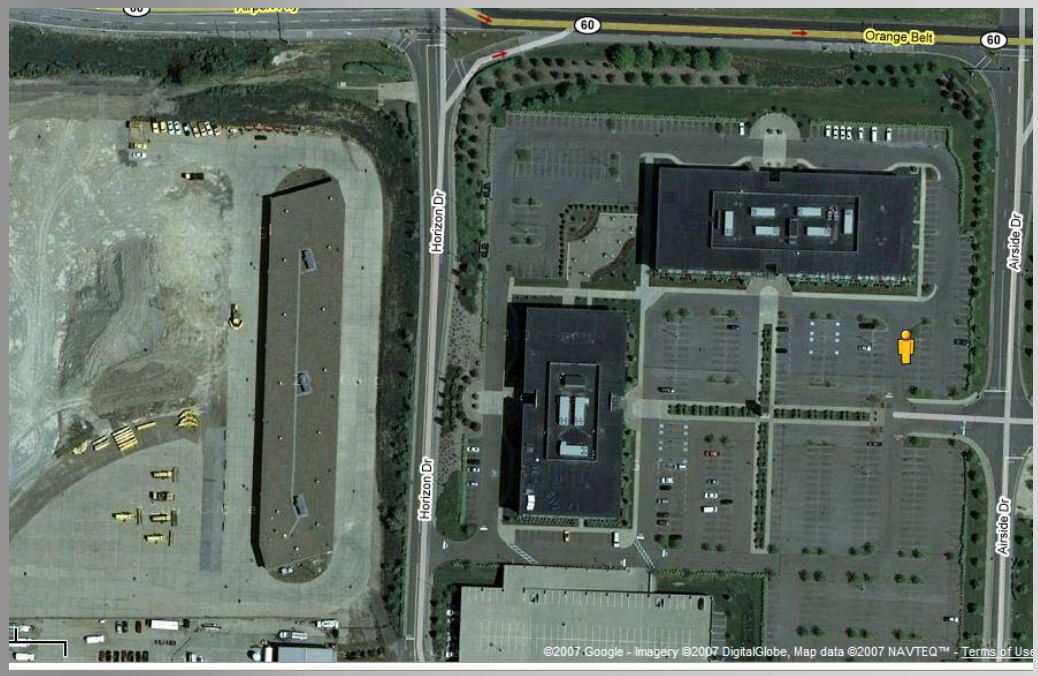
Michael Baker Corporate Headquarters

Eric Sternberg
Lighting Electrical
Advisor: Prof. Houser
Advisor: Prof. Dannerth

Building Overview

- Location: Airside Dr. Moon Township, PA
- Setting: Office Complex Next to Landing Strip



Building Overview

- Size: 117,003 sq ft
- Stories: 3 Stories
- Cost: $14,000,000
- Function: Office Building
- Construction Dates: Feb. 2002 – Feb. 2003

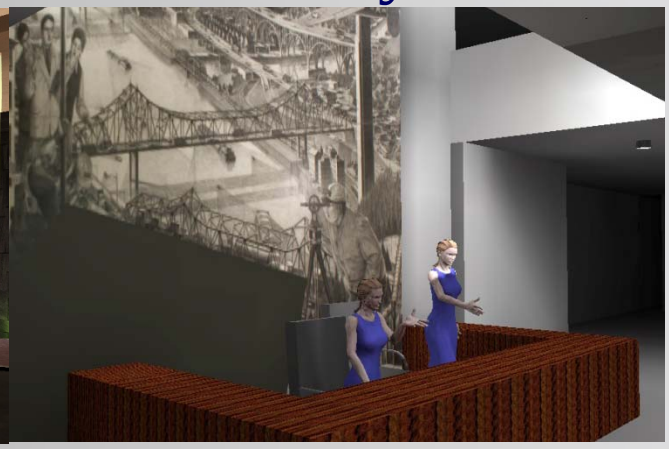
Requirements

Facade

Requirements

Facade

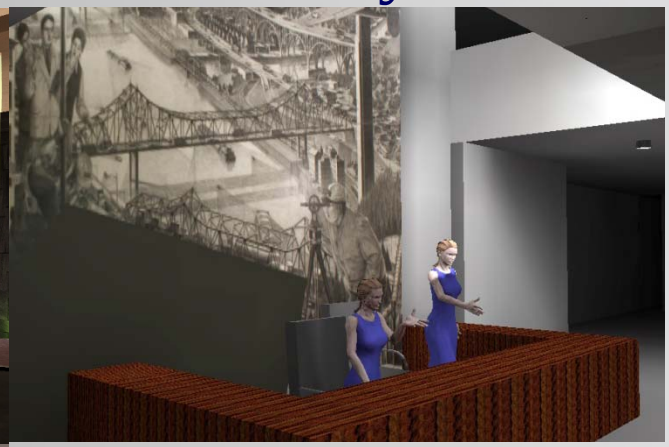
Lobby

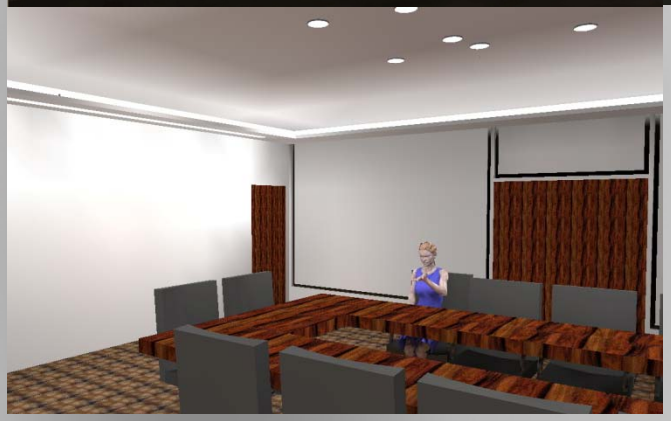


Requirements

Facade

Lobby



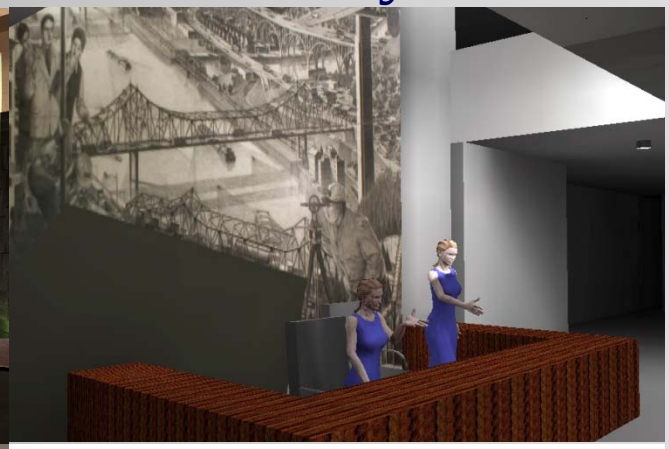


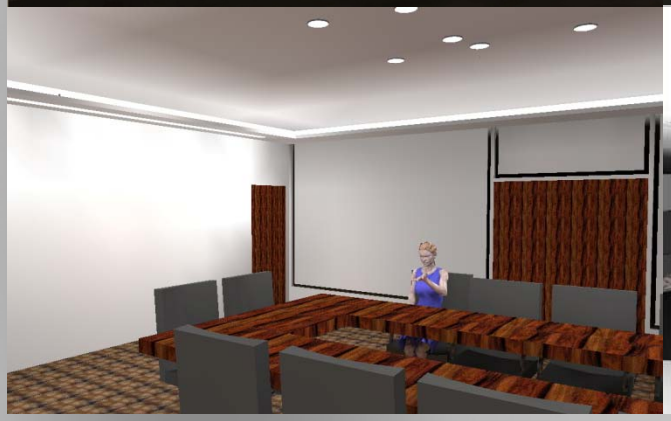
Presentation Room

Requirements

Facade

Lobby



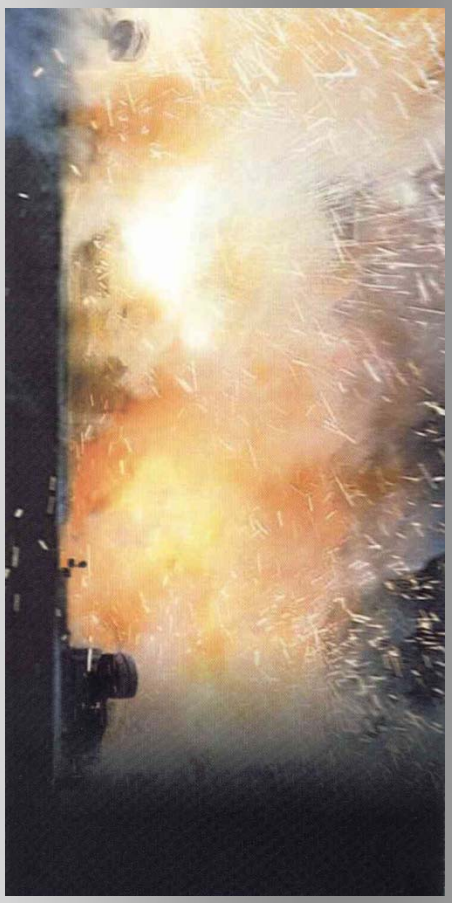


Presentation Room

Open Office

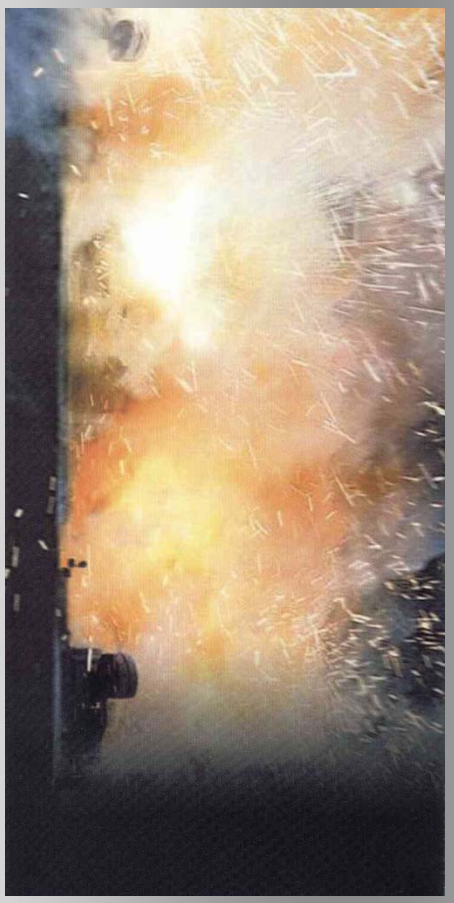
Requirements

Arc Flash Study



Requirements

Arc Flash Study



Back-up Generator

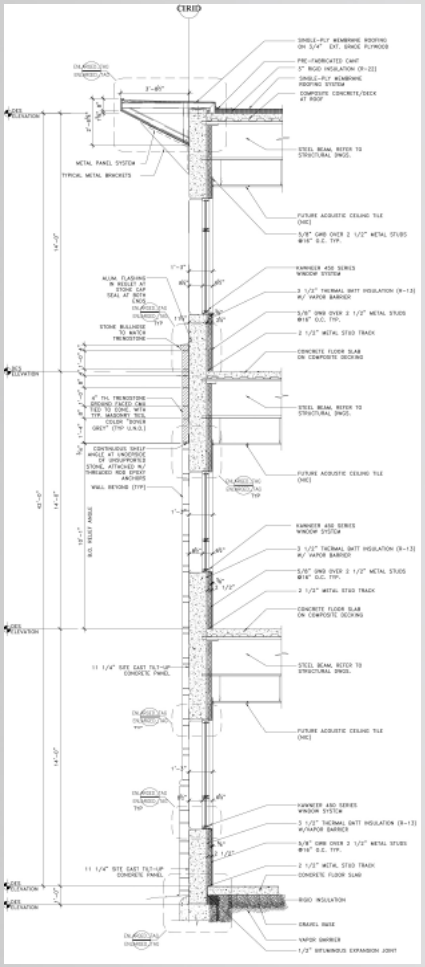
Requirements

Structural Breadth

Requirements

Structural Breadth

Mechanical Breadth



Outline

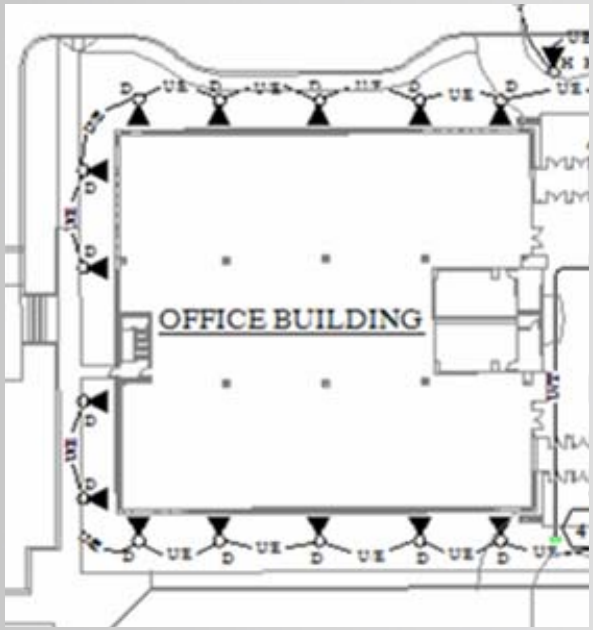
- Lighting: Façade, Lobby, Presentation Room, and Open Office
- Electrical: Arc Flash Study and Generator
- Structural Breadth: New Tilt up Concrete
- Mechanical Breadth: Thermal Transfer Analysis

Most of the topics are related to the change of window sizes

Façade

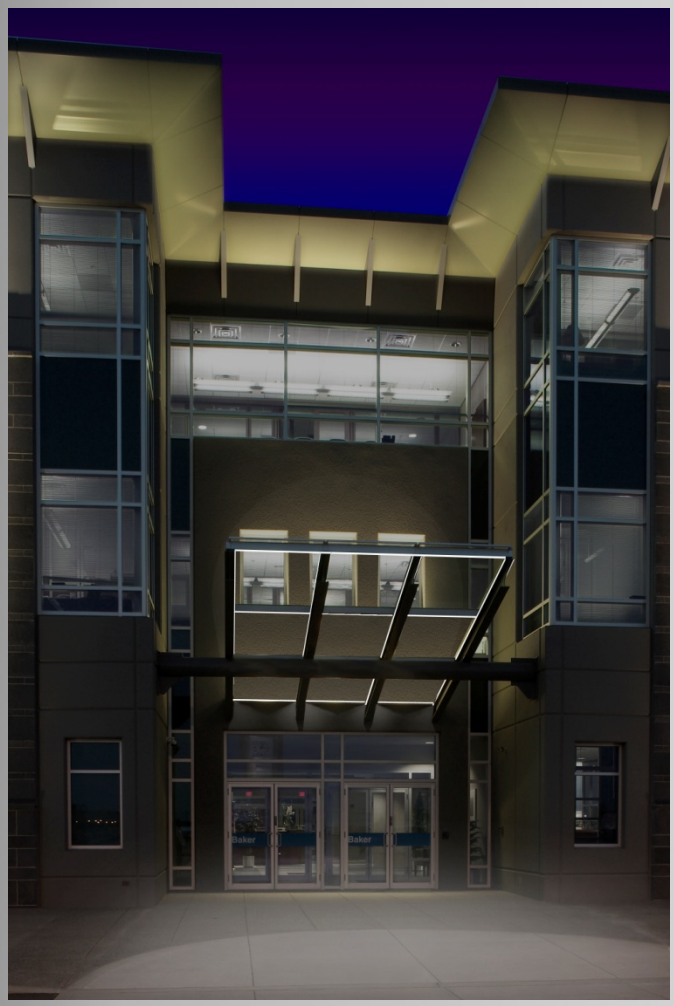
Points of Interest:

- Entrances
- Columns
- 12”x12” Tiles
- Awning
- Door Overhang

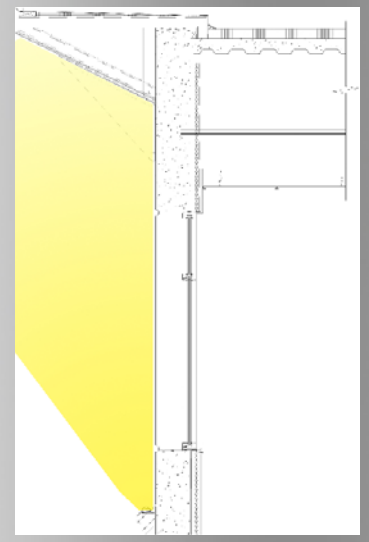


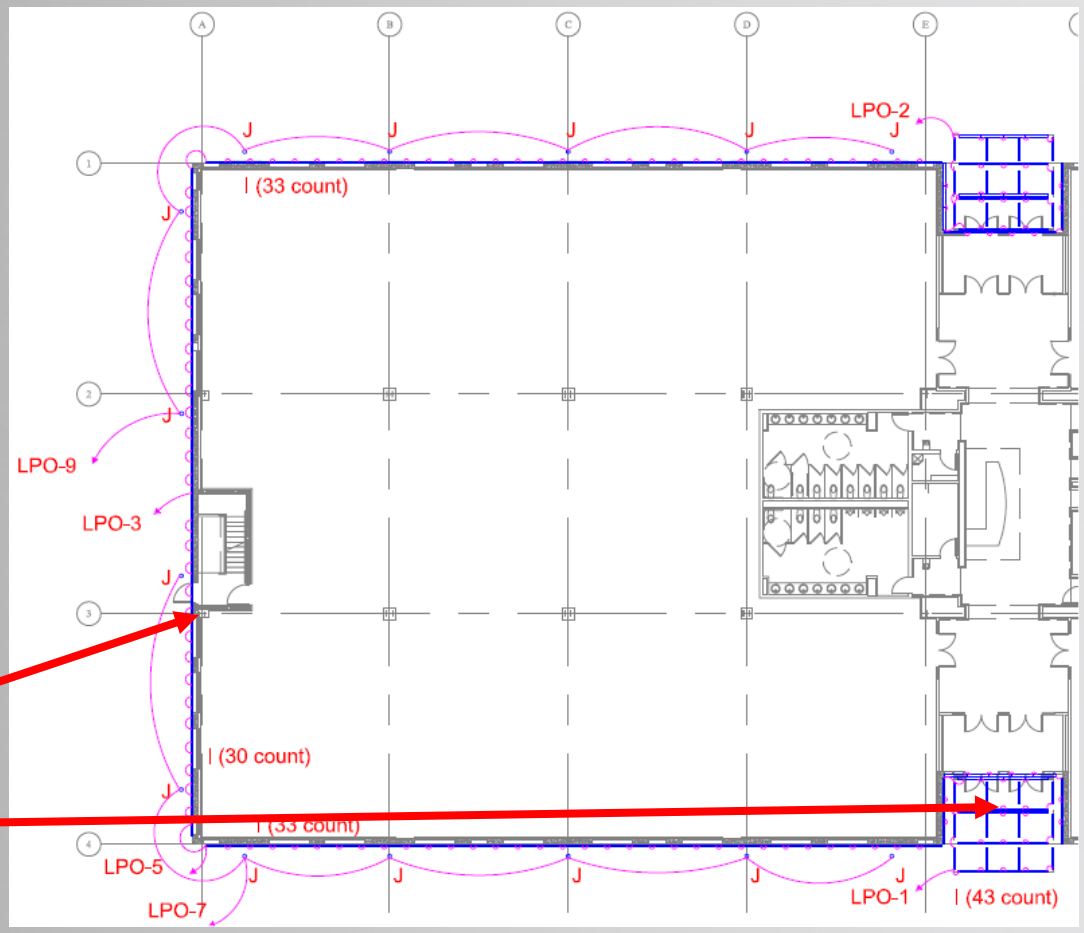
Façade: Design Criteria

Façade: Design Criteria



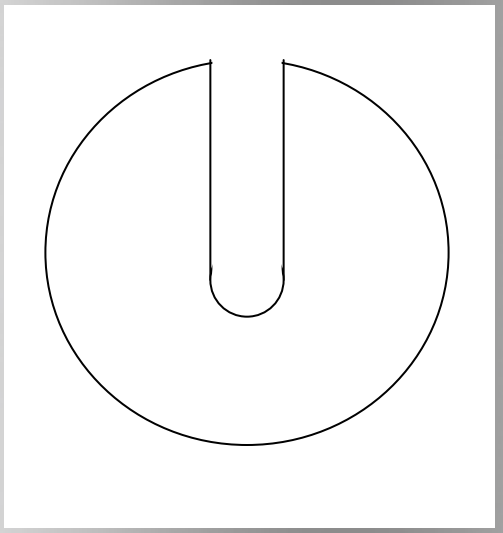
Façade: Luminaires

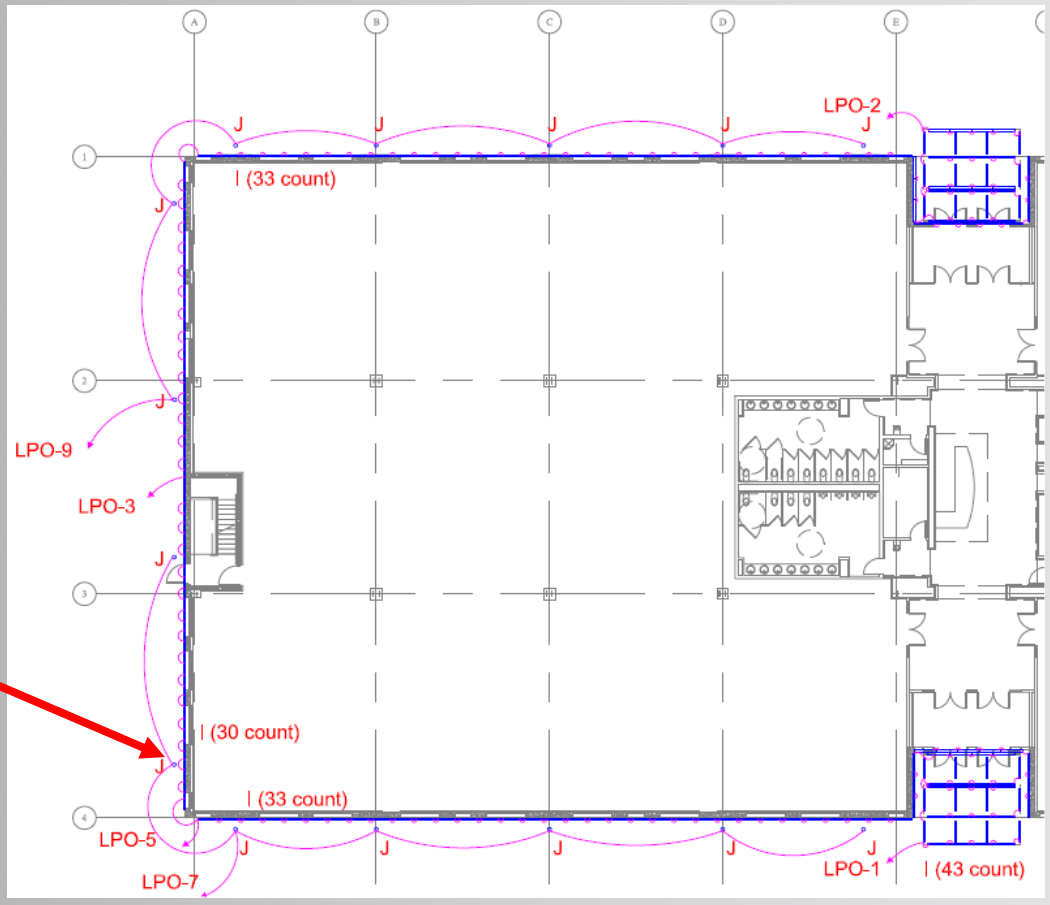




Luminaire I: LED Strip

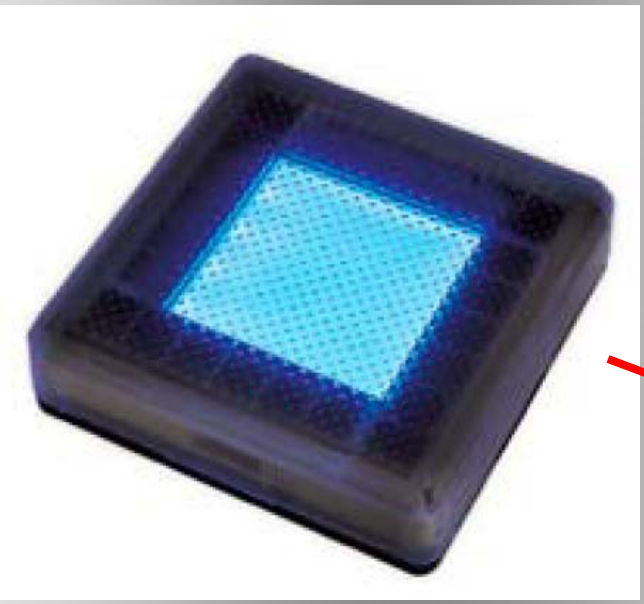
Façade: Luminaires



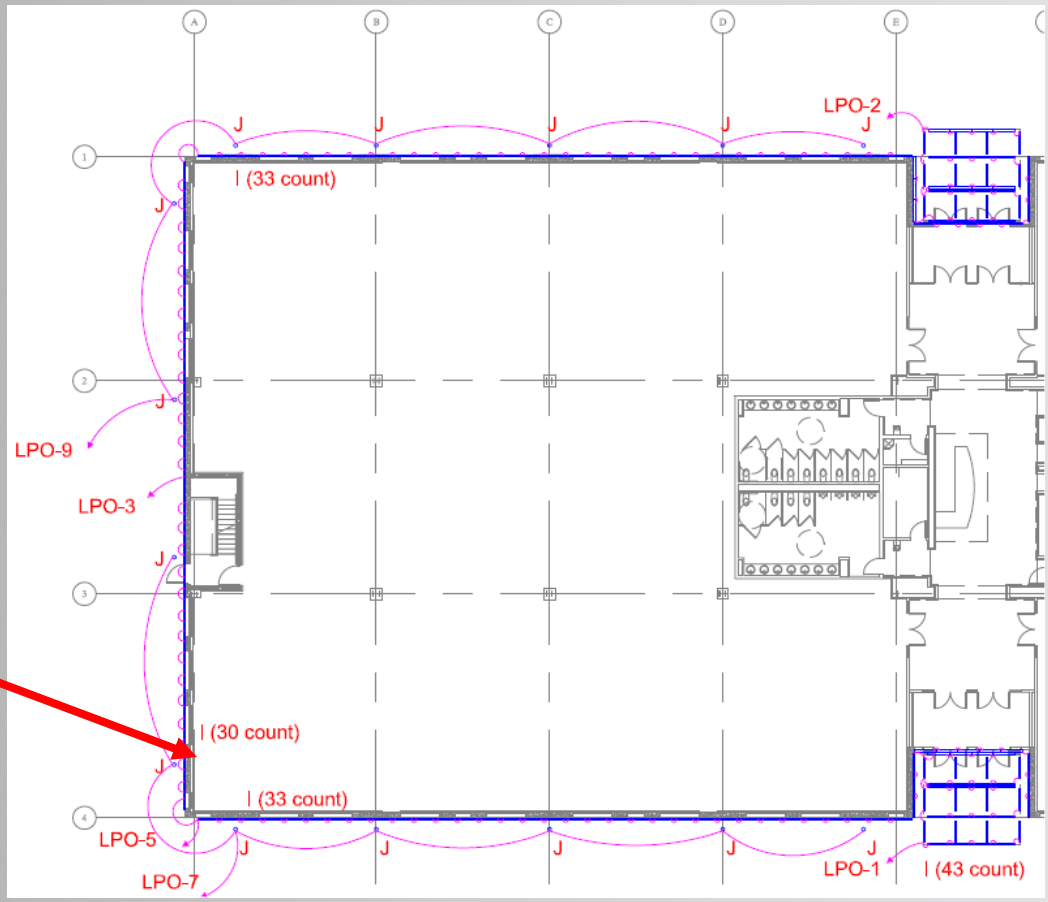


Luminaire J: Metal Halide

Façade: Luminaires

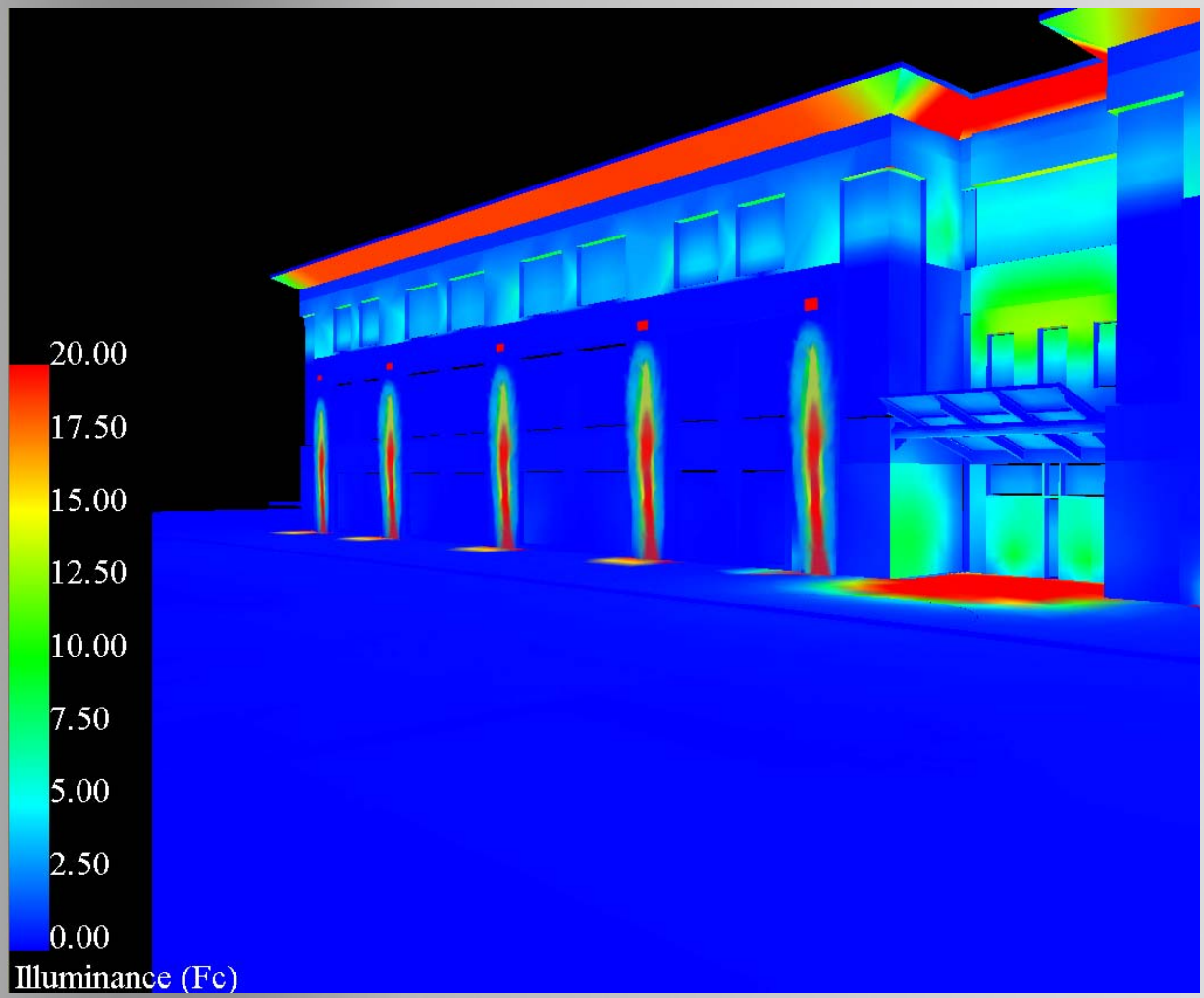


Luminaire E: LED Tile



Façade: Rendering

Façade: Pseudo Color



Façade: Power Density

Façade Power Density =0.2 W / sq ft
Walkway Power Density =0.08 W / sq ft

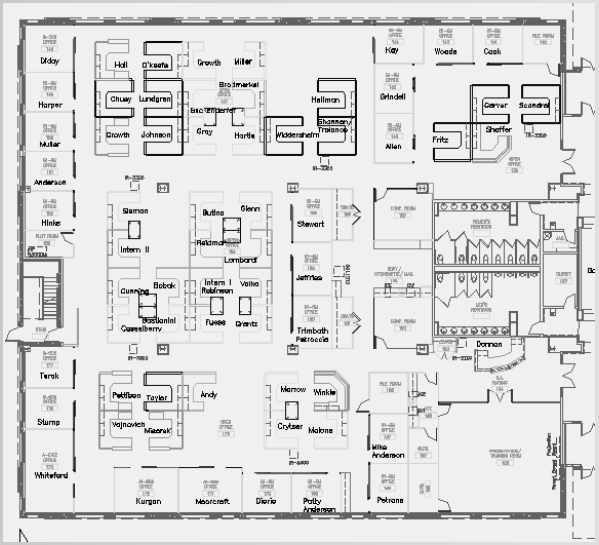
Using the Space-by-Space Method in ASHRAE 90.1
Façade Power Density =0.2 W / sq ft
Walkway Power Density =0.2 W / sq ft

All the requirements are met for ASHRAE 90.1 for the lobby fixtures.

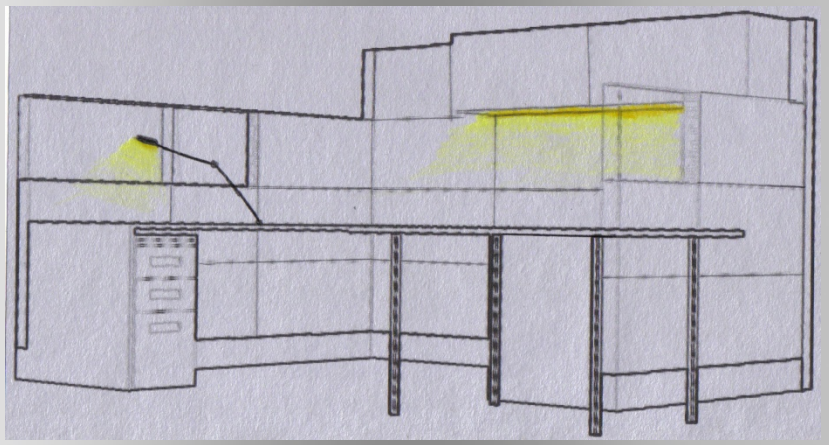
Open Office

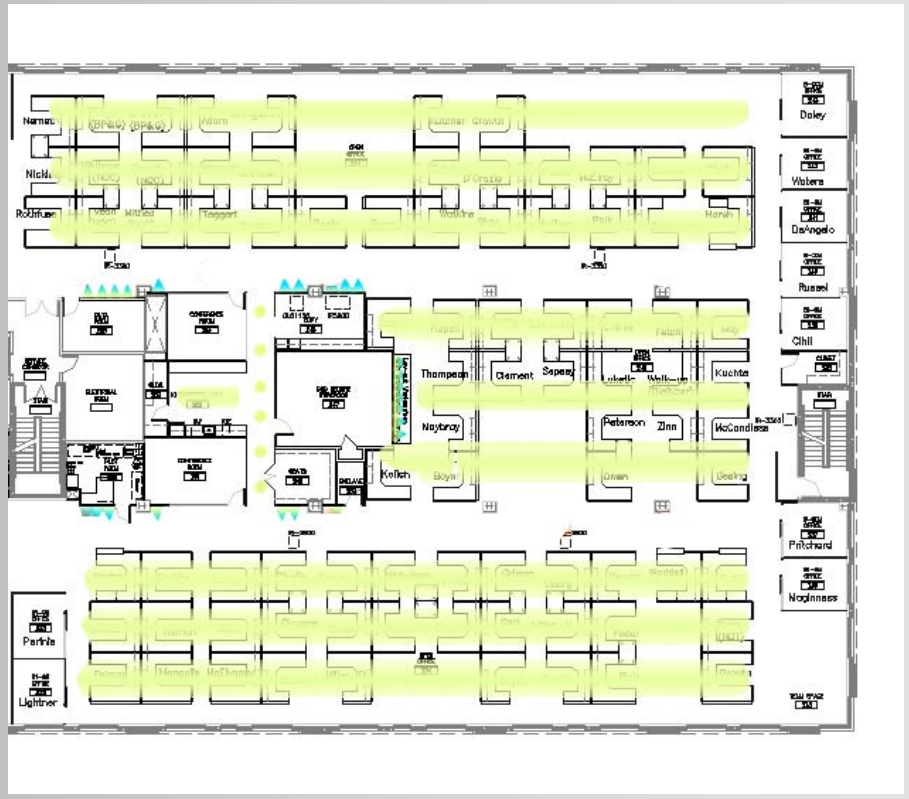
Points of Emphasis:

- Cubicles
- Artwork
- Ceiling Uniformity
- Daylighting



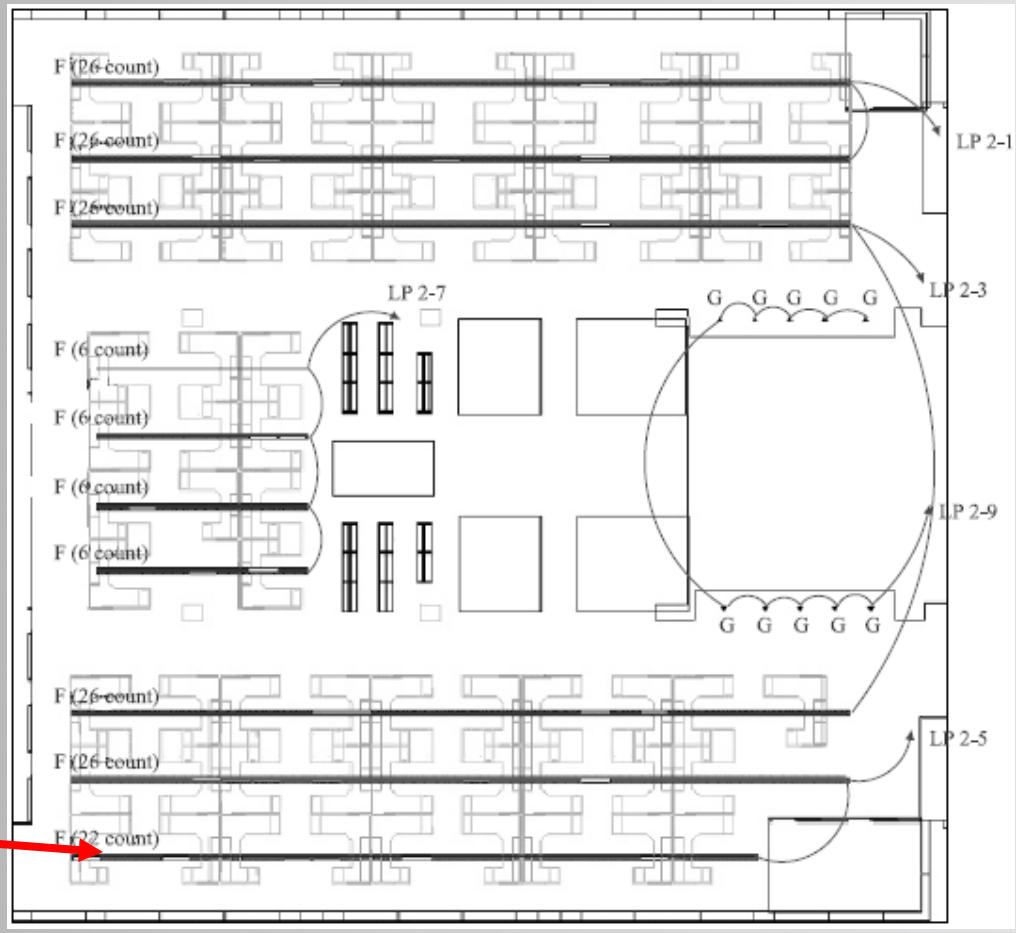
Open Office: Design Criteria





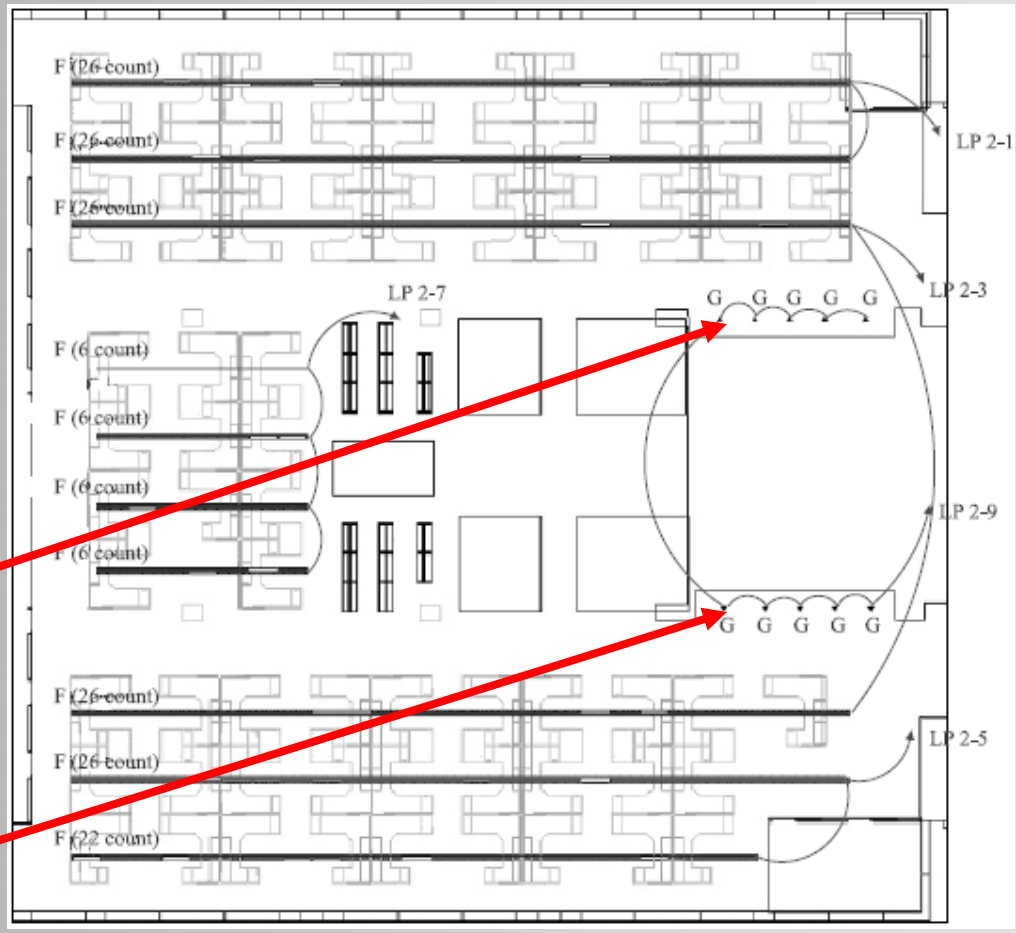
Open Office: Luminaires

Luminaire F: T5 Fluorescent indirect direct pendant



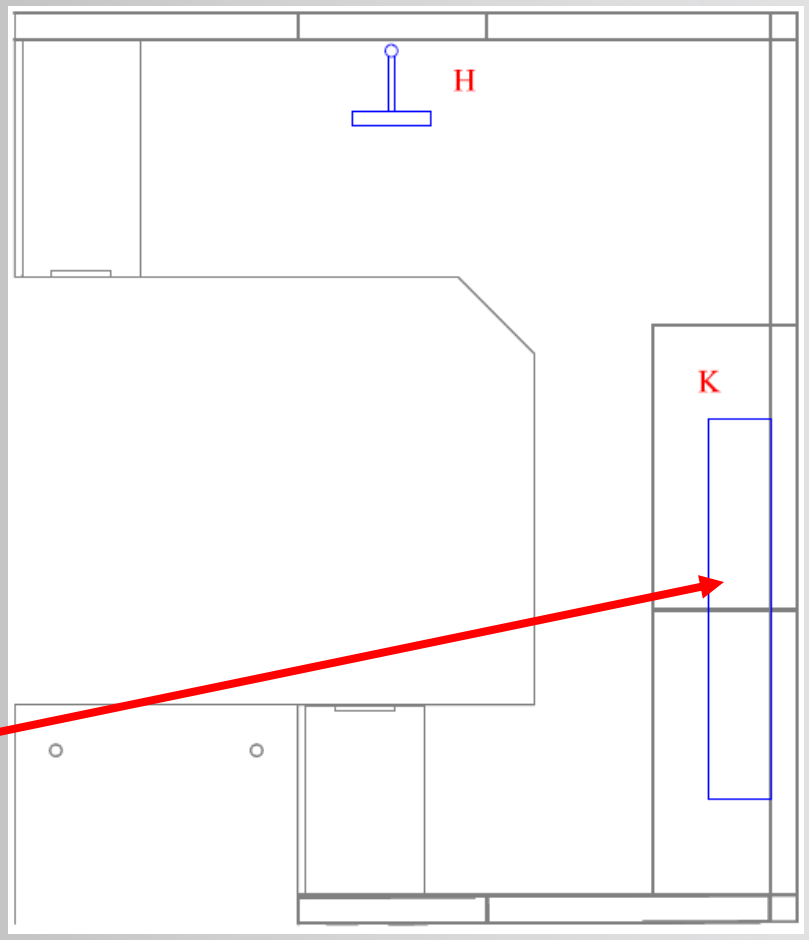
Open Office: Luminaires

Luminaire G: Recessed adjustable MR16



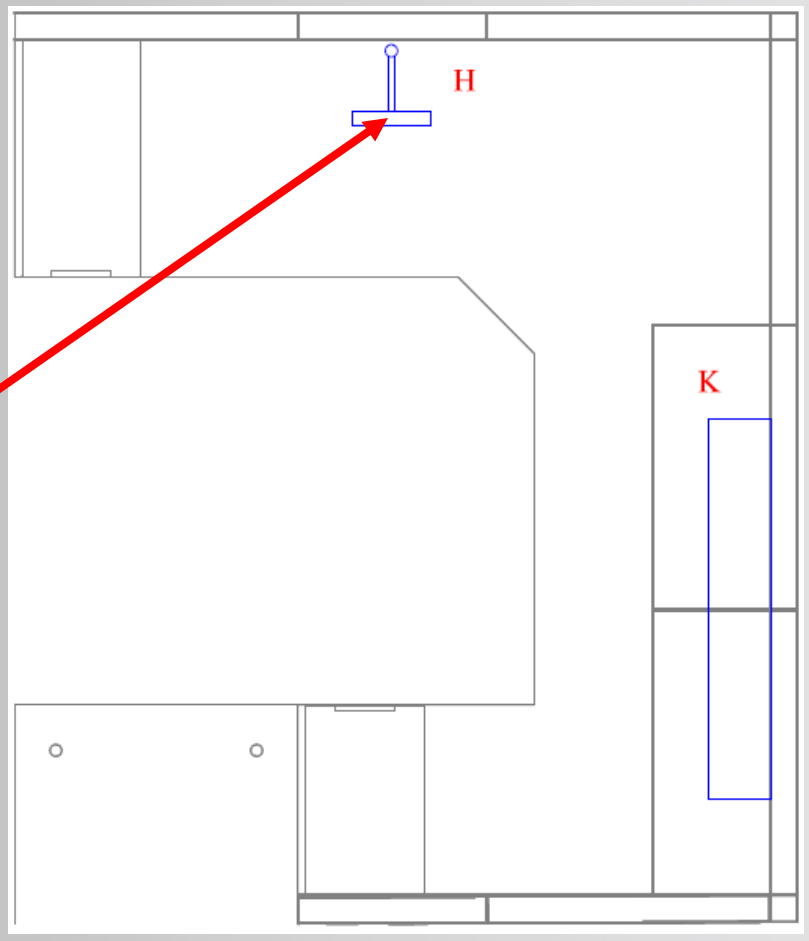
Open Office: Luminaires

Luminaire K: T5 Under cabinet Fixture



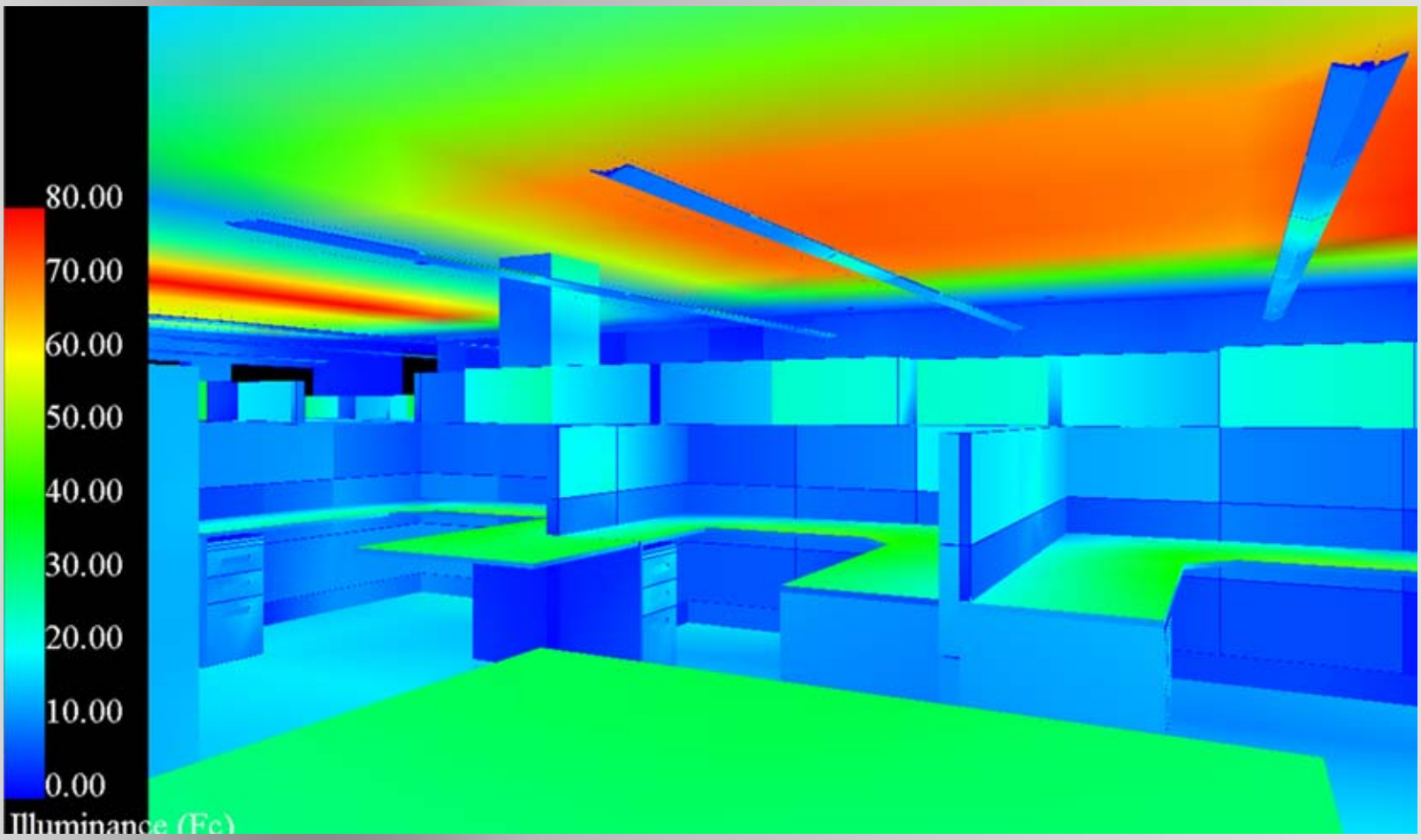
Open Office: Luminaires

Luminaire H: Surface mount LED on swivel arm



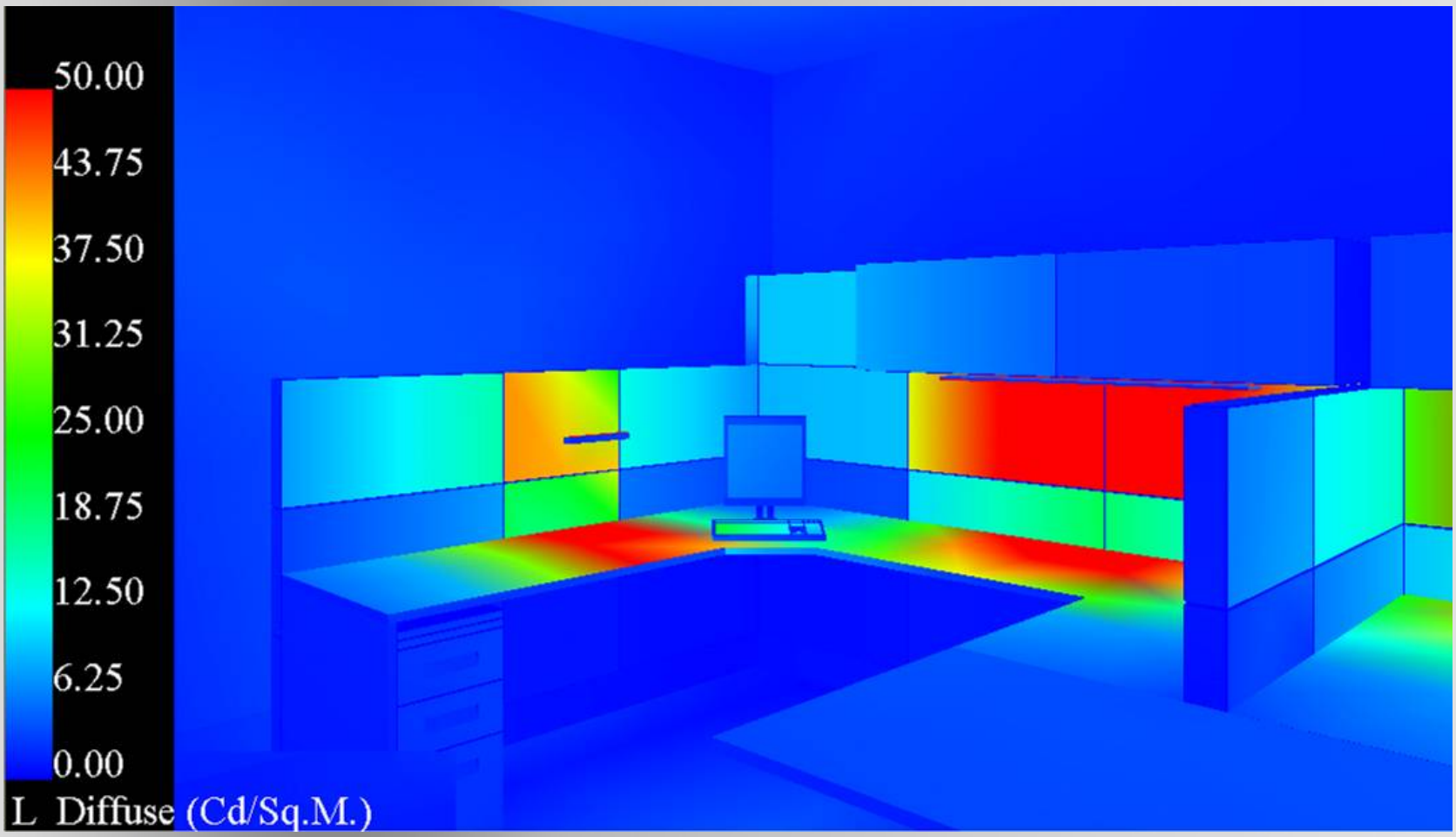
Open Office: Rendering

Open Office: Pseudo Color



No Task Lighting

Open Office: Pseudo Color



Task Lighting

Open Office: Power Density

Power Density =0.88 W / sq ft

Using the Space-by-Space Method in ASHRAE 90.1
Conference/Meeting/Multipurpose: 1.3 W/sq ft

All the requirements are met for ASHRAE 90.1 for the Open Office fixtures.

Open Office: Daylighting

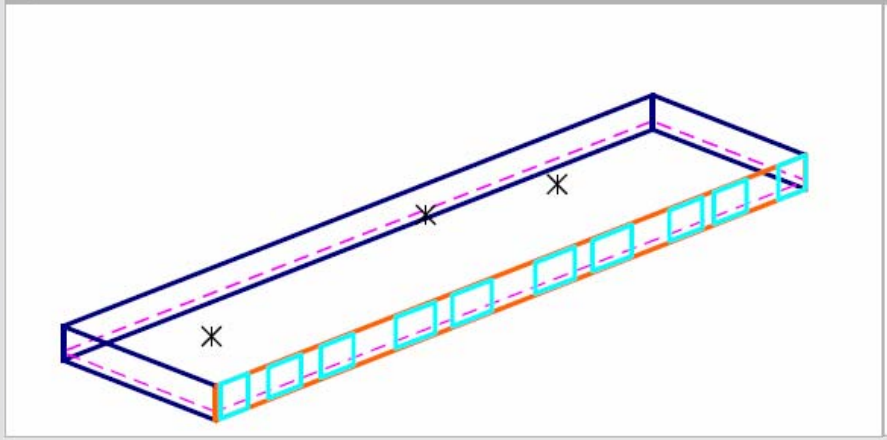
Open Office: Daylighting

Open Office: Daylighting

Photosensor Generator

South Wall

Space Isometric

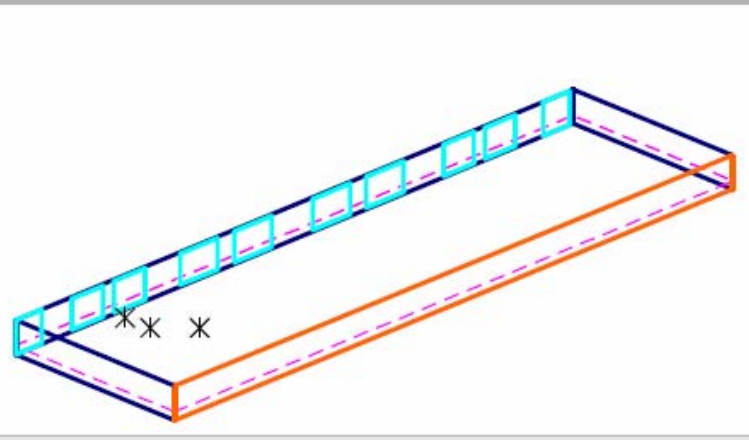


Photosensor Placement — Revert to Generated Points

Photosensor Name	Mounting	Location X	Location Y	Location Z	Aiming	Photosensor Type	Rotation
Sensor_1	C	98	20	10	D	Cosine	0
Sensor_2	C	14	15	10	D	Cosine	0
Sensor_3	C	74	26	10	D	Cosine	0

North Wall

Space Isometric



Photosensor Placement — Revert to Generated Points

Photosensor Name	Mounting	Location X	Location Y	Location Z	Aiming	Photosensor Type	Rotation
Sensor_1	C	14	26	10	D	Cosine	0
Sensor_2	C	14	20	10	D	Cosine	0
Sensor_3	C	20	14	10	D	Cosine	0

Analysis Tool - Annual Analysis

South Wall

Building-Wide Results			
	Total		Costs
Electric Savings, [kWh/yr]	30030	$	2,402
Additional Heating Load, [kBtu/yr]	30315	$	270
Cooling Load Savings, [kWh/yr]	9861	$	789
	Total	$	2,921

North Wall

Building-Wide Results			
	Total		Costs
Electric Savings, [kWh/yr]	29351	$	2,348
Additional Heating Load, [kBtu/yr]	28479	$	253
Cooling Load Savings, [kWh/yr]	9990	$	799
	Total	$	2,894

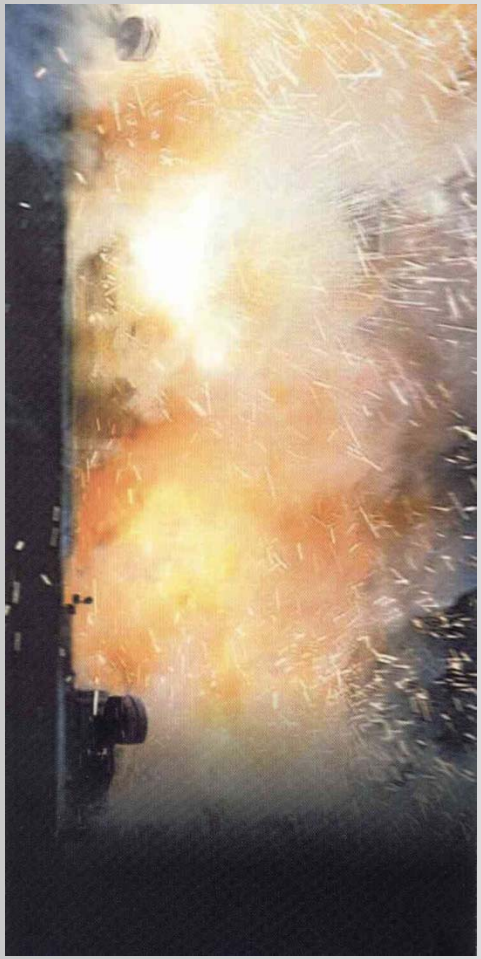
Total Yearly Savings: $5,815

Outline

- Lighting: Façade, Lobby, Presentation Room, and Open Office
- Electrical: Arc Flash Study and Generator
- Structural Breadth: New Tilt up Concrete
- Mechanical Breadth: Thermal Transfer Analysis

Arc Flash Analysis

Arc flashes are short circuits which cause massive energy to blast molten metal and expanding plasma outward with extreme force.



Arc Flash Analysis

	Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Ground	Equip Type	Gap (mm)	Arc Flash Boundary (mm)	Working Distance (mm)	Incident Energy (J/cm2)	Required Protective FR Clothing Category
1	BUS-0012	PD-0010	0.208	111.04	0.11	0.11	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)
2	BUS-0012	PD-0011	0.208	111.04	0.11	0.11	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)
3	BUS-0012	PD-0016	0.208	111.04	0.21	0.21	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)
4	BUS-0012	PD-0017	0.208	111.04	0.21	0.21	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)

Arc Flash Analysis

	Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Ground	Equip Type	Gap (mm)	Arc Flash Boundary (mm)	Working Distance (mm)	Incident Energy (J/cm2)	Required Protective FR Clothing Category
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3	BUS-0012	PD-0016	0.208	111.04	0.21	0.21	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)
4	BUS-0012	PD-0017	0.208	111.04	0.21	0.21	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)

Category 0 Category 2 Category 3

Arc Flash Analysis

	Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Ground	Equip Type	Gap (mm)	Arc Flash Boundary (mm)	Working Distance (mm)	Incident Energy (J/cm2)	Required Protective FR Clothing Category
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4	BUS-0012	PD-0017	0.208	111.04	0.21	0.21	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)

Category 0

Untreated Cotton

Arc Flash Analysis

	Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Ground	Equip Type	Gap (mm)	Arc Flash Boundary (mm)	Working Distance (mm)	Incident Energy (J/cm2)	Required Protective FR Clothing Category
1	BUS-0012	PD-0010	0.208	111.04	0.11	0.11	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)
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Category 0

Untreated Cotton

Category 2

Cotton Undergarments
FR Shirt/Pant

Arc Flash Analysis

	Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Ground	Equip Type	Gap (mm)	Arc Flash Boundary (mm)	Working Distance (mm)	Incident Energy (J/cm2)	Required Protective FR Clothing Category
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2	BUS-0012	PD-0011	0.208	111.04	0.11	0.11	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)
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4	BUS-0012	PD-0017	0.208	111.04	0.21	0.21	0.083	0.000	Yes	PNL	25	908	457	20	Category 2 (*N1) (*N2)

Category 0

Untreated Cotton

Category 2

Cotton Undergarments
FR Shirt/Pant

Category 3

Cotton Undergarments
FR Shirt/Pant
FR Coveralls

Back-up Generator

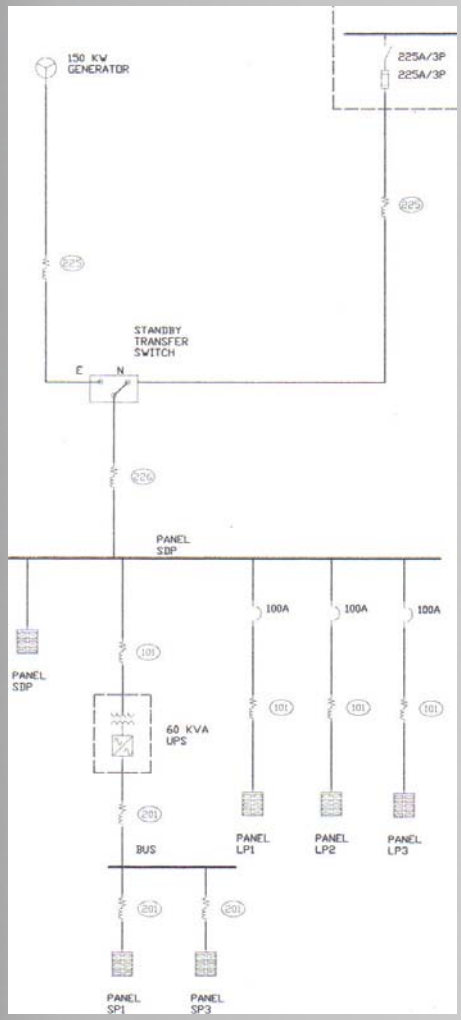
Panel	Load (KW)
SDP	92.5
LP1	19.5
LP2	15.3
LP3	17.8
Total	145.1

Back-up Generator

Requires a 150KW Generator

Panel	Load (KW)
SDP	92.5
LP1	19.5
LP2	15.3
LP3	17.8
Total	145.1

Back-up Generator: Single Line

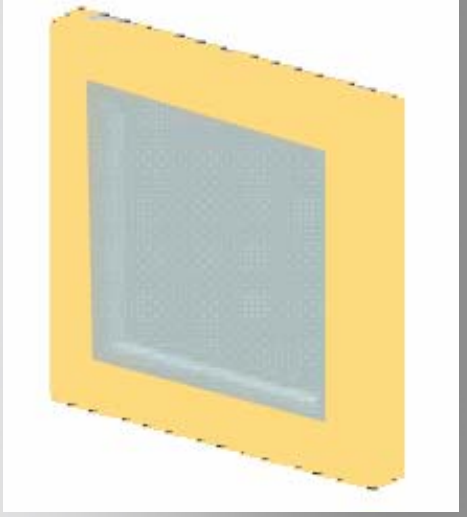


Outline

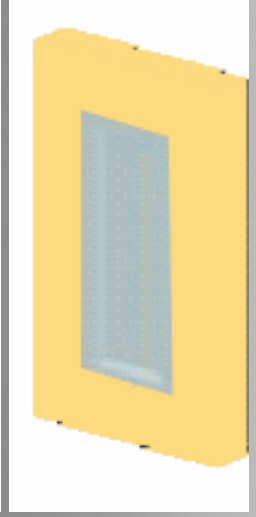
- Lighting: Façade, Lobby, Presentation Room, and Open Office
- Electrical: Arc Flash Study and Generator
- Structural Breadth: New Tilt up Concrete
- Mechanical Breadth: Thermal Transfer Analysis

Structural Breadth

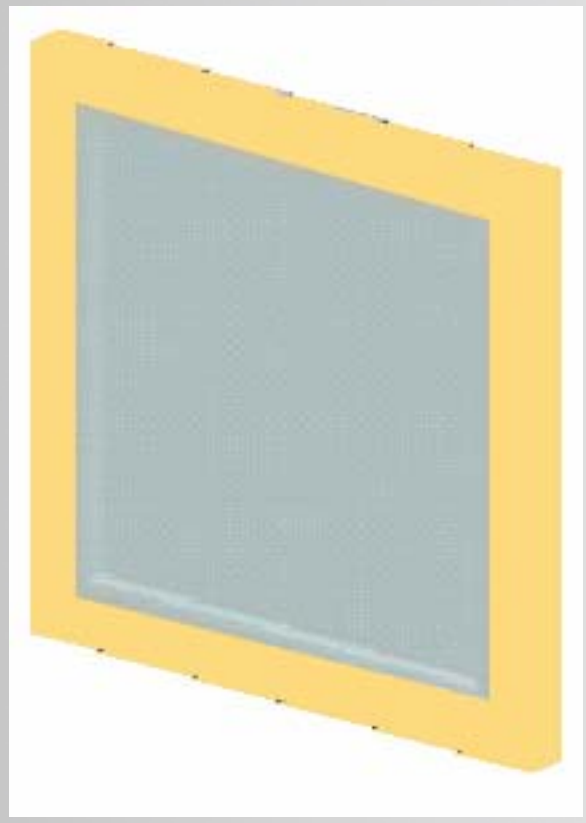
5x5



2x5



9x9



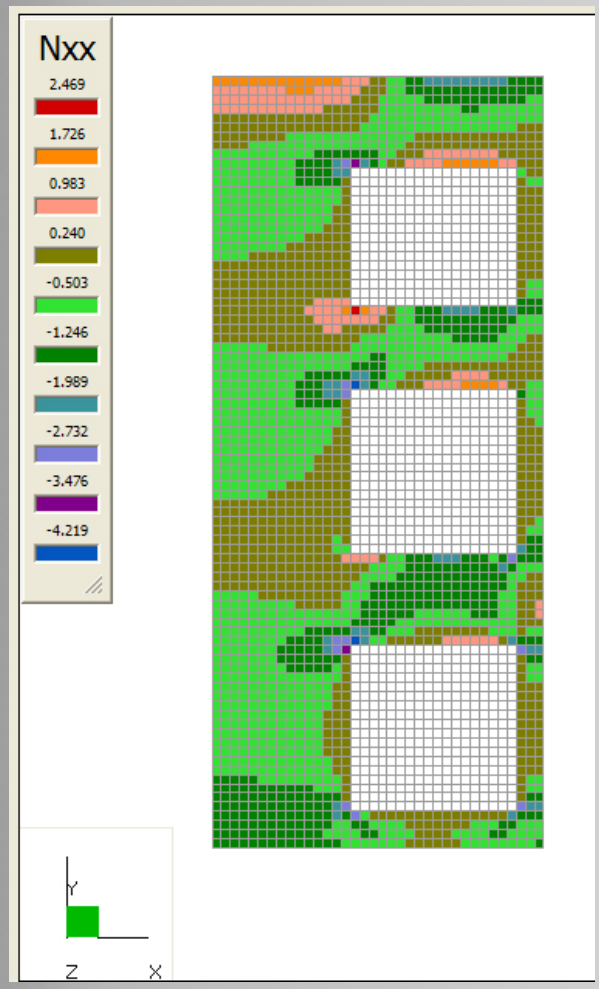
Wind Load

Components and Cladding
From ASCE 7-05

$$p_{net}=\lambda K_{zt} I p_{net30}=(1.51)(1.00)(1.0)(10.9\ psf)$$

16.5 psf

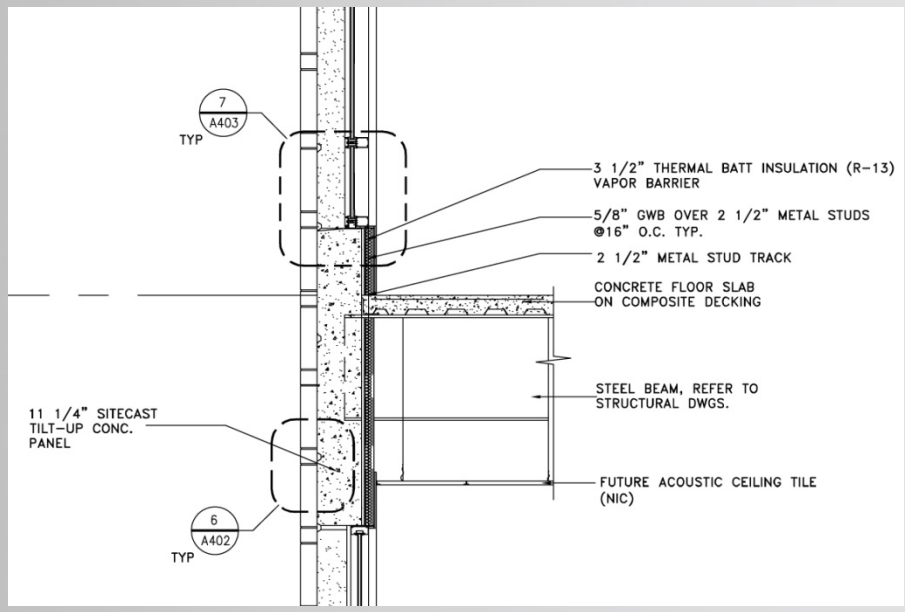
Internal Forces



PCA Wall Output

Mechanical Breadth

R Value Calulation		
	Element	R Value
1	Outside Surface	0.17
2	10" Concrete	1.20
3	3 1/2" Thermal Batt Insulation	13.00
4	Vapor Barrier	0.06
5	5/8" GWB	0.45
6	Inside	0.68
	Total	15.56



Window U value = 0.3

U= 1/R => R= 1/U = 1/0.3 = 3 1/3 ((h*ft2*oF)/Btu)

Mechanical Breadth

Material Ratios				
	Wall Area (ft^2)	Window Area (ft^2)	% Wall	% Window
Original	30626	6754	81.93%	18.07%
Altered	29471	7909	78.84%	21.16%

Mechanical Breadth

Totals		
	Difference (BTU)	Difference (Tons)
Summer	1.4	0.12
Winter	5.7	0.48

Increase Cooling Coil From

654.7 MBH

To

655.2 MBH

Increase Gas Heat Unit From

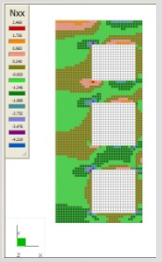
697.0 MBH

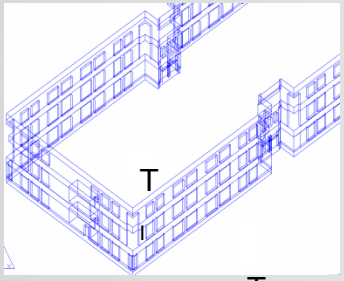
To

698.7 MBH

Conclusions

- Lighting: Was a success do to the creation of an energy efficient and appealing design
- Electrical: The Arc Flash Protection was accomplished. The back-up generator redesign for lighting was a success.
- Structural Breadth: Was a success as the wall could remain the same thickness regardless of the increased opening size
- Mechanical Breadth: Was a success do to the necessity of only a minor change to the heating and cooling unit





Questions ?