*	6	20	200	Case Study- Rear Downlights	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Café Pendants	1440	20	7	*			8	20	600	Café Uplights	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study 1104 (Phase 2)	500	20	9		*		10	20	500	Case Study 1104 (Phase 2)	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Auditorium- Rear Downlights	450	20	11			*	12	20	800	Seminar 2062- Perimeter	Dimmed Flourescent Ltg.
Spare	--	--	20	13	*			14	20	--	--	Spare
Spare	--	--	20	15		*		16	20	--	--	Spare
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHASE	3400		B PHASE						2360	C PHASE	2050
TOTAL CONNECTED LOAD (WATTS)		7810									DEMAND I	7029

REDESIGNED PANEL SCHEDULE

VOLTAGE	480Y/277					TAG						TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE					D1A						C/B MIN AIC		14,000
Bus Rating	60A					LOCATION						PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO					First Floor Electrical Room						REMARKS		
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	ZONE	POS NO	A PH	B PH	C PH	POS NO	ZONE	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
Dimmed Flourescent Ltg.	Auditorium- Cove Lights	1200	20	2	1	*			2	1	20	400	Auditorium- Side Coves	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study- Linear Pendants	680	20		3		*		4		20	680	Case Study- Linear Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Seminar 2062- Seating	600	20		5			*	6		20	200	Case Study- Rear Downlights	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Café- Wallwashers	558	20		7	*			8		20	174	Café Custom Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study 1104 (Phase 2)	500	20		9		*		10		20	500	Case Study 1104 (Phase 2)	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Auditorium- Cove Lights	1200	20	2	11			*	12		20	800	Seminar 2062- Perimeter	Dimmed Flourescent Ltg.
Spare	--	--	20		13	*			14	3	20	589	Auditorium- Downlights	Dimmed Flourescent Ltg.
Spare	--	--	20		15		*		16	4	20	275	Auditorium- Board Lights	Flourescent Ltg.
					17			*	18					
					19	*			20					
					21		*		22					
					23			*	24					
					25	*			26					
					27		*		28					
					29			*	30					
					31	*			32					
					33		*		34					
					35			*	36					
					37	*			38					
					39		*		40					
					41			*	42					
SUB-TOTAL	A PHASE	2921			B PHASE							2635	C PHASE 2800	
TOTAL CONNECTED LOAD (WATTS)		8356											DEMAND I	7520

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	L1	Panel Location:	FIRST FLOOR ELEC ROOM	
Nominal Phase to Neutral Voltage------->	277	Phase:	3	
Nominal Phase to Phase Voltage-------->	480	Wires:	4	

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	PNL L1			5670	w	0.85	5670	6671		
2	A				0	w	1.00	0	0		
3	B	PNL L1			5708	w	0.85	5708	6715		
4	B				0	w	1.00	0	0		
5	C	PNL L1			5548	w	0.85	5548	6527		
6	C				0	w	1.00	0	0		
7	A				0	w	1.00	0	0		
8	A				0	w	1.00	0	0		
9	B				0	w	1.00	0	0		
10	B				0	w	1.00	0	0		
11	C				0	w	1.00	0	0		
12	C				0	w	1.00	0	0		
13	A				0	w	1.00	0	0		
14	A				0	w	1.00	0	0		
15	B				0	w	1.00	0	0		
16	B				0	w	1.00	0	0		
17	C				0	w	1.00	0	0		
18	C				0	w	1.00	0	0		
19	A				0	w	1.00	0	0		
20	A				0	w	1.00	0	0		
21	B				0	w	1.00	0	0		
22	B				0	w	1.00	0	0		
23	C				0	w	1.00	0	0		
24	C				0	w	1.00	0	0		
25	A				0	w	1.00	0	0		
26	A				0	w	1.00	0	0		
27	B				0	w	1.00	0	0		
28	B				0	w	1.00	0	0		
29	C				0	w	1.00	0	0		
30	C				0	w	1.00	0	0		
31	A				0	w	1.00	0	0		
32	A				0	w	1.00	0	0		
33	B				0	w	1.00	0	0		
34	B				0	w	1.00	0	0		
35	C				0	w	1.00	0	0		
36	C				0	w	1.00	0	0		
37	A				0	w	1.00	0	0		
38	A				0	w	1.00	0	0		
39	B				0	w	1.00	0	0		
40	B				0	w	1.00	0	0		
41	C				0	w	1.00	0	0		
42	C				0	w	1.00	0	0		
PANEL TOTAL								16.9	19.9	Amps=	24.0

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL	A						5.7	6.7	33%	24.1
PHASE TOTAL	B						5.7	6.7	34%	24.2
PHASE TOTAL	C						5.5	6.5	33%	23.6

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		16.9	19.9	0.90	15.2	17.9	0.85		
Total Demand Loads						15.2	17.9			
Spare Capacity			20%			3.0	3.6			
Total Design Loads						18.3	21.5	0.85	Amps=	25.9

PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					D1A	Panel Location:			FIRST FLOOR ELEC ROOM	
Nominal Phase to Neutral Voltage------->					277	Phase:			3	
Nominal Phase to Phase Voltage-------->					480	Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	PNL D1A			2921	w	0.80	2921	3651	
2	A				0	w	1.00	0	0	
3	B	PNL D1A			2835	w	0.80	2835	3544	
4	B				0	w	1.00	0	0	
5	C	PNL D1A			2800	w	0.80	2800	3500	
6	C				0	w	1.00	0	0	
7	A				0	w	1.00	0	0	
8	A				0	w	1.00	0	0	
9	B				0	w	1.00	0	0	
10	B				0	w	1.00	0	0	
11	C				0	w	1.00	0	0	
12	C				0	w	1.00	0	0	
13	A				0	w	1.00	0	0	
14	A				0	w	1.00	0	0	
15	B				0	w	1.00	0	0	
16	B				0	w	1.00	0	0	
17	C				0	w	1.00	0	0	
18	C				0	w	1.00	0	0	
19	A				0	w	1.00	0	0	
20	A				0	w	1.00	0	0	
21	B				0	w	1.00	0	0	
22	B				0	w	1.00	0	0	
23	C				0	w	1.00	0	0	
24	C				0	w	1.00	0	0	
25	A				0	w	1.00	0	0	
26	A				0	w	1.00	0	0	
27	B				0	w	1.00	0	0	
28	B				0	w	1.00	0	0	
29	C				0	w	1.00	0	0	
30	C				0	w	1.00	0	0	
31	A				0	w	1.00	0	0	
32	A				0	w	1.00	0	0	
33	B				0	w	1.00	0	0	
34	B				0	w	1.00	0	0	
35	C				0	w	1.00	0	0	
36	C				0	w	1.00	0	0	
37	A				0	w	1.00	0	0	
38	A				0	w	1.00	0	0	
39	B				0	w	1.00	0	0	
40	B				0	w	1.00	0	0	
41	C				0	w	1.00	0	0	
42	C				0	w	1.00	0	0	
PANEL TOTAL								8.6	10.7	Amps= 12.9

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL	A						2.9	3.7	34%	13.2
PHASE TOTAL	B						2.8	3.5	33%	12.8
PHASE TOTAL	C						2.8	3.5	33%	12.6

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		8.6	10.7	0.95	8.1	10.2	0.80		
Total Demand Loads						8.1	10.2			
Spare Capacity			20%			1.6	2.0			
Total Design Loads						9.8	12.2	0.80	Amps=	14.7

Redesigned Feeders of Modified Panels

Feeder Sizing Worksheet		
Panelboard Tag	L1	D1A
Panelboard Voltage	480Y/277	480Y/277
Calculated Design Load (kw)	18.3	9.8
Calculated Design Load (kva)	21.5	12.2
Resultant Power Factor	0.85	0.8
Calculated Design Load (amps)	25.9	14.7
Feeder Protection Size	30A	20A
Sets	1	1
Wire Size		
Phase	(3) #10	(3) #12
Neutral	#10	#12
Ground	#10	#12
Conduit Size	3/4"	3/4"

Based on: Copper Wire, 75 degree C, THWN,
Copper wire
75 degree C THWN insulation
IMC Conduit
Maximum 500kcmil wire
Minimum 3/4" conduit
100% neutral

Control Scenes

Control Scenes				
Scenes:	Zone-1	Zone-2	Zone-3	Zone-4
Projector	OFF	OFF	Dimmed to 20%	OFF
Speaker	1/2 Switched ON	1/2 Switched ON	Dimmed to 50%	All ON
Class/Exam	All ON	All ON	All ON	All ON

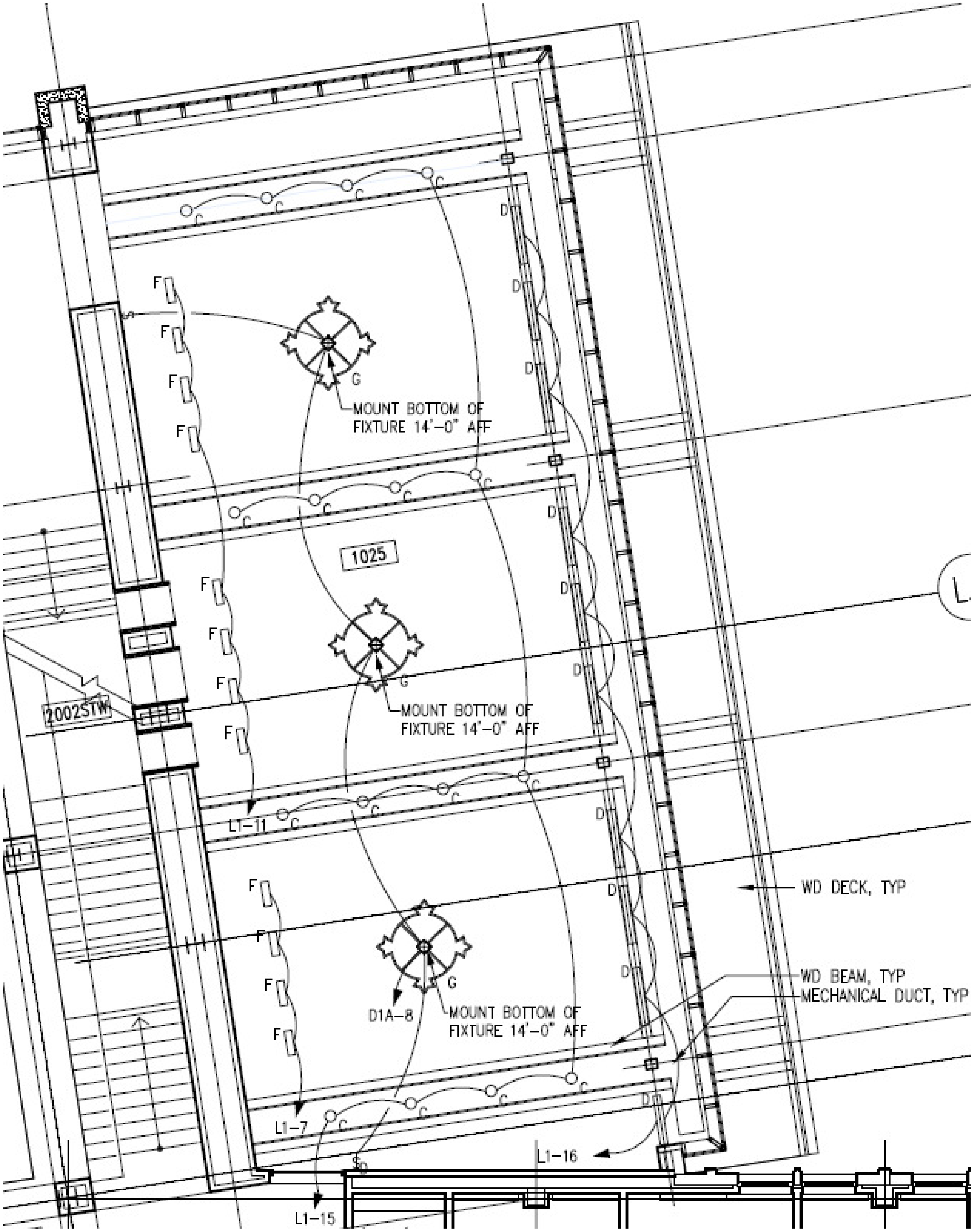
Café DUSON Student Lounge

The existing lighting design of the café utilizes circuits on two panelboard located in the first floor electrical room: panel L1 and panel D1A. On panel L1, one circuit was used for the non-dimmed fluorescent loads in the café: L1-2. On panel D1A, two circuits were used for all the dimmed fluorescent loads in the café: D1A-7 and D1A-8. The general lighting design for the space included compact fluorescent pendants as the main source of light in the space, linear fluorescent up lights to supplement the pendants, and compact fluorescent wall sconces to add light at the level of the people in the space.

The proposed lighting design will not reuse the one circuit on panel L1 but will instead use three spare circuits and one old circuit that was once was used by the auditorium sconces: L1-7, L1-11, L1-15, and L1-16. This panel, L1, will handle all the non-dimmed fluorescent and ceramic metal halide loads for the café. The two previously mentioned circuits from D1A will be reused for the dimmed fluorescent loads in the café. The proposed lighting design utilizes ceramic metal halide downlights as the main source of light in the space, linear fluorescent up lights, metal halide wallwashers, and compact fluorescent custom chandeliers.

As noted in the Lighting Depth section of this report, these circuits will be controlled by an astronomical time clock. The time clock will be located in the first floor electrical room, where panel L1 and panel D1A are located. In addition to the time clock the compact fluorescent custom chandeliers will be connected to a wall dimmer and a switch in a three-way switching application. The wall dimmer will be located next to the main corridor entrance the space and the regular switch will be located next to the secondary entrance the space.

Lighting and Circuiting Plan



Note: Please refer to Appendix B for 1/8" = 1'0" Lighting and Circuiting Plan

Lighting Panels

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277		TAG						TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING	SURFACE		**L1**						C/B MIN AIC			14,000
Bus Rating	60A		LOCATION						PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	MLO		First Floor Electrical Room						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
Flourescent Ltg.	West Corridor	1500	20	1	*			2	20	400	West Corridor & Café Sconces	Flourescent Ltg.
Flourescent Ltg.	East Corridor	400	20	3		*		4	20	400	East Corridor	Flourescent Ltg.
Flourescent Ltg.	Classroom 1011	700	20	5			*	6	20	700	Classroom 1009	Flourescent Ltg.
Flourescent Ltg.	Auditorium Sconces	300	20	7	*			8	20	2500	Auditorium-Board Lights/Basement Mech Elect Room	Flourescent Ltg.
Flourescent Ltg.	East Seminar Rooms, Offices	1400	20	9		*		10	20	1000	Restrooms, Seminar, AV Room	Flourescent Ltg.
Spare	--	--	20	11			*	12	20	2500	Exterior- Roadway	Flourescent Ltg.
Flourescent Ltg.	Exterior- Roadway	2500	20	13	*			14	20	--	--	Spare
Spare	--	--	20	15		*		16	20	--	--	Spare
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	**A PHASE**	**7200**		**B PHASE**						**3200**	**C PHASE 3900**	
TOTAL CONNECTED LOAD (WATTS)		**14300**									**DEMAND I**	**12870**

REDESIGNED PANEL SCHEDULE

VOLTAGE	480Y/277		TAG						TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING	SURFACE		**L1**						C/B MIN AIC			14,000
Bus Rating	60A		LOCATION						PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	MLO		First Floor Electrical Room						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
Flourescent Ltg.	West Corridor	1500	20	1	*			2	20	346	West Corridor	Flourescent Ltg.
Flourescent Ltg.	East Corridor	400	20	3		*		4	20	400	East Corridor Sconces, Portrait Lights	Flourescent Ltg.
Flourescent Ltg.	Classroom 1011	700	20	5			*	6	20	700	Classroom 1009	Flourescent Ltg.
Ceramic MH Ltg.	Café Wallwashers	824	20	7	*			8	20	500	Basement Mech/	Flourescent Ltg.
Flourescent Ltg.	East Seminar Rooms, Offices	1400	20	9		*		10	20	1000	Restrooms, Seminar, AV Room	Flourescent Ltg.
Ceramic MH Ltg.	Café Wallwashers	1648	20	11			*	12	20	2500	Exterior- Roadway	Flourescent Ltg.
Flourescent Ltg.	Exterior- Roadway	2500	20	13	*			14	20	--	--	Spare
Ceramic MH Ltg.	Café Downlights	1888	20	15		*		16	20	620	Café- Uplights	Flourescent Ltg.
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	**A PHASE**	**5670**		**B PHASE**						**5708**	**C PHASE**	**5548**
TOTAL CONNECTED LOAD (WATTS)		**16926**									**DEMAND LOAD**	**15233**

Lighting Panels (cont.)

EXISTING PANEL SCHEDULE

VOLTAGE		480Y/277	TAG							TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING		SURFACE	D1A							C/B MIN AIC		14,000
Bus Rating		60A	LOCATION							PHASES: 3	WIRES:	4
SIZE/TYPE MAINS		MLO	First Floor Electrical Room							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
Dimmed Flourescent Ltg.	Auditorium- Linear Pendants	680	20	1	*			2	20	680	Auditorium- Linear Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study- Linear Pendants	680	20	3		*		4	20	680	Case Study- Linear Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Seminar 2062- Seating	600	20	5			*	6	20	200	Case Study- Rear Downlights	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Café Pendants	1440	20	7	*			8	20	600	Café Uplights	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study 1104 (Phase 2)	500	20	9		*		10	20	500	Case Study 1104 (Phase 2)	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Auditorium- Rear Downlights	450	20	11			*	12	20	800	Seminar 2062- Perimeter	Dimmed Flourescent Ltg.
Spare	--	--	20	13	*			14	20	--	--	Spare
Spare	--	--	20	15		*		16	20	--	--	Spare
				17			*	18				
				19	*			20				
				21		*		22				
				23			*	24				
				25	*			26				
				27		*		28				
				29			*	30				
				31	*			32				
				33		*		34				
				35			*	36				
				37	*			38				
				39		*		40				
				41			*	42				
SUB-TOTAL	A PHASE	3400		B PHASE						2360	C PHASE	2050
TOTAL CONNECTED LOAD (WATTS)		7810									DEMAND I	7029

REDESIGNED PANEL SCHEDULE

VOLTAGE		480Y/277	TAG									TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING		SURFACE	D1A									C/B MIN AIC		14,000
Bus Rating		60A	LOCATION									PHASES: 3	WIRES:	4
SIZE/TYPE MAINS		MLO	First Floor Electrical Room									REMARKS		
LOAD DESCRIPTION	LOCATION	LOAD WATTS	C/B SIZE	ZONE	POS NO	A PH	B PH	C PH	POS NO	ZONE	C/B SIZE	LOAD WATTS	LOCATION	LOAD DESCRIPTION
Dimmed Flourescent Ltg.	Auditorium- Cove Lights	1200	20	2	1	*			2	1	20	400	Auditorium- Side Coves	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study- Linear Pendants	680	20		3		*		4		20	680	Case Study- Linear Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Seminar 2062- Seating	600	20		5			*	6		20	200	Case Study- Rear Downlights	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Café- Wallwashers	558	20		7	*			8		20	174	Café Custom Pendants	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Case Study 1104 (Phase 2)	500	20		9		*		10		20	500	Case Study 1104 (Phase 2)	Dimmed Flourescent Ltg.
Dimmed Flourescent Ltg.	Auditorium- Cove Lights	1200	20	2	11			*	12		20	800	Seminar 2062- Perimeter	Dimmed Flourescent Ltg.
Spare	--	--	20		13	*			14	3	20	589	Auditorium- Downlights	Dimmed Flourescent Ltg.
Spare	--	--	20		15		*		16	4	20	275	Auditorium- Board Lights	Flourescent Ltg.
					17			*	18					
					19	*			20					
					21		*		22					
					23			*	24					
					25	*			26					
					27		*		28					
					29			*	30					
					31	*			32					
					33		*		34					
					35			*	36					
					37	*			38					
					39		*		40					
					41			*	42					
SUB-TOTAL	A PHASE	2921			B PHASE							2635		C PHASE 2800
TOTAL CONNECTED LOAD (WATTS)		8356											DEMAND I	7520

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					L1	Panel Location:			FIRST FLOOR ELEC ROOM	
Nominal Phase to Neutral Voltage------->					277	Phase:			3	
Nominal Phase to Phase Voltage-------->					480	Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	PNL L1			5670	w	0.85	5670	6671	
2	A				0	w	1.00	0	0	
3	B	PNL L1			5708	w	0.85	5708	6715	
4	B				0	w	1.00	0	0	
5	C	PNL L1			5548	w	0.85	5548	6527	
6	C				0	w	1.00	0	0	
7	A				0	w	1.00	0	0	
8	A				0	w	1.00	0	0	
9	B				0	w	1.00	0	0	
10	B				0	w	1.00	0	0	
11	C				0	w	1.00	0	0	
12	C				0	w	1.00	0	0	
13	A				0	w	1.00	0	0	
14	A				0	w	1.00	0	0	
15	B				0	w	1.00	0	0	
16	B				0	w	1.00	0	0	
17	C				0	w	1.00	0	0	
18	C				0	w	1.00	0	0	
19	A				0	w	1.00	0	0	
20	A				0	w	1.00	0	0	
21	B				0	w	1.00	0	0	
22	B				0	w	1.00	0	0	
23	C				0	w	1.00	0	0	
24	C				0	w	1.00	0	0	
25	A				0	w	1.00	0	0	
26	A				0	w	1.00	0	0	
27	B				0	w	1.00	0	0	
28	B				0	w	1.00	0	0	
29	C				0	w	1.00	0	0	
30	C				0	w	1.00	0	0	
31	A				0	w	1.00	0	0	
32	A				0	w	1.00	0	0	
33	B				0	w	1.00	0	0	
34	B				0	w	1.00	0	0	
35	C				0	w	1.00	0	0	
36	C				0	w	1.00	0	0	
37	A				0	w	1.00	0	0	
38	A				0	w	1.00	0	0	
39	B				0	w	1.00	0	0	
40	B				0	w	1.00	0	0	
41	C				0	w	1.00	0	0	
42	C				0	w	1.00	0	0	
PANEL TOTAL								16.9	19.9	Amps= 24.0

PHASE LOADING							kW	kVA	%	Amps
	PHASE TOTAL	A					5.7	6.7	33%	24.1
	PHASE TOTAL	B					5.7	6.7	34%	24.2
	PHASE TOTAL	C					5.5	6.5	33%	23.6

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		16.9	19.9	0.90	15.2	17.9	0.85		
Total Demand Loads						15.2	17.9			
Spare Capacity			20%			3.0	3.6			
Total Design Loads						18.3	21.5	0.85	Amps=	25.9

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	D1A	Panel Location:	FIRST FLOOR ELEC ROOM
Nominal Phase to Neutral Voltage------->	277	Phase:	3
Nominal Phase to Phase Voltage-------->	480	Wires:	4

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	PNL D1A			2921	w	0.80	2921	3651	
2	A				0	w	1.00	0	0	
3	B	PNL D1A			2835	w	0.80	2835	3544	
4	B				0	w	1.00	0	0	
5	C	PNL D1A			2800	w	0.80	2800	3500	
6	C				0	w	1.00	0	0	
7	A				0	w	1.00	0	0	
8	A				0	w	1.00	0	0	
9	B				0	w	1.00	0	0	
10	B				0	w	1.00	0	0	
11	C				0	w	1.00	0	0	
12	C				0	w	1.00	0	0	
13	A				0	w	1.00	0	0	
14	A				0	w	1.00	0	0	
15	B				0	w	1.00	0	0	
16	B				0	w	1.00	0	0	
17	C				0	w	1.00	0	0	
18	C				0	w	1.00	0	0	
19	A				0	w	1.00	0	0	
20	A				0	w	1.00	0	0	
21	B				0	w	1.00	0	0	
22	B				0	w	1.00	0	0	
23	C				0	w	1.00	0	0	
24	C				0	w	1.00	0	0	
25	A				0	w	1.00	0	0	
26	A				0	w	1.00	0	0	
27	B				0	w	1.00	0	0	
28	B				0	w	1.00	0	0	
29	C				0	w	1.00	0	0	
30	C				0	w	1.00	0	0	
31	A				0	w	1.00	0	0	
32	A				0	w	1.00	0	0	
33	B				0	w	1.00	0	0	
34	B				0	w	1.00	0	0	
35	C				0	w	1.00	0	0	
36	C				0	w	1.00	0	0	
37	A				0	w	1.00	0	0	
38	A				0	w	1.00	0	0	
39	B				0	w	1.00	0	0	
40	B				0	w	1.00	0	0	
41	C				0	w	1.00	0	0	
42	C				0	w	1.00	0	0	
PANEL TOTAL								8.6	10.7	Amps= 12.9

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					2.9	3.7	34%	13.2
PHASE TOTAL	B					2.8	3.5	33%	12.8
PHASE TOTAL	C					2.8	3.5	33%	12.6

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		8.6	10.7	0.95	8.1	10.2	0.80		
Total Demand Loads						8.1	10.2			
Spare Capacity			20%			1.6	2.0			
Total Design Loads						9.8	12.2	0.80	Amps=	14.7

Redesigned Feeders of Modified Panels

Feeder Sizing Worksheet		
Panelboard Tag	L1	D1A
Panelboard Voltage	480Y/277	480Y/277
Calculated Design Load (kw)	18.3	9.8
Calculated Design Load (kva)	21.5	12.2
Resultant Power Factor	0.85	0.8
Calculated Design Load (amps)	25.9	14.7
Feeder Protection Size	30A	20A
Sets	1	1
Wire Size		
Phase	(3) #10	(3) #12
Neutral	#10	#12
Ground	#10	#12
Conduit Size	3/4"	3/4"

Based on: Copper Wire, 75 degree C, THWN,
- Copper wire
- 75 degree C THWN insulation
- IMC Conduit
- Maximum 500kcmil wire
- Minimum 3/4" conduit
- 100% neutral

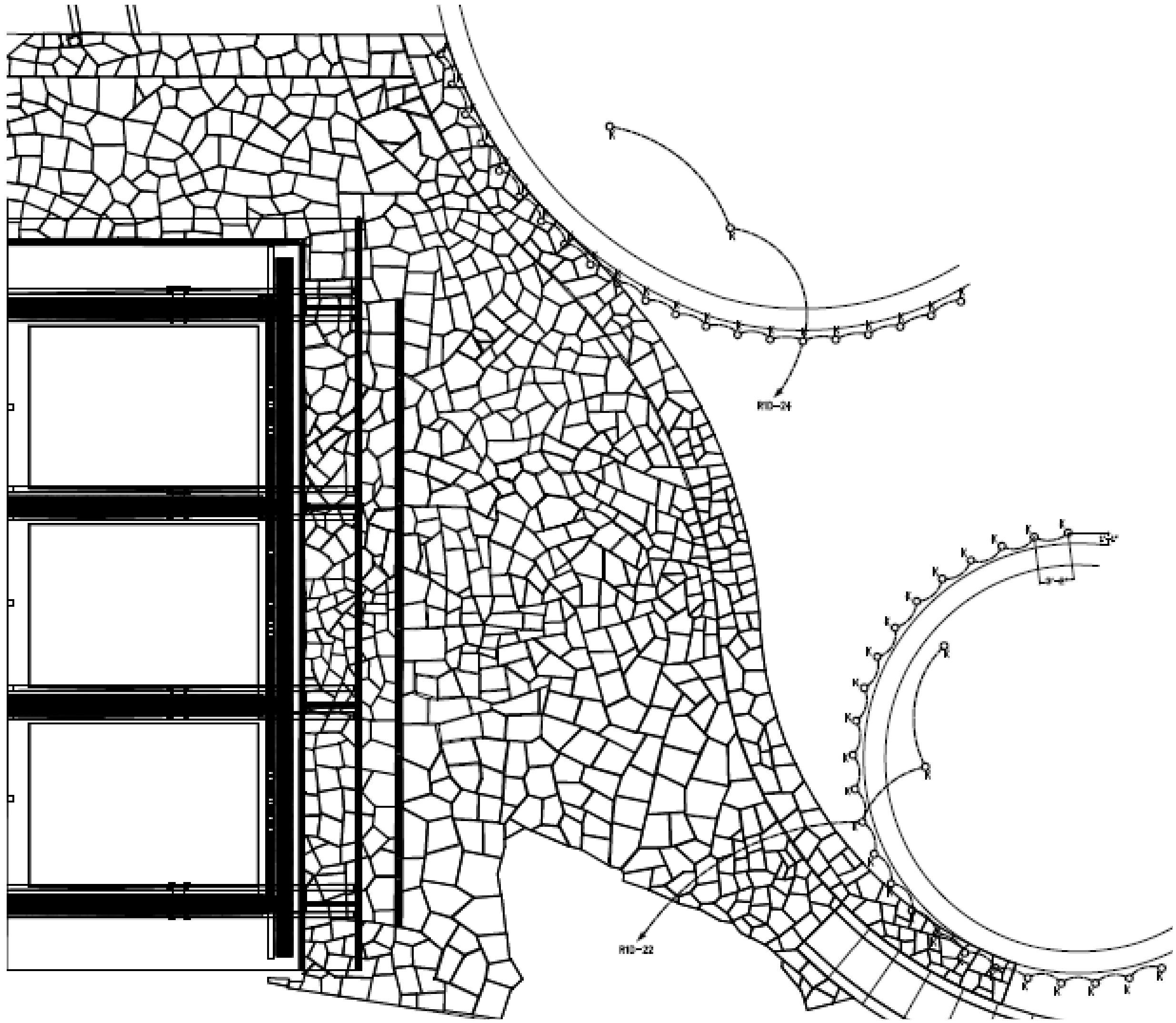
Champagne Outdoor Courtyard

The courtyard was not previously lit. The only light that this space receives is from the interior café lights and some trespass light from a few high pressure sodium street lights in the surrounding area. Since there were no lights for this space no panelboards or circuits were previously used.

The proposed lighting design will use a receptacle panel, panel R1D, since the lighting loads for this space are halogen sources and require 120V. Two previously spare circuits on panel R1D will be utilized: R1D-22 and R1D-24. The proposed lighting design uses 10W halogen sources to up light the curved retaining walls and the large trees that saved during construction. The lighting intent of up lighting these surfaces was to highlight those features and make them be seen by people within the café. Since the courtyard surface receives enough light from the café no additional light is being proposed.

As noted in the Lighting Depth section of this report, these two circuits will be controlled by an astronomical time clock. The time clock will be located in the first floor AV room, where panel R1D is located.

Lighting and Circuiting Plan



Note: Please refer to Appendix B for 1/8” = 1’0” Lighting and Circuiting Plan

Lighting Panels

EXISTING PANEL SCHEDULE

VOLTAGE	208Y/120	TAG					TYPE PANEL		NEMA 1 ENCLOSURE	
MOUNTING	SURFACE	R1D					C/B MIN AIC		10,000	
Bus Rating	100A	LOCATION					PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	MLO	FIRST FLOOR AV ROOM					REMARKS			
LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
RECP- AV ROOM	1260	20	1	*			2	20	1260	SEATING- CASE STUDY
RECP- CORRIDOR & STAIR	1260	20	3		*		4	20	1260	SEATING- CASE STUDY
RECP- SEMINAR	1260	20	5			*	6	20	1260	SEATING- CASE STUDY
RECP- AV ROOM	1000	20	7	*			8	20	1260	SEATING- CASE STUDY
RECP- CONF	1260	20	9		*		10	20	1260	SEATING- CASE STUDY
BLACKOUT SHADES	1000	20	11			*	12	20	1260	SEATING- CASE STUDY
PROJECTOR-CASE STUDY	1000	20	13	*			14	20	1000	PROJECTOR-CONF
RECP-SEMINAR	1260	20	15		*		16	20	1000	PROJECTOR-CONF
RECP-SEMINAR	1260	20	17			*	18	20	1260	RECP- CASE STUDY
RECP- AV CLOSET	1260	20	19	*			20	20	1260	FLOORBOX
PROJECTION SCREEN	1000	20	21		*		22	20	--	SPACE
RECP-SEMINAR	1260	20	23			*	24	20	--	SPACE
SUB-TOTAL	**A PHASE 9300**		**B PHASE**						**8300**	**C PHASE 8560**
TOTAL CONNECTED LOAD (W	**26160**									**DEMAND I 23544**

REDESIGNED PANEL SCHEDULE

VOLTAGE	208Y/120	TAG					TYPE PANEL		NEMA 1 ENCLOSURE	
MOUNTING	SURFACE	R1D					C/B MIN AIC		10,000	
Bus Rating	100A	LOCATION					PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	MLO	FIRST FLOOR AV ROOM					REMARKS			
LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
RECP- AV ROOM	1260	20	1	*			2	20	1260	SEATING- CASE STUDY
RECP- CORRIDOR & STAIR	1260	20	3		*		4	20	1260	SEATING- CASE STUDY
RECP- SEMINAR	1260	20	5			*	6	20	1260	SEATING- CASE STUDY
RECP- AV ROOM	1000	20	7	*			8	20	1260	SEATING- CASE STUDY
RECP- CONF	1260	20	9		*		10	20	1260	SEATING- CASE STUDY
BLACKOUT SHADES	1000	20	11			*	12	20	1260	SEATING- CASE STUDY
PROJECTOR-CASE STUDY	1000	20	13	*			14	20	1000	PROJECTOR-CONF
RECP-SEMINAR	1260	20	15		*		16	20	1000	PROJECTOR-CONF
RECP-SEMINAR	1260	20	17			*	18	20	1260	RECP- CASE STUDY
RECP- AV CLOSET	1260	20	19	*			20	20	1260	FLOORBOX
PROJECTION SCREEN	1000	20	21		*		22	20	260	Courtyard uplights
RECP-SEMINAR	1260	20	23			*	24	20	230	Courtyard uplights
SUB-TOTAL	**A PHASE 9300**		**B PHASE**						**8560**	**C PHASE 8790**
TOTAL CONNECTED LOAD (WATTS)	**26650**									**DEMAND LOAD 23985**

PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					R1D	Panel Location:			FIRST FLOOR ELEC ROOM	
Nominal Phase to Neutral Voltage------->					120	Phase:			3	
Nominal Phase to Phase Voltage-------->					208	Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	PNL R1D			9300	w	0.95	9300	9789	
2	A				0	w	1.00	0	0	
3	B	PNL R1D			8300	w	0.95	8300	8737	
4	B				0	w	1.00	0	0	
5	C	PNL R1D			8560	w	0.95	8560	9011	
6	C				0	w	1.00	0	0	
7	A				0	w	1.00	0	0	
8	A				0	w	1.00	0	0	
9	B				0	w	1.00	0	0	
10	B				0	w	1.00	0	0	
11	C				0	w	1.00	0	0	
12	C				0	w	1.00	0	0	
13	A				0	w	1.00	0	0	
14	A				0	w	1.00	0	0	
15	B				0	w	1.00	0	0	
16	B				0	w	1.00	0	0	
17	C				0	w	1.00	0	0	
18	C				0	w	1.00	0	0	
19	A				0	w	1.00	0	0	
20	A				0	w	1.00	0	0	
21	B				0	w	1.00	0	0	
22	B				0	w	1.00	0	0	
23	C				0	w	1.00	0	0	
24	C				0	w	1.00	0	0	
25	A				0	w	1.00	0	0	
26	A				0	w	1.00	0	0	
27	B				0	w	1.00	0	0	
28	B				0	w	1.00	0	0	
29	C				0	w	1.00	0	0	
30	C				0	w	1.00	0	0	
31	A				0	w	1.00	0	0	
32	A				0	w	1.00	0	0	
33	B				0	w	1.00	0	0	
34	B				0	w	1.00	0	0	
35	C				0	w	1.00	0	0	
36	C				0	w	1.00	0	0	
37	A				0	w	1.00	0	0	
38	A				0	w	1.00	0	0	
39	B				0	w	1.00	0	0	
40	B				0	w	1.00	0	0	
41	C				0	w	1.00	0	0	
42	C				0	w	1.00	0	0	
PANEL TOTAL								26.2	27.5	Amps= 76.5

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	9.3	9.8	36%	81.6
PHASE TOTAL	B	8.3	8.7	32%	72.8
PHASE TOTAL	C	8.6	9.0	33%	75.1

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		26.2	27.5	0.85	22.2	23.4	0.95		
Total Demand Loads						22.2	23.4			
Spare Capacity			20%			4.4	4.7			
Total Design Loads						26.7	28.1	0.95	Amps=	78.0

Redesigned Feeders of Modified Panels

Feeder Sizing Worksheet	
Panelboard Tag	R1D
Panelboard Voltage	208Y/120
Calculated Design Load (kw)	26.7
Calculated Design Load (kva)	28.1
Resultant Power Factor	1.0
Calculated Design Load (amps)	78
Feeder Protection Size	80A
Sets	1
Wire Size	
Phase	(3) #3
Neutral	#3
Ground	#8
Conduit Size	1-1/4"

Based on: Copper Wire, 75 degree C, THWN,
- Copper wire
- 75 degree C THWN insulation
- IMC Conduit
- Maximum 500kcmil wire
- Minimum 3/4" conduit
- 100% neutral

Energy Efficient Transformers Study

A cost-feasibility study was conducted using Powersmiths Energy Savings Payback Calculator, to see if replacing the building's current non-energy efficient transformers with their T1000-C3 series of energy efficient transformers is cost effective. The building currently uses the following transformer types.

EXISTING TRANSFORMER SCHEDULE

TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
TGA	480V,3PH,3W.	208Y/120V, 3PH,4W	30	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 0003ER Basement Mechanical Room
TGS	480V,3PH,3W.	208Y/120V, 3PH,4W	15	DRY TYPE	115 DEGREE C	(1) 5% Above Normal Full Capacity (1) 5% Below Normal Full Capacity	SUSPENDED	RM 0004ER Basement Electrical Room
TGE	480V,3PH,3W.	208Y/120V, 3PH,4W	15	DRY TYPE	115 DEGREE C	(1) 5% Above Normal Full Capacity (1) 5% Below Normal Full Capacity	SUSPENDED	RM 0004ER Basement Electrical Room
T1A	480V,3PH,3W.	208Y/120V, 3PH,4W	112.5	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 1016ER First Floor Electrical Room
T2A	480V,3PH,3W.	208Y/120V, 3PH,4W	112.5	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 2054ER Second Floor Electrical Room
T3A	480V,3PH,3W.	208Y/120V, 3PH,4W	112.5	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 3090ER Third Floor Electrical Room

TGA: **30kVA** General Purpose Transformer (Dry Type)
Price: 4,385 USD according to 2008 RS Means

30kVA Powersmiths T1000-C3 Transformer
Quoted Estimated Price: 5,500 USD (25% more)

TGS|TGE: **15kVA** General Purpose Transformer (Dry Type)
Price: 3,265 USD according to 2008 RS Means

15kVA Powersmiths T1000-C3 Transformer
Quoted Estimated Price: 4,100 USD (25% more)

T1A|T2A|T3A: **112.5kVA** General Purpose Transformer (Dry Type)
Price: 13,500 USD according to 2008 RS Means

112.5kVA Powersmiths T1000-C3 Transformer
Quoted Estimated Price: 16,800 USD (25% more)

Since the building is already built and occupied for over a year the building electrical was known and documented. The peak kW load during normal operating hours was documented from the building's metering system at 178 kW. This loading equates to 45% loading during normal operating hours and 15% load outside operating hours. The current arrangement of non-energy efficient transformers has an annual electric bill of approximately $58,000 as compared to $56,300 by using Powersmiths energy efficient transformers. This is an annual savings of about 3%.

As shown by the price comparisons for the two types of transformers, the energy efficient transformers cost about 25% more than the non-energy efficient transformers. This initial cost equates to about $51,200 for the non-energy efficient transformers and about $61,500 for the energy efficient transformers. Even though the initial price for the energy efficient transformers is greater, when combined with the annual energy cost savings, the energy efficient transformers will pay for themselves in just under six years. Considering an energy cost inflation rate of 4% energy efficient transformer system will save about $76,500 over a 20 year period and about $196,000 over a 32 year period.

Please refer to the following Powersmiths Energy Savings Payback Calculator worksheet for all the variables used in creating the prior energy estimates. The worksheet also provides environmental benefit information for using energy efficient transformers. These benefits are listed in the following table.

Annual Reduction in Greenhouse Gases (per EPA)	Equivalence
26 tons of CO_2 85 tons of Coal	5 Acres trees planted 3 Car Emissions
205 kgs of SO_2 88 kgs of NO_x	4 homes heated

Given these environmental benefits and the savings on annual operating costs, it is recommended that energy efficient transformers be used in this building.

POWERSMITHS

The ESP Calculator™

Toll Free : 1-800-747-9627 or (905) 791-1493

Energy Savings Payback Calculator

Project Description **Duke School of Nursing**

Date **26-Mar-08**

Data Entry

Transformers on Project

QTY	kVA	RS Means Costs	PowerSmiths Costs
2	15	$6,530	$8,163
1	30	$4,385	$5,481
	45		
	75		
3	112.5	$40,317	$50,396
	150		
	225		
	300		
	500		
	750		
	1000		
	1500		
	2000		
	7.5		
Total Transformer Costs		**$51,232**	**$64,040**

Available Full Load kW	**397.5**		
Average kVA (calc)	**66**		
equipment operating hrs/ day	12		
equipment operating days/yr	365	Calc Load kW	Calc Annual kWh
Load during normal operating hours	45%	178	778,645
Load outside operating hours	15%	60	261,158
		Total Annual Load kWh:	**1,039,802**

Annual Cost to Operate Load Only

kWh rate	$ 0.046	Annual Consumption:	$ 47,831
demand rate ($/kW/mo) ex. $10.00	$3.27	Annual Demand:	$ 6,976
		Total Cost to run load	**$ 54,807**

Annual Cost of Status Quo Transformer Losses & Associated Air Conditioning (A/C) burden

Status quo Efficiency (Normal Operation)	97.0%	
Transformer kW Losses (Normal Operation)	5.5	kW
Status quo Efficiency (Outside op. hrs)	92.0%	
Transformer kW Losses (Outside op. hrs)	5.2	kW
Annual addititional kWh from transformers	46,791	kWh
Annual Cost of Transformer Losses	$ 2,368	
A/C System Performance (kW/ton)	1.25	
Additional Tons of Cooling (on peak)	1.56	tons
Annual addititional kWh from A/C	16,616	kWh
Annual Cost of Associated A/C	$ 841	

Summary with Status Quo Transformer

Annual Cost of feeding Building Load	$ 54,807
Annual Cost of Transformer Losses	$ 2,368
Annual Cost of Associated A/C	$ 841
Electrical Bill (Status Quo Transformer)	**$ 58,016**

IMPORTANT: By using the ESP Calculator™, you are agreeing the TERMS OF USE section on page 3

POWERSMITHS

  doc#807-000440-110-A01 ***1-Mar-07***

POWERSMITHS — Page 2 — **The ESP Calculator™**

Toll Free : 1-800-747-9627 or (905) 791-1493

Energy Savings Payback Calculator

Using Powersmiths instead of status quo transformers

Powersmiths Efficiency (Normal Operation)	98.2%	
Powersmiths kW Losses (Normal Operation)	3.3	kW
Powersmiths Efficiency (Outside op. hrs)	97.6%	
Transformer kW Losses (Outside op. hrs)	1.5	kW
Annual addititional kWh from transformers	20,694	kWh
Annual Cost of Powersmiths Losses	$ 1,080	
Additional Tons of Cooling (on peak)	0.93	tons
Annual addititional kWh from A/C	7,349	kWh
Annual Cost of Associated A/C	$ 383	

Comparing Status Quo & Powersmiths

	Status Quo	Powersmiths	Reduction
Annual Cost of feeding Building Load	$ 54,807	$ 54,807	
Annual Cost of Transformer Losses	$ 2,368	$ 1,080	
Annual Cost of Associated A/C	$ 841	$ 383	
Annual estimated Electrical Bill	$ 58,016	$ 56,270	**3%**

Peak kW reduction (normal op hours)	**2.2**	**kW**
Annual kWh reduction	**35,364**	**kWh**
Reduction in Air Conditioning Load (on peak)	**0.64**	**tons**

Cost Analysis (calc)

Energy Cost Escalation (above inflation)	4.0%
Annual Power Quality Benefit	$ -

	Annual Operating Cost	Life Cycle Operating Cost & Savings 20 years	32 years
Status Quo Transformers	$3,209	$140,631	$360,246
Powersmiths Transformers	$1,463	$64,124	$164,263
Savings with Powersmiths	**$1,746**	**$76,507**	**$195,984**

Cost

	Cost
Powersmiths Transformers	$61,478
Status Quo Transformers	$51,232

Payback on total cost	5.87	years	current kWh rate:
Cost of Energy Savings	$ 0.009	/kWh	$0.046
Cost - Benefit Ratio	5.1	times less to save a kWh than to buy a kWh	

Leasing Option	60 Month Term	48 Month Term	36 Month Term
Total Annual Leasing Payments	**$12,953**	**$15,800**	**$20,103**
Net Annual Cost with savings	$11,208	$14,054	$18,358

Summary of Environmental Benefits

Annual Reduction in Greenhouse Gases (per EPA)		Equivalence	
26	tons of CO_2	5	Acres trees planted
85	tons of Coal	3	Car Emissions
205	kgs of SO_2	4	homes heated
88	kgs of NO_x		

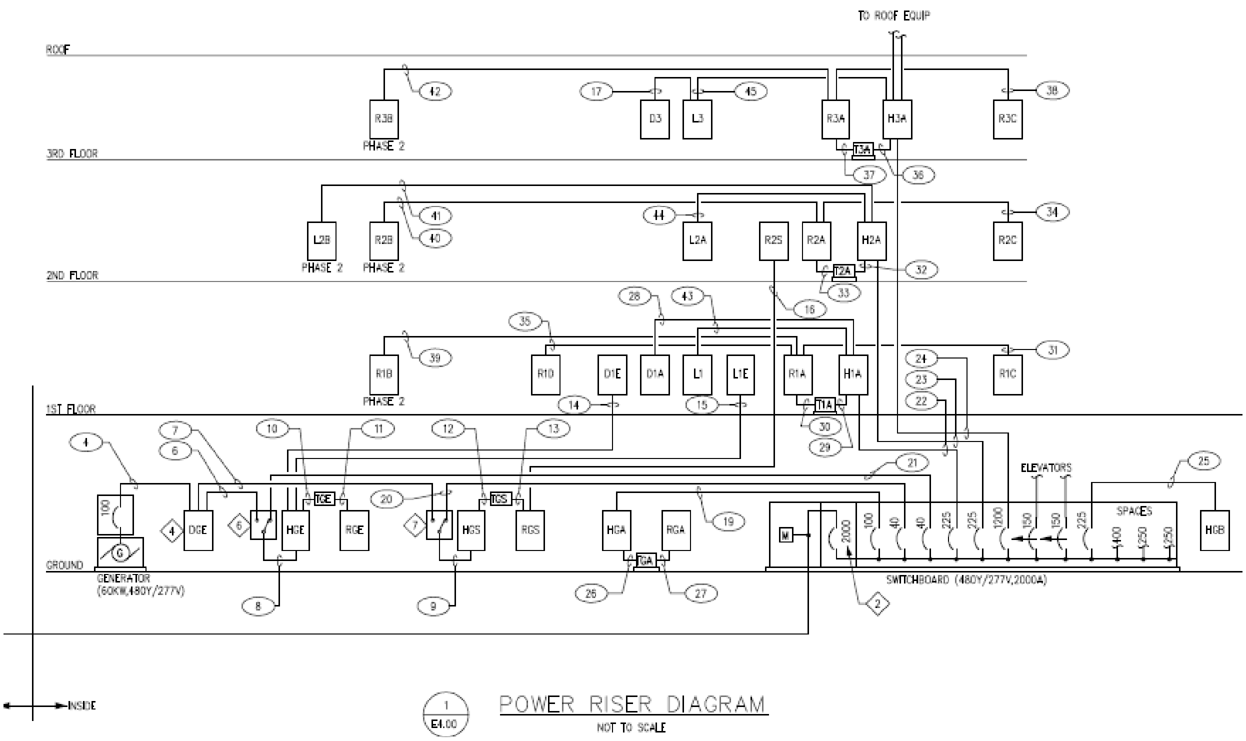
Central Transformer vs. Distributed Transformers Analysis

A cost-feasibility study was conducted on changing the existing distributed transformers to a central transformer system in the building. The existing normal power electrical system has four distribution transformers on each floor of the building. These transformers reduce the 480Y/277V supplied from the building service entrance to 208Y/120V which feed the receptacle panels in the building. The existing distribution transformers are listed in the transformer schedule below.

EXISTING DISTRIBUTION TRANSFORMER SCHEDULE								
TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
TGA	480V,3PH,3W.	208Y/120V, 3PH,4W	30	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 0003ER Basement Mechanical Room
T1A	480V,3PH,3W.	208Y/120V, 3PH,4W	112.5	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 1016ER First Floor Electrical Room
T2A	480V,3PH,3W.	208Y/120V, 3PH,4W	112.5	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 2054ER Second Floor Electrical Room
T3A	480V,3PH,3W.	208Y/120V, 3PH,4W	112.5	DRY TYPE	115 DEGREE C	(2) 2.5% Above Normal Full Capacity (2) 2.5% Below Normal Full Capacity	PAD MOUNTED ON FLOOR	RM 3090ER Third Floor Electrical Room

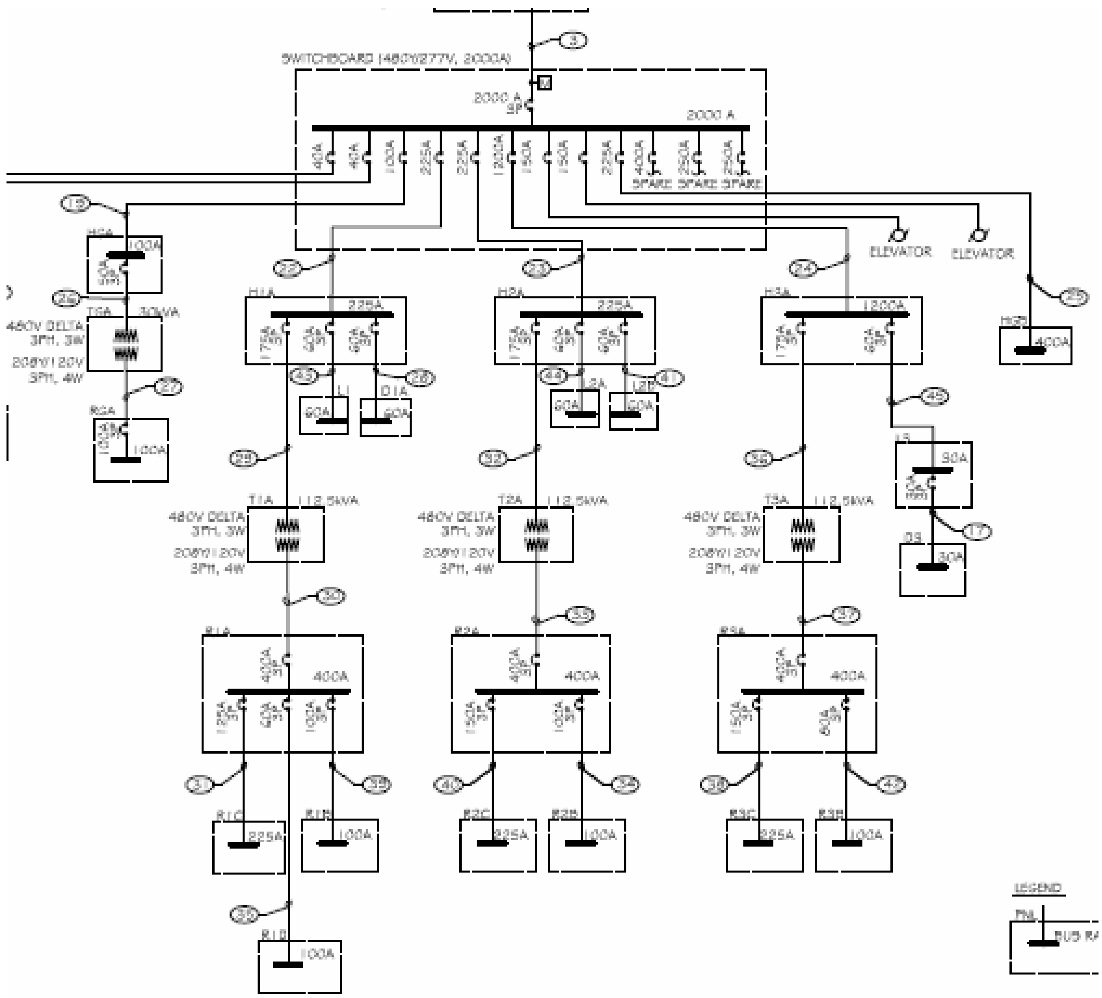
The proposed central transformer system will consolidate the four distribution transformers on the four floors into one large transformer located in the basement of the building. The central transformer will feed a new distribution panel, which then will feed the existing receptacle panels. The panels serving the existing distribution transformers will be resized and potentially reduced in sized, due to the removal of the transformer loads. The feeders and overcurrent devices serving these panelboards will be resized and potentially be reduced. The following riser diagram, single line diagrams, existing panelboard schedules, and modified panelboard schedules will detail the process in analyzing the comparison of these two systems.

Existing Riser Diagram



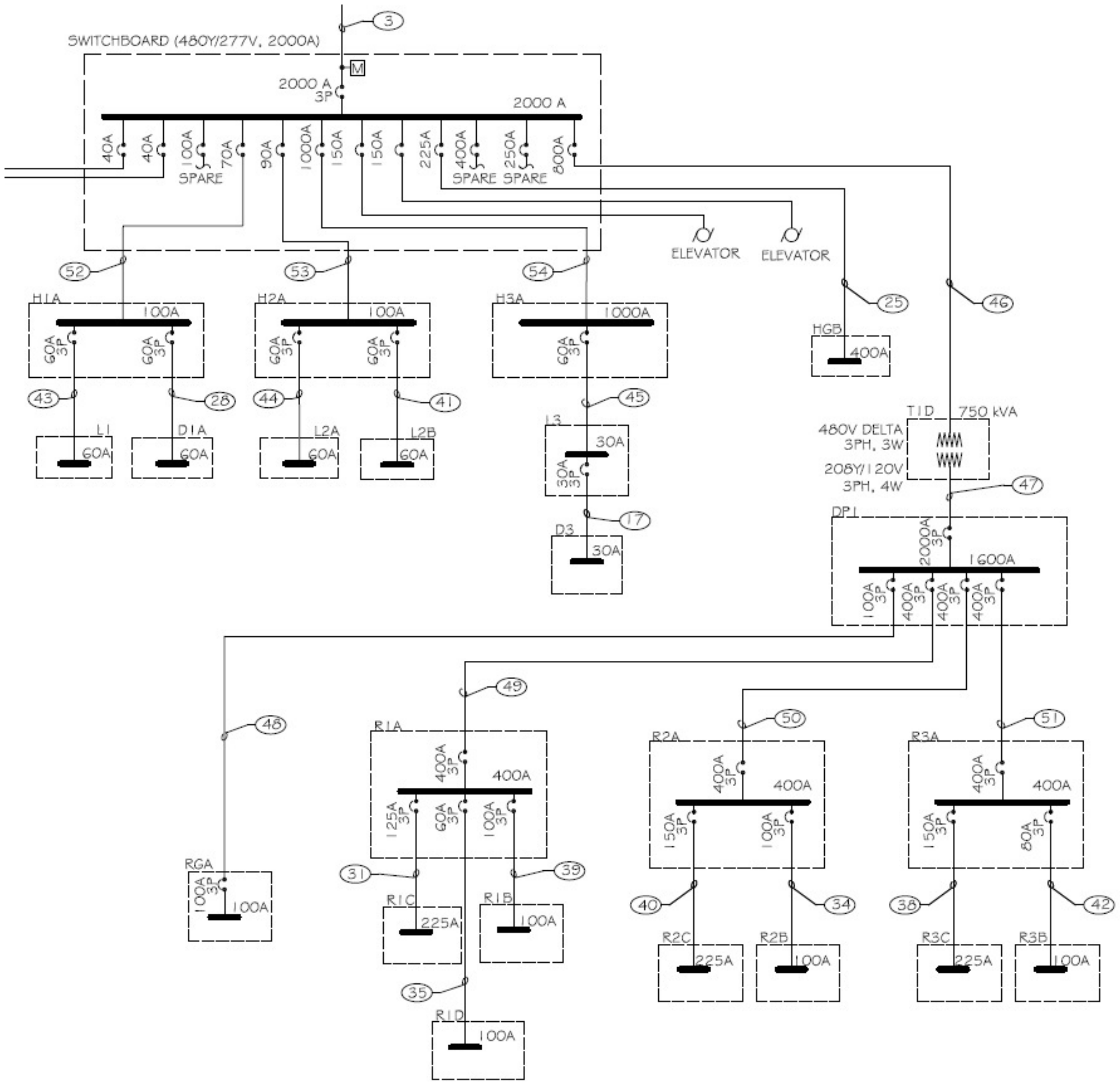
Note: Larger Riser Diagram found in Appendix B

Existing Single Line Diagram



Note: Larger and complete single line diagram of the existing system can be found in Appendix B.

Proposed Single Line Diagram of Central Transformer System:



Note: Larger and complete single line diagram of the new system can be found in Appendix B.

Evaluated Panelboards:

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE	H1A	C/B MIN AIC		18,000
Bus Rating	225A	LOCATION	PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO	FIRST FLOOR ELEC ROOM	REMARKS		

LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	2343		1	*			2		46792	
	2343		3		*		4		46792	
DIM PNL D1A	2343	60	5			*	6	175	46792	XFMR T1A
	4350		7	*			8		6000	
	4350		9		*		10		6000	
PNL L1	4350	80	11			*	12	30	6000	P-DWH-1
SPARE		20	13	*			14	--	--	SPACE
SPARE		20	15		*		16	--	--	SPACE
SPARE		20	17			*	18	--	--	SPACE
SPACE	--	20	19	*			20	--	--	SPACE
SPACE	--	20	21		*		22	--	--	SPACE
SPACE	--	20	23			*	24	--	--	SPACE
SUB-TOTAL	A PHASE 59485		B PHASE						59485	C PHASE 59485
TOTAL CONNECTED LOAD (WATTS)	178455									DEMAND LOAD 160610

MODIFIED PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE	H1A	C/B MIN AIC		18,000
Bus Rating	225A	LOCATION	PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO	FIRST FLOOR ELEC ROOM	REMARKS		

LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	2343		1	*			2		--	
	2343		3		*		4		--	
DIM PNL D1A	2343	60	5			*	6	175	--	SPARE
	4350		7	*			8		6000	
	4350		9		*		10		6000	
PNL L1	4350	80	11			*	12	30	6000	P-DWH-1
SPARE		20	13	*			14	--	--	SPACE
SPARE		20	15		*		16	--	--	SPACE
SPARE		20	17			*	18	--	--	SPACE
SPACE	--	20	19	*			20	--	--	SPACE
SPACE	--	20	21		*		22	--	--	SPACE
SPACE	--	20	23			*	24	--	--	SPACE
SUB-TOTAL	A PHASE 12693		B PHASE						12693	C PHASE 12693
TOTAL CONNECTED LOAD (WATTS)	38079									DEMAND LOAD 34271

Note: Due to the fact that I did not have the loads for all the receptacle and distribution panels. I recreated the loads with the assumption that each receptacle circuit had seven receptacles on it and the mechanical loads were obtained from the mechanical motor schedule. Please refer to Appendix C for the recreated panel schedules and panelboard sizing worksheets. The panelboard sizing worksheets were used in determining the sizing of the new transformer, panelboards, overcurrent protectors, and feeders.

MODIFIED PANELBOARD SIZING WORKSHEET										
Panel Tag------------------------->					H1A	Panel Location:			FIRST FLR ELEC RM	
Nominal Phase to Neutral Voltage------->					277	Phase:			3	
Nominal Phase to Phase Voltage-------->					480	Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	DIM PNL D1A	3		3400	w	0.98	3400	3469	
2	A	SPARE			0	w		0	0	
3	B	DIM PNL D1A	3		2360	w	0.98	2360	2408	
4	B	SPARE			0	w		0	0	
5	C	DIM PNL D1A	3		2050	w	0.98	2050	2092	
6	C	SPARE			0	w		0	0	
7	A	PNL L1	3		6900	w	0.85	6900	8118	
8	A	P-DWH-1			6000	w	1.00	6000	6000	
9	B	PNL L1	3		3200	w	0.85	3200	3765	
10	B	P-DWH-1			6000	w	1.00	6000	6000	
11	C	PNL L1	3		4400	w	0.85	4400	5176	
12	C	P-DWH-1			6000	w	1.00	6000	6000	
13	A				0	w		0	0	
14	A				0	w		0	0	
15	B				0	w		0	0	
16	B				0	w		0	0	
17	C				0	w		0	0	
18	C				0	w		0	0	
19	A				0	w		0	0	
20	A				0	w		0	0	
21	B				0	w		0	0	
22	B				0	w		0	0	
23	C				0	w		0	0	
24	C				0	w		0	0	
25	A				0	w		0	0	
26	A				0	w		0	0	
27	B				0	w		0	0	
28	B				0	w		0	0	
29	C				0	w		0	0	
30	C				0	w		0	0	
31	A				0	w		0	0	
32	A				0	w		0	0	
33	B				0	w		0	0	
34	B				0	w		0	0	
35	C				0	w		0	0	
36	C				0	w		0	0	
37	A				0	w		0	0	
38	A				0	w		0	0	
39	B				0	w		0	0	
40	B				0	w		0	0	
41	C				0	w		0	0	
42	C				0	w		0	0	
PANEL TOTAL								40.3	43.0	Amps= 51.8
PHASE LOADING								kW	kVA	% / Amps
PHASE TOTAL			A					16.3	17.6	41% / 63.5
PHASE TOTAL			B					11.6	12.2	28% / 43.9
PHASE TOTAL			C					12.5	13.3	31% / 47.9

LOAD CATAGORIES			Connected			Demand				
			kW	kVA	DF	kW	kVA	PF		Ver. 1.02
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		22.3	25.0	0.90	20.1	22.5	0.89		
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		18.0	18.0	0.95	17.1	17.1	1.00		
Total Demand Loads						37.2	39.6			
Spare Capacity			20%			7.4	7.9			
Total Design Loads						44.6	47.6	0.94	Amps=	57.2

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277	TAG						TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE	**H2A**						C/B MIN AIC		18,000
Bus Rating	225A	LOCATION						PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO	SECOND FLOOR ELEC ROOM						REMARKS		
LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	42261		1	*			2		3330	
	42261		3		*		4		3330	
XFMR T2A	42261	175	5			*	6	60	3330	PNL L2B (PHASE 2 PNL)
	3480		7	*			8		6000	
	3480		9		*		10		6000	
PNL L2A	3480	60	11			*	12	30	6000	P-DWH-1
SPARE	--	--	13	*			14		3000	
SPARE	--	--	15		*		16		3000	
SPARE	--	--	17			*	18	15	3000	P-DWH-3
SPACE	--	--	19	*			20	--	--	SPACE
SPACE	--	--	21		*		22	--	--	SPACE
SPACE	--	--	23			*	24	--	--	SPACE
SPACE	--	--	25	*			26	--	--	SPACE
SPACE	--	--	27		*		28	--	--	SPACE
SPACE	--	--	29			*	30	--	--	SPACE
SUB-TOTAL	**A PHASE 58071**		**B PHASE**						**58071**	**C PHASE 58071**
TOTAL CONNECTED LOAD (WATTS)	**174213**									**DEMAND LOAD 156792**

MODIFIED PANEL SCHEDULE

VOLTAGE	480Y/277	TAG						TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE	**H2A**						C/B MIN AIC		18,000
Bus Rating	225A	LOCATION						PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO	SECOND FLOOR ELEC ROOM						REMARKS		
LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	--		1	*			2		3330	
	--		3		*		4		3330	
SPARE	--	175	5			*	6	60	3330	PNL L2B (PHASE 2 PNL)
	3480		7	*			8		6000	
	3480		9		*		10		6000	
PNL L2A	3480	60	11			*	12	30	6000	P-DWH-1
SPARE	--	--	13	*			14		3000	
SPARE	--	--	15		*		16		3000	
SPARE	--	--	17			*	18	15	3000	P-DWH-3
SPACE	--	--	19	*			20	--	--	SPACE
SPACE	--	--	21		*		22	--	--	SPACE
SPACE	--	--	23			*	24	--	--	SPACE
SPACE	--	--	25	*			26	--	--	SPACE
SPACE	--	--	27		*		28	--	--	SPACE
SPACE	--	--	29			*	30	--	--	SPACE
SUB-TOTAL	**A PHASE 15810**		**B PHASE**						**15810**	**C PHASE 15810**
TOTAL CONNECTED LOAD (WATTS)	**47430**									**DEMAND LOAD 42687**

MODIFIED PANELBOARD SIZING WORKSHEET											
Panel Tag------------------------->					H2A	Panel Location:			SECOND FLR ELEC RM		
Nominal Phase to Neutral Voltage------->					277	Phase:			3		
Nominal Phase to Phase Voltage-------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	SPARE			0	w		0	0		
2	A	PNL L2B	3		4800	w	0.85	4800	5647		
3	B	SPARE			0	w		0	0		
4	B	PNL L2B	3		2400	w	0.85	2400	2824		
5	C	SPARE			0	w		0	0		
6	C	PNL L2B	3		3900	w	0.85	3900	4588		
7	A	PNL L2A	3		5900	w	0.85	5900	6941		
8	A	P-DWH-1	7		6000	w	1.00	6000	6000		
9	B	PNL L2A	3		3300	w	0.85	3300	3882		
10	B	P-DWH-1	7		6000	w	1.00	6000	6000		
11	C	PNL L2A	3		2400	w	0.85	2400	2824		
12	C	P-DWH-1	7		6000	w	1.00	6000	6000		
13	A	SPARE			0	w		0	0		
14	A	P-DWH-3	7		3000	w	1.00	3000	3000		
15	B	SPARE			0	w		0	0		
16	B	P-DWH-3	7		3000	w	1.00	3000	3000		
17	C	SPARE			0	w		0	0		
18	C	P-DWH-3	7		3000	w	1.00	3000	3000		
19	A				0	w		0	0		
20	A				0	w		0	0		
21	B				0	w		0	0		
22	B				0	w		0	0		
23	C				0	w		0	0		
24	C				0	w		0	0		
25	A				0	w		0	0		
26	A				0	w		0	0		
27	B				0	w		0	0		
28	B				0	w		0	0		
29	C				0	w		0	0		
30	C				0	w		0	0		
31	A				0	w		0	0		
32	A				0	w		0	0		
33	B				0	w		0	0		
34	B				0	w		0	0		
35	C				0	w		0	0		
36	C				0	w		0	0		
37	A				0	w		0	0		
38	A				0	w		0	0		
39	B				0	w		0	0		
40	B				0	w		0	0		
41	C				0	w		0	0		
42	C				0	w		0	0		
PANEL TOTAL								49.7	53.7	Amps=	64.6
PHASE LOADING								kW	kVA	%	Amps
		PHASE TOTAL	A					19.7	21.6	40%	77.9
		PHASE TOTAL	B					14.7	15.7	29%	56.7
		PHASE TOTAL	C					15.3	16.4	31%	59.2
LOAD CATAGORIES				Connected			Demand				Ver. 1.02
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0		0.0	0.0			
2	computers			0.0	0.0		0.0	0.0			
3	fluorescent lighting			22.7	26.7	0.90	20.4	24.0	0.85		
4	HID lighting			0.0	0.0		0.0	0.0			
5	incandescent lighting			0.0	0.0		0.0	0.0			
6	HVAC fans			0.0	0.0		0.0	0.0			
7	heating			27.0	27.0	0.95	25.7	25.7	1.00		
8	kitchen equipment			0.0	0.0		0.0	0.0			
9	unassigned			0.0	0.0		0.0	0.0			
Total Demand Loads							46.1	49.7			
Spare Capacity				20%			9.2	9.9			
Total Design Loads							55.3	59.6	0.93	Amps=	71.7

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL: NEMA 1 ENCLOSURE
MOUNTING	PAD	H3A	C/B MIN AIC: 18,000
Bus Rating	1200A	LOCATION	PHASES: 3 / WIRES: 4
SIZE/TYPE MAINS	MLO	THIRD FLOOR ELEC ROOM	REMARKS

LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	30678		1	*			2		21450	
	30678		3		*		4		21450	
AHU-1	30678	200	5			*	6	125	21450	AHU-2
	91667		7	*			8		42151	
	91667		9		*		10		42151	
CHILLER	91667	600	11			*	12	175	42151	AHU-5
	41394		13	*			14		3000	
	41394		15		*		16		3000	
XFMR T3A	41394	175	17			*	18	15	3000	P-DWH-3
	249		19	*			20		1243	
	249		21		*		22		1243	
EF-3	249	15	23			*	24	15	1243	F-VENT-4
	4785		25	*			26		124	
	4785		27		*		28		124	
PNL L3	4785	60	29			*	30	15	124	EF-4
	--		31	*			32		--	
	--		33		*		34		--	
SPARE	--	--	35			*	36	--	--	SPARE
SUB-TOTAL	**A PHASE 231831**		**B PHASE**						**231831**	**C PHASE 231831**
TOTAL CONNECTED LOAD (WATTS)	**695493**									**DEMAND LOAD 625944**

MODIFIED PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL: NEMA 1 ENCLOSURE
MOUNTING	PAD	H3A	C/B MIN AIC: 18,000
Bus Rating	1200A	LOCATION	PHASES: 3 / WIRES: 4
SIZE/TYPE MAINS	MLO	THIRD FLOOR ELEC ROOM	REMARKS

LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	30678		1	*			2		21450	
	30678		3		*		4		21450	
AHU-1	30678	200	5			*	6	125	21450	AHU-2
	91667		7	*			8		42151	
	91667		9		*		10		42151	
CHILLER	91667	600	11			*	12	175	42151	AHU-5
	--		13	*			14		3000	
	--		15		*		16		3000	
SPARE	--	175	17			*	18	15	3000	P-DWH-3
	249		19	*			20		1243	
	249		21		*		22		1243	
EF-3	249	15	23			*	24	15	1243	F-VENT-4
	4785		25	*			26		124	
	4785		27		*		28		124	
PNL L3	4785	60	29			*	30	15	124	EF-4
	--		31	*			32		--	
	--		33		*		34		--	
SPARE	--	--	35			*	36	--	--	SPARE
SUB-TOTAL	**A PHASE 190437**		**B PHASE**						**190437**	**C PHASE 190437**
TOTAL CONNECTED LOAD (WATTS)	**571311**									**DEMAND LOAD 514180**

MODIFIED PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->					H3A	Panel Location:		THIRD FLR ELEC RM			
Nominal Phase to Neutral Voltage------->					277	Phase:		3			
Nominal Phase to Phase Voltage-------->					480	Wires:		4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	AHU-1	6		30678	w	0.95	30678	32293		
2	A	AHU-2	6		21450	w	0.95	21450	22579		
3	B	AHU-1	6		30678	w	0.95	30678	32293		
4	B	AHU-2	6		21450	w	0.95	21450	22579		
5	C	AHU-1	6		30678	w	0.95	30678	32293		
6	C	AHU-2	6		21450	w	0.95	21450	22579		
7	A	CHILLER	7		91667	w	0.95	91667	96491		
8	A	AHU-5	6		42151	w	0.95	42151	44370		
9	B	CHILLER	7		91667	w	0.95	91667	96491		
10	B	AHU-5	6		42151	w	0.95	42151	44370		
11	C	CHILLER	7		91667	w	0.95	91667	96491		
12	C	AHU-5	6		42151	w	0.95	42151	44370		
13	A	SPARE			0	w		0	0		
14	A	P-DWH-3	7		3000	w	1.00	3000	3000		
15	B	SPARE			0	w		0	0		
16	B	P-DWH-3	7		3000	w	1.00	3000	3000		
17	C	SPARE			0	w		0	0		
18	C	P-DWH-3	7		3000	w	1.00	3000	3000		
19	A	EF-3	6		249	w	0.95	249	262		
20	A	F-VENT-4	6		1243	w	0.95	1243	1308		
21	B	EF-3	6		249	w	0.95	249	262		
22	B	F-VENT-4	6		1243	w	0.95	1243	1308		
23	C	EF-3	6		249	w	0.95	249	262		
24	C	F-VENT-4	6		1243	w	0.95	1243	1308		
25	A	PNL L3	3		5900	w	0.90	5900	6556		
26	A	EF-4	6		124	w	0.95	124	131		
27	B	PNL L3	3		4650	w	0.90	4650	5167		
28	B	EF-4	6		124	w	0.95	124	131		
29	C	PNL L3	3		5400	w	0.90	5400	6000		
30	C	EF-4	6		124	w	0.95	124	131		
31	A				0	w		0	0		
32	A				0	w		0	0		
33	B				0	w		0	0		
34	B				0	w		0	0		
35	C				0	w		0	0		
36	C				0	w		0	0		
37	A				0	w		0	0		
38	A				0	w		0	0		
39	B				0	w		0	0		
40	B				0	w		0	0		
41	C				0	w		0	0		
42	C				0	w		0	0		
PANEL TOTAL								587.6	619.0	Amps=	744.9
PHASE LOADING								kW	kVA	%	Amps
PHASE TOTAL			A					196.5	207.0	33%	747.3
PHASE TOTAL			B					195.2	205.6	33%	742.2
PHASE TOTAL			C					196.0	206.4	33%	745.2
LOAD CATAGORIES				Connected			Demand				Ver. 1.02
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0		0.0	0.0			
2	computers			0.0	0.0		0.0	0.0			
3	fluorescent lighting			16.0	17.7	0.90	14.4	16.0	0.90		
4	HID lighting			0.0	0.0		0.0	0.0			
5	incandescent lighting			0.0	0.0		0.0	0.0			
6	HVAC fans			287.7	302.8	0.95	273.3	287.7	0.95		
7	heating			284.0	298.5	0.95	269.8	283.6	0.95		
8	kitchen equipment			0.0	0.0		0.0	0.0			
9	unassigned			0.0	0.0		0.0	0.0			
Total Demand Loads							557.5	587.2			
Spare Capacity				20%			111.5	117.4			
Total Design Loads							668.9	704.6	0.95	Amps=	847.9

EXISTING PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE	**HGA**	C/B MIN AIC		25,000
Bus Rating	100A	LOCATION	PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO	BASEMENT ELEC ROOM	REMARKS		

LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	8558		1	*			2	20	--	SPARE
	8558		3		*		4	20	--	SPARE
XFMR TGA	8558	50	5			*	6	20	--	SPARE
SPACE	--	--	7	*			8	20	--	SPARE
SPACE	--	--	9		*		10	20	--	SPARE
SPACE	--	--	11			*	12	20	--	SPARE
SPACE	--	--	13	*			14	--	--	SPACE
SPACE	--	--	15		*		16	--	--	SPACE
SPACE	--	--	17			*	18	--	--	SPACE
SPACE	--	--	19	*			20	--	--	SPACE
SPACE	--	--	21		*		22	--	--	SPACE
SPACE	--	--	23			*	24	--	--	SPACE
SPACE	--	--	25	*			26	--	--	SPACE
SPACE	--	--	27		*		28	--	--	SPACE
SPACE	--	--	29			*	30	--	--	SPACE
SUB-TOTAL	**A PHASE** 8558		**B PHASE**						8558	**C PHASE** 8558
TOTAL CONNECTED LOAD (WATTS)	25674									**DEMAND LOAD** 23107

MODIFIED PANEL SCHEDULE

VOLTAGE	480Y/277	TAG	TYPE PANEL		NEMA 1 ENCLOSURE
MOUNTING	SURFACE	**HGA (NOT NEEDED)**	C/B MIN AIC		25,000
Bus Rating	100A	LOCATION	PHASES: 3	WIRES:	4
SIZE/TYPE MAINS	MLO	BASEMENT ELEC ROOM	REMARKS		

LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
	--		1	*			2	20	--	SPARE
	--		3		*		4	20	--	SPARE
SPACE	--	50	5			*	6	20	--	SPARE
SPACE	--	--	7	*			8	20	--	SPARE
SPACE	--	--	9		*		10	20	--	SPARE
SPACE	--	--	11			*	12	20	--	SPARE
SPACE	--	--	13	*			14	--	--	SPACE
SPACE	--	--	15		*		16	--	--	SPACE
SPACE	--	--	17			*	18	--	--	SPACE
SPACE	--	--	19	*			20	--	--	SPACE
SPACE	--	--	21		*		22	--	--	SPACE
SPACE	--	--	23			*	24	--	--	SPACE
SPACE	--	--	25	*			26	--	--	SPACE
SPACE	--	--	27		*		28	--	--	SPACE
SPACE	--	--	29			*	30	--	--	SPACE
SUB-TOTAL	**A PHASE** 0		**B PHASE**						0	**C PHASE** 0
TOTAL CONNECTED LOAD (WATTS)	0									**DEMAND LOAD** 0

EXISTING PANEL SCHEDULE

VOLTAGE	208Y/120	TAG					TYPE PANEL			NEMA 1 ENCLOSURE
MOUNTING	SURFACE	RGA					C/B MIN AIC			25,000
Bus Rating	100A	LOCATION					PHASES:	3	WIRES:	4
SIZE/TYPE MAINS	3P100A MCB	Basement Elec Room					REMARKS			
LOAD DESCRIPTION	LOAD WATTS	C/B SIZE	POS NO	A PH	B PH	C PH	POS NO	C/B SIZE	LOAD WATTS	LOAD DESCRIPTION
UNIT HEATERS	15	20	1	*			2	20	1260	RECPT- MECH ROOM
ELEVATOR SUMP P-ELEV-1	372	20	3		*		4	20	1260	RECPT- MECH ROOM
ELEVATOR SUMP	372	20	5			*	6	20	1260	RECPT- ELEV
VENT FAN F-VENT-3	37.3	15	7	*			8	20	1260	RECPT- ELEC ROOM
ACU-4, ACU-5, ACU-6	681	20	9		*		10	20	500	ELEV PIT LTG
ELEV #1 CAB LTG, HVAC	100	20	11			*	12	20	2067	
ELEV #2 CAB LTG, HVAC	100	20	13	*			14	20	2067	ACCU-4
AHU-4 LTG, RECEPTS	1260	20	15		*		16	20	2067	
EF-6	186.4	15	17			*	18		2067	ACCU-5
PARKING LOT GATE	372.0	20	19	*			20		2067	
PARKING LOT GATE	372.0	20	21		*		22		2067	ACCU-6
REFRIGERATED AIR DRYER	1864.4	20	23			*	24		--	SPARE
GEN BATTERY CHARGER	1000.0	20	25	*			26		--	SPARE
GEN BLOCK HEATER	1000.0	20	27		*		28		--	SPARE
SPARE	--	20	29			*	30		--	SPARE
			31	*			32			
			33		*		34			
			35			*	36			
			37	*			38			
			39		*		40			
			41			*	42			
SUB-TOTAL	A PHASE 8178		B PHASE					9579	C PHASE 7917	
TOTAL CONNECTED LOAD (WATTS)	25674								DEMAND LOAD	23107

EXISTING PANELBOARD SIZING WORKSHEET

Panel Tag------------------------->	RGA	Panel Location:	FIRST FLOOR ELEC ROOM	
Nominal Phase to Neutral Voltage------->	120	Phase:	3	
Nominal Phase to Phase Voltage-------->	208	Wires:	4	

Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	PNL RGA			8178	w	0.90	8178	9087	
2	A				0	w	1.00	0	0	
3	B	PNL RGA			9579	w	0.90	9579	10643	
4	B				0	w	1.00	0	0	
5	C	PNL RGA			7917	w	0.90	7917	8797	
6	C				0	w	1.00	0	0	
7	A				0	w	1.00	0	0	
8	A				0	w	1.00	0	0	
9	B				0	w	1.00	0	0	
10	B				0	w	1.00	0	0	
11	C				0	w	1.00	0	0	
12	C				0	w	1.00	0	0	
13	A				0	w	1.00	0	0	
14	A				0	w	1.00	0	0	
15	B				0	w	1.00	0	0	
16	B				0	w	1.00	0	0	
17	C				0	w	1.00	0	0	
18	C				0	w	1.00	0	0	
19	A				0	w	1.00	0	0	
20	A				0	w	1.00	0	0	
21	B				0	w	1.00	0	0	
22	B				0	w	1.00	0	0	
23	C				0	w	1.00	0	0	
24	C				0	w	1.00	0	0	
25	A				0	w	1.00	0	0	
26	A				0	w	1.00	0	0	
27	B				0	w	1.00	0	0	
28	B				0	w	1.00	0	0	
29	C				0	w	1.00	0	0	
30	C				0	w	1.00	0	0	
31	A				0	w	1.00	0	0	
32	A				0	w	1.00	0	0	
33	B				0	w	1.00	0	0	
34	B				0	w	1.00	0	0	
35	C				0	w	1.00	0	0	
36	C				0	w	1.00	0	0	
37	A				0	w	1.00	0	0	
38	A				0	w	1.00	0	0	
39	B				0	w	1.00	0	0	
40	B				0	w	1.00	0	0	
41	C				0	w	1.00	0	0	
42	C				0	w	1.00	0	0	
PANEL TOTAL								25.7	28.5	Amps= 79.2

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					8.2	9.1	32%	75.7
PHASE TOTAL	B					9.6	10.6	37%	88.7
PHASE TOTAL	C					7.9	8.8	31%	73.3

LOAD CATAGORIES			Connected			Demand				Ver. 1.02
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		25.7	28.5	0.80	20.5	22.8	0.90		
Total Demand Loads						20.5	22.8			
Spare Capacity			20%			4.1	4.6			
Total Design Loads						24.6	27.4	0.90	Amps=	76.1

New Transformer (TD1) Sizing

Feeder & Transformer Sizing Worksheet		
Panelboard Tag	DP1	SWBD to T1D
Panelboard Voltage	208Y/120	277Y/480
Calculated Design Load (kw)	447.6	
Calculated Design Load (kva)	523.5	
Resultant Power Factor	0.86	
Calculated Design Load (amps)	1454.2	787.0907967
Feeder Protection Size	2000A	800A
Sets	6	3
Wire Size		
3 Phase	500 KCMIL	300 KCMIL
1 Neutral	500 KCMIL	
1 Ground	250 KCMIL	1/0 AWG
Conduit Size	3"	2"
Transformer		
Size	750 kVA	
Secondary Protection	1816.363377	2000A
Primary Protection	787.0907967	800A
Remarks		

Based on: Copper Wire, 75 degree C, THWN,

Copper wire
75 degree C THWN insulation
IMC Conduit
Maximum 500kcmil wire
Minimum 3/4" conduit
100% neutral
Dry type transformers with primary and seconday feeders exceeding 25 feet

Cost Analysis of Equipment

*Pricing information from 2008 RS Means

Previous Equipment		
Item	Size	Cost
Panel H1A	225A Bus Bar	$1,045
H1A Circuit Breaker	225A	$1,239
Panel H2A	225A Bus Bar	$1,045
H2A Circuit Breaker	225A	$1,239
Panel H3A	1200A Bus Bar	$4,425
H3A Circuit Breaker	1200A	$12,055
Panel HGA	100A Bus Bar	$763
HGA Circuit Breaker	100A	$606
TGA Primary Circuit Breaker	50A	$499
Xfmr TGA	30 kVA	$4,385
Xfmr T1A	112.5 kVA	$13,439
Xfmr T2A	112.5 kVA	$13,439
Xfmr T3A	112.5 kVA	$13,439
Total Equipment Cost		$67,618

New Equipment		
Item	Size	Cost
Distribution Panel DP1	1600A Bus Bar	$5,025
Panel H1A	100A Bus Bar	$763
H1A Circuit Breaker	70A	$606
Panel H2A	100A Bus Bar	$763
H2A Circuit Breaker	90A	$606
Panel H3A	1000A Bus Bar	$3,660
H3A Circuit Breaker	1000A	$6,065
XFMR T1D	750 kVA	$34,620
Total Equipment Cost		$52,108

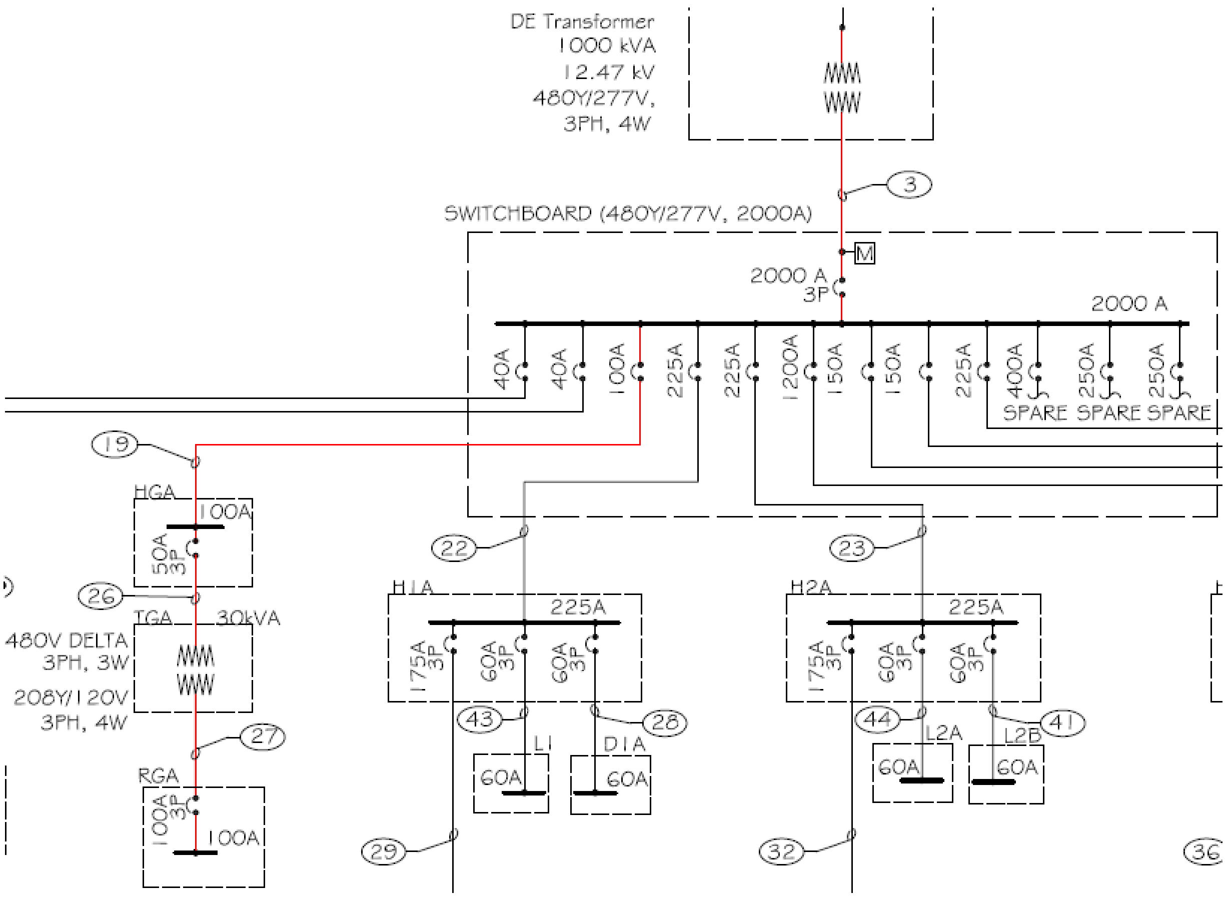
Previous Feeders									
Feeder #	Length/100	Sets	Phase Wire Size	Cost/c.l.f.	Neutral Wire Size	Cost/c.l.f.	Ground Conductors	Cost/c.l.f.	Total Cost per Feeder
Feeder 19	0.0825	1	#1 AWG	$286	#1 AWG	$286	#8 AWG	86	$54
Feeder 22	0.72	1	4/0 AWG	$626	4/0 AWG	$626	#4 AWG	166.5	$1,021
Feeder 23	0.855	1	4/0 AWG	$626	4/0 AWG	$626	#4 AWG	166.5	$1,213
Feeder 24	1.0025	3	600 KCMIL	$1,603	600 KCMIL	$1,603	3/0 AWG	516	$11,194
Feeder 26	0.02	1	#6 AWG	$118	--	$0	#10 AWG	60.5	$4
Feeder 27	0.0325	1	#1 AWG	$286	#1 AWG	$286	#6 AWG	118	$22
Feeder 29	0.675	1	2/0 AWG	$419	--	$0	#6 AWG	118	$362
Feeder 32	0.805	1	2/0 AWG	$419	--	$0	#6 AWG	118	$432
Feeder 36	0.945	1	2/0 AWG	$419	--	$0	#6 AWG	118	$507
Feeder 30	0.025	1	500 KCMIL	$1,303	500 KCMIL	$1,303	1/0 AWG	344	$74
Feeder 33	0.0325	1	500 KCMIL	$1,303	500 KCMIL	$1,303	1/0 AWG	344	$96
Feeder 37	0.0325	1	500 KCMIL	$1,303	500 KCMIL	$1,303	1/0 AWG	344	$96
								Total Feeder Cost	$15,076

New Feeders									
Feeder #	Length/100	Sets	Phase Wire Size	Cost/c.l.f.	Neutral Wire Size	Cost/c.l.f.	Ground Conductors	Cost/c.l.f.	Total Cost per Feeder
Feeder 46	0.1	3	300 KCMIL	$847	--	$847	1/0 AWG	344	$611
Feeder 47	0.0325	6	500 KCMIL	$1,303	500 KCMIL	$1,303	250 AWG	727	$650
Feeder 48	0.0575	1	#3 AWG	$196	#3 AWG	$196	#8 AWG	86	$27
Feeder 49	0.6975	2	3/0 AWG	$516	3/0 AWG	$516	#3 AWG	196	$1,713
Feeder 50	0.8375	2	3/0 AWG	$516	3/0 AWG	$516	#3 AWG	196	$2,057
Feeder 51	0.9775	2	3/0 AWG	$516	3/0 AWG	$516	#3 AWG	196	$2,401
Feeder 52	0.72	1	#3 AWG	$196	#3 AWG	$196	#8 AWG	86	$344
Feeder 53	0.855	1	#3 AWG	$196	#3 AWG	$196	#8 AWG	86	$409
Feeder 54	1.0025	3	400 KCMIL	$1,084	400 KCMIL	$1,084	2/0 AWG	419	$7,780
								Total Feeder Cost	$15,993

Total Equipment Cost	
Total Equipment Savings	$15,510
Total Feeder Savings	($917)
Total Cost of Distributed Transformer System	$82,694
Total Cost of Central Transformer System	$68,101
Total Savings	$14,593

After performing the cost analysis study, it is recommended that a central transformer system be utilized. The major reason for the savings of $14,593 is the resized transformers. The original system contained three large transformers (112.5 kVA) and a medium size transformer (30 kVA) at a total cost of $44,702 as compared to $34,620 for a single (750 kVA) transformer. The resized feeders actually cost more than the existing system but when compared to the total costs of the system it is basically negligible

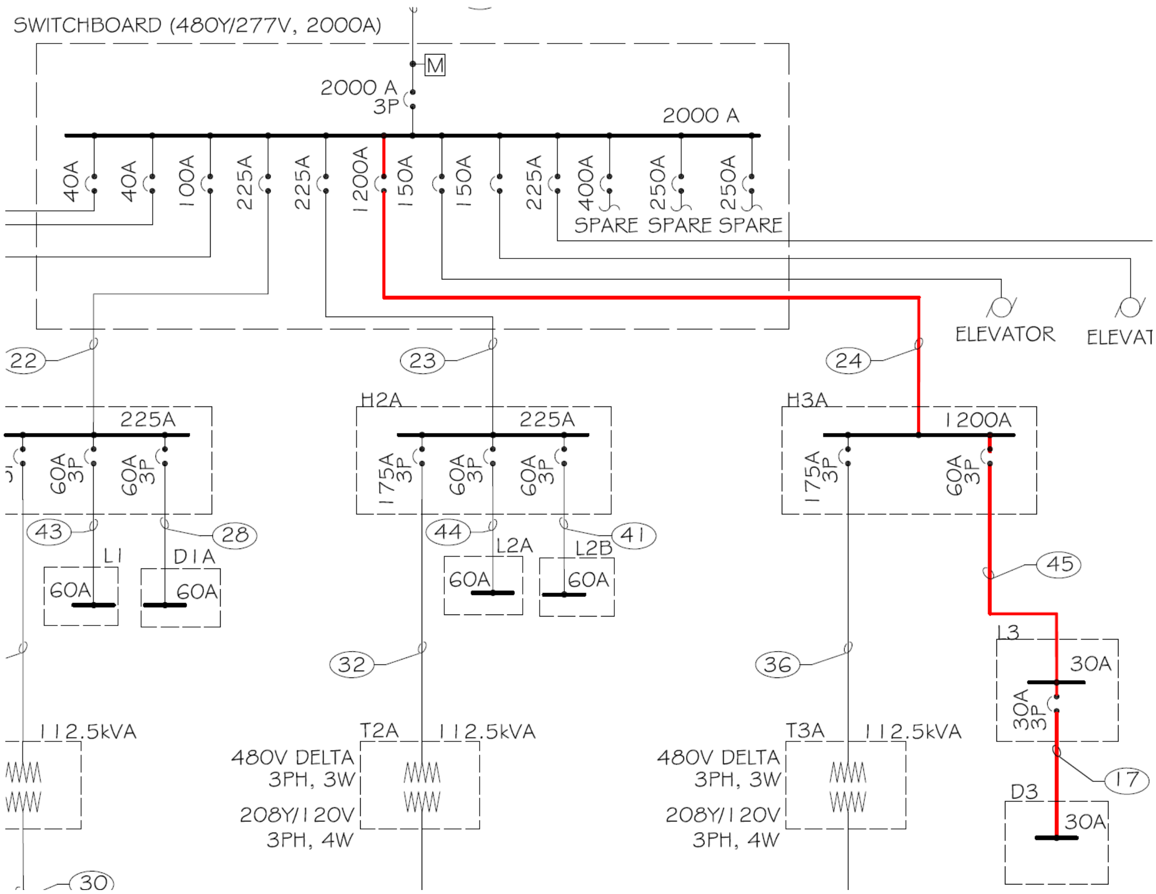
Short Circuit Analysis



Per Unit Short Circuit Method			
Point	**Location**	**Available Fault**	**Standard Breaking Rating**
A	Utility Transformer Secondary Side	20,413	25,000
B	Main Switchboard	19,355	25,000
C	HGA Panelboard	17,188	25,000
D	Transformer TGA	16,929	25,000
E	RGA Panelboard	552	14,000

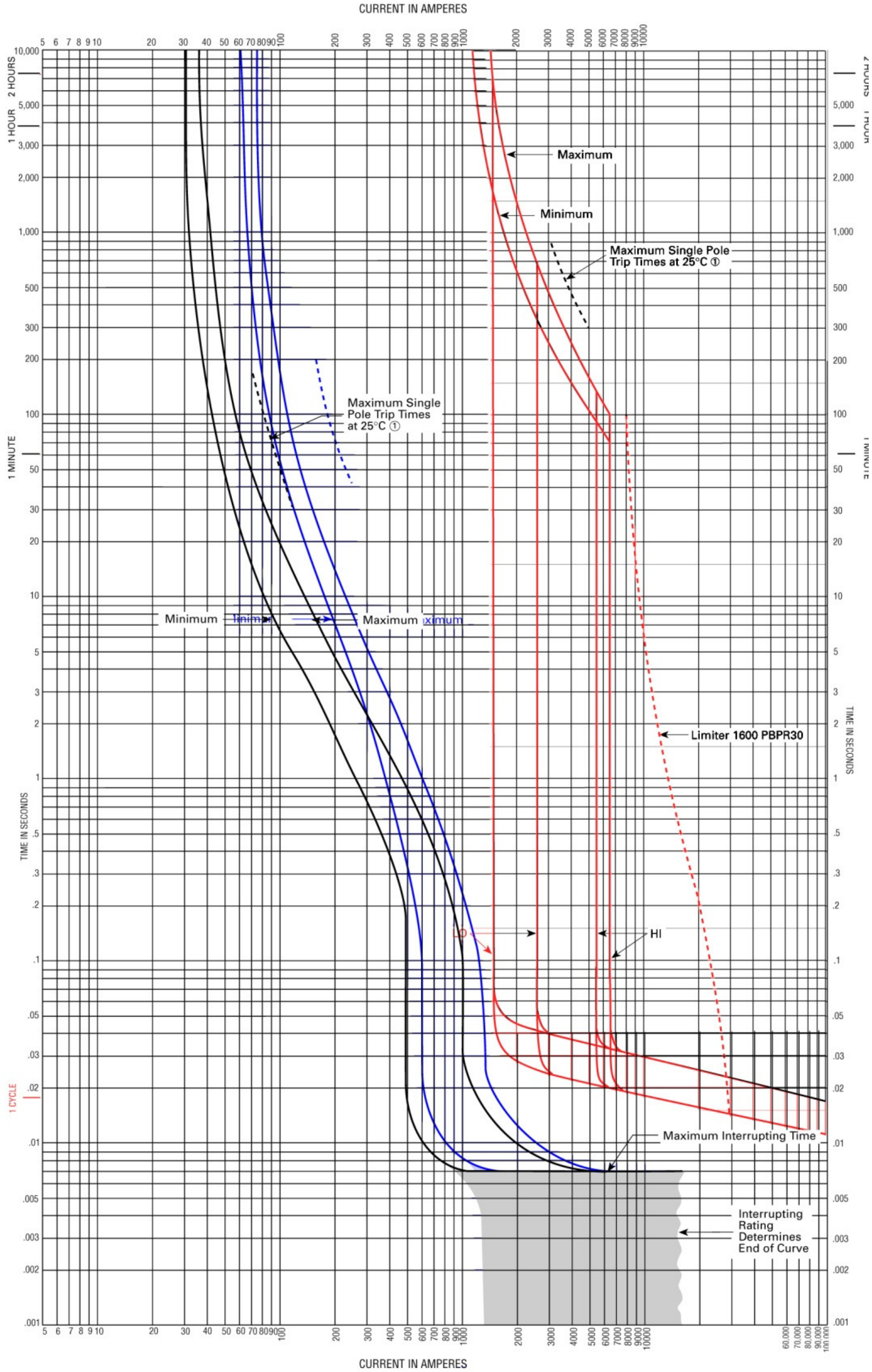
Per Unit Short Circuit Method			
Base kVA	10,000		
Available Utility Fault (kVA)	1,000,000		
System Voltage (kV)	0.48		
Utility Transformer Primary Side			
Utility Transformer Size (kVA)	1,000	X (p.u.) = (Base kVA/Utility S.C. kVA)	0.01
Utility Transformer Secondary Side			
Average % Z.	5.8	X (p.u.)= (%X * base kVA)/(100 *xfmr kVA)	0.534718
Average X/R	2.38	R(p.u.) = (%R * base KVA)/(100 *xfrmr kVA)	0.224671
R (%)	2.246712314		
X (%)	5.347175308	ΣX(p.u.)	0.544718
		ΣR(p.u.)	0.224671
		ΣZ(p.u.)	0.589232
		$I_{sc\ rms\ sym}$	**20413.23**
Main Switchboard			
# of sets	6	X(p.u.)	0.026761
length	75.5	R(p.u.)	0.019443
Wire Size	400 KCMIL		
X_L	0.049		
R	0.0356	ΣX(p.u.)	0.571479
X	0.000616583	ΣR(p.u.)	0.244114
R	0.000447967	ΣZ(p.u.)	0.621434
		$I_{sc\ rms\ sym}$	**19355.45**
HGA Panelboard			
# of sets	1	X(p.u.)	0.036491
length	14.75	R(p.u.)	0.102431
Wire Size	#1		
X_L	0.057		
R	0.16	ΣX(p.u.)	0.60797
X	0.00084075	ΣR(p.u.)	0.346545
R	0.00236	ΣZ(p.u.)	0.6998
		$I_{sc\ rms\ sym}$	**17187.94**
Transformer TGA Primary Side			
# of sets	1	X(p.u.)	0.006689
length	2.25	R(p.u.)	0.009838
Wire Size	#6		
X_L	0.0685	ΣX(p.u.)	0.614659
R	0.51	ΣR(p.u.)	0.356383
X	0.000154125	ΣZ(p.u.)	0.710503
R	0.000226667		
		$I_{sc\ rms\ sym}$	**16929.03**
Transformer TGA Secondary Side			
Transformer Size (kVA)	30		
Average % Z.	6.4	X (p.u.)= (%X * base kVA)/(100 *xfmr kVA)	14.44387
Average X/R	0.92	R(p.u.) = (%R * base KVA)/(100 *xfrmr kVA)	15.69986
R (%)	4.709958475		
X (%)	4.333161797	ΣX(p.u.)	15.05853
		ΣR(p.u.)	15.7097
		ΣZ(p.u.)	21.7613
		$I_{sc\ rms\ sym}$	**552.7304**
RGA Panelboard			
# of sets	1	X(p.u.)	0.004948
length	2	R(p.u.)	0.013889
Wire Size	#1		
X_L	0.057		
R	0.16	ΣX(p.u.)	15.06348
X	0.000114	ΣR(p.u.)	15.72359
R	0.00032	ΣZ(p.u.)	21.77475
		$I_{sc\ rms\ sym}$	**552.389**

Overcurrent Protection Device Coordination Study



Protection Device Coordination Study

Black Line = 30A | Blue Line = 60A | Red Line =1200A



Coordination Study Analysis

After overlaying the overcurrent time delay curves of a 30A, 60A, and 1200A circuit breaker, there is limit overlap. The 60A circuit breaker starts to overlap the 30A circuit breaker with its lower limit starting at 200A and 2 sec and continues to 5000A and 0.07 sec. The 30A lower limit however remains ahead of the lower limit of the 60A circuit breaker. This means that there is a slight chance that the 30A circuit breaker will trip before the 60A breaker starting at 200A and 2 sec. Other than this overlap the circuit breakers will trip in the proper order: the 30A circuit breaker will trip before the 60A and the 1200A will trip before both the 30A and the 60A.

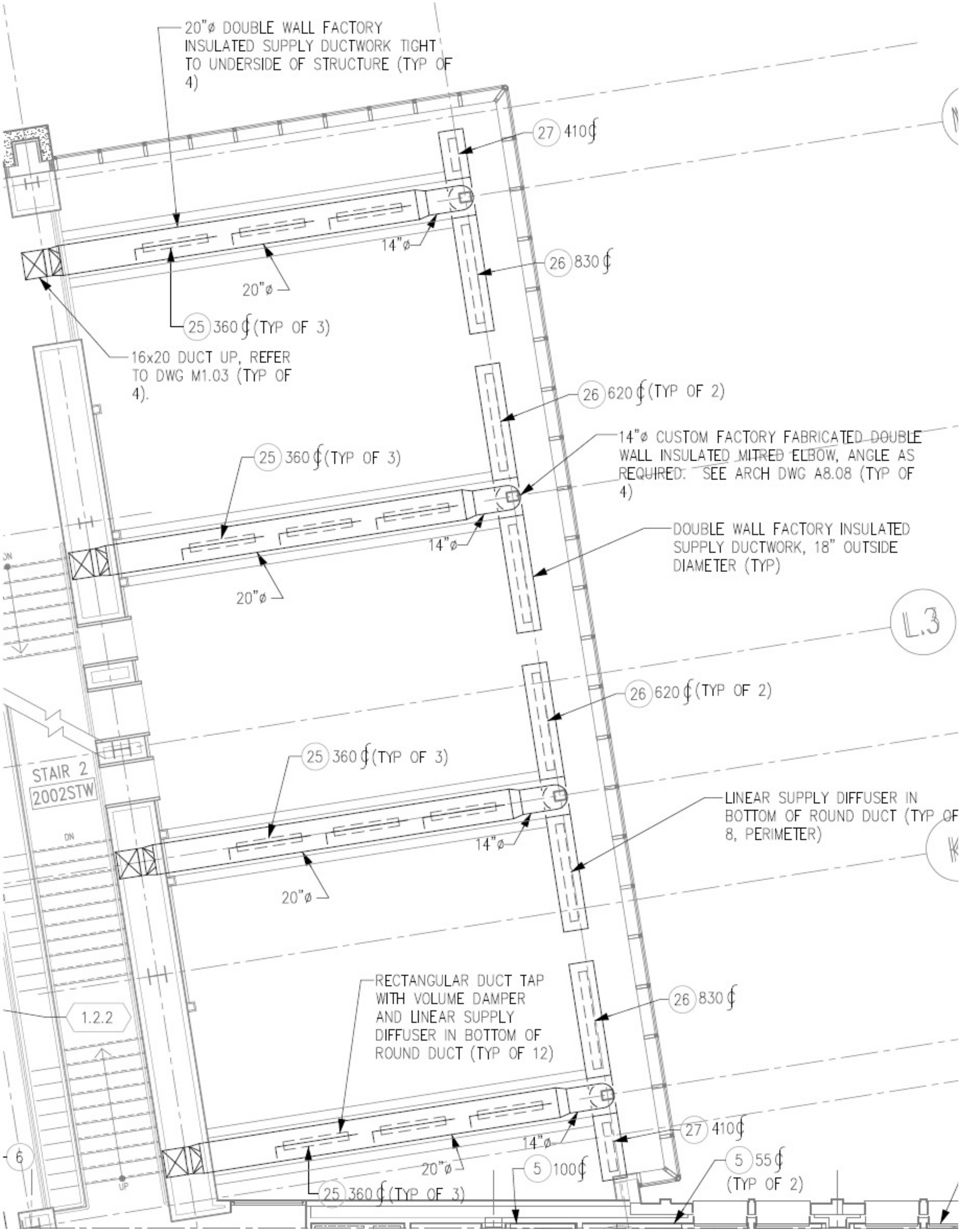
Mechanical Breadth

Introduction

As part of my proposed lighting design for the Café DUSON, my design intent is to integrate most of the lighting into the architecture and to visually clean up the space. The existing lighting design utilizes 24 compact fluorescent pendant fixtures as the main lighting source within the café. In order to maintain the proper level of illumination on the workplane and remove these 24 pendants, lighting needs to be integrated into the four wooden roof beams.

The previously mentioned wooden roof beams are actually two 24-in tall by 6-3/4-in wide individual beams spaced 24-in apart from each other. The existing mechanical design has a 20-in diameter double wall insulated round supply duct running between each of these coupled beam systems. These 20-in round supply ducts then transition into a 14-in diameter round duct that runs perpendicular to the 20-in round ducts and parallel to the large glass curtain wall. Please refer to the following existing mechanical plan for more information.

Existing Mechanical Plan



Proposed Mechanical Change

The proposed mechanical modification is to change the existing double wall insulated 20-in round ducts to 20-in by 16-in double wall insulated rectangular ducts. The design intention for changing the round ducts to rectangular ducts is to decrease the height of the ducts within the beam space. As part of my lighting redesign I am placing 6-in high ceramic metal halide downlights with an aperture of 11-in. If I were to place these downlights within the beam space with the 20-in round ducts, I would exceed the 24-in beam space height by 2-in. However, by changing the round ducts to 20-in by 16-in rectangular 1-in insulated double wall ducts I gain the necessary 2-in to fully enclose the beam space with a wood panel and recess the 6-in high downlights.

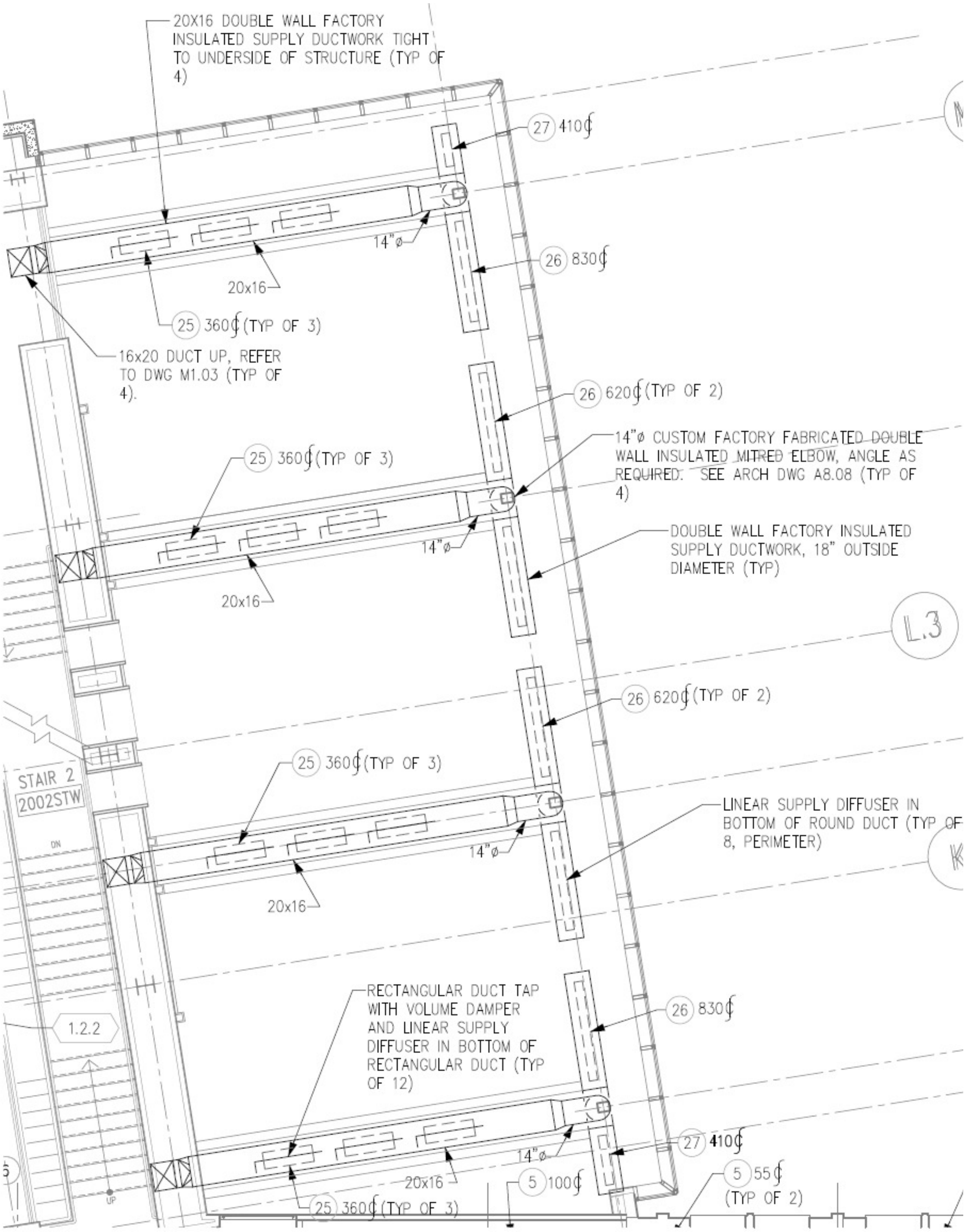
A problem that arises visually by enclosing the beam space is that the relatively thin looking individual beams now become solid thick looking beams. Considering the other wooden timber in the space, the scale of the enclosed beams looks out of place. In order to avoid this scale issue and to still enclose the beam space, I am proposing that the height of the beams be changed from 24-in to 26-1/2-in. This additional height will allow for all the mechanical and lighting equipment to be enclosed as well as maintain the scale of the beams with the other wood in the space.

I am also proposing that the mechanical slot air diffusers be changed to accommodate the light layout as well as match the scale of the downlights. The existing linear slot diffusers, Titus Model CT-480, are 48-in long by 4-in wide. The proposed linear slot diffusers, Titus Model ML-38, are instead 36-in long by 12-in wide. Since the downlights are spaced every 42-in the existing diffusers would not fit between the lights. By decreasing the length of the diffusers, the width increases to 12-in. This increase in width actually works out visual, since the downlights are 11-in in diameter.

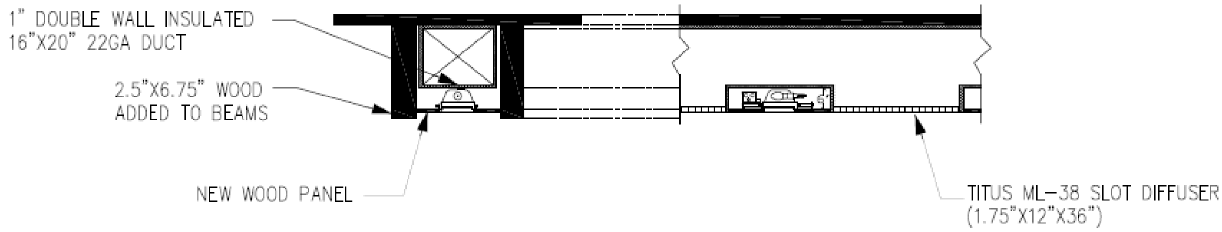
The proposed diffuser will have 8-slots, each 3/4-in wide and provide the scheduled 360 cfm at an acceptable NC value of NC-20. An advantage of using this type of diffuser is that the slots allow you to have vertical and horizontal discharge. By having both vertical and horizontal air discharges the throw area of the diffuser increases. The existing 4-in diffusers do not have both the vertical and horizontal discharge and does not offer as wide of a throw area as the proposed diffuser.

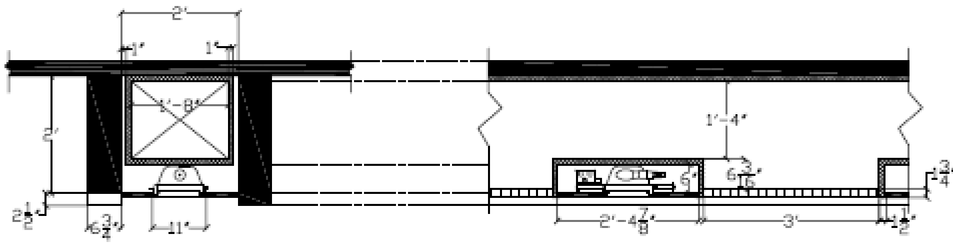
Please refer to the following plans and detail for more detail of the proposed mechanical and lighting integration.

Proposed Mechanical Plan



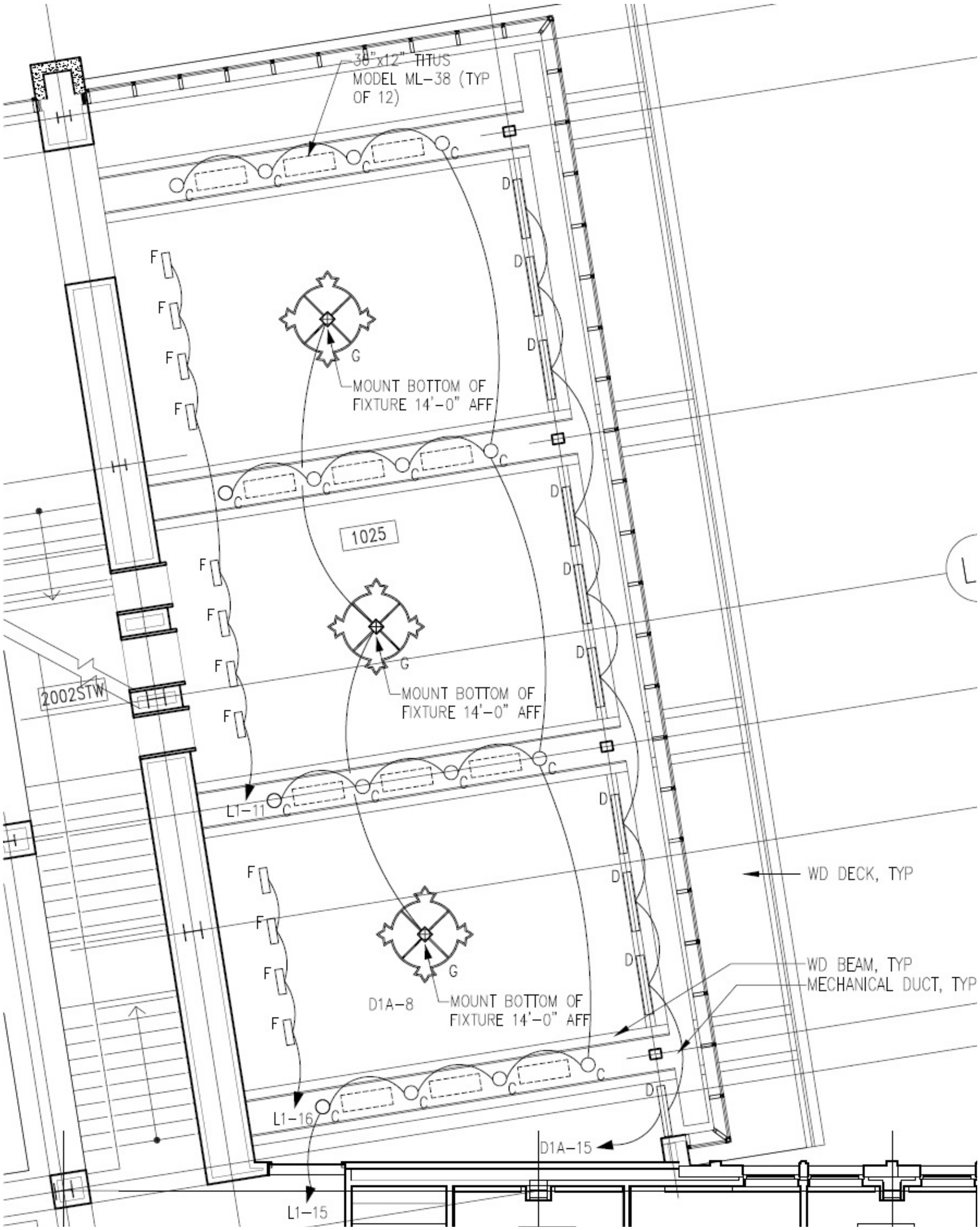
Mechanical and Lighting Integration Detail





Note: Larger drawings can be found in Appendix B along with relevant cut sheets

Mechanical and Lighting Coordination Plan



Mechanical Cost Estimate

<table>
<tr><th colspan="8">Mechanical Cost Estimate</th></tr>
<tr><th>Duct Description</th><th colspan="2">Gauge</th><th colspan="2">Linear Ft (L.F.)</th><th colspan="2">Cost/L.F.</th><th>Total Cost</th></tr>
<tr><td>Existing 22GA, 20" Dia. Round Factory Installed Double Wall Insulated Duct</td><td colspan="2">24ga</td><td colspan="2">22</td><td colspan="2">$27.70</td><td>$609.40</td></tr>
<tr><th>Duct Description</th><th>Sum-Two-Sides</th><th>Gauge</th><th>Linear Ft</th><th>Wt-Lbs/lf</th><th>Wt-Lbs</th><th>Cost/Lbs</th><th>Total Cost</th></tr>
<tr><td>Proposed 22GA, 20"x16" Factory Installed 1" Double Wall Insulated Duct</td><td>36</td><td>22ga</td><td>22</td><td>9</td><td>198</td><td>$7.31</td><td>$1,447.38</td></tr>
<tr><td colspan="7">Total Mechanical Cost Difference</td><td>($837.98)</td></tr>
</table>

*All unit cost values obtained from 2008 RS Means

Conclusion

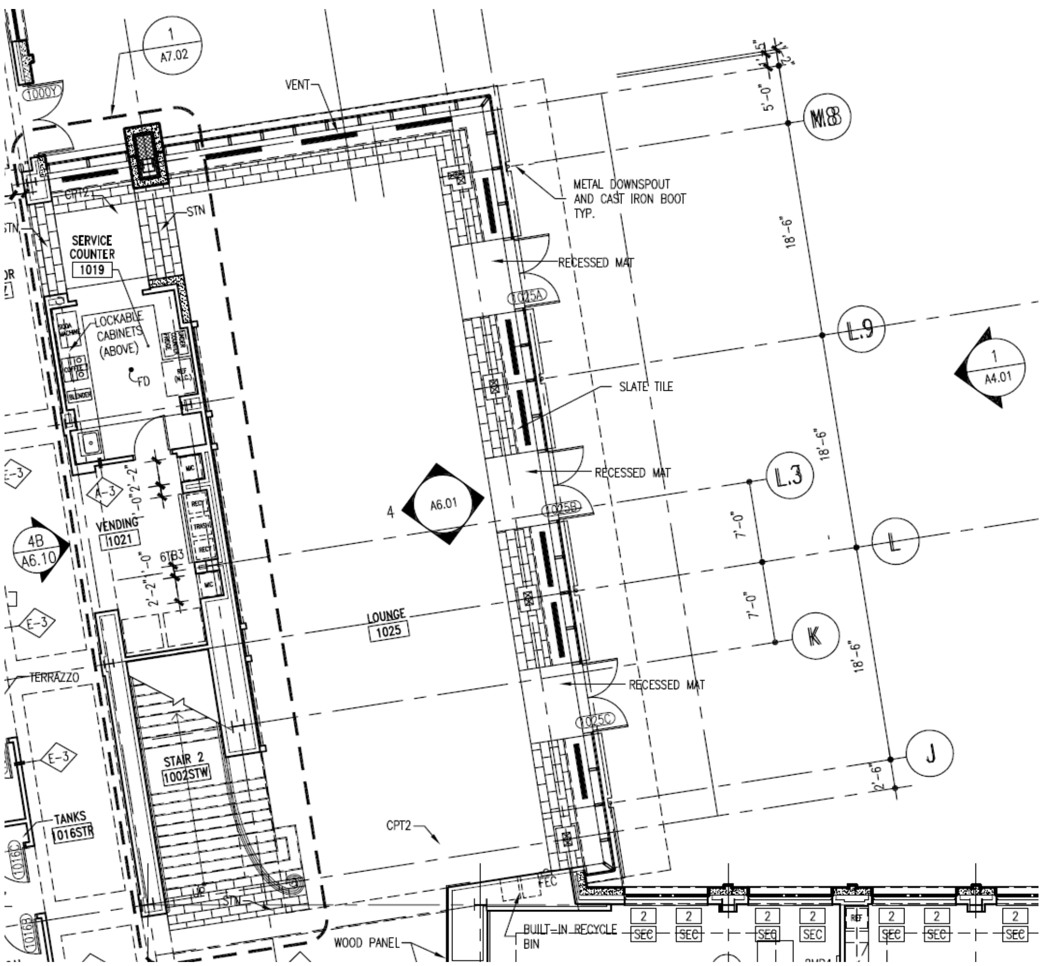
The proposed mechanical change will cost an additional $838, as compared to the existing mechanical system. This cost estimate assumes that the diffuser changes are equivalent in price, since no pricing information could be obtained for these two products. Also, this estimate is not including the additional wood that was proposed for the entire integration of the lighting and mechanical systems in the café. Even though this change from a round to rectangular duct cost a more, it is justifiable to say that this additional cost is worth it to make the space look better and potentially function better with the better diffusers.

Acoustical Breadth

Introduction

The Café DUSON Student Lounge is a large double high space that contains a large amount of wood, glass, and painted gypsum wall board. These materials are highly reflective acoustically. The space also contains two large parallel walls, one of which is the large glass curtain wall in front of the arches. The parallel walls can create flutter echoes if not treated correctly. Since this space is designed to be a relaxing study lounge and a general gathering space, reverberation times are critical to limit the amount of noise in the space. For this reason a reverberation time (T_{60}) study will be conducted to determine what measures need to be addressed to correct these times.

Architectural Plan



Reverberation Time Calculations

Existing Reverberation Time (T_{60}) Calculation							
Surface Description	[S] Surface Area (ft^2)	Absorption Coefficient (α)					
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Thin Carpet Flooring on Concrete	1843.0	**0.020**	**0.060**	**0.140**	**0.570**	**0.600**	**0.650**
A = S(α)		36.86	110.58	258.02	1050.51	1105.80	1197.95
Wood Tongue and Groove Ceiling	1710.0	**0.240**	**0.190**	**0.140**	**0.080**	**0.130**	**0.100**
A = S(α)		410.40	324.90	239.40	136.80	222.30	171.00
Wood Ceiling Beams	985.5	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		147.83	108.41	98.55	68.99	59.13	68.99
Wood Support Beams	243.3	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		36.49	26.76	24.33	17.03	14.60	17.03
Wood Columns	188.4	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		28.27	20.73	18.84	13.19	11.31	13.19
Wood Suport Arches	244.4	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		36.67	26.89	24.44	17.11	14.67	17.11
Wood Arches	340.0	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		51.00	37.40	34.00	23.80	20.40	23.80
Concrete Footings	50.3	**0.010**	**0.010**	**0.015**	**0.020**	**0.020**	**0.020**
A = S(α)		0.50	0.50	0.75	1.01	1.01	1.01
Wood Railing	13.1	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		1.97	1.44	1.31	0.92	0.79	0.92
Exterior Glass, 1"	2126.8	**0.180**	**0.060**	**0.040**	**0.050**	**0.020**	**0.020**
A = S(α)		382.83	127.61	85.07	106.34	42.54	42.54
Thin Fabric Wall Panels	380.3	**0.030**	**0.040**	**0.110**	**0.170**	**0.240**	**0.350**
A = S(α)		11.41	15.21	41.83	64.65	91.27	133.11
Wood Paneling, 1/4", with airspace behind	211.7	**0.420**	**0.210**	**0.100**	**0.080**	**0.060**	**0.060**
A = S(α)		88.91	44.46	21.17	16.94	12.70	12.70
Inner Wall Wood Beam Columns	225.1	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		33.77	24.77	22.51	15.76	13.51	15.76
GWB, 1/2", on 2x4 studs	1539.7	**0.290**	**0.100**	**0.050**	**0.040**	**0.070**	**0.090**
A = S(α)		446.51	153.97	76.99	61.59	107.78	138.57

Recommended Reverberation Times

Room volume = 1270 m^3

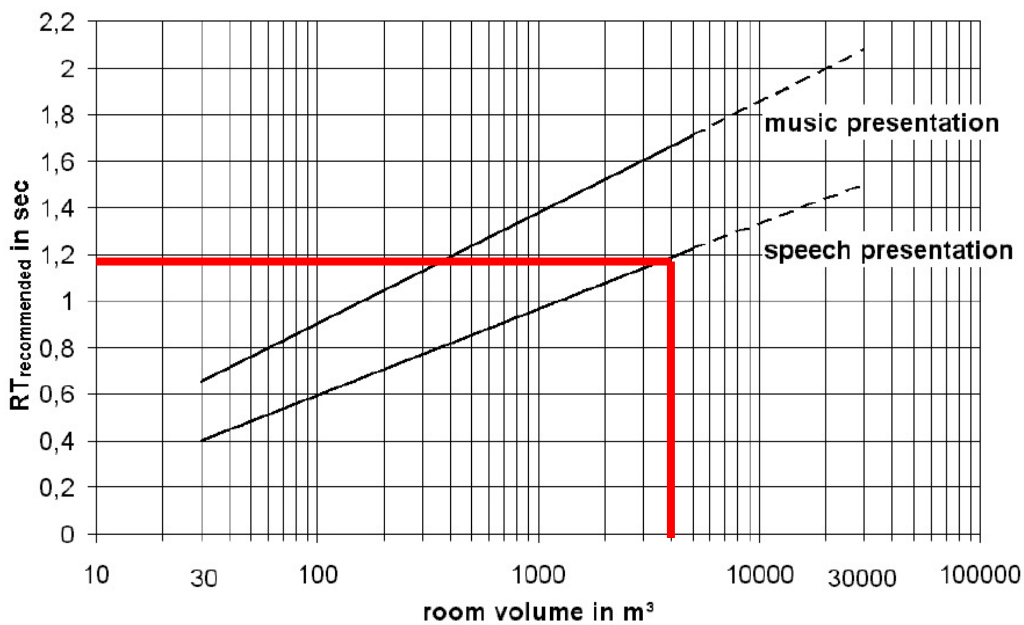


Figure 1.1: Recommended value of the mean reverberation time $RT_{recommended}$ from 500 Hz to 1000 Hz for speech and music presentations as a function of room volume V

Existing Reverberation Times

Existing Reverberation Time (T_{60}) Calculation							
		Frequency					
Room Volume (67.5' X 27.25' X 24') ft^3=	44145	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Reverberation Time (Seconds)	T_{60}= 0.049V/ΣA	1.26	2.11	2.28	1.36	1.26	1.17
Target Reverberation Time (Figure 1.1 Value)	1-2 sec	Acceptable	Not Acceptable	Not Acceptable	Acceptable	Acceptable	Acceptable

After performing the existing reverberation time calculations the times for the 250Hz and the 500Hz frequencies fell above the recommended reverberation time of 1- 2 seconds. These frequencies make up part of the sound energies in speech that contain vowels. Since the vowels make up 75% of sound energy in speech, it is this part of the spectrum that accounts for quality of a person's speech.

In order to correct these reverberation times, more absorptive material is required in the space. Since two of the café's walls are glass and the ceiling is exposed architectural wood, the properties of one or both of the remaining two walls must become slightly more absorptive. Some of the materials on the large non-glass wall, the wall opposite the arches, are thin fabric wrapped panels. The following table shows the calculations for changing those thin fabric wrapped panels to heavier fabric wrapped on 5/8" perforated mineral board panels.

Corrected Reverberation Time (T_{60}) Calculation							
Surface Description	[S] Surface Area (ft^2)	Absorption Coefficient (α)					
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Thin Carpet Flooring on Concrete	1843.0	0.020	0.060	0.140	0.570	0.600	0.650
A = S(α)		36.86	110.58	258.02	1050.51	1105.80	1197.95
Wood Tongue and Groove Ceiling	1710.0	0.240	0.190	0.140	0.080	0.130	0.100
A = S(α)		410.40	324.90	239.40	136.80	222.30	171.00
Wood Ceiling Beams	985.5	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		147.83	108.41	98.55	68.99	59.13	68.99
Wood Support Beams	243.3	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		36.49	26.76	24.33	17.03	14.60	17.03
Wood Columns	188.4	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		28.27	20.73	18.84	13.19	11.31	13.19
Wood Suport Arches	244.4	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		36.67	26.89	24.44	17.11	14.67	17.11
Wood Arches	340.0	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		51.00	37.40	34.00	23.80	20.40	23.80
Concrete Footings	50.3	0.010	0.010	0.015	0.020	0.020	0.020
A = S(α)		0.50	0.50	0.75	1.01	1.01	1.01
Wood Railing	13.1	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		1.97	1.44	1.31	0.92	0.79	0.92
Exterior Glass, 1"	2126.8	0.180	0.060	0.040	0.050	0.020	0.020
A = S(α)		382.83	127.61	85.07	106.34	42.54	42.54
Carpet, heavy, on 5/8-in perforated mineral board	380.3	0.37	0.410	0.630	0.850	0.960	0.920
A = S(α)		140.71	155.92	239.59	323.26	365.09	349.88
Wood Paneling, 1/4", with airspace behind	211.7	0.420	0.210	0.100	0.080	0.060	0.060
A = S(α)		88.91	44.46	21.17	16.94	12.70	12.70
Inner Wall Wood Beam Columns	225.1	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		33.77	24.77	22.51	15.76	13.51	15.76
GWB, 1/2", on 2x4 studs	1539.7	0.290	0.100	0.050	0.040	0.070	0.090
A = S(α)		446.51	153.97	76.99	61.59	107.78	138.57

Corrected Reverberation Time (T_{60}) Calculation							
		Frequency					
Room Volume (67.5' X 27.25' X 24') =	44145	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Reverberation Time (Seconds)	T_{60}= 0.049V/ΣA	1.17	1.86	1.89	1.17	1.09	1.04
Target Reverberation Time (Figure 1.1 Value)	1-2 sec	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Cost Analysis

Acoustical Cost Estimate			
Material Description	**Surface Area (SF)**	**Cost/SF**	**Total Cost**
Existing Thin Fabric Wrapped Panels	380.3	$6.97	$2,650.69
Proposed Carpet, heavy, on 5/8-in perforated mineral board	380.3	$8.97	$3,411.29
		Total Acoustical Cost Difference	($760.60)

*All unit cost values obtained from 2008 RS Means

Conclusion

The sound quality of the space was improved by reaching the recommended reverberation time range with the modification to the fabric wrapped panels on the west wall. The cost analysis determined that by spending an extra $770 on material cost for the space the reverberation times fall with the recommended range for the space. In conclusion it is recommended that this relatively minimal cost is worthwhile in improving the sound quality of the room.

Summary | Conclusion

Lighting Depth

The Lighting Depth looked at the redesign of four different spaces within the Duke School of Nursing. The lighting design in each space meets IESNA design criteria and ASHRAE 90.1 power density allowances. The design goal of tying all the spaces together with the lighting was met. The previously mentioned goal starts in the lobby, where the lights are in square patterns within the square wooden beam pattern and a custom chandelier that contains arches and the school logo. Then in the auditorium the ceiling was dropped and a square pattern cove system was put in place with down lights running down the "beams", the dropped part of the ceiling. Next in the café the same custom chandelier from the lobby were used and visually framed out by the arches. Also in the café the downlights were placed within the roof beam supports which create a square pattern. Finally, the courtyard retaining walls are arcs which are highlighted by an in-ground luminaire which housing is square in shape. The other design goals were achieved as well with the aesthetically pleasing simple lighting design.

During the calculation part of the lighting design process I was faced by an over lit and a high energy use auditorium space. In order to get a uniformly lit cove system, a large quantity of 4-ft luminaires had to be utilized. Since the illuminance in the space was greater than the recommended IESNA values, I was able to use a low ballast factor ballast (0.77). By reducing the ballast factor, fewer watts are used per fixture and less lumens are produced from the lamps. By doing this I was able to meet the ASHRAE 90.1 power density allowance and still meet the IESNA design criteria. The disadvantage to using a low ballast factor ballast is that they are not capable of being dimmed. For this reason, the specified Lutron Graffic Eye will only switch a certain quantity of these fixtures on or off to raise or lower the light level in the space.

Electrical Depth

The Electrical Depth analyzed several components of the entire building electrical system designed lighting spaces was conducted. A panelboard coordination study was conducted for all the lighting changes made in the Lighting Depth. The panelboard loads were adjusted accordingly and then all the associated equipment (circuit breakers, feeders, and possibly transformers) was resized to reflect the lighting changes. However, due to the fact that the there were no substantial lighting load changes from the existing lighting system the equipment nearly stayed the same.

In the energy efficient transformer feasibility-cost comparison, known electrical metering data as well as other building energy variables were entered into Powersmiths payback calculator. It was determined that implementing energy efficient transformers in the entire building is not only a money saver after the 6 year payback period but also environmentally friendly because of the reduced energy production. In the central transformer system cost comparison to the distributed transformer system, it was determined that it is beneficial to use the proposed system. The challenging part to doing the central transformer study was that my panelboard schedules did not have loads per circuit for most of the panelboards in the building. The mechanical loads were determined from the mechanical motor schedule and I had to make assumptions as to the loading on all the receptacle loads. After computing the estimated loads the panelboard sizes matched the panelboard sizes on the single line diagram. Once the loads on the existing panelboards were known, the comparison was relatively simple.

The Mechanical Breadth looked at modifying the mechanical duct system of the café in order to be able to integrate it with proposed lighting system. This integration of systems improved the visual appearance of the space, which equated to the improvement of the architectural integrity of the space. The breadth concluded that the results of the integration are worth the minimal cost.

The Acoustical Breadth looked at reducing the reverberation times in the café, since this space is a study lounge and a large social gathering, the amount of noise and the quality of speech in the space are important elements. The breadth concluded that the quality of speech could be improved with the replacement of the fabric on the wrapped wall panels with thicker fabric, at a minimal cost difference.

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National Electric Code 2005, Quincy, MA: National Fire Protection Association, Inc., 2004

PowerSmiths Energy Savings Payback (ESP) Calculator

GE Lamp Product Catalog 2004

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