Atrium Lighting Redesign

Space Description

After walking through the front canopy of the hospital, you enter into a beautiful three-story atrium area. This new atrium area will serve as a central gathering space where visitors, patients, and employees will be able to relax, reflect and converse with others. Below is an initial drawing of what the architect expected the space to look like and contain. The only difference from the drawing and the existing space is the furniture that was installed into the atrium. Instead of park benches used throughout the space, more comfortable couches and chairs were purchased.

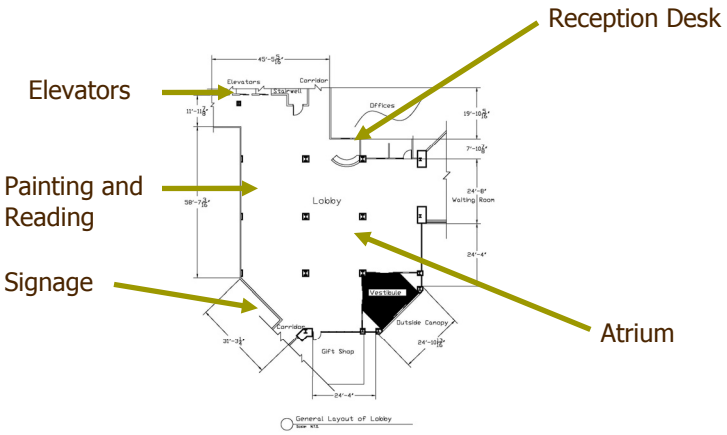
Other than the furniture changing, the sketch above accurately shows the spatial makeup of the new atrium. From the architect's sketch you can see that he has decided to use various types of materials throughout the space such as brick, finished wood and gypsum board. The space also can be perceived as being broken up into different spaces by the changing in ceiling elevations and by the architect using the column grid to create flooring tile patterns and ceiling grid pods. This separation of spaces will be useful to determine the layout of the furniture and the layout of the lighting redesign.

Surface Properties:

Type	Material	Reflectance
Wall Gypsum	White Mist Paint	78%
Column Gypsum	Ermine Paint (whitish)	64%
Floor	Ceramic Floor Tile (clay color)	30%
Ceiling	White ACT	85%
Glazing on Interior	Monolithic Clear Float Glass	8%
Glazing to Exterior	Reflective & Low-Emissivity Insulating Glass	75%
Doors	Wood	45%
Brick Walls	Red Brick	18%
Open Space		30%

Design Concept

The new atrium lighting design can be broken down into five separate areas: the general three-story high atrium area, reading areas, paintings and egress sign, receptionist desk, and the elevator area. First let's talk about the general atrium area. The atrium area will be illuminated by a new artificial sky lighting system. The original ceiling design of the atrium utilizes a sloped ceiling design with suspended metal tiles. The lighting redesign will require that the existing metal ceiling tile be changed to a diffusing glass system. In order to create a good uniform luminance from the skylights, light will first be bounced off of the ceiling above the diffusing tiles and then reflected onto and through the diffusing glass (see appendix for details). This lighting setup will provide a good aesthetic quality while giving the space a rather uniform light distribution across the floor, which is optimal for spaces that will mostly be occupied by the elderly. Another important design space in the atrium is the receptionist desk. This area should be designed so that upon entering the atrium, the occupant has no doubt as to where to go for verbal information. Therefore, the area (desktop, front of desk and the floor directly in front) should be illuminated higher than its surrounding areas. This higher illumination will catch the entering people's attention and provide them with a sense of direction. This principle of providing higher illumination on areas of higher importance will also be used in the elevator area, as well as on the circulation signage.



Wallwash luminaires will be used to wash the elevator doors and circulation signage with higher light levels than their surroundings. Probably the most difficult area to design is the reading area, where couches and chairs are located, because it is made up of three different ceiling heights. The area under the first floor canopy can be illuminated by general downlights, while the two taller spaces will utilize column mounted fixtures to produce ambient light for reading tasks. The paintings in this reading area will be illuminated by recessed accent lights that will allow the paintings to stand out and appear vivid. It is important that these wallwashers be located in locations that will not produce direct glare for the resting occupants along the back wall of the atrium.

Design Criteria

Tasks

Egress
Reading at benches (magazines, newspapers, etc.)
Reading signage on walls
Communicating with receptionist
Meeting with people

Illuminance Levels:

- Horizontal Illuminance Level on Floor

  Recommended value form IESNA 9th edition is Category B
  Category B = 5 fc

  Adjustments

Age>55	+1
Important	0
30% – 70%	-1
	0

  No adjustments necessary

  Suggested Value = 10 fc

  I suggested this value because the space is located in a healthcare facility and the majority of occupants moving throughout the space are elder and may have trouble seeing under low illuminance values.

- Horizontal Illuminance on Receptionists Desktop

  Recommended value from IESNA 9th edition is Category D
  Category D = 30 fc

  No adjustments necessary

- Horizontal Illuminance Level on Benches

  Recommended value from IESNA 9th edition for Reading of magazines is Category D
  Category E = 30 fc

  No adjustments necessary

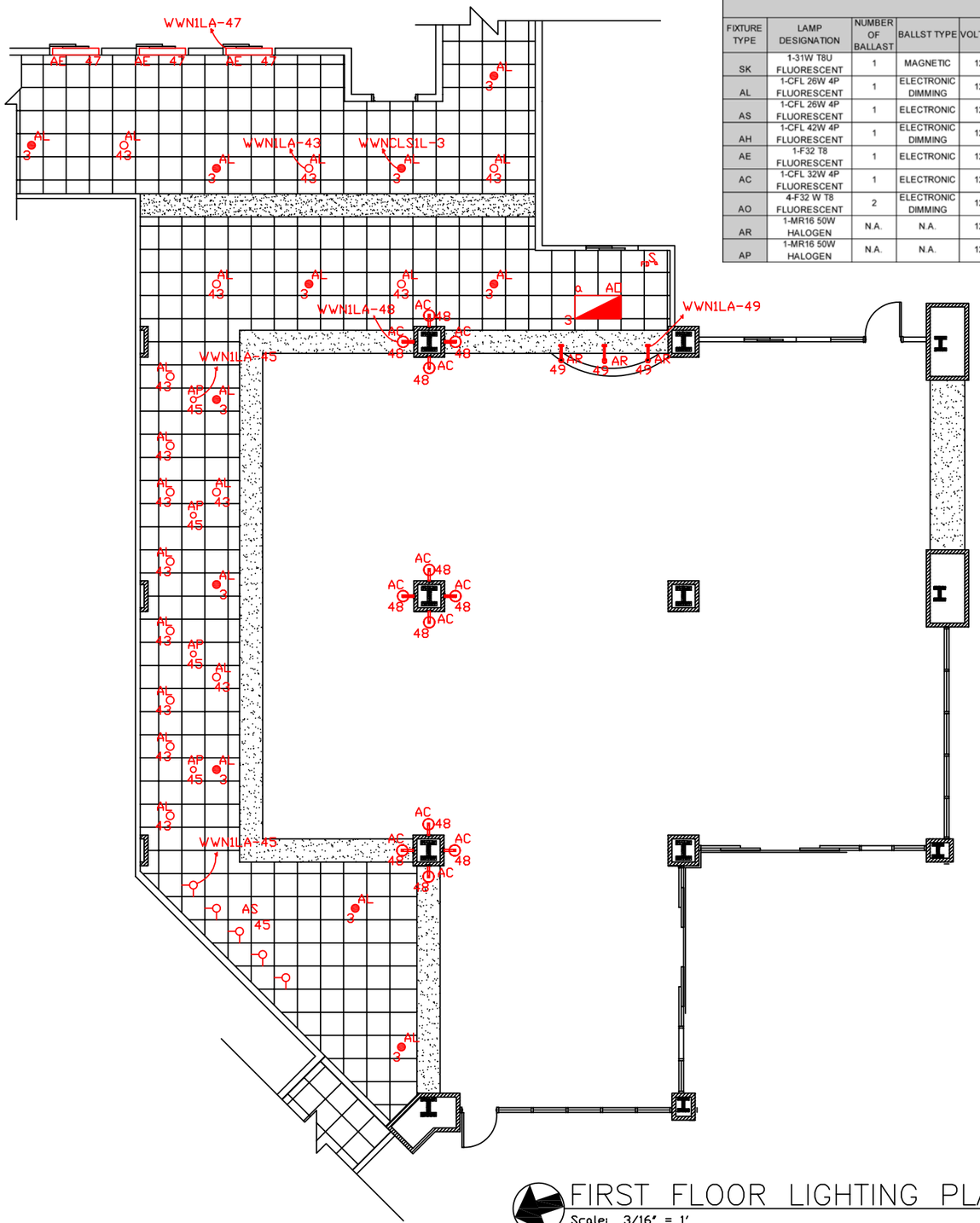
- Vertical Illuminance Level on Signage
  Recommended value from IESNA 9th edition is Category D
  Category E = 30fc
  No adjustments necessary

- Vertical Illuminance Level on Walls
  Recommended value from IESNA 9th edition is Category A
  Category A = 3 fc
  No adjustments necessary

Design Considerations:

- One of the most critical design considerations in a space such as a hospital lobby is the light distribution across the floor. This is because the senior pedestrians in this space have low adaptation rates for varying light levels. Therefore we should strive to achieve relatively uniform flooring.
- One factor that can reduce this effect is the use of day lighting integration and control.
- Use photoelectric controls along with blinds and shades to control the space and help neutralize the contrast from the outside daylight to the inside lighting environment.
- Use day lighting control to eliminate unwanted direct glare from windows and doors.
- Avoid high luminance surfaces that create direct glare and lower task visibility in the space. Another problem which lowers task visibility in the space is reflected glare. Reflected glare in this space should be eliminated by avoiding glossy surfaces along with points of high luminance when compared to its surroundings.
- Use variations in light levels and color patterns to convey directionality within the lobby. Light the elevators, receptionist, signage and egress paths with higher illuminance values than the surroundings.
- Use lamps with CRIs of 80 and above in the lobby to achieve good facial modeling.
- Use interreflected light throughout the space to decrease sharp shadows and high contrast on faces.
- Use lamps with CCTs around 3500 in wall sconces and under the second floor balcony to give the brick a vibrant red color and to give healthy looking skin tones.

Control System: Use photoelectric sensors to dim the different lighting systems throughout the space to desired levels. Use a tamper free switching system that lets the owner manually turn the different lighting systems on and off.



LUMINAIRE SCHEDULE

FIXTURE TYPE	LAMP DESIGNATION	NUMBER OF BALLAST	BALLST TYPE	VOLTAGE	MOUNTING	MOUNTING HIGHT	FIXTURE CATALOG NUMBER	LAMP ORDERING CODE	BALLAST CATALOG NUMBER
SK	1-31W T8U FLUORESCENT	1	MAGNETIC	120	SURFACE	33' 10 OR 35' 1 1/2"	ELLIPTIPAR F302-L139-S-00-120	OSRAM SYLVANIA FBO31/835/XP/ECO	ADVANCE TRANSFORMER R-1P32-TP
AL	1-CFL 26W 4P FLUORESCENT	1	ELECTRONIC DIMMING	120	RECESSED	9' 10" OR 8'	LITHONIA LP8F-26DTT-120-ADEZ-803	PHILLIPIS PL-T 42W/835/4P/ALTO	ADVANCE TRANSFORMER REZ-1T32
AS	1-CFL 26W 4P FLUORESCENT	1	ELECTRONIC	120	RECESSED	9' 10"	EDISON PRICE LIGHITNG WLX-T226/6-120-VOL	OSRAM SYLVANIA CF26DT/E/827	ADVANCE TRANSFORMER RCF-2S26-H1-LD-QS
AH	1-CFL 42W 4P FLUORESCENT	1	ELECTRONIC DIMMING	120	RECESSED	21' 6"	LITHONIA LP8F-42TRT-120-ADEZ-802	PHILLIPIS PL-T 42W/835/4P/ALTO	ADVANCE TRANSFORMER IZT-1T42-M2-BS@120
AE	1-F32 T8 FLUORESCENT	1	ELECTRONIC	120	RECESSED	8'	LITECONTROL 85N-14T8-S/BW-CWM-G-ELB-PR	PHILLIPIS F32T8/TL835/ALTO	ADVANCE TRANSFORMER RZT-132
AC	1-CFL 32W 4P FLUORESCENT	1	ELECTRONIC	120	SURFACE	9'10"	DELRAY 2363-H-32-120-E	PHILLIPIS CF32DT/E/827	ADVANCE TRANSFORMER ICF-2S26-H1-LD@230
AO	4-F32 W T8 FLUORESCENT	2	ELECTRONIC DIMMING	120	RECESSED	9' 10"	LITHONIA 2PM4-G-4-32LD-120	PHILLIPIS F32T8/TL835/ALTO	ADVANCE TRANSFORMER REZ-2S32-SC
AR	1-MR16 50W HALOGEN	N.A.	N.A.	120	SURFACE	10' 8"	COOPER LIGHTING 922-50MR16-12-BK	PHILLIPIS 50MRC16/FL36	N.A.
AP	1-MR16 50W HALOGEN	N.A.	N.A.	120	RECESSED	9' 10"	ERCO MRC16 50W 12V GU5.3 10°	PHILLIPIS 50MRC16/SP10	N.A.

NEW

EXISTING

FIRST FLOOR LIGHTING PLAN

Scale: 3/16" = 1'

General Notes

No.	Revision/Issue	Date

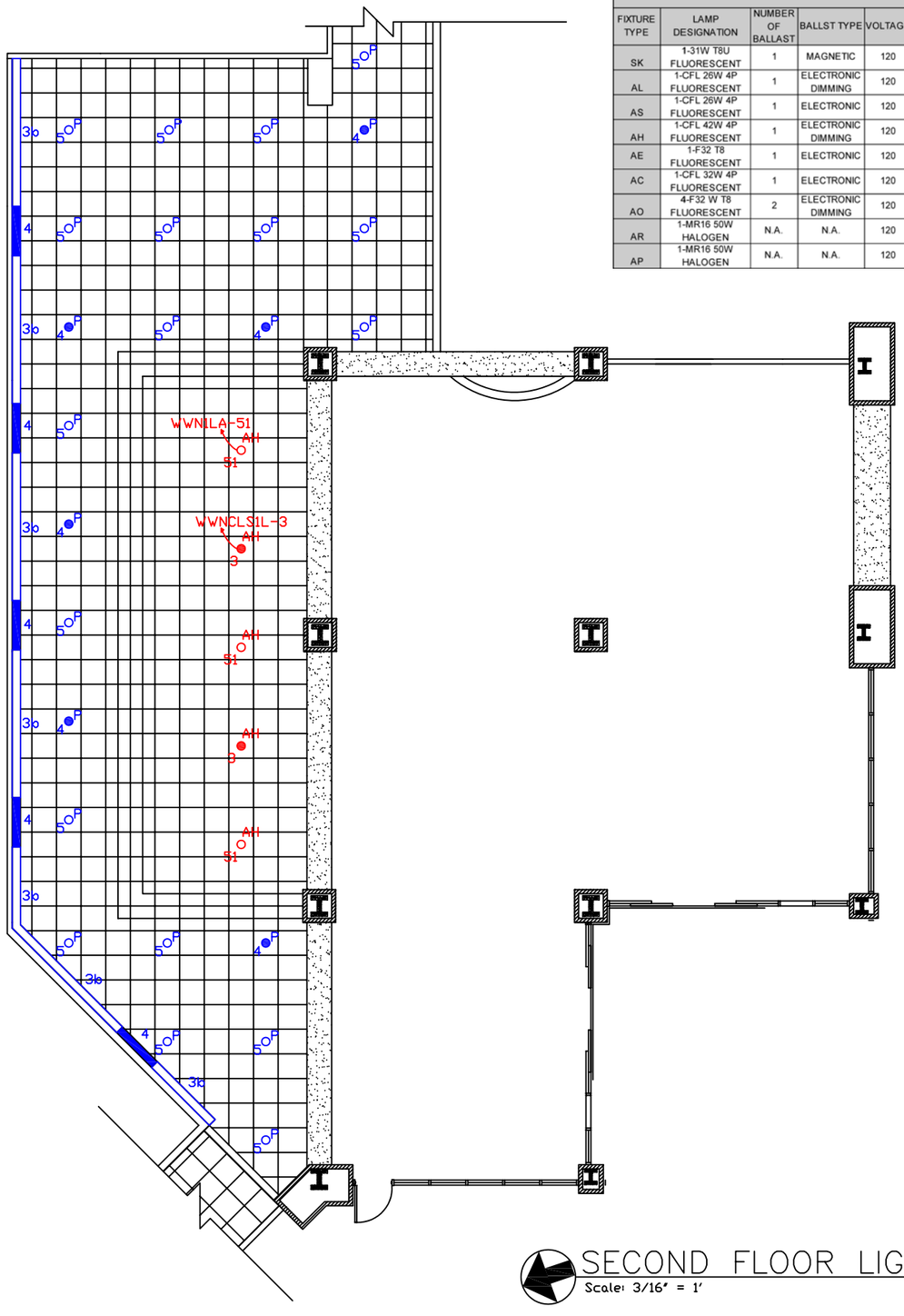
Firm Name and Address

Ben Ardary
Architectural Eng.
Penn. State University
State College, PA

Project Name and Address

DRMC
West Wing Addition
100 Hospital Ave.
DuBois, PA

Project	Sheet
THESIS	E-A1
Date: 4/2/2005	
Scale: 3/16"=1'	



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AL	1-CFL 26W 4P FLUORESCENT	1	ELECTRONIC DIMMING	120	RECESSED	9' 10" OR 8'	LITHONIA LP8F-26DTT-120-ADEZ-803	PHILLIPIS PL-T 42W/835/4P/ALTO	ADVANCE TRANSFORMER REZ-1T32
AS	1-CFL 26W 4P FLUORESCENT	1	ELECTRONIC	120	RECESSED	9' 10"	EDISON PRICE LIGHITNG WLX-T226/6-120-VOL	OSRAM SYLVANIA CF26DT/E/827	ADVANCE TRANSFORMER RCF-2S26-H1-LD-QS
AH	1-CFL 42W 4P FLUORESCENT	1	ELECTRONIC DIMMING	120	RECESSED	21' 6"	LITHONIA LP8F-42TRT-120-ADEZ-802	PHILLIPIS PL-T 42W/835/4P/ALTO	ADVANCE TRANSFORMER IZT-1T42-M2-BS@120
AE	1-F32 T8 FLUORESCENT	1	ELECTRONIC	120	RECESSED	8'	LITECONTROL 85N-14T8-S/BW-CWM-G-ELB-PR	PHILLIPIS F32T8/TL835/ALTO	ADVANCE TRANSFORMER RZT-132
AC	1-CFL 32W 4P FLUORESCENT	1	ELECTRONIC	120	SURFACE	9'10"	DELRAY 2363-H-32-120-E	PHILLIPS CF32DT/E/827	ADVANCE TRANSFORMER ICF-2S26-H1-LD@230
AO	4-F32 W T8 FLUORESCENT	2	ELECTRONIC DIMMING	120	RECESSED	9' 10"	LITHONIA 2PM4-G-4-32LD-120	PHILLIPIS F32T8/TL835/ALTO	ADVANCE TRANSFORMER REZ-2S32-SC
AR	1-MR16 50W HALOGEN	N.A.	N.A.	120	SURFACE	10' 8"	COOPER LIGHTING 922-50MR16-12-BK	PHILLIPIS 50MRC16/FL36	N.A.
AP	1-MR16 50W HALOGEN	N.A.	N.A.	120	RECESSED	9' 10"	ERCO MRC16 50W 12V GU5.3 10°	PHILLIPIS 50MRC16/SP10	N.A.

NEW

EXISTING

SECOND FLOOR LIGHTING PLAN

Scale: 3/16" = 1'

General Notes

No.	Revision/Issue	Date

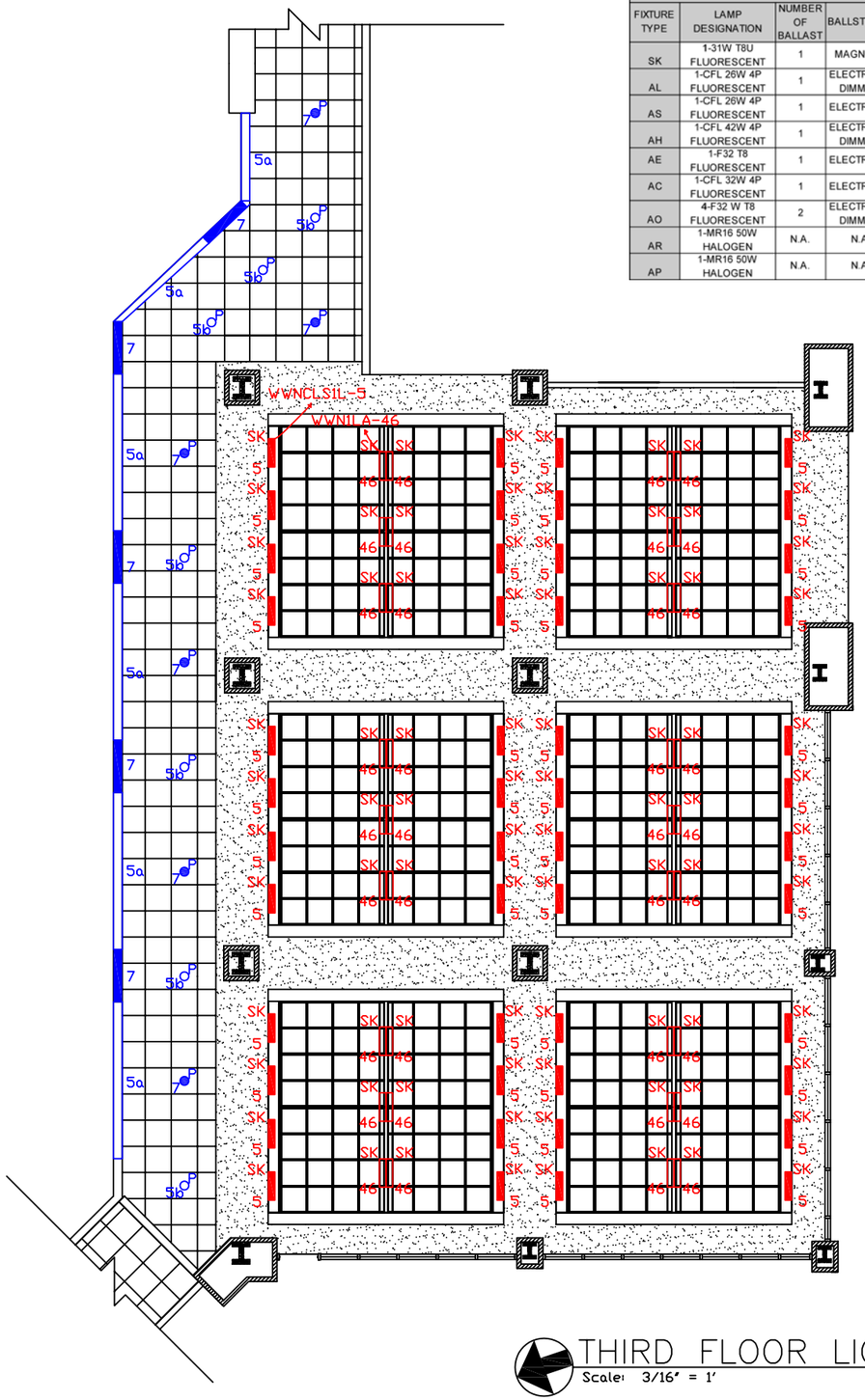
Firm Name and Address

Ben Ardary
Architectural Eng.
Penn. State University
State College, PA

Project Name and Address

DRMC
West Wing Addition
100 Hospital Ave.
DuBois, PA

Project: THESIS	Sheet: E–A2
Date: 4/2/2005	
Scale: 3/16"=1'	



LUMINAIRE SCHEDULE

FIXTURE TYPE	LAMP DESIGNATION	NUMBER OF BALLAST	BALLST TYPE	VOLTAGE	MOUNTING	MOUNTING HIGHT	FIXTURE CATALOG NUMBER	LAMP ORDERING CODE	BALLAST CATALOG NUMBER
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AL	1-CFL 26W 4P FLUORESCENT	1	ELECTRONIC DIMMING	120	RECESSED	9' 10" OR 8'	LITHONIA LP8F-26DTT-120-ADEZ-803	PHILLIPIS PL-T 42W/835/4P/ALTO	ADVANCE TRANSFORMER REZ-1T32
AS	1-CFL 26W 4P FLUORESCENT	1	ELECTRONIC	120	RECESSED	9' 10"	EDISON PRICE LIGHITNG WLX-T226/6-120-VOL	OSRAM SYLVANIA CF26DT/E/827	ADVANCE TRANSFORMER RCF-2S26-H1-LD-QS
AH	1-CFL 42W 4P FLUORESCENT	1	ELECTRONIC DIMMING	120	RECESSED	21' 6"	LITHONIA LP8F-42TRT-120-ADEZ-802	PHILLIPIS PL-T 42W/835/4P/ALTO	ADVANCE TRANSFORMER IZT-1T42-M2-BS@120
AE	1-F32 T8 FLUORESCENT	1	ELECTRONIC	120	RECESSED	8'	LITECONTROL 85N-14T8-S/BW-CWM-G-ELB-PR	PHILLIPIS F32T8/TL835/ALTO	ADVANCE TRANSFORMER RZT-132
AC	1-CFL 32W 4P FLUORESCENT	1	ELECTRONIC	120	SURFACE	9'10"	DELRAY 2363-H-32-120-E	PHILLIPS CF32DT/E/827	ADVANCE TRANSFORMER ICF-2S26-H1-LD@230
AO	4-F32 W T8 FLUORESCENT	2	ELECTRONIC DIMMING	120	RECESSED	9' 10"	LITHONIA 2PM4-G-4-32LD-120	PHILLIPIS F32T8/TL835/ALTO	ADVANCE TRANSFORMER REZ-2S32-SC
AR	1-MR16 50W HALOGEN	N.A.	N.A.	120	SURFACE	10' 8"	COOPER LIGHTING 922-50MR16-12-BK	PHILLIPIS 50MRC16/FL36	N.A.
AP	1-MR16 50W HALOGEN	N.A.	N.A.	120	RECESSED	9' 10"	ERCO MRC16 50W 12V GU5.3 10°	PHILLIPIS 50MRC16/SP10	N.A.

NEW

EXISTING

THIRD FLOOR LIGHTING PLAN

Scale: 3/16" = 1'

General Notes

No.	Revision/Issue	Date

Firm Name and Address

Ben Ardary
Architectural Eng.
Penn. State University
State College, PA

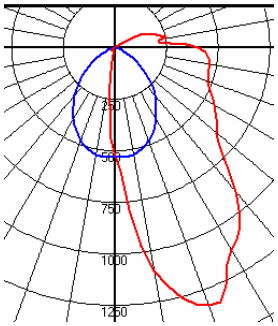
Project Name and Address

DRMC
West Wing Addition
100 Hospital Ave.
DuBois, PA

Project	Sheet
THESIS	E-A3
Date 4/2/2005	
Scale 3/16"=1'	

Equipment

Luminaire SK –Skylight Luminaires

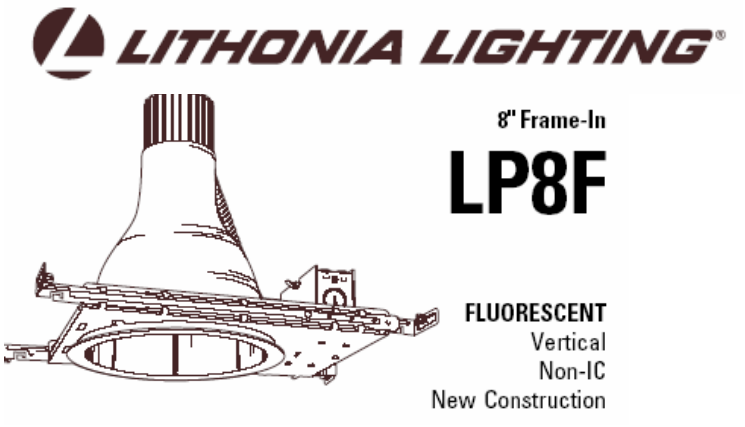


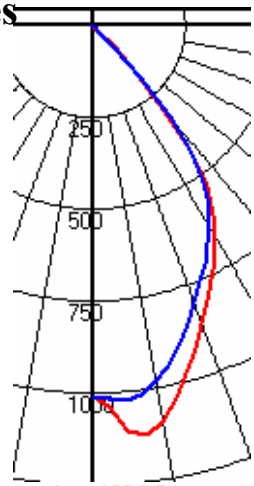
IES file will be rotated 90deg counter-clockwise to obtain the correct light distribution

Bilaterally Symmetric 180-0 Degrees 90-270 Degrees

Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AS	VI	Very Clean	12 Month	1.5	Indirect	0.95	0.93	0.92	0.95	**0.77**

Luminaire AL – First Floor Balcony Luminaires

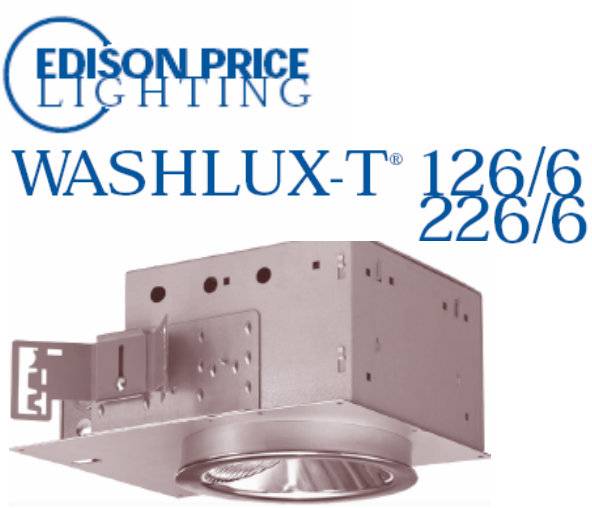


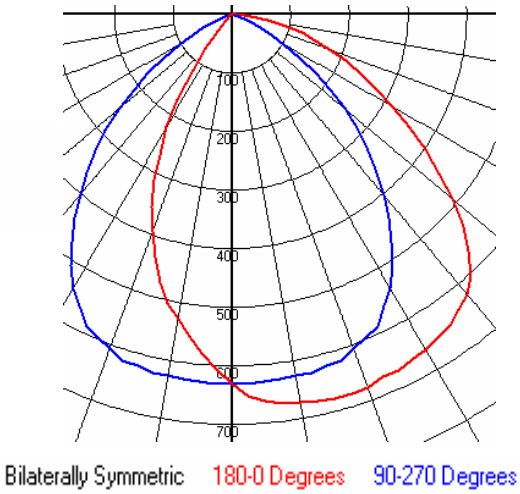


Bilaterally Symmetric 180-0 Degrees 90-270 Degrees

Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AG	IV	Very Clean	12 Month	3.4	Direct	0.94	0.98	0.86	1.0	**0.79**

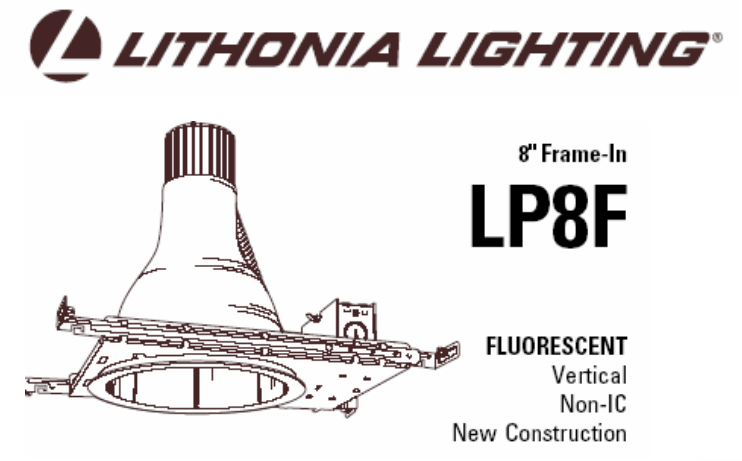
Luminaire AS – Circulation Sign Luminaires

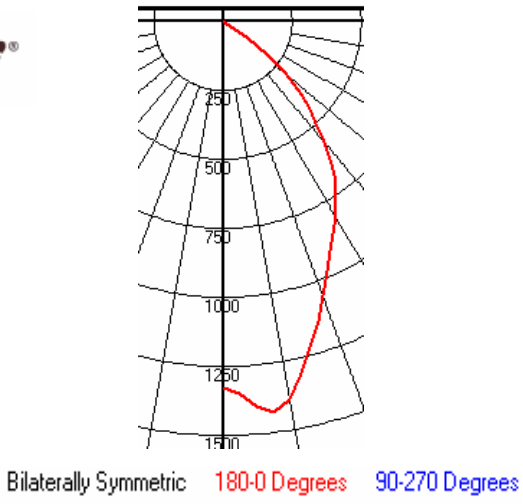




Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AC	V	Very Clean	12 Month	3.4	Direct	0.93	0.98	0.86	1.0	**0.78**

Luminaire AH – Second Floor Balcony Luminaires



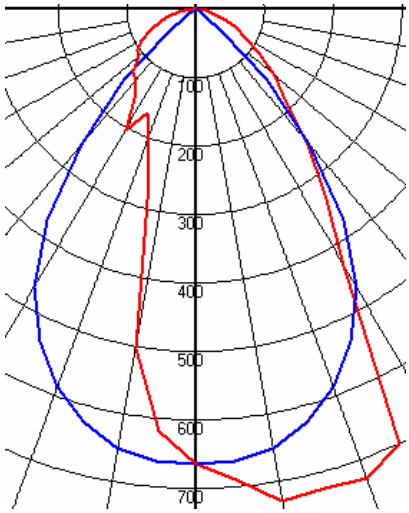


Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AH	IV	Very Clean	12 Month	7.3	Direct	0.94	0.97	0.85	1.0	**0.78**

Luminaire AE – Elevator Luminaires

LITECONTROL

Wall/Slot®-II
85N
Recessed Perimeter

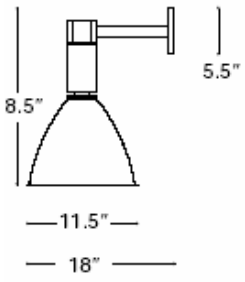


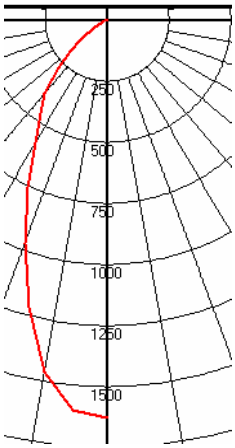
Bilaterally Symmetric 180-0 Degrees 90-270 Degrees

Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AE	IV	Very Clean	12 Month	3.4	Direct	0.94	0.98	0.95	0.88	**0.77**

Luminaire AC – Chair Luminaires

DELRAY LIGHTING INCORPORATED





Bilaterally Symmetric 180-0 Degrees 90-270 Degrees

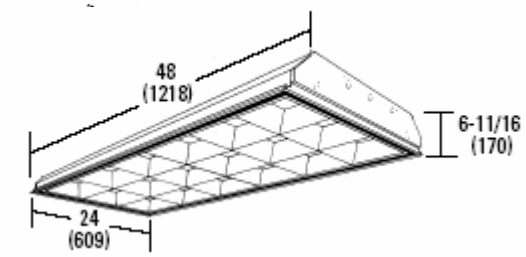
Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AR	IV	Very Clean	12 Month	4.5	Direct	0.94	0.98	0.86	1.0	**0.79**

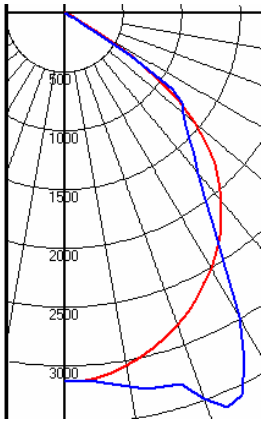
Luminaire AO – Receptionist Area Luminaire

LITHONIA LIGHTING®

PARAMAX® Parabolic Troffer

PM4 2'x4'



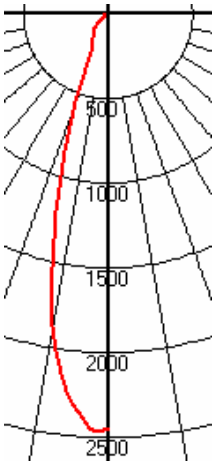


Bilaterally Symmetric 180-0 Degrees 90-270 Degrees

Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AD	IV	Very Clean	12 Month	3.4	Direct	0.94	0.98	0.95	0.88	**0.77**

Luminaire AR – Receptionist Desktop Luminaires

COOPER Lighting
Lumière

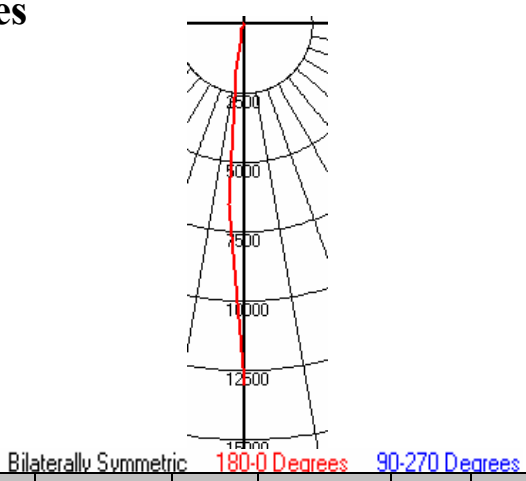


Bilaterally Symmetric 180-0 Degrees 90-270 Degrees

Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AA	IV	Very Clean	12 Month	7.5	Direct	0.94	0.97	1.0	1.0	**0.91**

Luminaire AP – Painting Luminaires

ERCO
Gimbal Directional spotlight



Luminaire	Maint. Category	Cleanliness	Cleaning Cycle	RCR	CIE Category	LDD	RSDD	LLD	BF	**Total LLF**
AP	IV	Very Clean	12 Month	3.4	Direct	0.94	0.98	1.0	1.0	**0.92**

Power Density Calculation

Fixture	Quantity	W/Fixture	Watts
SK	84	35	2940
AC	12	37.6	451.2
AR	3	50	150
AL	21	30.6	642.6
AH	5	50	250
AS	5	57	287
AE	3	33	99
AO	1	128	128
AP	4	50	200
		Total	5147.8

Total W = 5147.8 W
Power Density in ASHRAE Standard 90.1 requires you to break the atrium up by floor.
1st Floor Area = 4950 ft^2.
2nd Floor Area = 3150 ft^2
3rd Floor Area = 2750 ft^2.
Total Area = 6510 ft^2

Power Density = 5147.8W/ 6510ft^2
= 0.79W/ft^2

Power Density **DOES** comply with ASHRAE Standard 90.1 that says by using the Space-by-Space method to find your Allowable Power Density for a three-story atrium area is 1.8 W/ft^2 (0.6 W/ft^2 per floor).

Control System

The redesigned lighting system will be controlled by an existing Lithonia Lighting panel and existing Lithonia photosensors. Low voltage control wiring for the new luminaires will be run to designated switches, ballasts, and photosensors from the control panel. There are two photosensors located in the atrium area, one under the first floor balcony (photo cell #2) toward the elevators and one in the vestibule between the atrium and the canopy (photo cell #1). Below is a control schedule for the redesigned lighting system.

LIGHTING REDESING CONTROL SCHEDULE	
FIXTURE TYPE	CONTROL
SK	ON-OFF CONTROLLED VIA LV CONTORL PANEL
AC	ON-OFF CONTROLLED VIA LV CONTORL PANEL
AR	ON-OFF CONTROLLED VIA LV CONTORL PANEL
AL	AUTOMATIC DIMMING MODULE CONTROLLED VIA INTERIOR PHOTO CELL #2
AH	AUTOMATIC DIMMING MODULE CONTROLLED VIA INTERIOR PHOTO CELL #2
AS	ON-OFF CONTROLLED VIA LV CONTORL PANEL
AE	ON-OFF CONTROLLED VIA LV CONTORL PANEL
AO	ON-OFF CONTROLLED VIA RECEPTION DIMMER SWITCH
AP	ON-OFF CONTOLLRED VIA LV CONTROL PANEL

Atrium Design Analysis

The following sections of the atrium lighting redesign provide visual and numerical evidence of the performance of the new lighting system. First, the following renderings, which were performed in AGI 32, give visual information on how the new lighting system could perform in the atrium area. To back up this visual information, calculations were run in AGI 32 to determine if the atrium lighting redesign achieved the specified design criteria. Calculation grids were placed on the floor of the atrium, reception desk, elevator doors, signage, paintings, and at chair locations where the occupant will be reading.

Atrium Renderings:

Back Wall

Entrance from Existing Hospital

Entrance View

Typical Skylight

Balconies

Front Entrance

Elevators

View From Balcony

Calculation Results

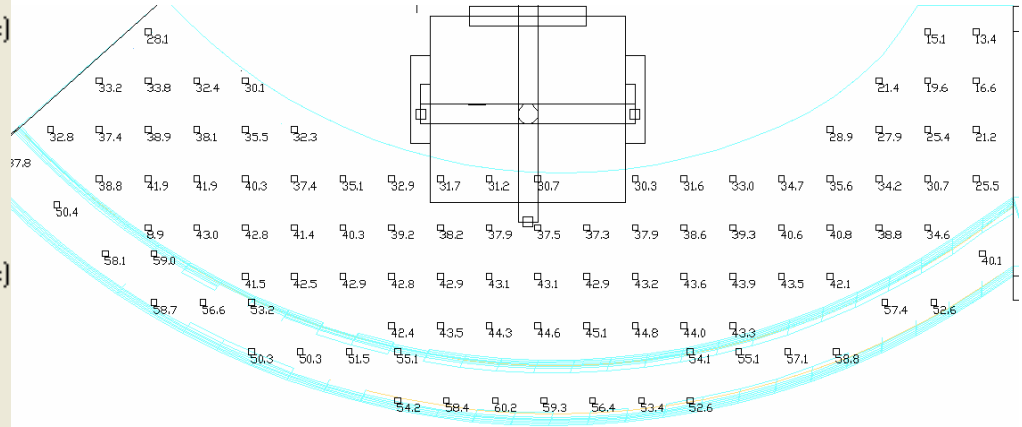
All Calculations were performed in AGI 32
Calculation Values are all in fc.

Reception Desk

Workplane at desk tops.

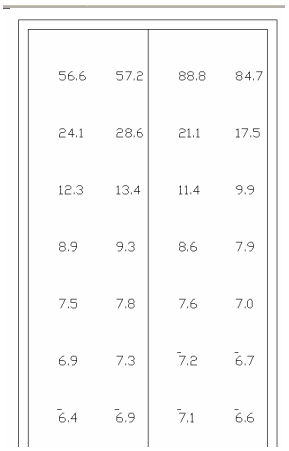
recption top
Illuminance Values(Fc)
Average=54.03
Maximum=60.2
Minimum=37.8
Avg/Min=1.43
Max/Min=1.59

reception desk
Illuminance Values(Fc)
Average=35.88
Maximum=45.1
Minimum=8.9
Avg/Min=4.03
Max/Min=5.07



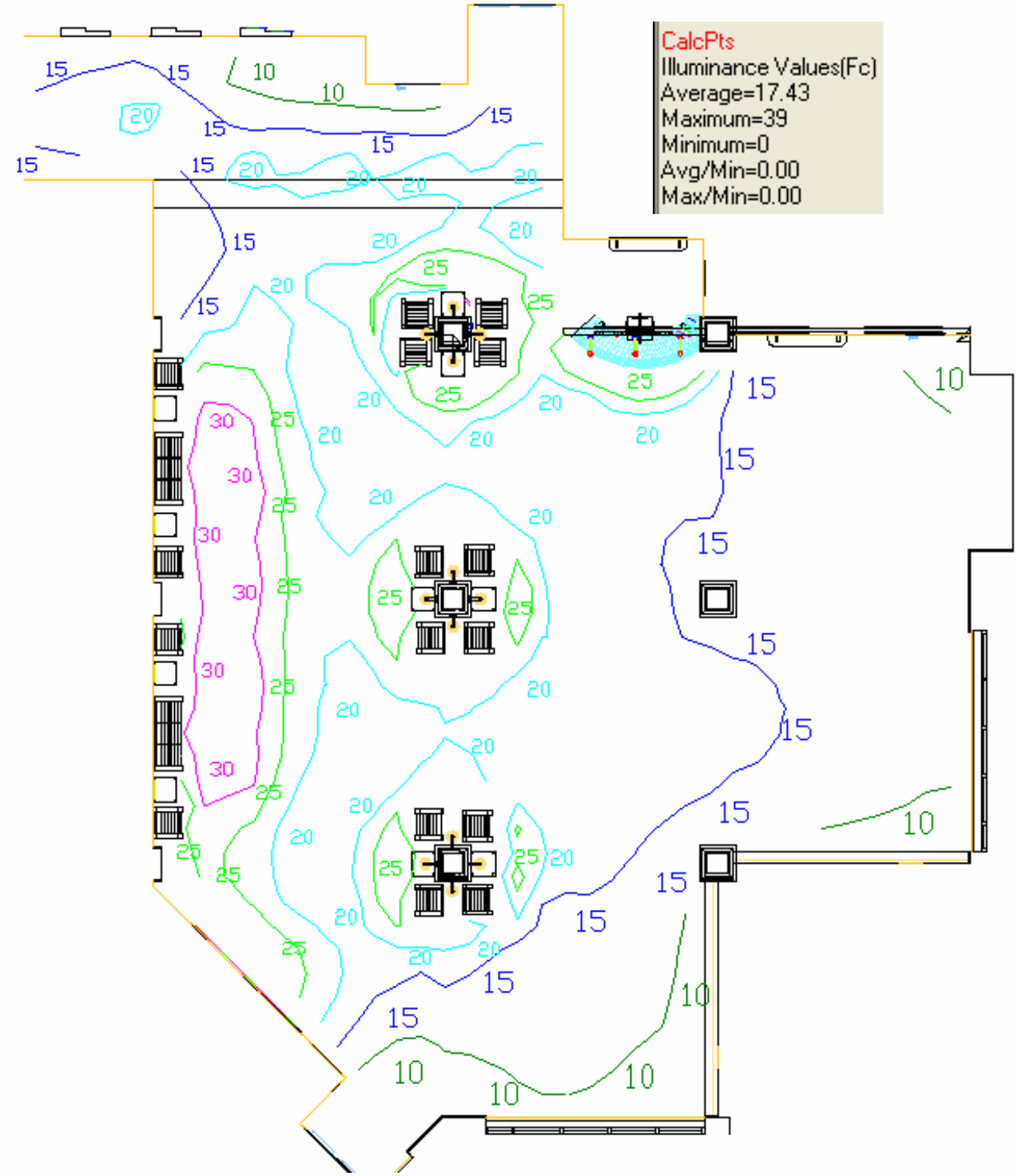
Elevator Doors

elevator_Planar_8
Illuminance Values(Fc)
Average=20.86
Maximum=88.8
Minimum=6.6
Avg/Min=3.16
Max/Min=13.45



Atrium Floor Area

Workplane is on floor.



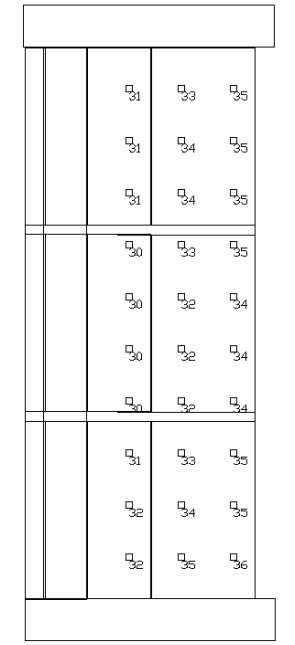
Circulation Signage

sign_Planar_4
Illuminance Values(Fc)
Average=32.58
Maximum=45
Minimum=17
Avg/Min=1.92
Max/Min=2.65

32	38	41	43	44	44	45	45	45	45	44	42
29	34	38	40	41	42	42	42	42	42	41	39
24	27	31	33	34	35	35	35	35	34	33	31
20	23	25	27	28	28	29	29	29	28	27	26
17	19	21	22	23	24	24	25	25	24	23	22

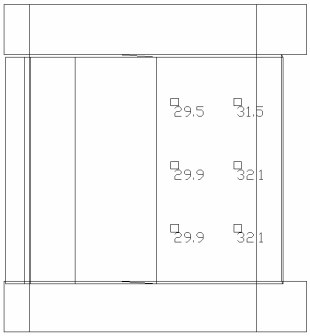
Reading Grids

Couch1 and Chair are located against the back wall.
Chair2 is located around brick columns.
Calculation points are at typical reading levels.

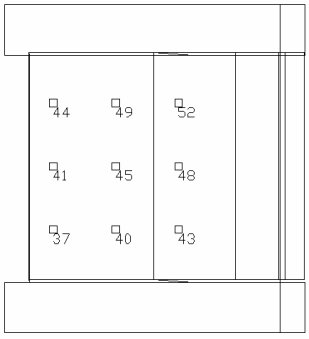


Couch1
Illuminance Values(Fc)
Average=32.93
Maximum=36
Minimum=30
Avg/Min=1.10
Max/Min=1.20

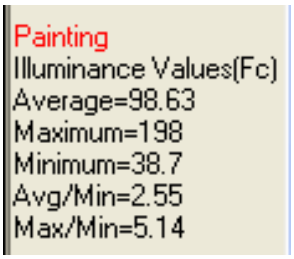
Chair
Illuminance Values(Fc)
Average=30.83
Maximum=32.1
Minimum=29.5
Avg/Min=1.05
Max/Min=1.09

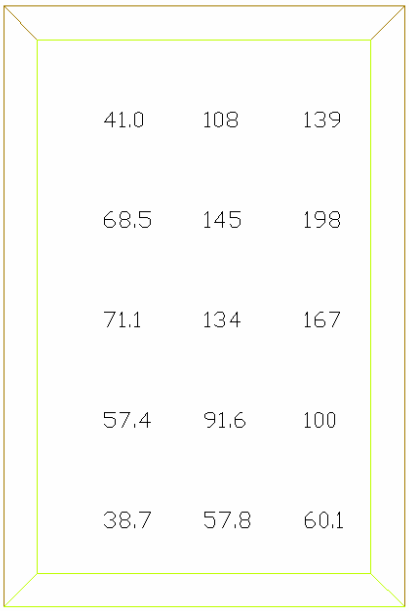


Chair2
Illuminance Values(Fc)
Average=44.33
Maximum=52
Minimum=37
Avg/Min=1.20
Max/Min=1.41



Paintings





Design Results

As you can see from the calculation results above, the lighting redesign has, for the most part, met all required criteria specified. The renderings show that light was distributed properly throughout the space and would direct incoming occupants to their desired locations. As for the amount of light on specific surfaces, the reception desk has over 30 fc throughout the tabletop and the occupant table top (reception top) has over 50 fc on it which should definitely make it stand out in the atrium area. The elevator doors proved tricky to illuminate evenly. The best found design produced around 80 fc at the top but quickly depleted as the light moved down the elevator doors. Although there is a rather large light gradient on the doors, the renderings showed that the gradient made the elevator doors stand out even more so than if they were illuminated evenly. As for the general floor, it came out rather well with a slow increase in illuminance from the existing hospital to the lounge area. The lounge area had a relatively high illuminance value when compared to the criteria value of 10 fc, but was unavoidable due to the reading task design criteria and the space properties. The wallwashers that illuminated the circulation signage provided the recommended light level of 30 fc for the majority of the sign but fell short towards the bottom of the sign. The low values on the signage should not be a problem because the surrounding dimly lit walls will provide enough of a contrast to let the signage stand out in the atrium. Because the paintings were illuminated with recessed accent lights, a large gradient swept across the painting form the upper right corner to the lower left corner. This large gradient will give the painting a more artistic appeal and provide a point of interest in the space. Lastly, the calculation results for the reading areas show that ample light was projected onto the workplane and therefore meets the design criteria.