THESIS 2007

BY KHA N DANG

THESIS SPRING 2007
CONSULTANTS
R.MISTRICK//T.DANNERTH

ARCHITECTURAL ENGINEERING • LIGHTING/ELECTRICAL OPTION

Project Teams

Occupant	Yale University
Architect	Kieran Timberlake Associates LLP
Structural	CVM Engineers
C/M/E Engineer	BVH Integrated Services
Lighting	Arup Lighting
Landscape	Andropogon Associates
Parking	Tim Haahs and Associates, Inc.
Code	Bruce Spiewak
Environmental	Atelier Ten
Signage	Strong Cohen
Elevator	Van Duesen and Associates

Building Statistics

Occupant Type	Education/Parking/Gallery
Size (SF)	155,828 SF
Construction Schedule	March 2006 - June 2007
Cost	$36 Million USD
Delivery Method	Design-Bid | Fast Tracked

The Yale Sculpture Building consists of three connecting buildings. The Main Sculpture Building is a four story, 55,000 sq. ft. building for the Sculpture Department of the Yale School of Art. The second building is a double-height single floor gallery for exhibition of student work. The last structure is a five level parking garage. The garage has up to 288 parking spaces and contains a 9,000 sq.ft. area for retail and office space.

Sculpture Building
100ft 4 floors, Basement
Steel frame, double-skin, naturally ventilated curtian wall system

Parking Garage
88ft 5 levels
Vine Planter System

Photo Courtesy of Kieran Timberlake Associates LLP

YALE SCULPTURE BUILDING AND PARKING GARAGE
New Haven, Connecticut

Gallery Building
64ft Double-Height
Stone Clad, Steel Frame

Structural System

Sculpture Building and Gallery
- -Steel Frame and Concrete Slab
- -10” Shear Wall / 8” CMU Shaft
- -12” Foundation Walls with Footings every 20’

Parking Garage
- -Post-Tension construction
- -18.5 k/ft Uniform Post Tension force
- -12”-18” Reinforced concrete foundation walls

Lighting | Electrical System

Fluorescent Lighting Used Throughout Buildings
1200A 408Y/277V 3 phase Main Switchboard
200KW Emergency Generator
31 208Y/120 Panelboards
9 480Y/277 Panelboards
Individual Metered Retail spaces
13 Step-down Transformers
125 HP 3P 480V Fire pump

HVAC

Radiant Heating System
Displacement Air Ventilation System
Recycled Water System with Zentex Ozone disinfection

Other Systems

Green Roof System
Active Curtain Wall System
Solar Hot Water System

KHA N. DANG

ARCHITECTURAL ENGINEERING - LIGHTING | ELECTRICAL
http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/KND107

ELECTRICAL

ARCHITECTURE

LIGHTING

GREEN

ENGINEERING

“While great efforts have been taken to provide accurate and complete information on the pages of this report, please be aware that the information contained herewith is considered a work-in-progress for this 2007 thesis project. Modifications and changes related to the original building designs and construction methodologies for this senior thesis project are solely the interpretation of **Kha N Dang**. Changes and discrepancies in no way imply that the original design contained errors or was flawed. Differing assumptions, code references, requirements, and methodologies have been incorporated into this thesis project; therefore, investigation results may vary from the original design. ”

TABLE OF CONTENTS

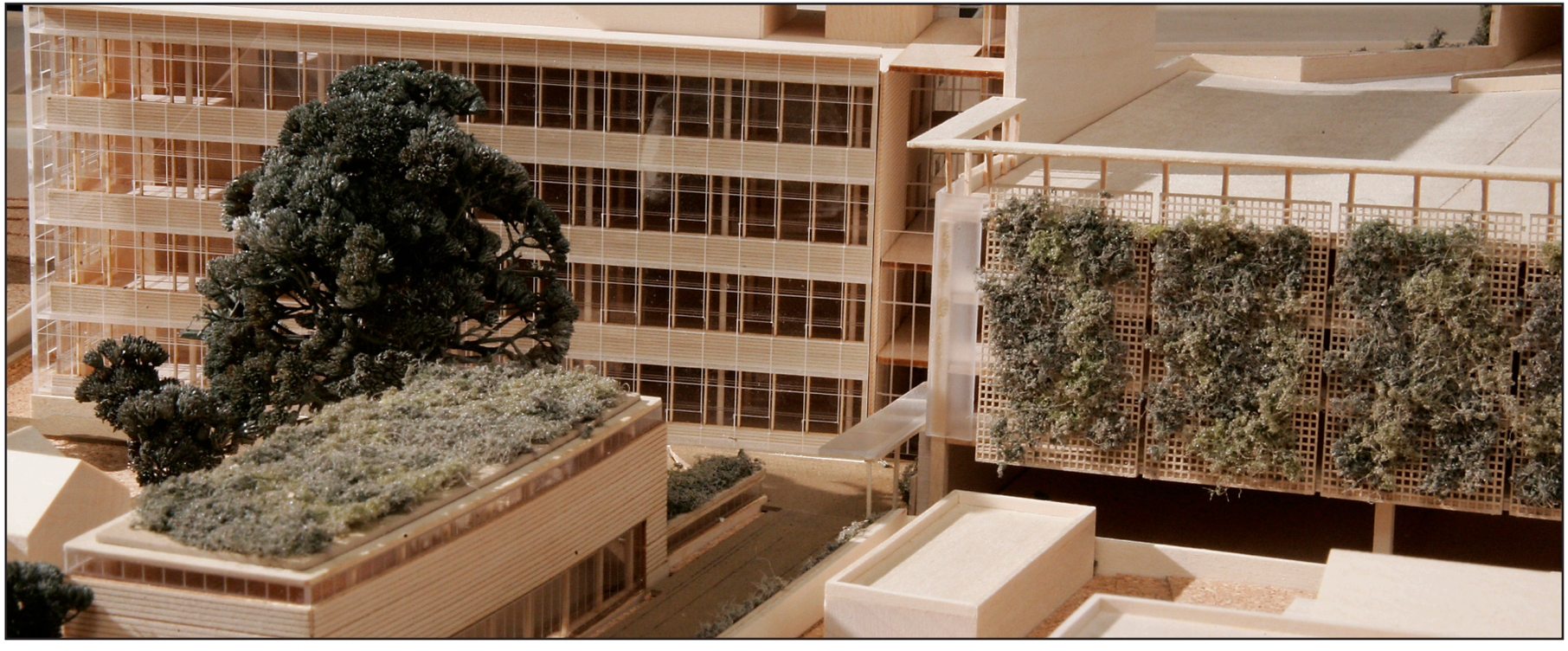
EXECUTIVE SUMMARY

This Yale Sculpture Building is a three part building that serves as the edge of the Yale Campus and the residential sector. The primary focus of the design of this structure is sustainability. The building contains classrooms, offices, retail spaces, studios, parking areas and a Gallery.

This report contains a redesign of the lighting and electrical (partial) systems. The following pages will discuss the criteria for the newly designed systems and contain an in-depth (case-studies) study for four (4) spaces. These spaces are Dean's Office, Studios, Gallery and Exterior/ Landscape.

Since the lighting system will be changed, the mechanical system will need to change to correspond to the new heating and cooling loads. The main focus of the mechanical redesign will be to downsize equipment to increase rentable space and decrease initial cost.

In my redesign of the fourth (4th) floor studio, a clerestory was added to decrease the use of electrical lighting. The addition of the clerestory warrants an investigation of the stability of the existing structure.



BUILDING STATISTICS

GENERAL INFORMATION

Building Name	Yale Sculpture Building
Location	New Haven, Connecticut
Building Occupant	Yale University
Occupancy Type	Education | Gallery | Parking
Size [SF]	155,828 SF
Height	Sculpture Building - 100 FT
	Gallery - 64 FT
	Parking Garage - 88 FT
Construction Schedule	March 30, 2006 - June 30, 2007
Approximate Cost	$36 Million USD
Delivery Method	Design-Bid | Fast Tracked
Sponsor	Steven Johns
	Kieran Timberlake Associates

PROJECT TEAMS

Architect	Kieran Timberlake Associates LLP
Structural	[Removed by Request]
C/M/E Engineer	[Removed by Request]
Lighting Design	[Removed by Request]
Landscape	[Removed by Request]
Parking	[Removed by Request]
Code	[Removed by Request]
Environmental	[Removed by Request]
Signage	[Removed by Request]
Elevator	[Removed by Request]

GENERAL DESIGN SUMMARY

ARCHITECTURE

The Yale Sculpture Building is composed of three connected buildings. The main Sculpture Building is a four story, 55,000 square feet building. This section will briefly house the architecture department and will be permanently occupied by the Sculpture department of the Yale School of Art. The building contains loft-like studios, classrooms, shop space, faculty and administrative offices, and storage throughout its occupancy. Adjacent to the main building, the parking garage can accommodate 288 vehicles. The first level of the garage contains a 9,000 square foot space for retail and office space. The last structure is the Gallery which is connect to the other buildings via a underground tunnel. This structure supports a green roof and is designated for student exhibition.

ZONING

2005 Connecticut State Building Code (CSBC)
2005 Connecticut State Fire Safety Code (CSFSC)
Connecticut State Amendments to IBC, IMC, IECC and ANSI 117.1 2003
2003 International Building Code (IBC)
2003 International Residential Code
2003 International Plumbing Code
2003 International Mechanical Code
2003 International Energy Conservation Code
2003 International Fire Code
NFPA 70 National Electric Code
  221 Standard for Fire Walls and Fire Barriers Walls
2003 ICC Performance Code
2003 ICC/ANSI A117.1

HISTORICAL REQUIREMENTS

Zoning was a slight issue on the site since it was composed of several properties. A particular problem was a structure that was considered to be a “Historically Reserved Building.” The problem was resolved when research showed that the building in question was not actually registered as a historical site.

BUILDING ENVELOPE | ROOFING SYSTEM

The Sculpture Building is an exposed steel frame structure with a glass, double-skin, naturally ventilated curtain wall system. The south facade features a full length shade system that is designed to decrease glare and heat gain through the curtain wall system. The roof system is composed of a steel grid of W beams and sloped concrete slab.

The Gallery is a stone clad, steel frame building with a sub-grade connection tunnel to the Sculpture Building. The roof of the Gallery contains a green garden that is supported by a grid of hollow structural shapes (HSS) and W beams.

The Parking Garage is a post-tension concrete structure that is supported by concrete columns. The North and South facades will have full length vine planters .

CONSTRUCTION PROCESS

The project's delivery method was design-bid that was fast tracked. The total cost of the Yale Sculpture Building was approximately $36 million USD. Construction started in March 2006 and is planned to be completed in June 2007.

ELECTRICAL SYSTEM

The electrical system for Yale Sculpture Building is composed of three separated secondary electrical services from the primary transformer. The main switchgear in the Sculpture Building is rated at 1200A, 480Y/277 volts with a short circuit rating of 100,000A . This supplies power to both the main building and the Gallery. The lighting and receptacles in the main building are powered by a 112.5KVA step transformer off the main switchgear. One of the secondary supplies is connected to a fire protection system that consists of a fire pump and fire cabinet. The fire cabinet is rated at 1200A and connects to a 3 phase, 125HP, 460V fire pump. The last electrical supply feeds into the Parking Garage. Level One of the structure contains areas for offices and retail shops which is metered by a commercial switchboard. The emergency power system is connected to the electrical system via three automatic transfer switches that feed to a 200KW power generator.

LIGHTING SYSTEM

Sculpture Building

The lighting system in the main Sculpture Building operates on a 480Y/277 system. Linear fluorescent luminaires are used throughout the building for energy conservation and easy maintenance. These fixtures use a three lamp, tandem wiring configuration. Daylight and occupancy sensors control lighting levels on all floors. Accent lighting for the lobbies are compact fluorescent downlights. The utility areas such as storage and electrical rooms have industrial type fluorescent fixtures.

Gallery

The lighting system in the Gallery is based on a track gird for flexibility in lighting levels and angles. The space is controlled by two occupancy senors.

Parking Garage

The Parking Garage is evenly illuminated by a grid of 150W surface mounted area flood lights.

MECHANICAL SYSTEM

The Yale Sculpture Building utilizes a radiant heating system. One rooftop air handling unit circulates air in the building. The system contains three boilers and two variable flow controllers. One boiler and one variable flow controller are on standby.

PLUMBING

The Yale Sculpture building utilizes a recycled water system. The system is intended to supply recycled water to the water closets of the Sculpture Building at a capacity and pressure to properly operate the plumbing fixtures at their maximum capacity. The recycled water system also supplies the irrigation system. Zentex Ozone generators and control panels are used to disinfect each system. The recycled water is colored dye in the water closet and clearly labeled “RECYCLED NON-POTABLE WATER”.

STRUCTURAL

The Main Sculpture Building and Gallery structural systems are steel framed construction. The foundation of the Sculpture building consists of primary 6’-6” x 10’-6” x 2’-0” and 6’-6” x 8’-0” x 2’-0” footings spaced 20’-0” around the perimeter and 8’-0” x 8’-0” x 2’-6” footings spaced 28’-0” in the interior section of the building. The foundation walls are typically 12” concrete walls. The steel frame of the building is typically composed of W16x31 steel beams that span 28’-0”. The beams are supported by W24x55 girders that span 20’-0”. A 10” shear wall is common on all levels along with an 8” CMU shaft. The shear wall encloses a stairwell and utility core. The concrete slab varies from a 2.5” – 3” thick normal weight concrete on composite metal floor deck. The foundation of the Gallery consists of footings ranging from 6’-0” x 6’-0” x 1’-6” to 24’-0” x 10’-0” x 2’-0”. The thickness of the reinforced concrete walls are from 12” to 18” thick. The concrete slab is 3” thick normal weight concrete on 3” deep composite metal floor deck. The roof construction is a grid of HSS 12x4x1/4 beams that is supported by W24x62 girders.

The Parking Garage’s structural system is a post-tension construction. The typical slab thickness is seven inches with an approximately 18.5 k/ft uniform post tensioning force required. Concrete columns are approximately spaced 60 feet apart North/ South and 23 feet apart East/ West. Shear walls surround the stairwells and central utility core.

FIRE PROTECTION

The Yale Sculpture building uses a system of sprinklers for fire protection. The Main Sculpture building and Gallery utilize a wet pipe system that has a Fire Department connection. Sprinkler heads are provided with a maximum of 130 square feet range with additional sprinkler heads below and around duct work, piping, conduits, equipment and as required insuring proper floor coverage as regarded in NFPA #13. Sprinkler wire guards are provided where mechanical damage might occur.

TRANSPORTATION

The transportation system consists of two hydraulic elevators. The first is classified as a 3000 lbs capacity passenger that runs on a 480V 3 phase power supply. The second elevator is a type Class “A” freight loading that has a 12,000 lbs capacity.

LIGHTING DESIGN

PRIMARY PRINCIPLES

During the redesign of the lighting system, there were three (3) underlining concepts that influenced the design.

The first concept was to get the right amount of light to the task while avoiding glare and maintaining quality lighting. The placement of luminaires were determined by the located of permanent equipment and flow of movement throughout the space. Lighting levels were determined by IESNA Lighting Handbook 9th Edition.

The second concept was to use energy efficient luminaires / systems. The primary candidate for this concept will be fluorescent fixtures. Controls were a important part of the design of the lighting system. Often, energy is wasted by active luminaires in unoccupied rooms. Power densities were coordinated with ASHRAE 90.1 2004.

The final concept was the use of sustainable design practices. Daylight harvesting was a important factor in the initial design of the building and it will continue to be used in this redesigned system.

This report will only cover the in-depth study of four (4) spaces. These spaces are:

- Exterior / Landscape
- Gallery
- Dean's Office
- Studio

The photometric data, analysis and lighting layouts of all other spaces can be found in the supplement sheet set located at www.arche.psu.edu/thesis/eportfolio/2007/portfolios/knd107.

LIGHTING DESIGN

EXTERIOR / LANDSCAPE

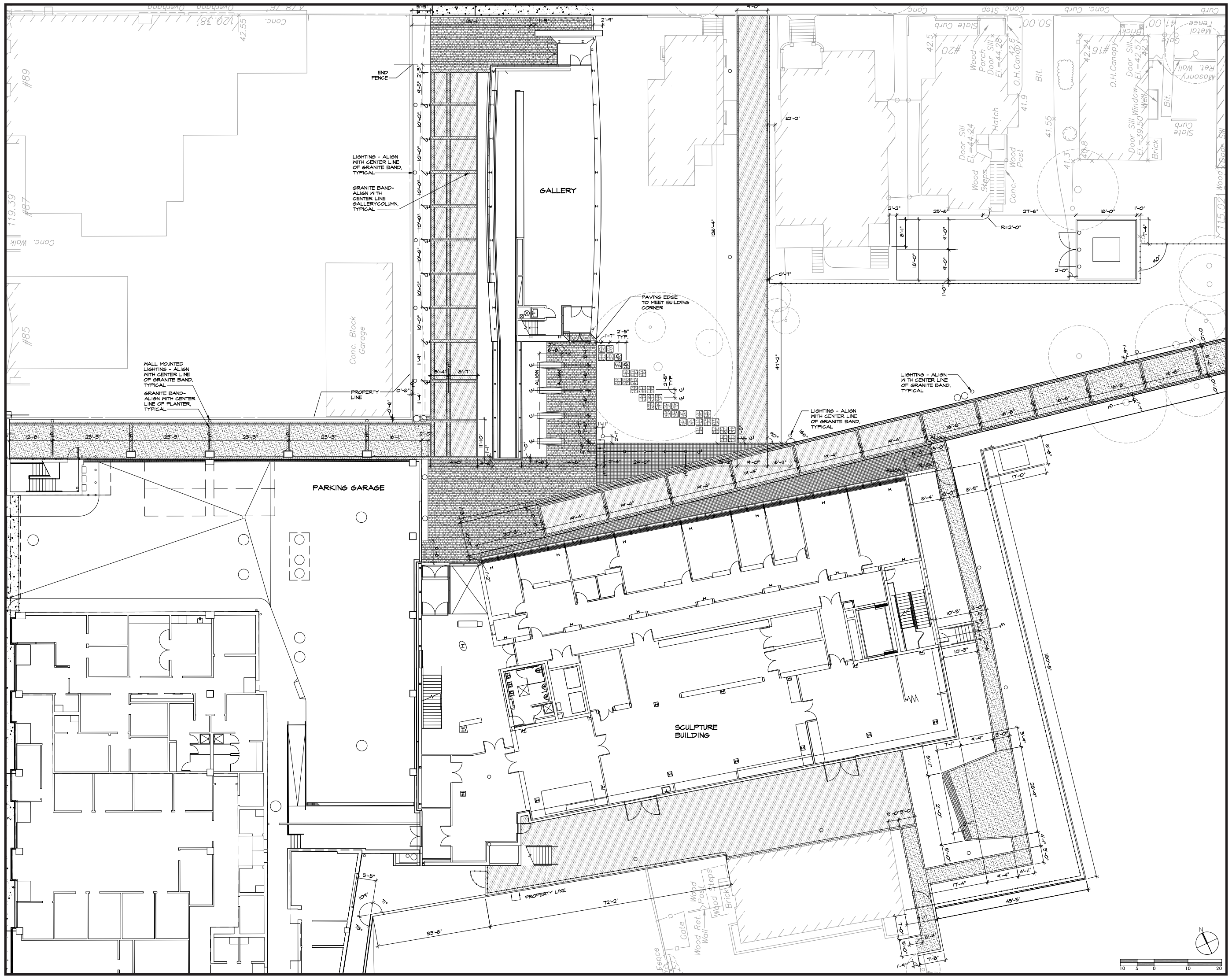
The exterior / landscape connects the residential area to the University campus. The lighting design of this space was determined by LEED 2.2 Sustainable Sites Credit 8.0 Light Pollution. The design complies with this requirement with the use of full cut-off luminaires that operates on a timer / motion sensor combination. The landscape will also house / display student works. Due to weather constraints, a custom luminaire housing was designed to protect both fixtures and sculptures alike.

DESIGN CRITERIA

ILLUMINANCE (Horizontal and Vertical)	30 lux or 3 fc for both horizontal and vertical illuminances
DIRECT / REFLECTED GLARE	Provide a comfortable environment for pedestrian traffic
PUBLIC SAFETY	Ample light levels for facial recognition and traveling path
LIGHTING POLLUTION / TRESPASS	LEED SS Credit 8.0 - Preserve the environment
LIGHT DISTRIBUTION	Even distribution on paths and higher at points of interest

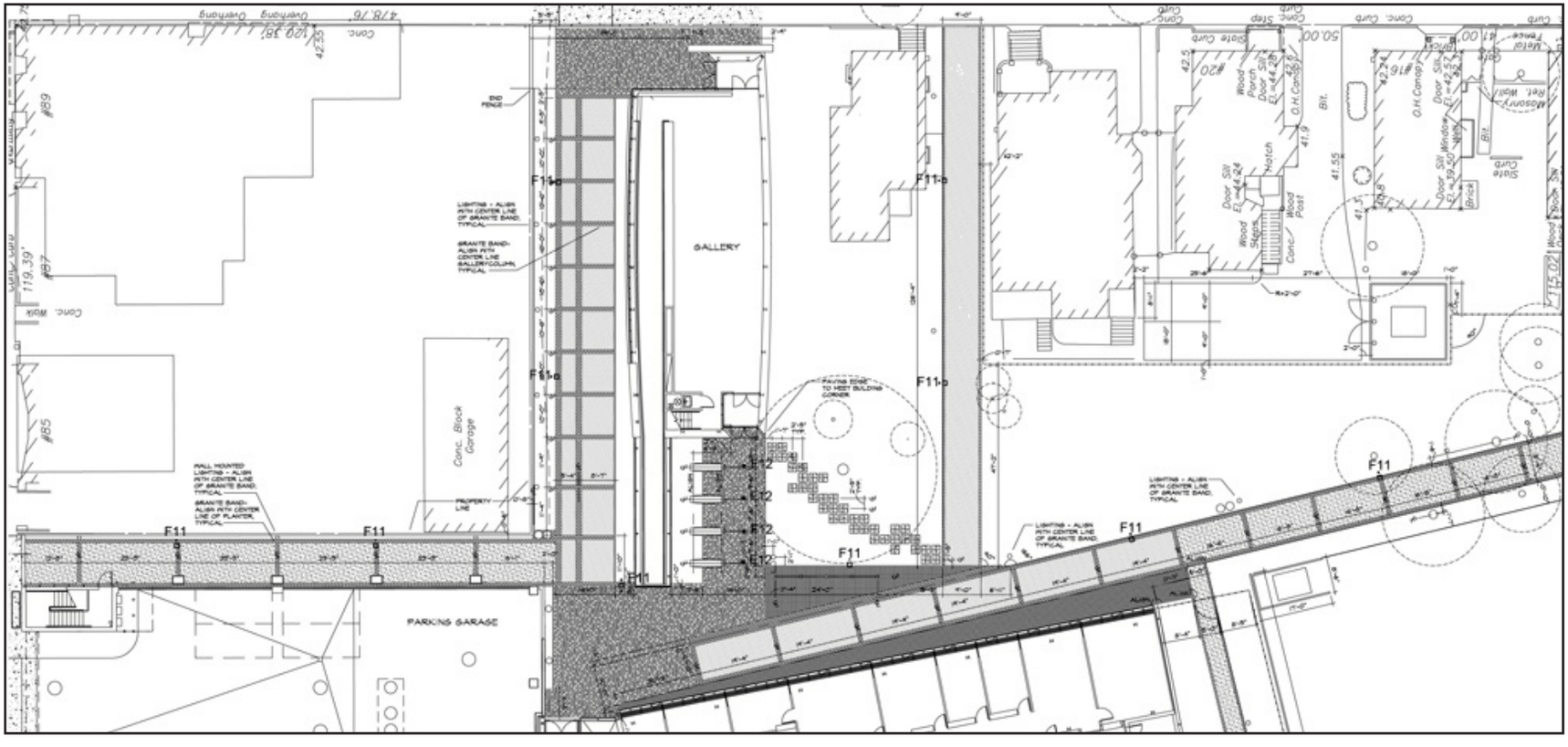
SURFACE REFLECTANCE

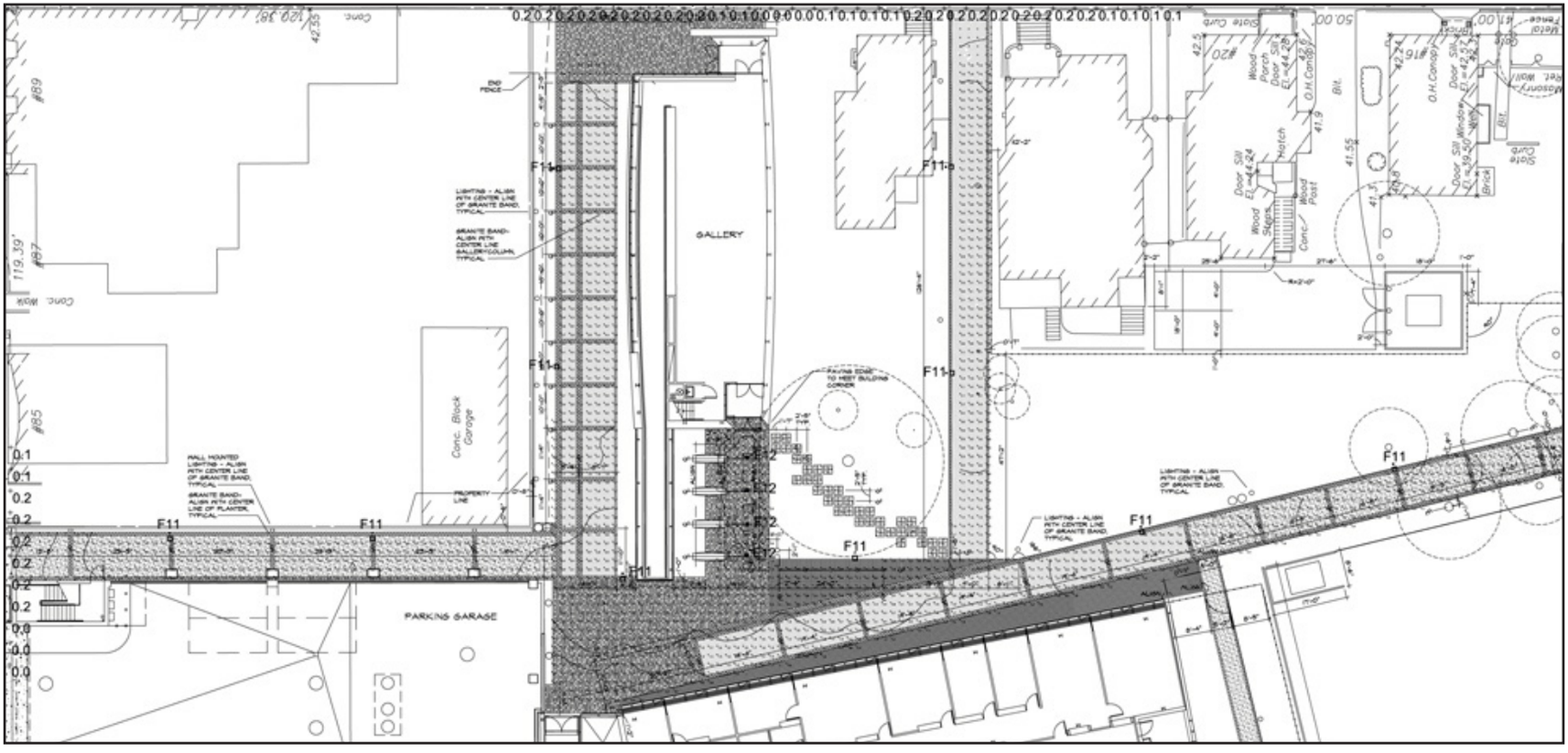
STEEL (W-Beams)	0.20
CONCRETE	0.20
MULLIONS (Painted)	0.35
GLAZING (Double Glazed Low E IGU)	0.6
METAL (Custom Fixture Housing)	0.35


GALLERY
PARKING GARAGE
SCULPTURE BUILDING
PROPERTY LINE

■ LIGHTING DESIGN

EXTERIOR / LANDSCAPE





Please Refer to supplement sheet set for clarifications and larger size drawings (CS-100 & CS-101). The PDF version located at www.arche.psu.edu/thesis/eportfolio/2007/portfolios/knd107 can be used to view details.

LIGHTING DESIGN

EXTERIOR / LANDSCAPE

LUMINAIRE SCHEDULE

SYMBOL	LABEL	QTY	CATALOG NUMBER	DESCRIPTION	LAMP	LLF	WATTS
▭	F11	10	FH3-150MH	TYPE 4 FULL CUT OFF	150W ED-17 MH	0.62	185
○	F12	4	ALR8-50MH	BOLLARD	50W CLR MH V-S-C	0.62	95

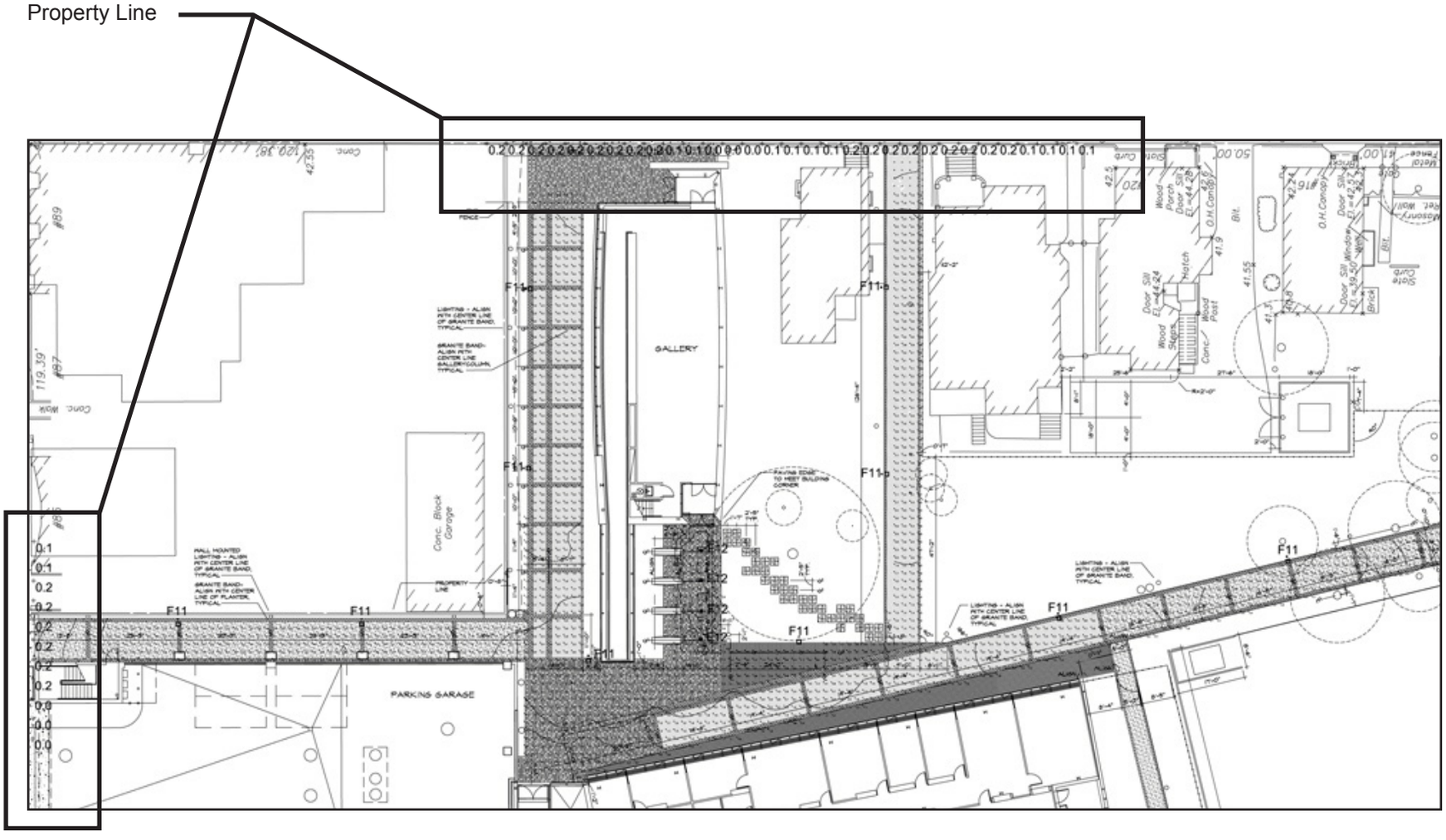
POWER DENSITY

Luminaires	14
Total Power	2230.0 W
Area	13936 SF (Appox)
Power Density	0.16 W/SF

PHOTOMETRIC DATA

Average Illuminance	3 FC
Maximum	7.2 FC
Minimum	0.2 FC
Max/Min	36.0:1
Average/Min	14.0:1

The minimum occurs at the property boundary. The average is 36 lx or 3 FC which complies with IES standards.



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LIGHTING DESIGN

EXTERIOR / LANDSCAPE

LEED - SUSTAINABLE SITES CREDIT 8.0

INTENTS

Minimize light trespass from building and site

Reduce sky-glow to increase night sky access

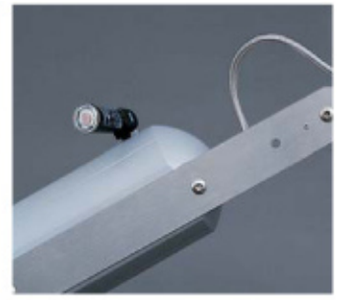
Improve visibility (Glare)

Reduce development impact on environment

☐ **HSS**

HOUSE SIDE SHIELD

House side shield to cutoff light behind the pole and shield the lamp from view.



☐ **BPC12** 120 volt

☐ **BPC27** 208/240/277 volt

PHOTOCELL

Button type photocell with adjustable swivel for aiming. Requires field wiring.

INTERIOR LIGHTING

Non-emergency lighting is controlled to turn off during non-business hours with manual override controls. Refer to individual spaces for control systems.

EXTERIOR LIGHTING

Achieve lower lighting power densities required by ASHRAE 90.1-2004 Section 9 Table 9.4.5

- 20% lower than standard
- Allowable LPD = 0.20W/SF
- Achieved LPD = 0.16W/SF (achieved 20% lower LPD)

Follow requirements defined by IESNA RP-33

- Site Lighting Zone 3 (Commercial/Industrial, Hi-Density Res.)
- 0.2 Horizontal & Vertical at site boundary
- Luminaire is full cut-off and controlled by localized photocell

LIGHTING DESIGN

GALLERY

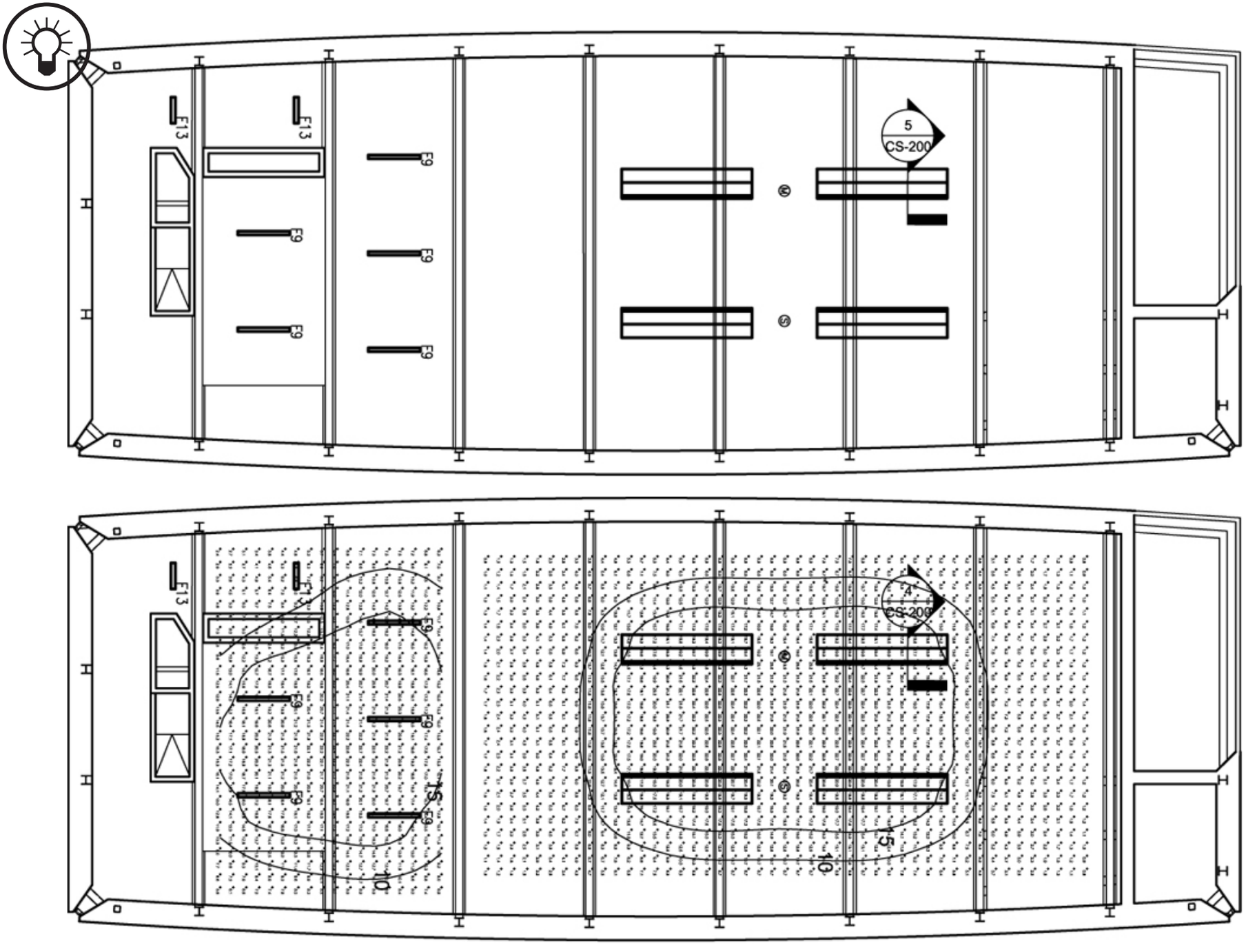
Here the viewer can explore various forms of art work. The gallery has various exhibitions and student works displayed at different times of the year. From the Gallery, a connection tunnel unifies the Gallery and Sculpture Building.

DESIGN CRITERIA

ILLUMINANCE (Horizontal and Vertical)	10 lux or 1 fc for both horizontal and vertical illuminances (Egress)
DIRECT / REFLECTED GLARE	Provide a comfortable environment for viewing sculptures and art
ACCENT LIGHTING	Make the sculptures look dynamic
DAYLIGHT INTEGRATION	Decrease direct glare from windows (clerestories)
LIGHT DISTRIBUTION	Even distribution on paths and higher at points of interest

SURFACE REFLECTANCE

STEEL (W-Beams)	0.20
CONCRETE	0.20
MULLIONS (Painted)	0.8
GLAZING (Double Glazed Low E IGU)	0.6
METAL (Custom Fixture Housing)	0.35
Gypsum Board	0.70
CLR FIN (Clearance Finish)	0.80
RCB (Rubber Cove Band)	0.50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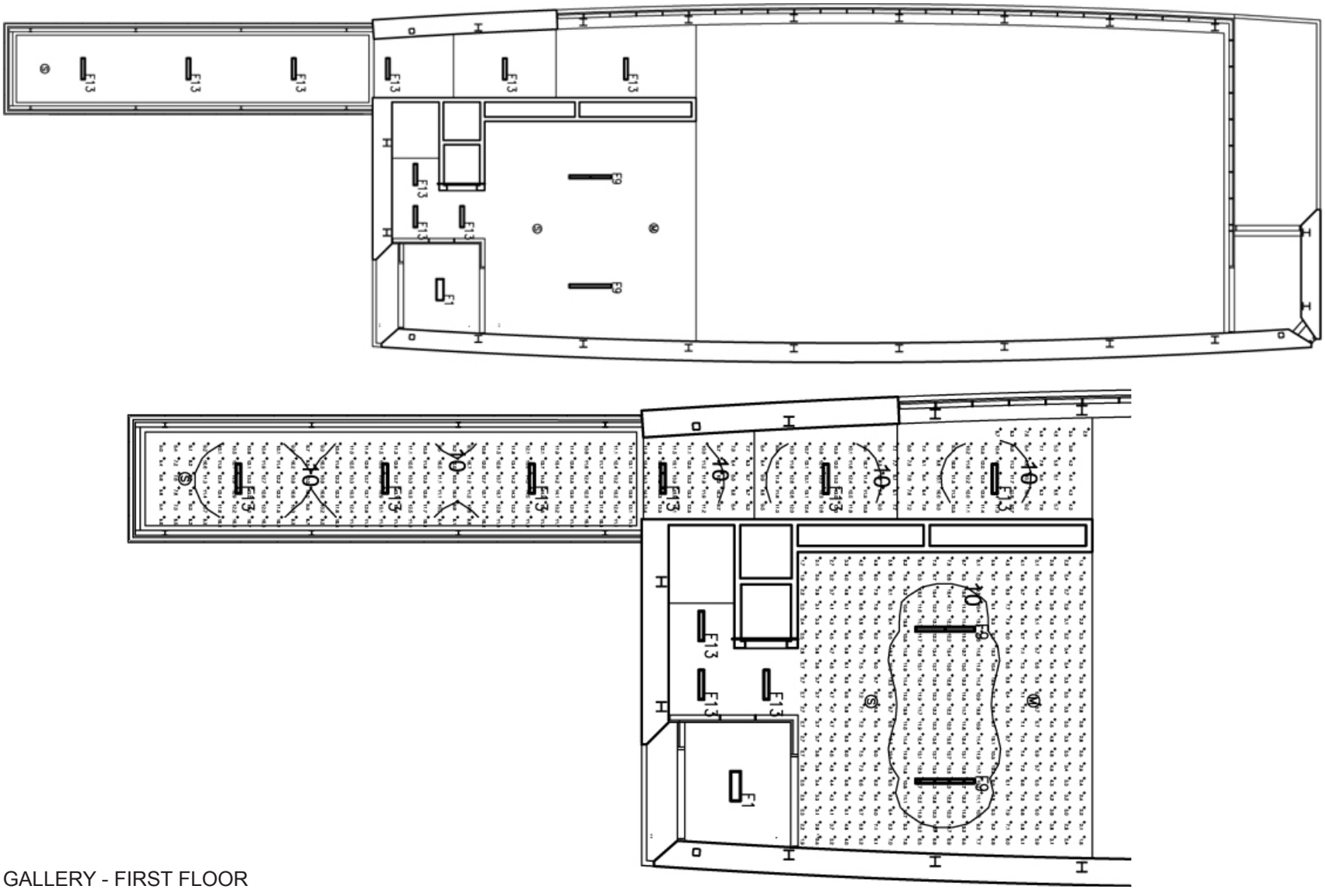
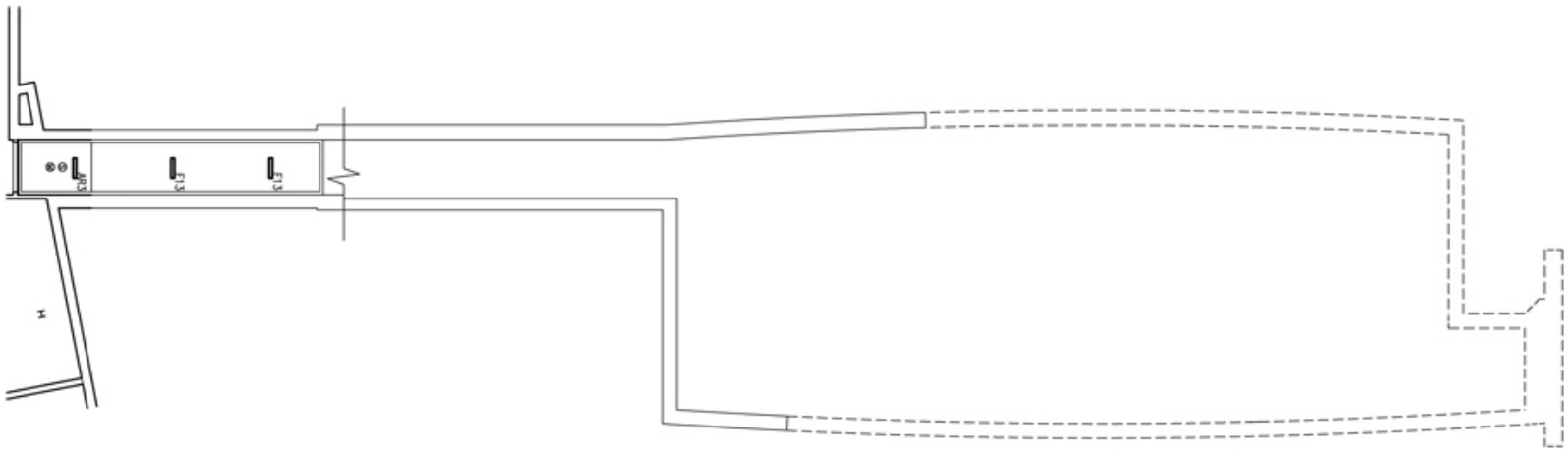
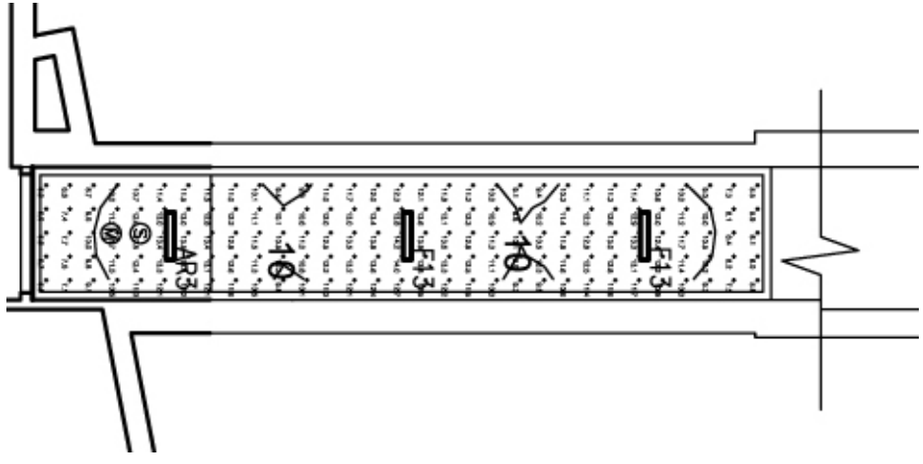
■ LIGHTING DESIGN

GALLERY



GALLERY - FIRST FLOOR





GALLERY - BASEMENT

Please Refer to supplement sheet set for clarifications and larger size drawings (CS-200 & CS-201). The PDF version located at www.arche.psu.edu/thesis/eportfolio/2007/portfolios/knd107 can be used to view details.

LIGHTING DESIGN

GALLERY

LUMINAIRE SCHEDULE

SYMBOL	LABEL	QTY	CATALOG NUMBER	DESCRIPTION	LAMP	LLF	WATTS
	F9	15	RX5-DX-RX5F	FLUORESCENT	54W T5	0.75	99
	F13	9	RC45-D-1-ET5-MBL	FLUORESCENT	T5	0.75	33

POWER DENSITY

DESCRIPTION	LUMINAIRES	WATT	AREA	POWER DENSITY
Basement	3	99 W	154 SF	0.6 W/SF
First Floor	8	396.0 W	851.0 SF	0.5 W/SF
Second Floor	13	1287.0 W	2048.3 SF	0.6 W/SF

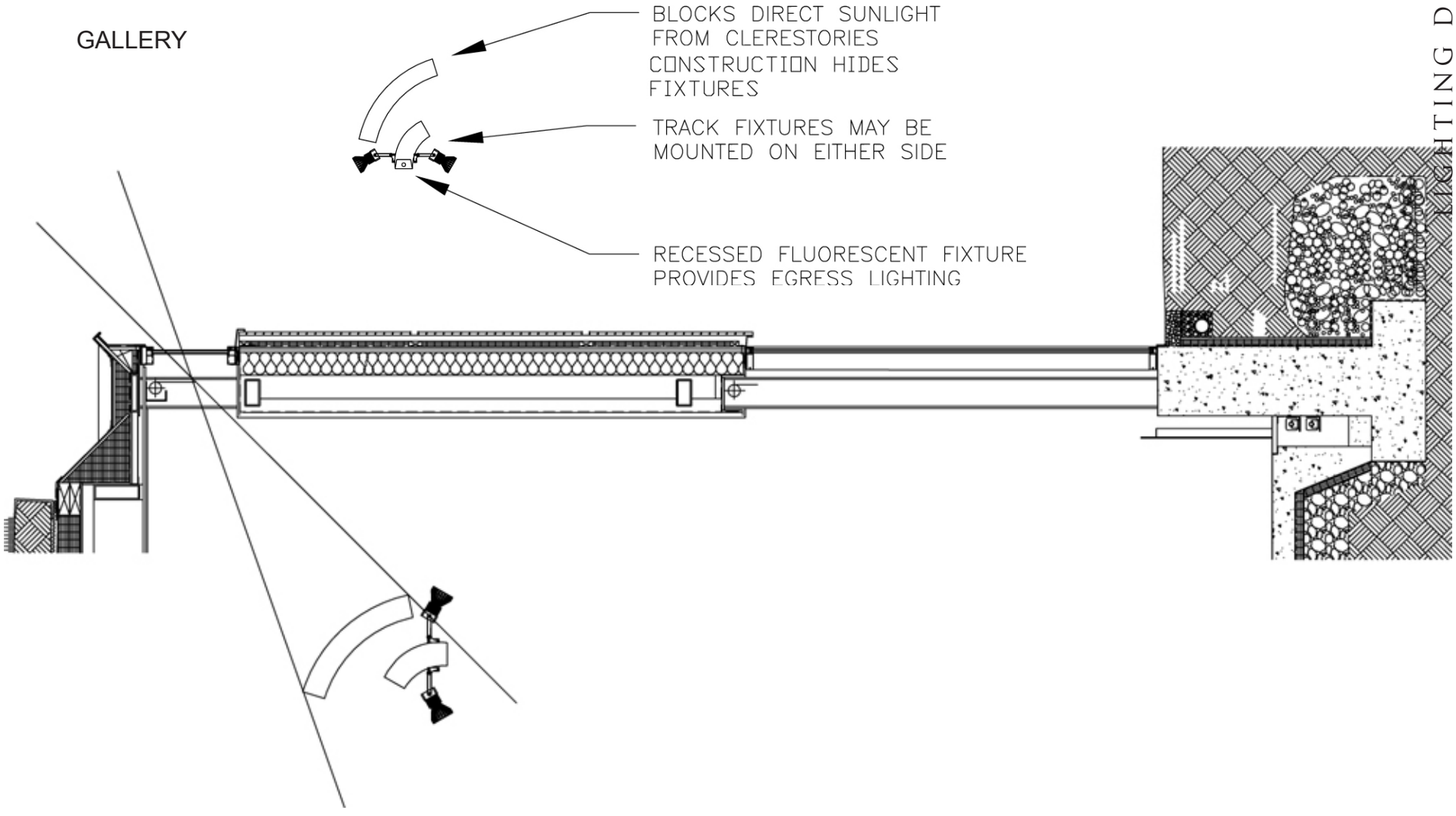
PHOTOMETRIC DATA

DESCRIPTION	AVG	MAX	MIN	MAX/MIN	AVG/MIN
First Floor	7.2 FC	13.7 FC	1.5 FC	9.1:1	4.8:1
Main Floor	11.3 FC	22.9 FC	0.8 FC	28.6:1	14.1:1
Mezzanine	14.5 FC	22.7 FC	2.4 FC	9.5:1	6.0:1
Tunnel	11.0 FC	14.5 FC	2.9 FC	5.0:1	3.7:1

GENERAL LIGHTING WAS DESIGNED WITH LIFE SAFETY CODE IN MIND. SUITABLE TRACK FIXTURES ARE LISTED IN APPENDIX A.

LIGHTING DESIGN

GALLERY



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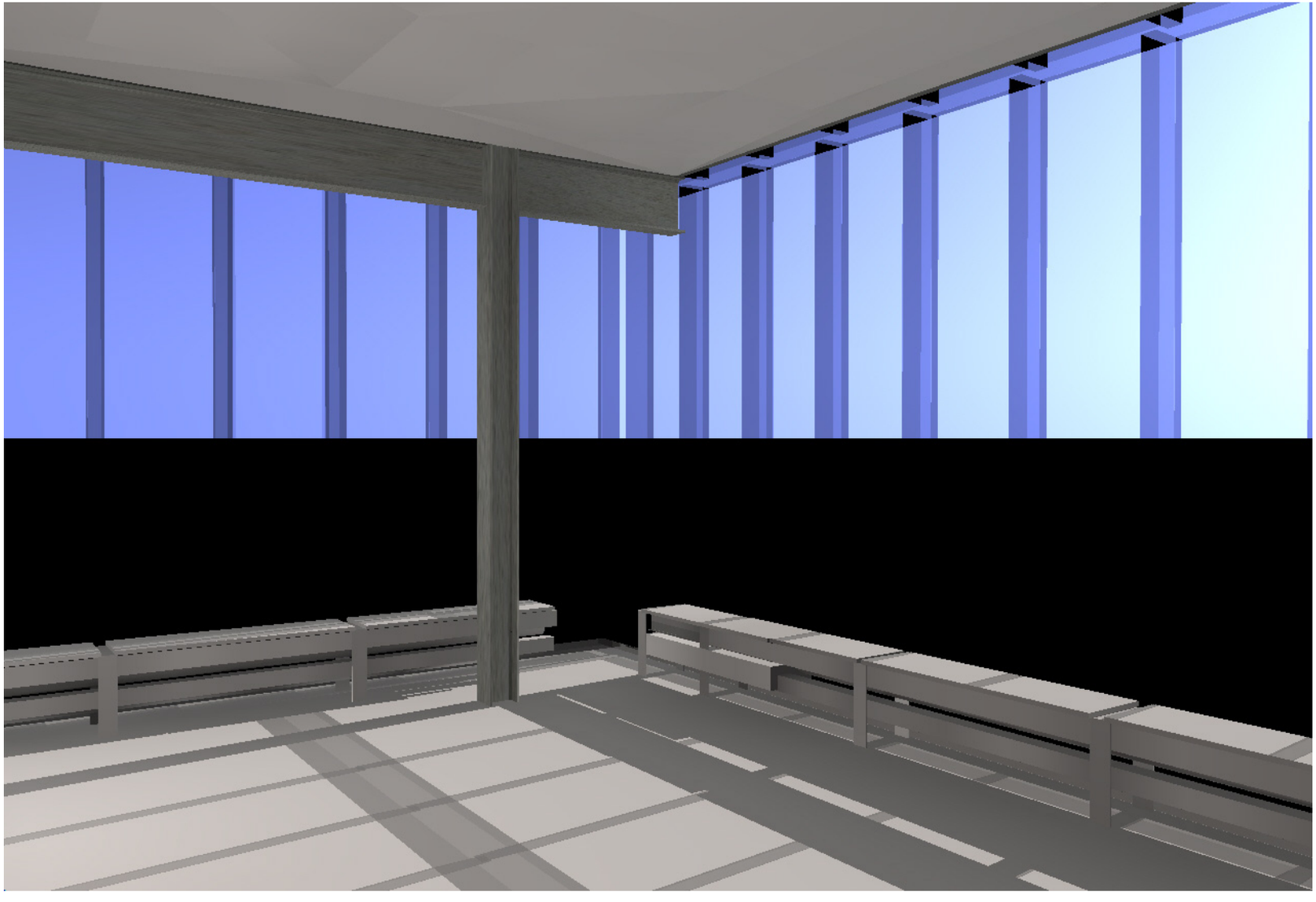


LIGHTING DESIGN

DEAN'S OFFICE

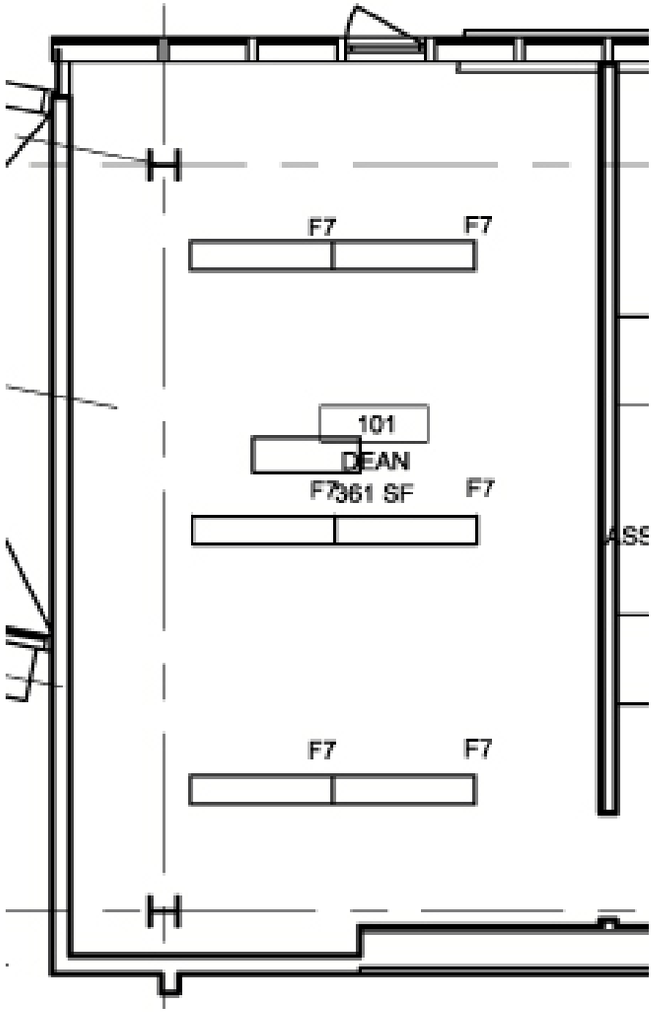
The Dean's Office was a study on daylighting controls and lighting quality. The room has ample daylight so a control scheme will be very important to keep the space pleasant to work in.

DESIGN CRITERIA

ILLUMINANCE (Horizontal and Vertical)	500 lux or 50 fc on workplane (2.5 AFF)
DIRECT / REFLECTED GLARE	Provide a comfortable environment
DAYLIGHT INTEGRATION	Decrease direct glare from windows
LIGHT DISTRIBUTION	Even distribution on the workplane

SURFACE REFLECTANCE

STEEL (W-Beams)	0.20
CONCRETE	0.20
MULLIONS (Painted)	0.8
GLAZING (Double Glazed Low E IGU)	0.6
METAL (Custom Fixture Housing)	0.35
Gypsum Board	0.70
CLR FIN (Clearance Finish)	0.80
RCB (Rubber Cove Band)	0.50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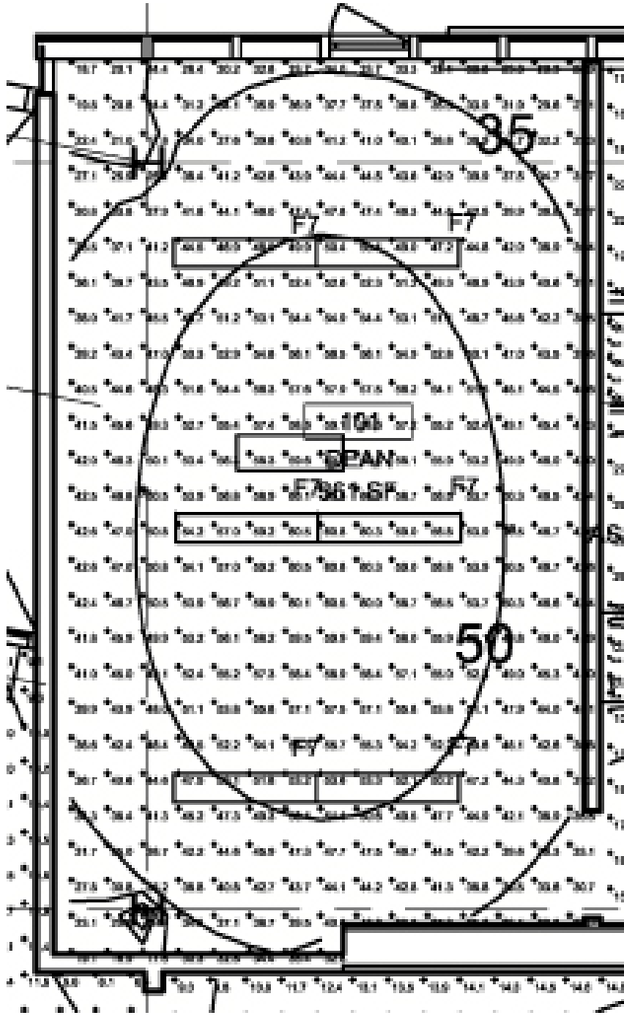
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LIGHTING DESIGN

DEAN'S OFFICE

LUMINAIRE SCHEDULE

SYMBOL	LABEL	QTY	CATALOG NUMBER	DESCRIPTION	LAMP	LLF	WATTS
▭	F7	6	EGAM1-2-54T5HO	FLUORESCENT	54W T5	0.75	117

POWER DENSITY

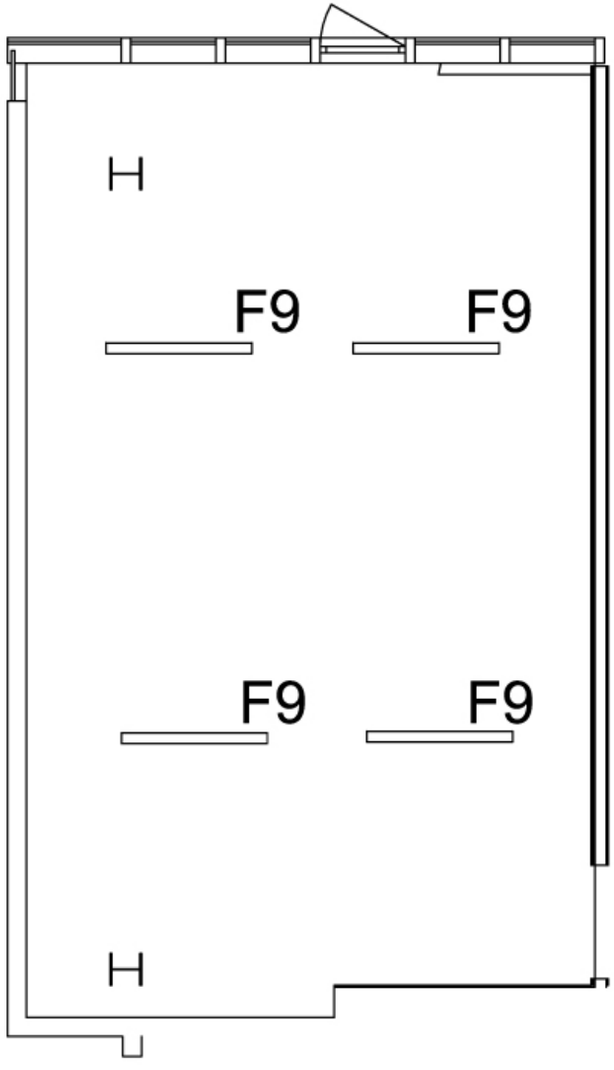
Luminaires	6
Total Power	702W
Area	370 SF
Power Density	1.9 W/SF

PHOTOMETRIC DATA

Average Illuminance	45 FC
Maximum	60.8 FC
Minimum	4.4 FC
Max/Min	13.8:1
Average/Min	10.3:1

This design supplies ample amount of electrical lighting into the space. The system uses mostly indirect lighting for glare control. This system will also work seamless with dimming, a change in illuminance will be less noticeable than direct lighting.

REFER TO APPENDIX B FOR DAYLIGHT ANALYSIS.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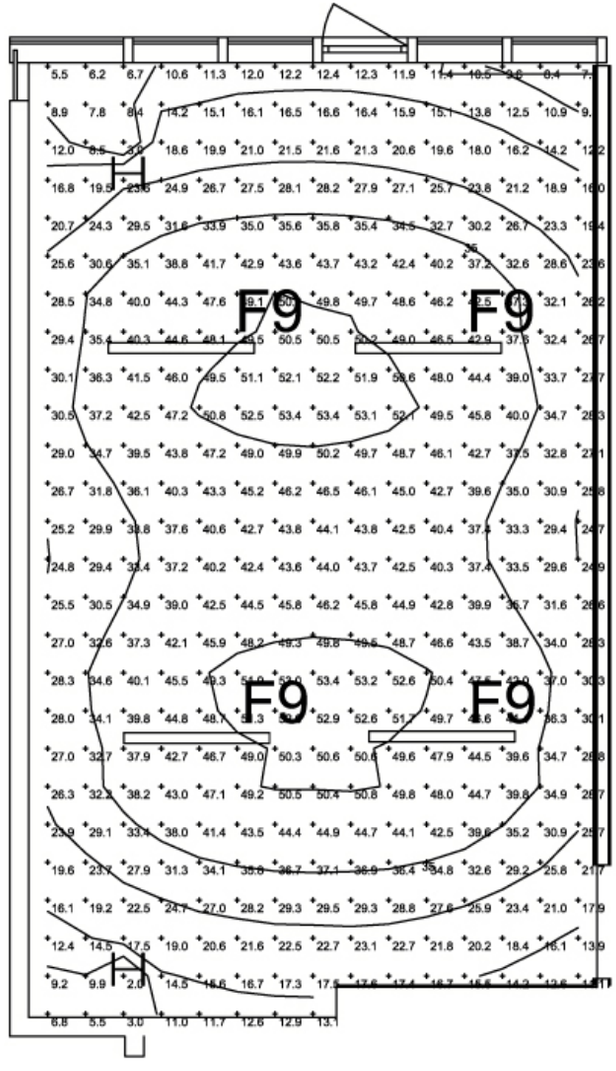
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LIGHTING DESIGN

DEAN'S OFFICE

LUMINAIRE SCHEDULE

SYMBOL	LABEL	QTY	CATALOG NUMBER	DESCRIPTION	LAMP	LLF	WATTS
▭	F9	4	rx5-dx-rx5-2445	FLUORESCENT	54W T5	0.75	99

POWER DENSITY

Luminaires	4
Total Power	396.0W
Area	370 SF
Power Density	1.1 W/SF

PHOTOMETRIC DATA

Average Illuminance	35 FC
Maximum	53.4 FC
Minimum	2.0 FC
Max/Min	26.7:1
Average/Min	16.5:1

This design uses 4 luminaires instead of the 6 from the first design. The first design has a better control of glare since it is all indirect lighting. However, this design has a lower power density and initial cost compared to the first design.

REFER TO APPENDIX C FOR DAYLIGHT ANALYSIS and EL-200 & EL-201 for details

LIGHTING DESIGN

STUDIO

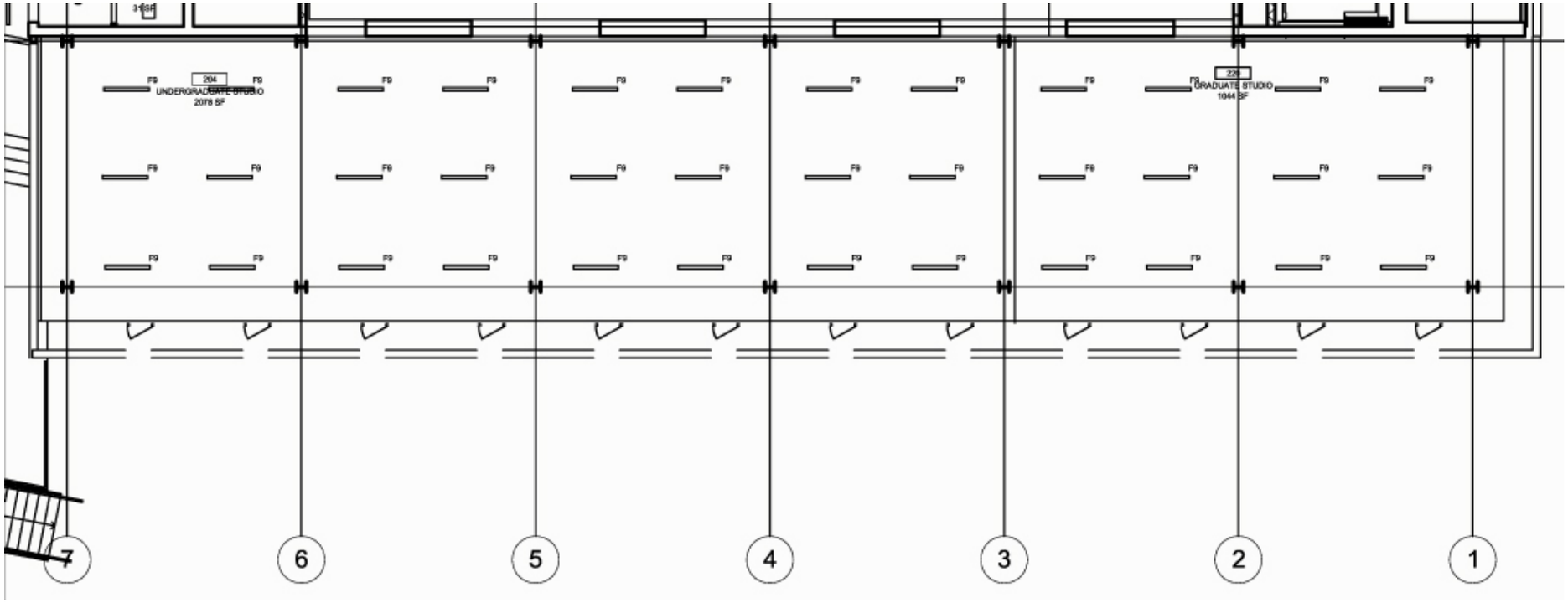
The studios occupy floors two - four on the North and South sides of the main Sculpture Building. These areas are the optimal spaces for daylight harvesting and energy conservation.

DESIGN CRITERIA

ILLUMINANCE (Horizontal and Vertical)	500 lux or 50 fc on workplane (2.5 AFF)
DIRECT / REFLECTED GLARE	Provide a comfortable environment for student activities
DAYLIGHT INTEGRATION	Decrease direct glare from windows and clerestories
LIGHT DISTRIBUTION	Even distribution on the workplane

SURFACE REFLECTANCE

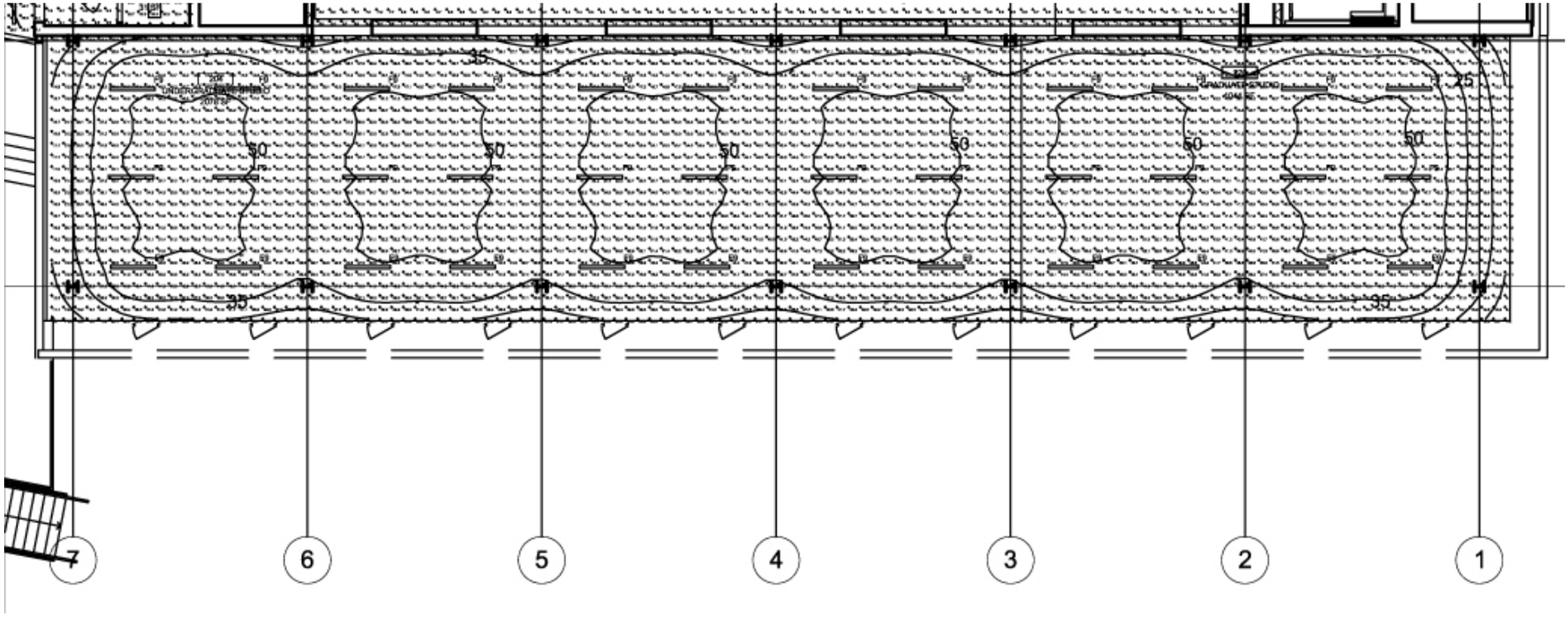
STEEL (W-Beams)	0.20
CONCRETE	0.20
MULLIONS (Painted)	0.8
GLAZING (Double Glazed Low E IGU)	0.6
METAL (Custom Fixture Housing)	0.35
Gypsum Board	0.70
CLR FIN (Clearance Finish)	0.80
RCB (Rubber Cove Band)	0.50



Please Refer to supplement sheet set for clarifications and larger size drawings (EL-300 & EL-301). The PDF version located at www.arche.psu.edu/thesis/eportfolio/2007/portfolios/knd107 can be used to view details.

■ LIGHTING DESIGN

STUDIO



LIGHTING DESIGN

DEAN'S OFFICE

LUMINAIRE SCHEDULE

SYMBOL	LABEL	QTY	CATALOG NUMBER	DESCRIPTION	LAMP	LLF	WATTS
▭	F9	36	rx5-dx-rx5-2445	FLUORESCENT	54W T5	0.75	99

POWER DENSITY

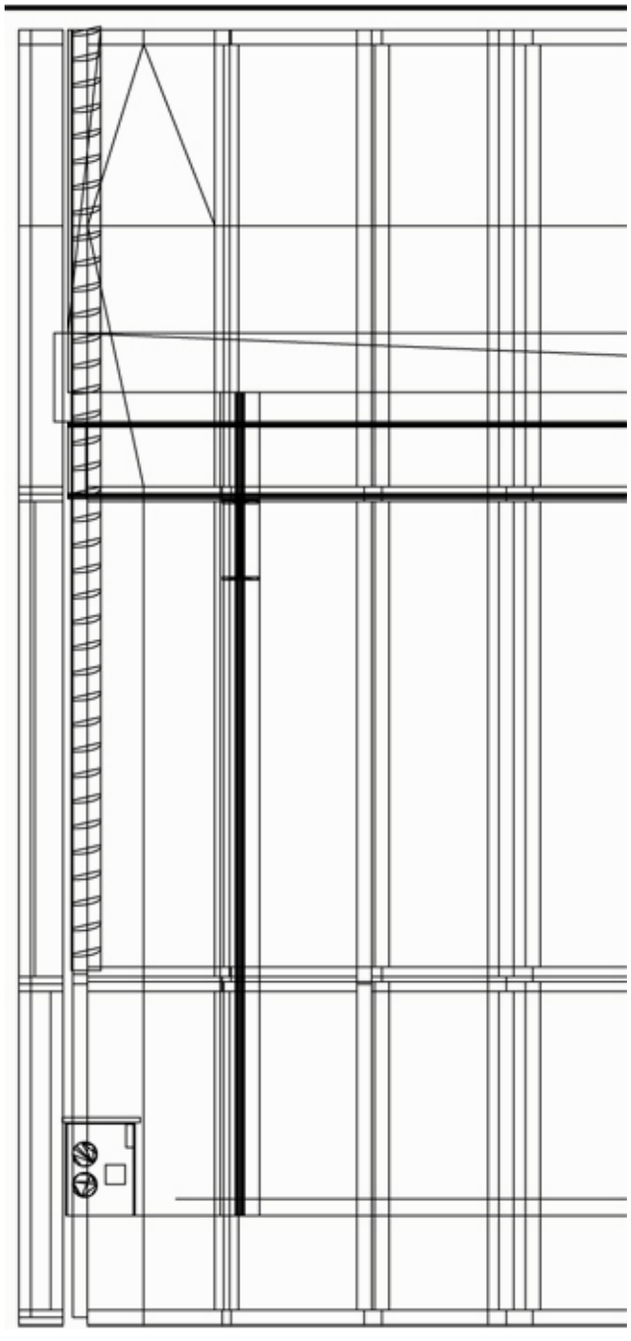
Luminaires	36
Total Power	3564.0 W
Area	3038.6 SF
Power Density	1.2 W/SF

PHOTOMETRIC DATA

Average Illuminance	43.0 FC
Maximum	56.7 FC
Minimum	8.0 FC
Max/Min	7.7:1
Average/Min	5.7:1

This design allows the rows to be dimmed individual according to available daylight. The design is repeated for floors 2-4 with the fourth floor including a clerestory. The lighting in the room is controlled by temperature sensors, occupancy sensors and photocells.

SEE ELECTRICAL DRAWINGS FOR CONTROLS, APPENDIX D FOR DAYLIGHT ANALYSIS AND EL-300, EL-301 FOR DETAILS.



SHADE DEVICE

The geometry of the louvers allows viewing to the outside while deflecting direct sunlight. The curved design is intended to increase the amount of diffused sunlight into the space.

SEE CS-300 FOR FURTHER DETAILS.

LIGHTING DESIGN

STUDIO

The South Facade of the Sculpture Building has a exterior shading device in the original design. In this design, a new interior shade device was modeled to decrease unwanted glare and heat loss/gain. The reason for interior controls are so that the end user can adjust the shade to their preference. The shade system operates similarly to garage doors. The shade can be automatically opened and shut via a motor and track system. The shade is pulled on a track that secures the device between to beams (appox 10'). The operation of this system coordinates with a Building Automation System (BAS).

The overall control scheme is the following:

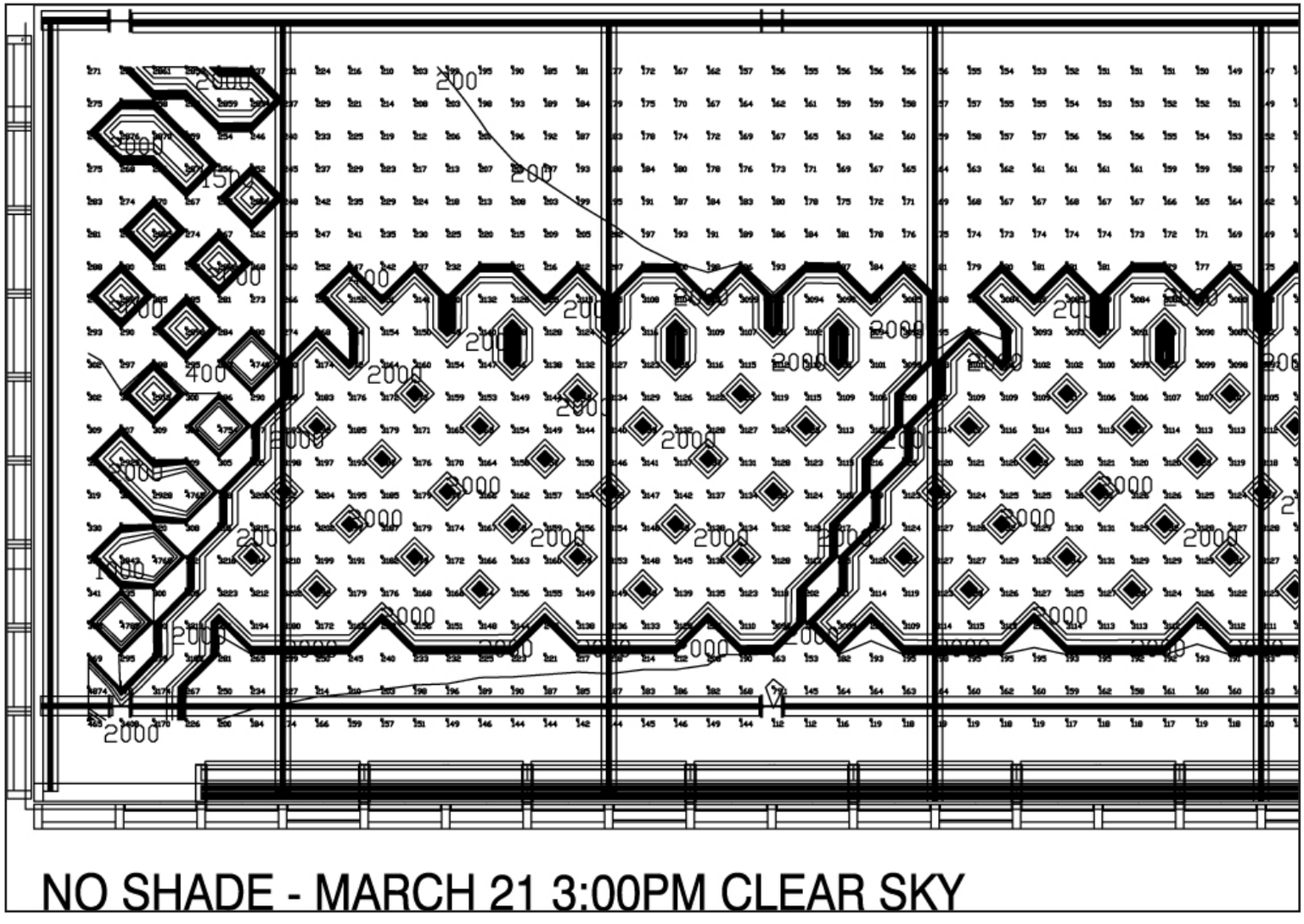
Temperature Sensor

Photocell

Occupancy Sensor

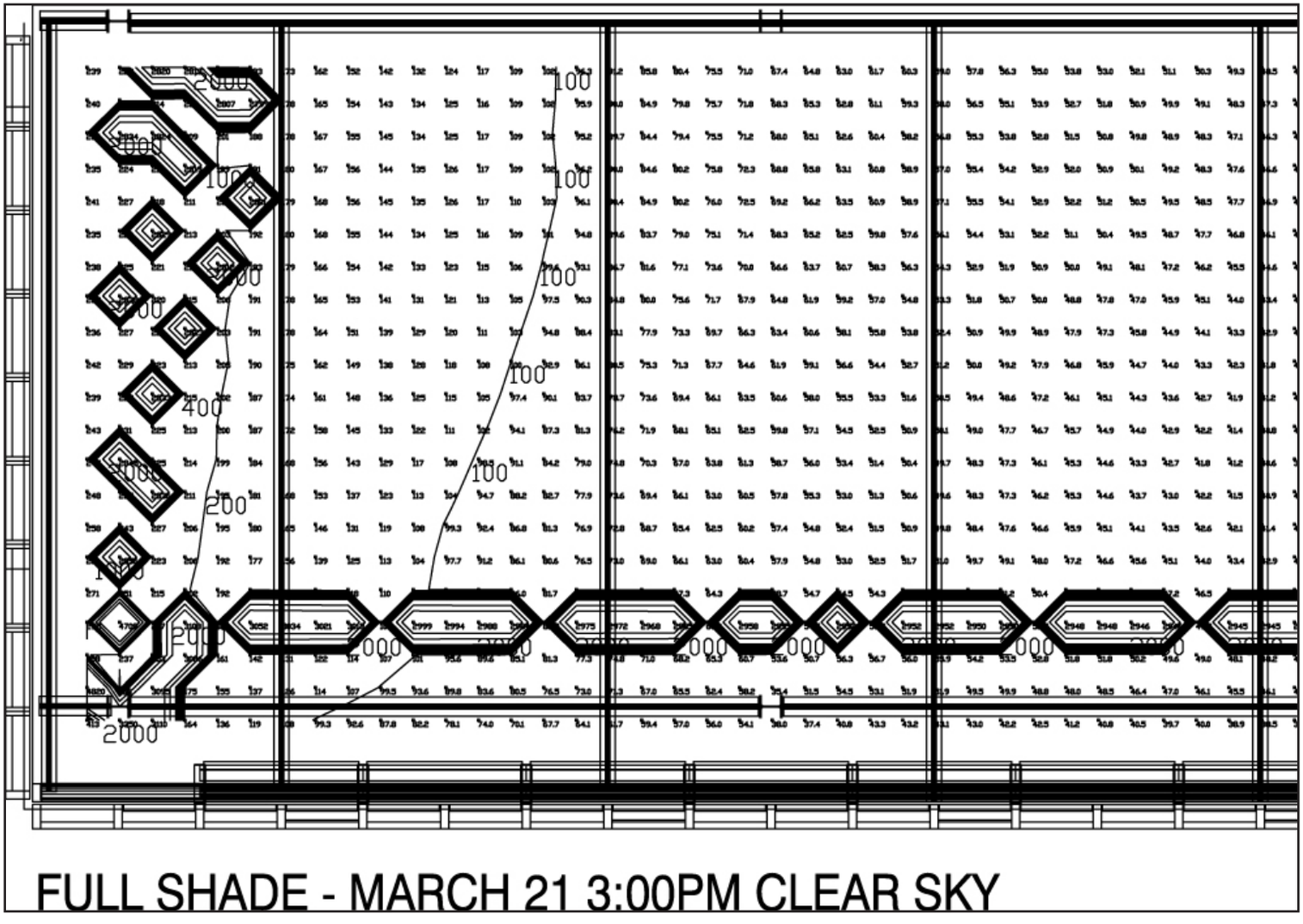
The Temperature sensor controls the electric lighting and shades. If the temperature reaches 72 degrees (winter) or 75 degrees (summer) then the shades are pulled down and the electrical lighting turned on. This ensures that the minimal amount of energy is used since cooling the space will require more energy.

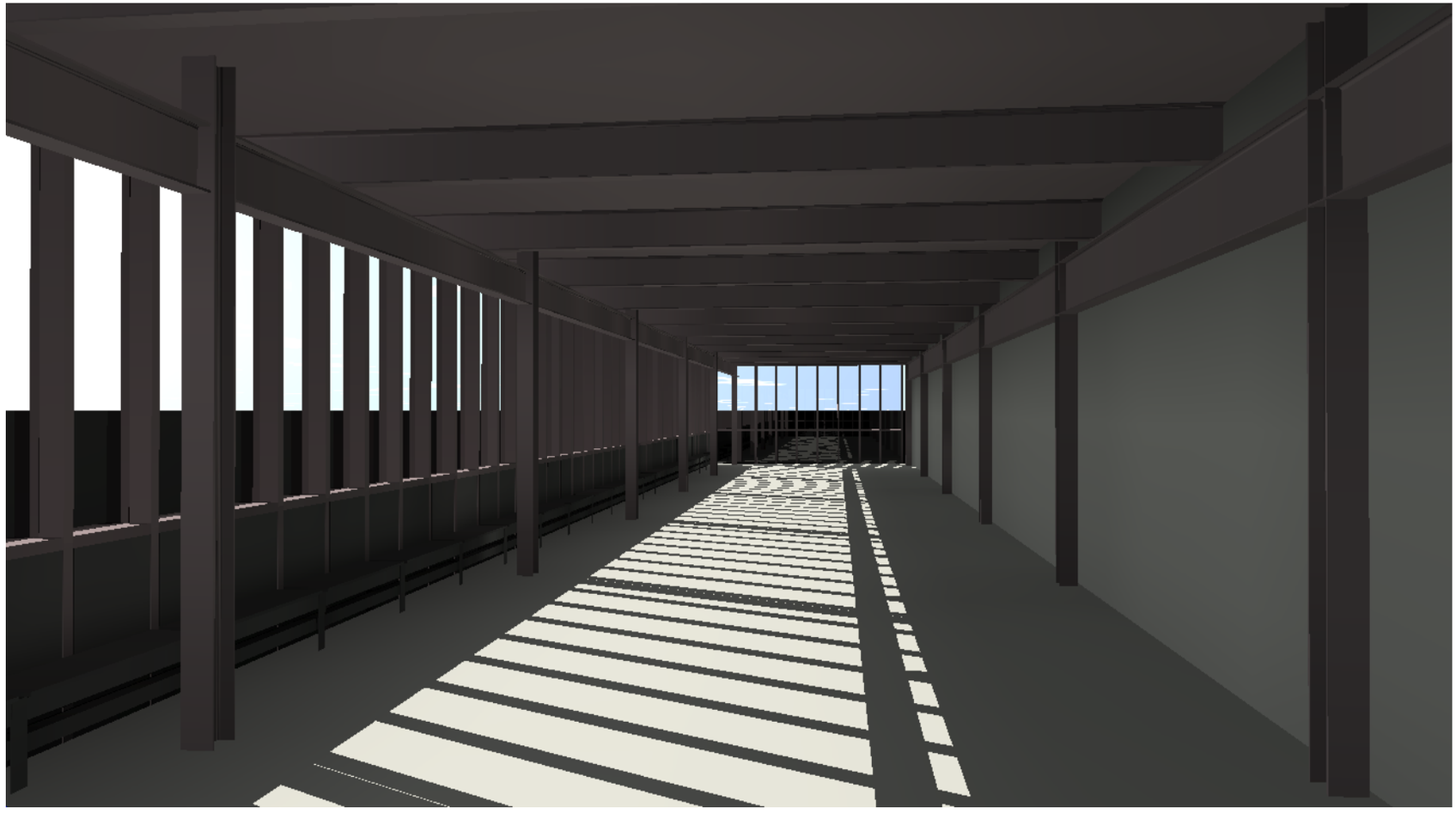
The Occupancy sensor has overriding controls on the electrical lighting. If there are no occupants then the lights will turn off.



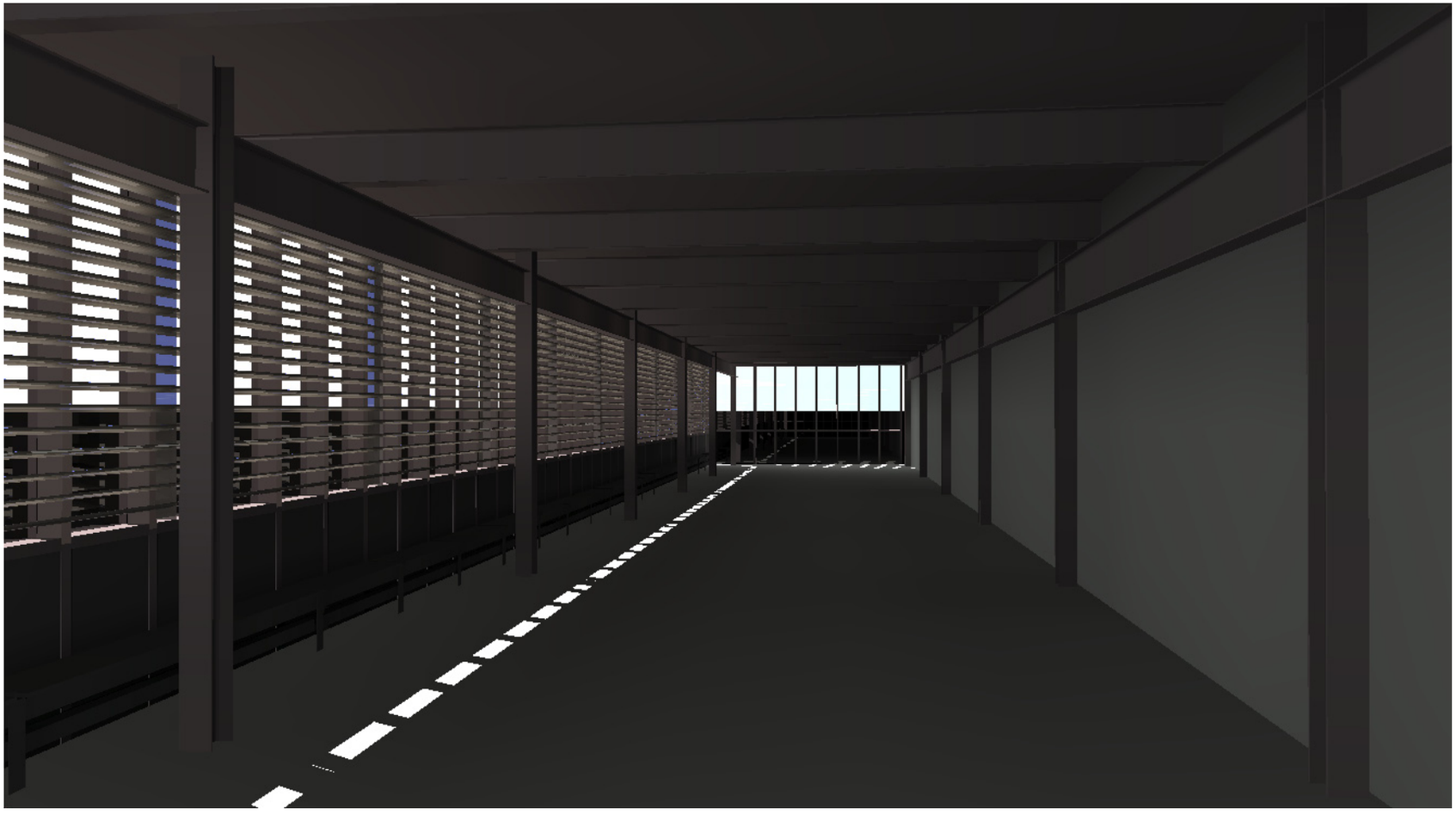
NO SHADE - MARCH 21 3:00PM CLEAR SKY

■ LIGHTING DESIGN





■ LIGHTING DESIGN



LIGHTING DESIGN

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 100A/3P C/B

PANEL TAG: LP-B1
PANEL LOCATION: BASEMENT
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD LP-B1

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LTG	2,6,8,10	1755	20A/1P	1	*			2	20A/1P	1742	2,92A,12,12A,12E	LTG
LTG	90,1,3	1730	20A/1P	3		*		4	20A/1P	1288	9,Hallway	LTG
LTG	15,17,19	1587	20A/1P	5			*	6	20A/1P	1794	16b,14,22,24	LTG
0		0	20A/1P	7	*			8	20A/1P	0		
		0	20A/1P	9		*		10	20A/1P	0		
		0	20A/1P	11			*	12	20A/1P	0		
		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	3.50	TOTAL DESIGN LOAD (KW)	15.46
CONNECTED LOAD (KW) - B	3.02	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C	3.38	TOTAL DESIGN LOAD (AMPS)	21

ELECTRICAL DESIGN

Since the lighting design was redesigned, the electrical system must be redesigned to correspond to the new loads. A coordination study was also done to insure proper protection from fault currents.

Refer to EP-XXX series sheets for circuit and control information.

LPB2	208Y/120	225	125	SURFACE	42	22,000	20	1	12	–	27
							30	3	–	1	

Original Panelboard

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W	PANEL TAG: LP-F1	MIN. C/B AIC: 10K
SIZE/TYPE BUS: 100A	PANEL LOCATION: FIRST FLOOR	OPTIONS: PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN: 100A/3P C/B	PANEL MOUNTING: SURFACE	FOR PANELBOARD LP-F1

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LTG	)2,102A,190,190	1759	20A/1P	1	*			2	20A/1P	1866	101,193,103C	LTG
LTG	103B,103,107,10	1859	20A/1P	3		*		4	20A/1P	2000	113,113A,119,121	LTG
LTG	108 114 116	1872	20A/1P	5			*	6	20A/1P	1872	112	LTG
LTG	104	585	20A/1P	7	*			8	20A/1P	0		SPARE
LTG	104	585	20A/1P	9		*		10	20A/1P	0		SPARE
LTG	104 192 190	692	20A/1P	11			*	12	20A/1P	0		SPARE
0		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	4.21	TOTAL DESIGN LOAD (KW)	20.45
CONNECTED LOAD (KW) - B	4.44	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C	4.44	TOTAL DESIGN LOAD (AMPS)	27

■ ELECTRICAL DESIGN

Original Panelboard

LP1	208Y/120	225	125	SURFACE	42	22,000	20	1	20	–	20
							20	2	2	–	

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 100A/3P C/B

PANEL TAG: LP-F2
PANEL LOCATION: SECOND FLOOR
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD LP-F2

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LTG	A1	750	20A/1P	1	*			2	20A/1P	750	B1	LTG
LTG	A2	750	20A/1P	3		*		4	20A/1P	750	B2	LTG
LTG	A3	750	20A/1P	5			*	6	20A/1P	750	B3	LTG
LTG	LOBBY	820	20A/1P	7	*			8	20A/1P	792	LOUNGE	LTG
LTG	HALLWAY	756	20A/1P	9		*		10	20A/1P	762	RESTROOM	LTG
LTG	CRIT A	703	20A/1P	11			*	12	20A/1P	797	CRIT B	LTG
0		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	3.11	TOTAL DESIGN LOAD (KW)	10.59
CONNECTED LOAD (KW) - B	3.02	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C	3.00	TOTAL DESIGN LOAD (AMPS)	14

■ ELECTRICAL DESIGN

Original Panelboard

LP2	208Y/120	225	125	SURFACE	24	22,000	20	1	4	–	20
							50	3	–	1	

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 100A/3P C/B

PANEL TAG: LP-F3
PANEL LOCATION: THIRD FLOOR
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD LP-F3

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LTG	A1	750	20A/1P	1	*			2	20A/1P	750	B1	LTG
LTG	A2	750	20A/1P	3		*		4	20A/1P	750	B2	LTG
LTG	A3	750	20A/1P	5			*	6	20A/1P	750	B3	LTG
LTG	LOBBY	820	20A/1P	7	*			8	20A/1P	792	LOUNGE	LTG
LTG	HALLWAY	756	20A/1P	9		*		10	20A/1P	762	RESTROOM	LTG
LTG	CRIT A	703	20A/1P	11			*	12	20A/1P	797	CRIT B	LTG
0		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	3.11	TOTAL DESIGN LOAD (KW)	10.59
CONNECTED LOAD (KW) - B	3.02	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C	3.00	TOTAL DESIGN LOAD (AMPS)	14

■ ELECTRICAL DESIGN

Original Panelboard

LP3	208Y/120	225	125	SURFACE	24	22,000	20	1	5	–	17
							20	2	1		
							50	3	–	1	

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 100A/3P C/B

PANEL TAG: LP-F4
PANEL LOCATION: FOURTH FLOOR
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD LP-F4

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LTG	A1	750	20A/1P	1	*			2	20A/1P	750	B1	LTG
LTG	A2	750	20A/1P	3		*		4	20A/1P	750	B2	LTG
LTG	A3	750	20A/1P	5			*	6	20A/1P	750	B3	LTG
LTG	LOBBY	820	20A/1P	7	*			8	20A/1P	792	LOUNGE	LTG
LTG	HALLWAY	756	20A/1P	9		*		10	20A/1P	762	RESTROOM	LTG
LTG	CRIT A	703	20A/1P	11			*	12	20A/1P	797	CRIT B	LTG
0		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

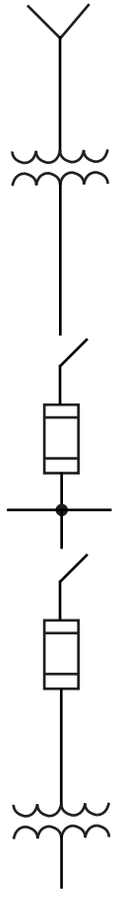
CONNECTED LOAD (KW) - A	3.11	TOTAL DESIGN LOAD (KW)	10.59
CONNECTED LOAD (KW) - B	3.02	POWER FACTOR	0.90
CONNECTED LOAD (KW) - C	3.00	TOTAL DESIGN LOAD (AMPS)	14

■ ELECTRICAL DESIGN

Original Panelboard

LP4	208Y/120	225	125	SURFACE	24	22,000	20	1	7	–	17
							50	3	–	1	

SHORT CIRCUIT CALCULATION



ASSUME INFINITE
AVAILABLE UTILITY

1000 KVA
TRANSFORMER
480V, 3PH
3.5%Z

I (F.I.) = 1230A

100' - 500 KCMIL

1600A

400A

20' - 2/0

225 KVA
TRANSFORMER
208V, 3PH
1.2%Z

$$I = \frac{1000 * 1000}{480 * 1.73} = 1203A$$

$$\frac{100}{3.5} = 28.57$$

I (SC) = 1203 * 28.57 = 34370A

$$F = \frac{1.732 * 100 * 34370}{26706 * 4 * 480} = 0.11$$

$$M = \frac{1}{1 + 0.11} = 0.8959$$

I SC RMS = 34370 * 0.8959 = 30794.84A

$$F = \frac{1.732 * 20 * 30794}{2 * 11424 * 4 * 480} = 0.1$$

$$M = \frac{1}{1 + 0.1} = 0.91$$

I SC RMS = 34370 * 0.91 = 28067.2A

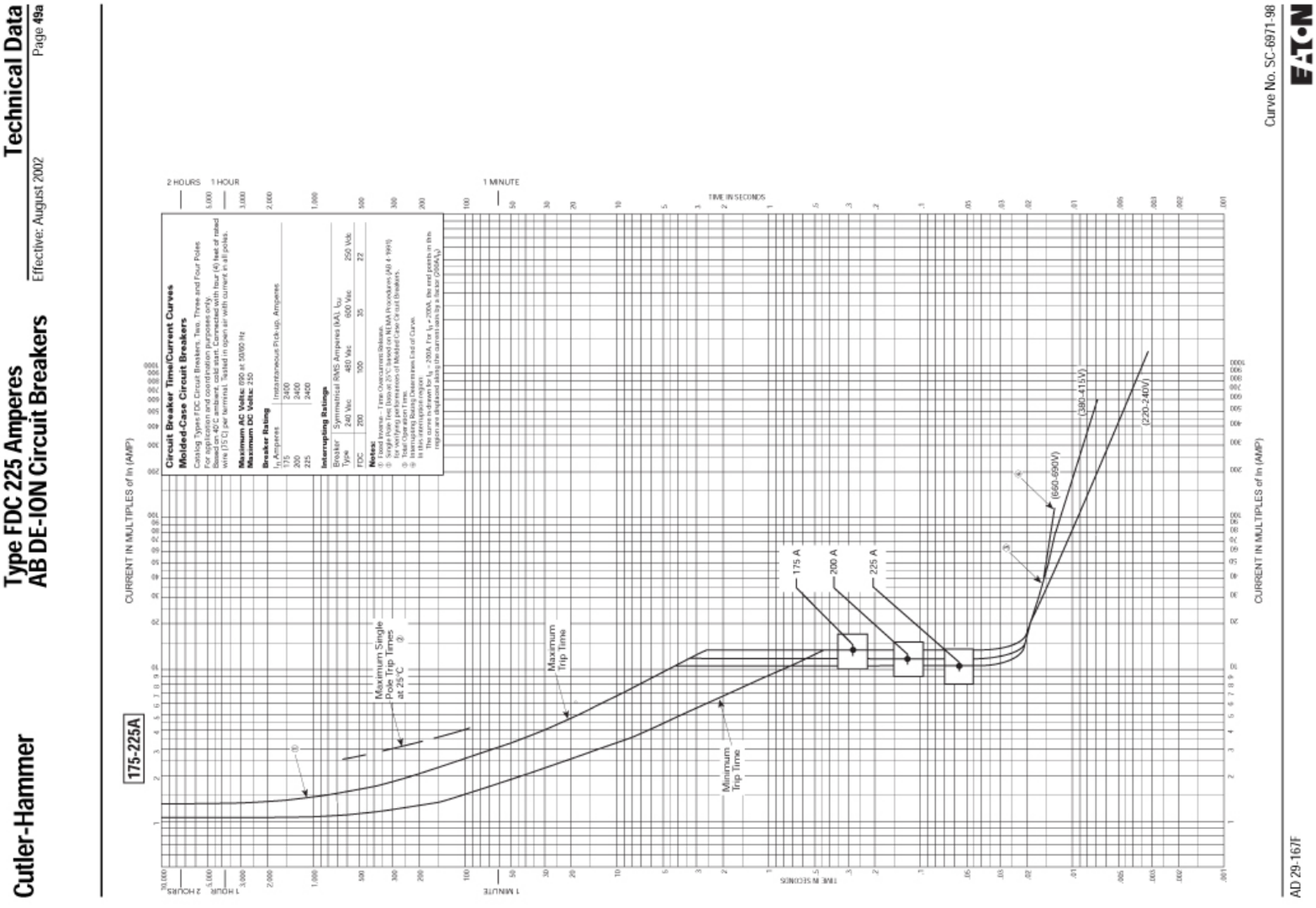
$$F = \frac{1.732 * 480 * 1.2 * 28067.2}{100000 * 225} = 1.25$$

$$M = \frac{1}{1 + 1.25} = 0.45$$

$$I\ SC\ RMS = \frac{28067.2 * 0.45 * 480}{208} = 28857.5A$$

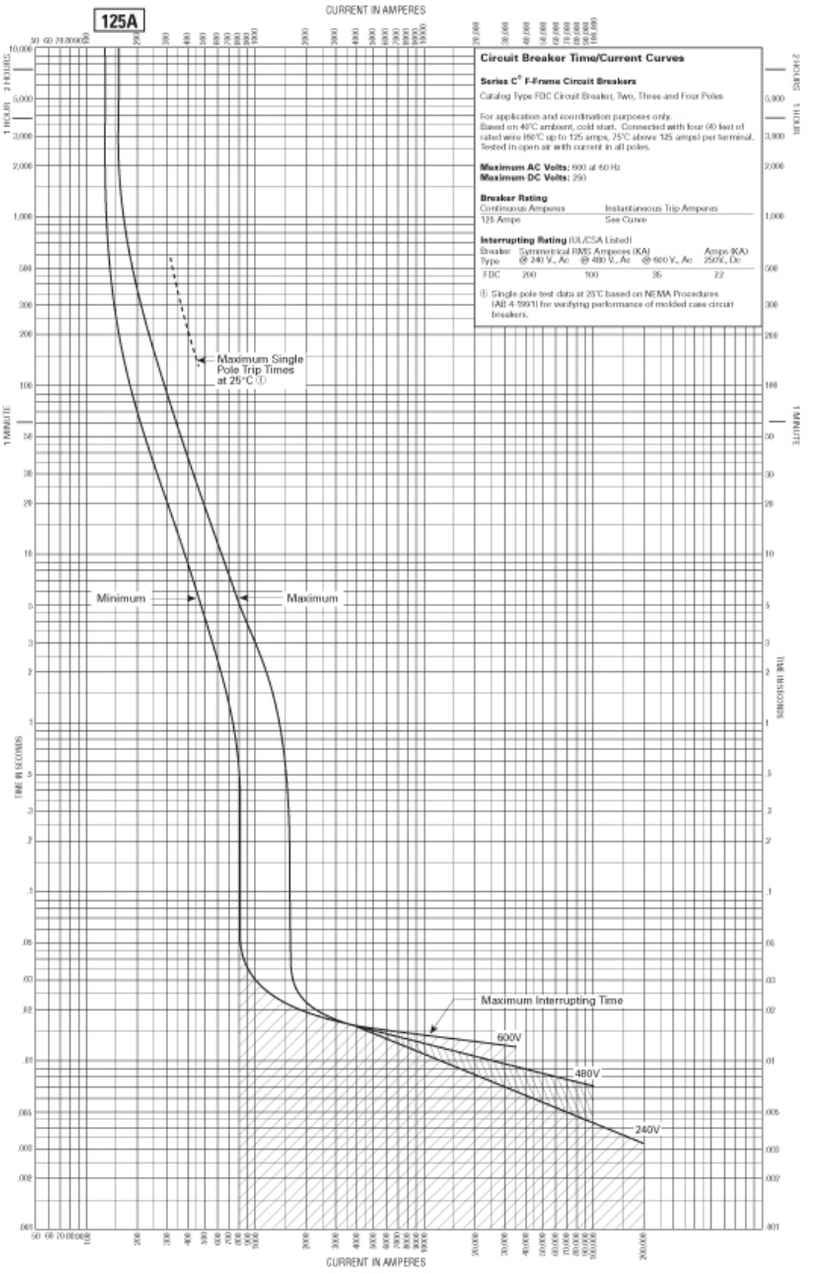
■ ELECTRICAL DESIGN

CURCUIT BREAKER COORDINATION



AB DE-ION Circuit Breakers

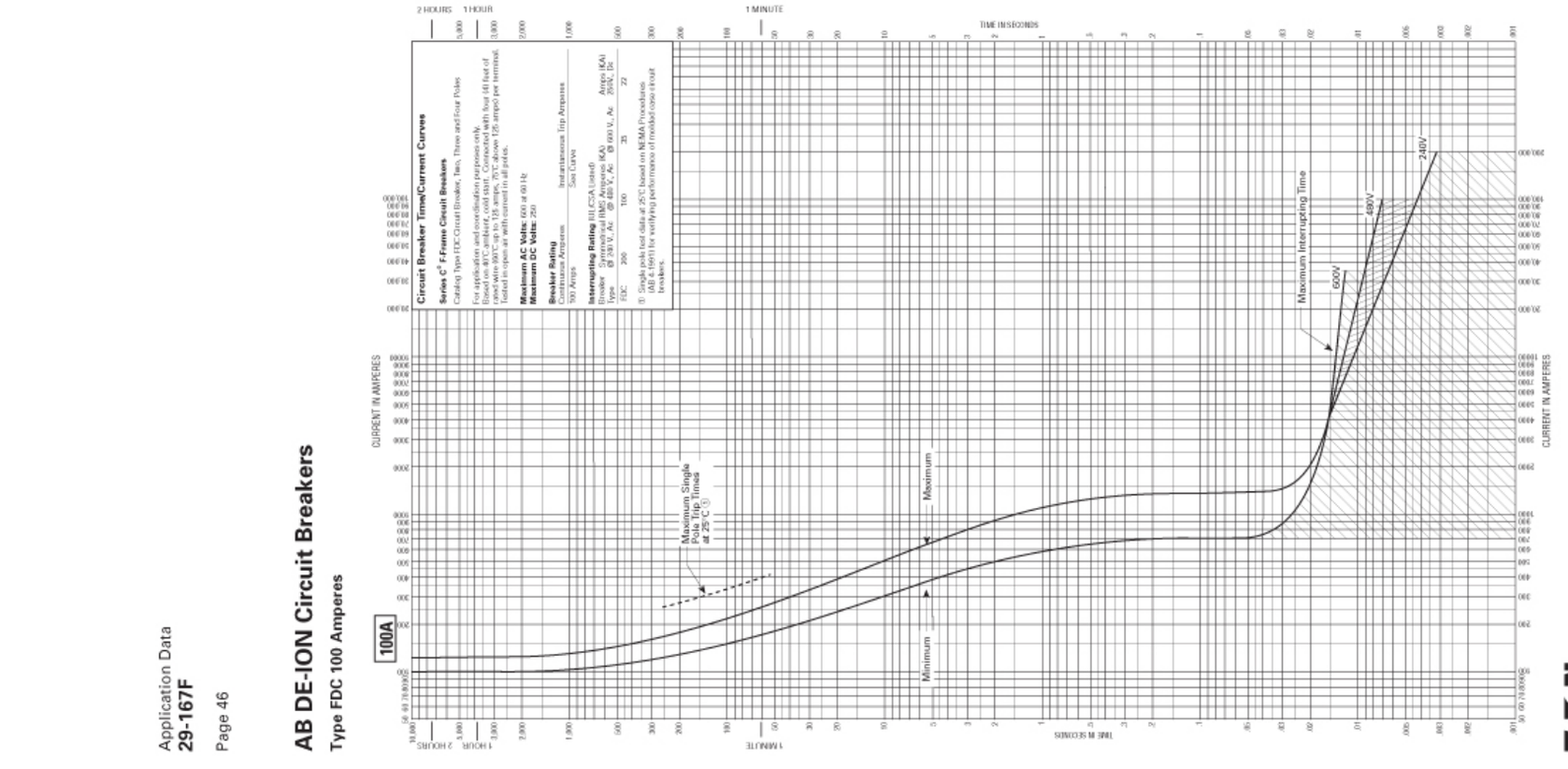
Type FDC 125 Amperes



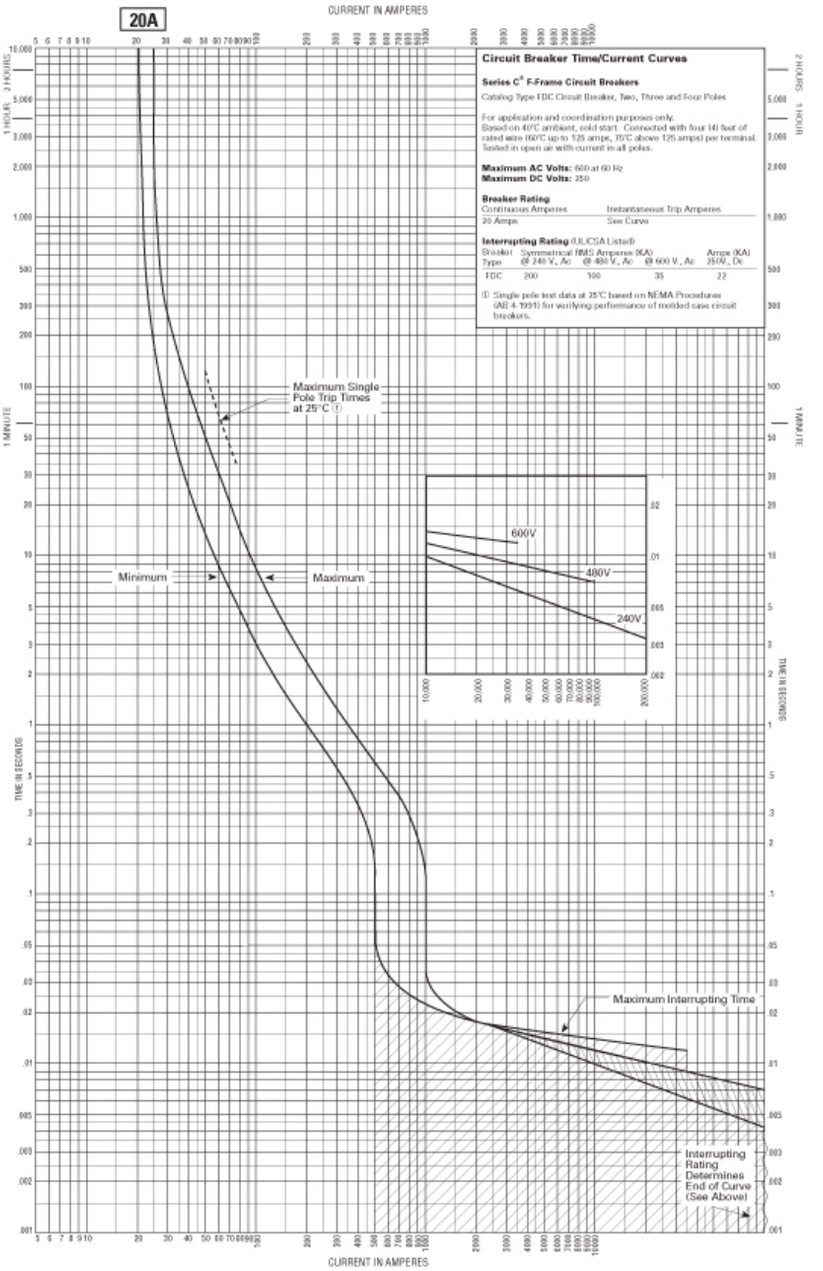
EATON

■ ELECTRICAL DESIGN

CIRCUIT BREAKER COORDINATION



Type FDC 20 Amperes

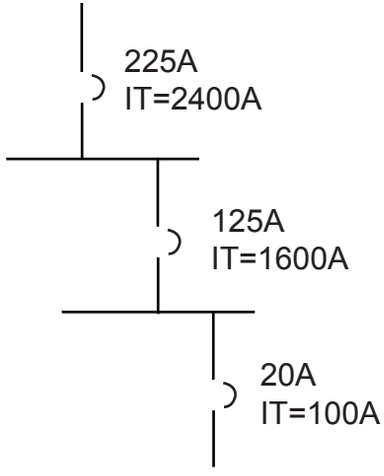


October 1997

ELECTRICAL DESIGN

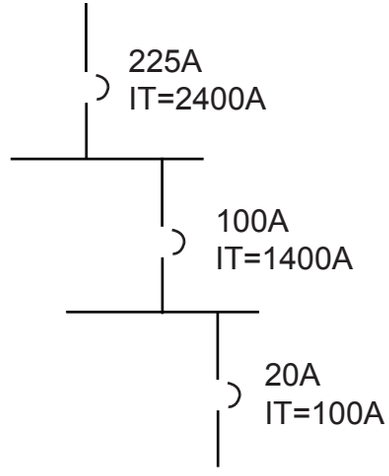
CIRCUIT BREAKER COORDINATION

225A circuit breaker has a instantaneous trip rating of 2400A
125A circuit breaker has a instantaneous trip rating of 1600A
100A circuit breaker has a instantaneous trip rating of 1400A
20A circuit breaker has a instantaneous trip rating of 100A



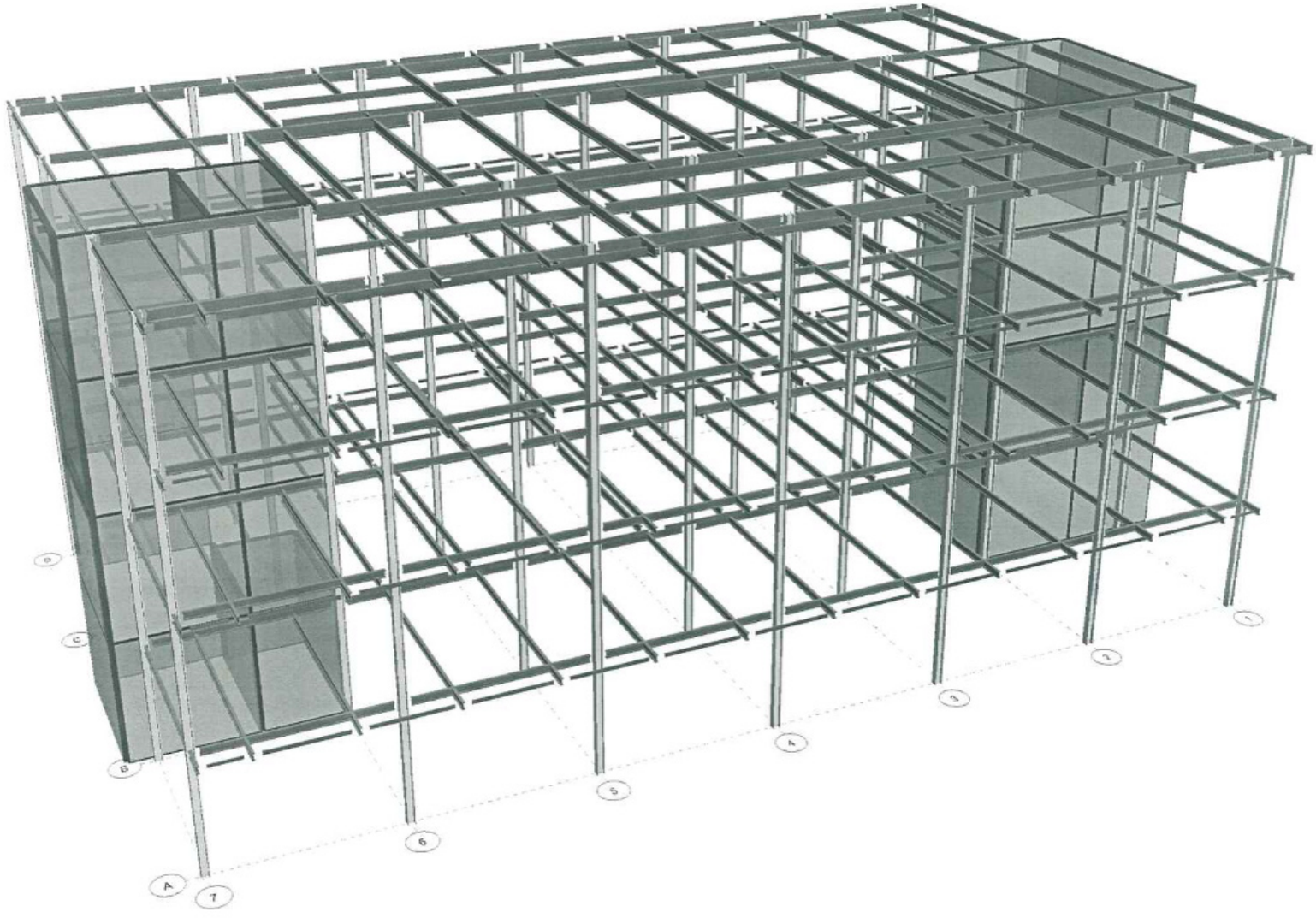
Any fault on the loadside of the 20A circuit breaker greater than 1600A will open both the 20A and 125A.

Any fault on the loadside of the 20A circuit breaker greater than 2400A will open the 20A,125A and 225A breakers.



Any fault on the loadside of the 20A circuit breaker greater than 1400A will open both the 20A and 125A.

Any fault on the loadside of the 20A circuit breaker greater than 2400A will open the 20A,125A and 225A breakers.



STRUCTURAL ANALYSIS

ROOF FRAME

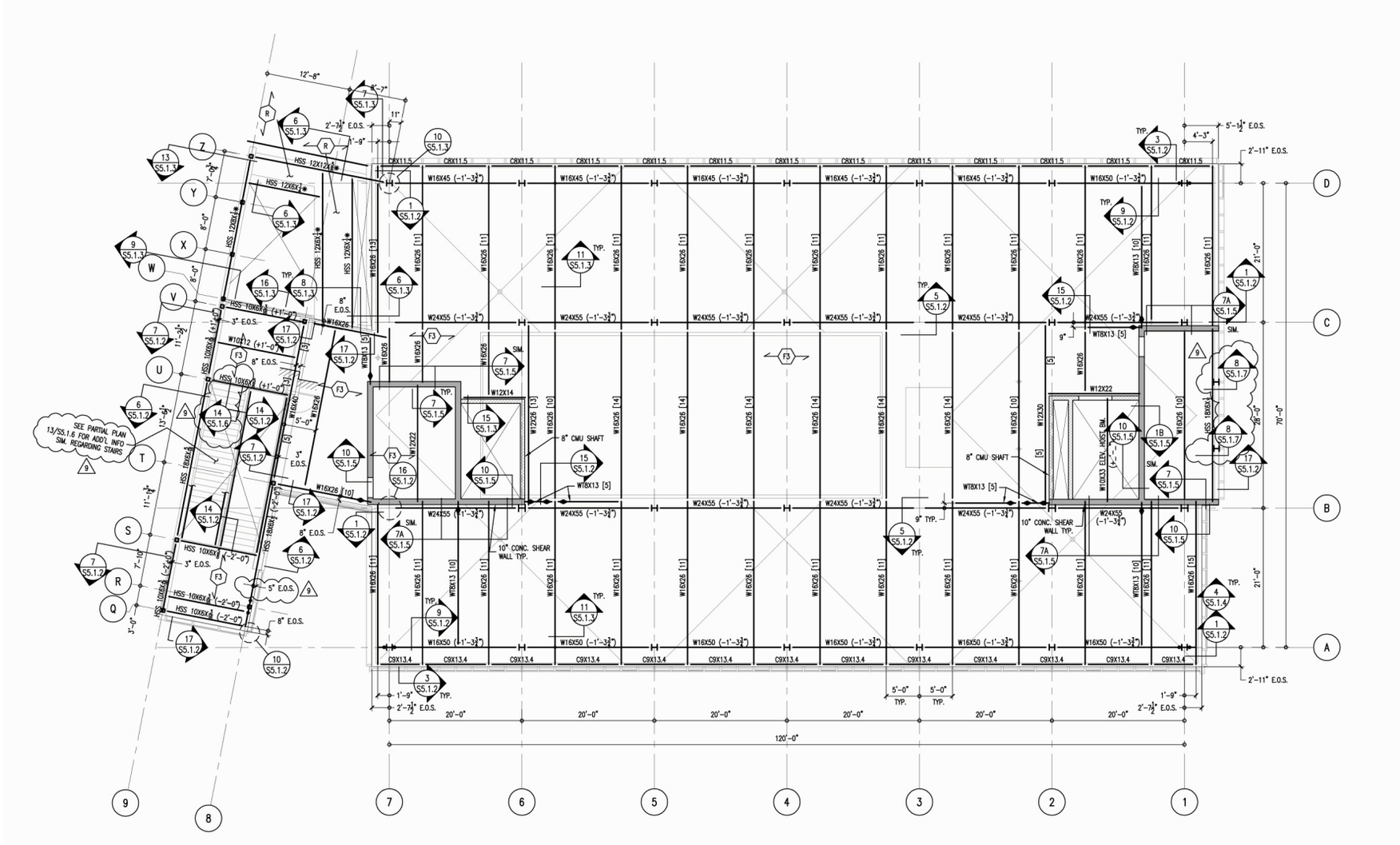
Existing Structure

The existing structure consists of composite beams. They are not typical for 4-story buildings but an assumption of composite action is being used on the roof because of unpredictable future rooftop units. Along all of the bays, the steel is erected using a hung span type of construction. This type of design is more inexpensive than normal framing design. At the perimeter of the building, the ends of the hung spans are cantilevered beams that are braced at the ends with channels. These channels support a very small portion of the roof, but I assume that they most likely brace the curtain wall at the perimeter. Also, there is a large rooftop unit at the center bay of the building.

Redesigned Structure

Almost all of the existing steel is being altered due to the new clerestory to project much more natural light into the fourth floor. There is a big change in the type of deck on the roof that is redesigned. There is the removal of the composite slab on the roof because it is no longer needed. The opening of the new clerestory eliminates future space to be heavily loaded upon. From this we can use Epicore 3.5 x 18 gage decking. This decking has the ability to span 10' with a loading of 15 psf dead load and 30 psf live load. Because of the size opening of the new clerestory, the hung span design has been removed. For the existing roof top unit, a composite slab is still used in that area only. Taking most of the concrete away from the roof will reduce the mass dead load of the structure and also costs. Although the hung span was removed, a cantilevered system is still used to reduce the moment of the roof loading and therefore, "cutting" down costs on beam sizes. An overall change that was considered in design was snow drift. With the new proposed clerestory, the perimeter can drift snow up to 62 psf against the glazing/construction. Another concern was that there can be sliding snow between the high rooftop unit and the sloped side of the clerestory. This area was designed for 51 psf. All other areas that were not mentioned were designed for 30 psf which is considered as the roof live load. The 30 psf approximates a load of snow being 3 feet tall.

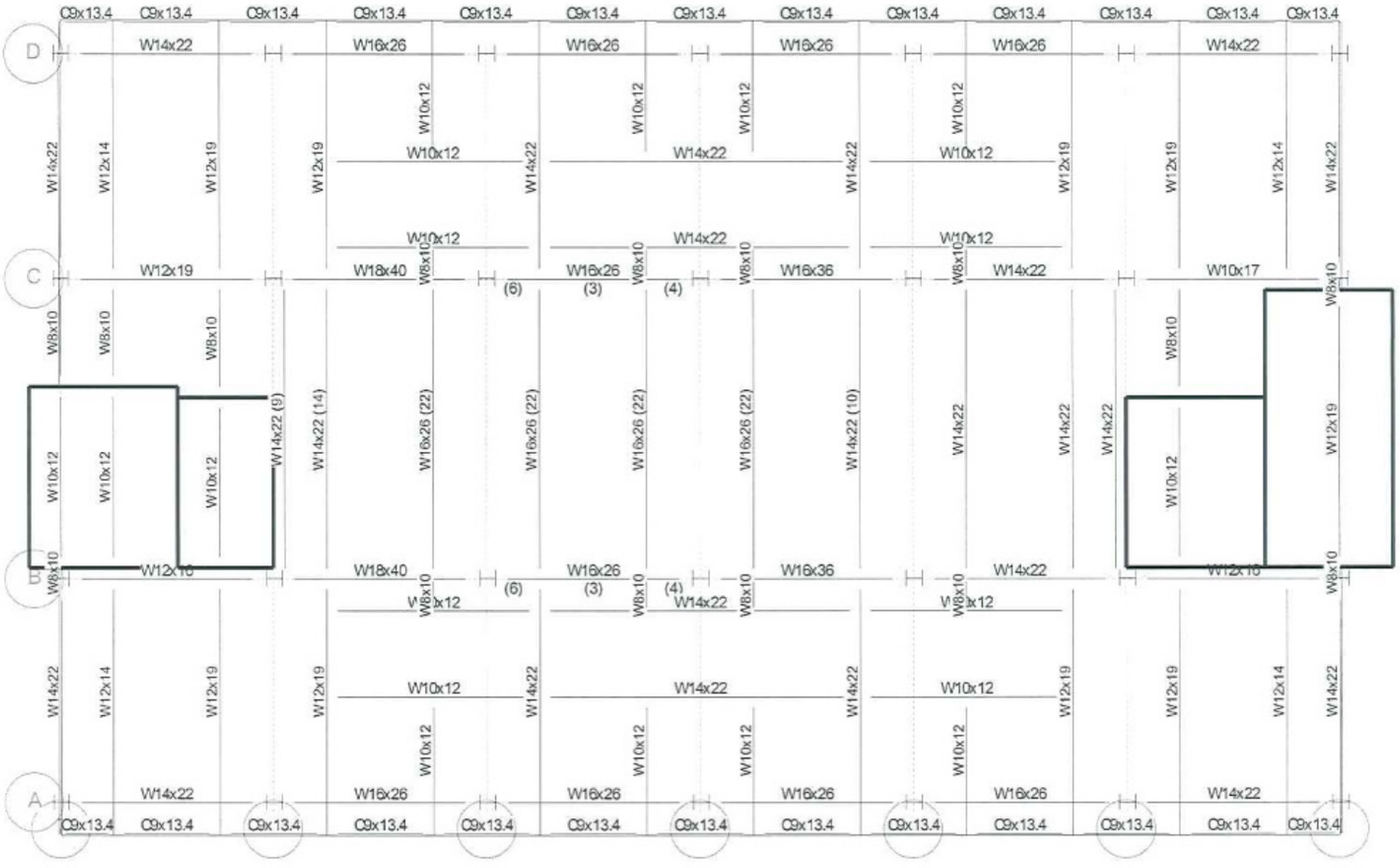
REFER TO APPENDIX E FOR COMPLETE COMPUTER ANALYSIS USING RAM.



EXISTING FRAME

■ STRUCTURAL ANALYSIS

ROOF FRAME



REDESIGNED FRAME

MECHANICAL ANALYSIS

The change in the lighting system alters the amount of heating and cooling needed in the building. The following is a calculation to determine the amount of savings in CFM. A power density of 2 W/SF was assumed to calculate the difference in the two systems.

Space	Area	Standard PD	New PD	Standard Watts	New Watts	3.412	Standard BTU/h	New BTU/h	1.08 * T	Existing CFM	New CFM
Corridor	816.7	2	0.8	1633.4	653.36	3.412	5573.1608	2229.26432	21.6	258.0167037	103.2066815
Bathroom	157.5	2	1.4	315	220.5	3.412	1074.78	752.346	21.6	49.75833333	34.83083333
Crit Space	1370	2	1.3	2740	1781	3.412	9348.88	6076.772	21.6	432.8185185	281.332037
Lobby	460	2	1.7	920	782	3.412	3139.04	2668.184	21.6	145.3259259	123.527037
Studios	6072	2	1.2	12144	7286.4	3.412	41435.328	24861.1968	21.6	1918.302222	1150.981333

TOTAL	2804.221704	1693.877922
SAVINGS		1110.343781

Space	Area	Standard PD	New PD	Standard Watts	New Watts	3.412	Standard BTU/h	New BTU/h	1.08 * T	Existing CFM	New CFM
Fire Pump	490	2	1	980	490	3.412	3343.76	1671.88	21.6	154.8037037	77.40185185
Boiler Room	858	2	0.8	1716	686.4	3.412	5854.992	2341.9968	21.6	271.0644444	108.4257778
Storage	496	2	0.8	992	396.8	3.412	3384.704	1353.8816	21.6	156.6992593	62.6797037
Main Elec Room	245	2	0.8	490	196	3.412	1671.88	668.752	21.6	77.40185185	30.96074074
Hallway	650	2	0.6	1300	390	3.412	4435.6	1330.68	21.6	205.3518519	61.60555556
Emer Elec Room	245	2	1.8	490	441	3.412	1671.88	1504.692	21.6	77.40185185	69.66166667
Telecom	245	2	1.8	490	441	3.412	1671.88	1504.692	21.6	77.40185185	69.66166667
Pub office	248	2	0.7	496	173.6	3.412	1692.352	592.3232	21.6	78.34962963	27.42237037
Compressor Room	245	2	1.1	490	269.5	3.412	1671.88	919.534	21.6	77.40185185	42.57101852
Locker room	245	2	1.8	490	441	3.412	1671.88	1504.692	21.6	77.40185185	69.66166667
Shower A	34	2	1.3	68	44.2	3.412	232.016	150.8104	21.6	10.74148148	6.981962963
Shower B	34	2	1.5	68	51	3.412	232.016	174.012	21.6	10.74148148	8.056111111
Storage	735	2	0.5	1470	367.5	3.412	5015.64	1253.91	21.6	232.2055556	58.05138889
Adv. Media	688	2	1.3	1376	894.4	3.412	4694.912	3051.6928	21.6	217.357037	141.2820741
Storage	490	2	1.2	980	588	3.412	3343.76	2006.256	21.6	154.8037037	92.88222222
Server Room	122.6	2	1.3	245.2	159.38	3.412	836.6224	543.80456	21.6	38.73251852	25.17613704
Computer Lab	898.5	2	1.3	1797	1168.05	3.412	6131.364	3985.3866	21.6	283.8594444	184.5086389
Com Lab Staff	718.8	2	1.2	1437.6	862.56	3.412	4905.0912	2943.05472	21.6	227.0875556	136.2525333
Elevator Machine	245.2	2	1.9	490.4	465.88	3.412	1673.2448	1589.58256	21.6	77.46503704	73.59178519
Lobby	681	2	0.7	1362	476.7	3.412	4647.144	1626.5004	21.6	215.1455556	75.30094444
restroom	222	2	1.1	444	244.2	3.412	1514.928	833.2104	21.6	70.13555556	38.57455556
Restroom	222	2	1.4	444	310.8	3.412	1514.928	1060.4496	21.6	70.13555556	49.09488889
Janitor Closet	34	2	1.1	68	37.4	3.412	232.016	127.6088	21.6	10.74148148	5.907814815
Hallway	354	2	0.9	708	318.6	3.412	2415.696	1087.0632	21.6	111.8377778	50.327
Laser Cutting Lab	496	2	1.1	992	545.6	3.412	3384.704	1861.5872	21.6	156.6992593	86.18459259

TOTAL	3140.967148	1652.224669
SAVINGS		1488.74248

MECHANICAL ANALYSIS

Space	Area	Standard PD	New PD	Standard Watts	New Watts	3.412	Standard BTU/h	New BTU/h	1.08 * T	Existing CFM	New CFM
Dean Office	370	2	1.1	740	407	3.412	2524.88	1388.684	21.6	116.8925926	64.29092593
Metal Shop	600	2	1.6	1200	960	3.412	4094.4	3275.52	21.6	189.5555556	151.6444444
Storage	804	2	0.8	1608	643.2	3.412	5486.496	2194.5984	21.6	254.0044444	101.6017778
Recyc Closet	130	2	1.9	260	247	3.412	887.12	842.764	21.6	41.07037037	39.01685185
Storage 2	170	2	1.4	340	238	3.412	1160.08	812.056	21.6	53.70740741	37.59518519
Recep/Hallway	891	2	1.1	1782	980.1	3.412	6080.184	3344.1012	21.6	281.49	154.8195
Assoc Dean	160	2	1.5	320	240	3.412	1091.84	818.88	21.6	50.54814815	37.91111111
Labs	1330	2	1.3	2660	1729	3.412	9075.92	5899.348	21.6	420.1814815	273.117963
Assoc Dean	163.9	2	1.5	327.8	245.85	3.412	1118.4536	838.8402	21.6	51.78025926	38.83519444
Undergrad chair	163.1	2	1.5	326.2	244.65	3.412	1112.9944	834.7458	21.6	51.52751852	38.64563889
Wood Shop	1440.8	2	1.7	2881.6	2449.36	3.412	9832.0192	8357.21632	21.6	455.1860741	386.908163
Register	248	2	1.9	496	471.2	3.412	1692.352	1607.7344	21.6	78.34962963	74.43214815
Admin Workshop	145.5	2	1.7	291	247.35	3.412	992.892	843.9582	21.6	45.96722222	39.07213889
Mailroom	48	2	2.6	96	124.8	3.412	327.552	425.8176	21.6	15.16444444	19.71377778
Storage	45	2	2.7	90	121.5	3.412	307.08	414.558	21.6	14.21666667	19.1925
Teaching Lab	1053.8	2	1.4	2107.6	1475.32	3.412	7191.1312	5033.79184	21.6	332.9227407	233.0459185
Business Office	163	2	1.5	326	244.5	3.412	1112.312	834.234	21.6	51.49592593	38.62194444
Faculty Conference	522	2	1.8	1044	939.6	3.412	3562.128	3205.9152	21.6	164.9133333	148.422
Shop Staff	286	2	1.7	572	486.2	3.412	1951.664	1658.9144	21.6	90.35481481	76.80159259
Lobby	807	2	0.9	1614	726.3	3.412	5506.968	2478.1356	21.6	254.9522222	114.7285
Vestibule	124	2	1.1	248	136.4	3.412	846.176	465.3968	21.6	39.17481481	21.54614815
Toilet	158	2	1.4	316	221.2	3.412	1078.192	754.7344	21.6	49.9162963	34.94140741
Janitor Closet	31	2	1.1	62	34.1	3.412	211.544	116.3492	21.6	9.793703704	5.386537037
Hallway	875	2	0.7	1750	612.5	3.412	5971	2089.85	21.6	276.4351852	96.75231481

TOTAL	3389.600852	2247.043683
SAVINGS		1142.557169

The totals savings in the building is 3741 CFM. This amount of savings does not warrant a downsizing in mechanical equipment.

CONCLUSIONS

The lighting design in this building was designed for energy conservation. With LEED in mind, the design took form in such a way that the design did not hinder the prospect of obtaining additional points. The lighting levels in the building exceed IESNA requirements and in most spaces daylight provides the bulk of the illuminance. The shade devices help control the amount of daylight in spaces and can decrease the amount of daylight into a room by 50% (shown in studio daylight study). In accordance with ASHRAE 90.1 2004, the building will meet the maximum allowable lighting power densities using the space by space method.

Special commissioning will have to be implemented to assure that the control scheme for the studios are operating as designed. This design will further decrease the amount of wasted energy in the building.

ACKNOWEDGEMENTS

I would like to express my sincere appreciation to all the people who have helped me during my difficult time of completing this thesis.

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-THANK YOU

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