technical report 1

angelica santana | lighting/electrical

princeton neuroscience and psychology complex, princeton, new jersey

Technical Report 1: Lighting Existing Conditions and Design Criteria Report

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October 4, 2010

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. General Building Data .

Name | Neuroscience & Psychology Building Complex

Location | Princeton, NJ
Campus location: south of Icahn Laboratory on the current site of Lot 20, next to Roberts Stadium

Occupants | Neuroscience Institute and the Psychology Department

Function | Educational: state-of-the-art labs, faculty offices, and classrooms

Size | 248,000 sqft

Stories | Psychology building is six stories high, while the neuroscience building is five stories

Design architect | Rafael Moneo Valles Arquitecto

Executive architect | Davis Brody Bond, LLP | http://www.davisbrody.com/

Laboratory planning | GPR / Jacobs Consultancy | http://www.jacobsconsultancy.com/

Structural/MEP | Ove Arup & Partners Consulting Engineers, P.C. | http://www.arup.com/

Landscape architects | Michael Van Valkenburgh Associates, Inc. | http://www.mvvainc.com/

Civil/site engineers | Van Note–Harvey Associates, P.C. | http://www.vannoteharvey.com/

Construction manager | Barr & Barr, Inc Builders | http://www.barrandbarr.com/

Princeton project manager | Ahmed Sultan

Princeton program manager | Mark Wilson

Date of construction | summer 2010 to spring 2013

Cost | 180 million dollars, exact cost not available at this time

Project delivery method | Design-Bid-Build

Architectural context | The Neuroscience & Psychology Complex at Princeton University is comprised of two modern structures joined by a common space. Designed by Jose Rafael Moneo Valles who is known for “integrating contemporary architecture into rich physical contexts”, the buildings’ design not only connects with the intricate landscape but also binds the two separate disciplines housed within with a literal bridge-like shared area. Linking the two sciences is essential for collaboration and community which is enhanced by the location of the site adjacent to the physics, chemistry, and genomics buildings. The buildings’ facades carry the theme of connection by having rain screens in between floors hiding where the slab separation would be. The lighting, another key feature of the design, will join the exterior to the interior. Where the light does not penetrate through the glass skins of the façade, there will be light monitors spanning the entire height of the building allowing the light to cascade down connecting all the different levels.

Site of Neuroscience & Psychology Complex under construction, Icahn Laboratory on the left

. Executive Summary .

Technical Report 1 is a description of the existing lighting systems in the Princeton Neuroscience & Psychology Complex. The building contains many laboratory spaces as well as classrooms and public spaces. Four spaces were required as part of the assignment, but because of the amount of interesting spaces available, five were analyzed.

The four categories to analyze include a large work space, a special purpose space, a circulation space, and an exterior space. To represent these, the main lecture hall, the cafeteria, the lobby, and the north entrance were chosen in order respectively. The extra space is a light well/stairway that is very interesting.

For each space, there is a brief architectural description that includes predominant surface materials. It is then followed by a description of the existing lighting system. After, there is a list of the design criteria, researched using the IESNA Lighting Handbook. Finally, an evaluation of the existing lighting design was performed by comparing it to the criteria found. Images enhance the text but since the building is under construction, they are mostly plans, sections, with some renderings and photographs. The final critique includes some of the changes that will take place under the proposed lighting scheme. This will be explained in further detail on Technical Report 3 (so stay tuned for more!).

. General Lighting Evaluation .

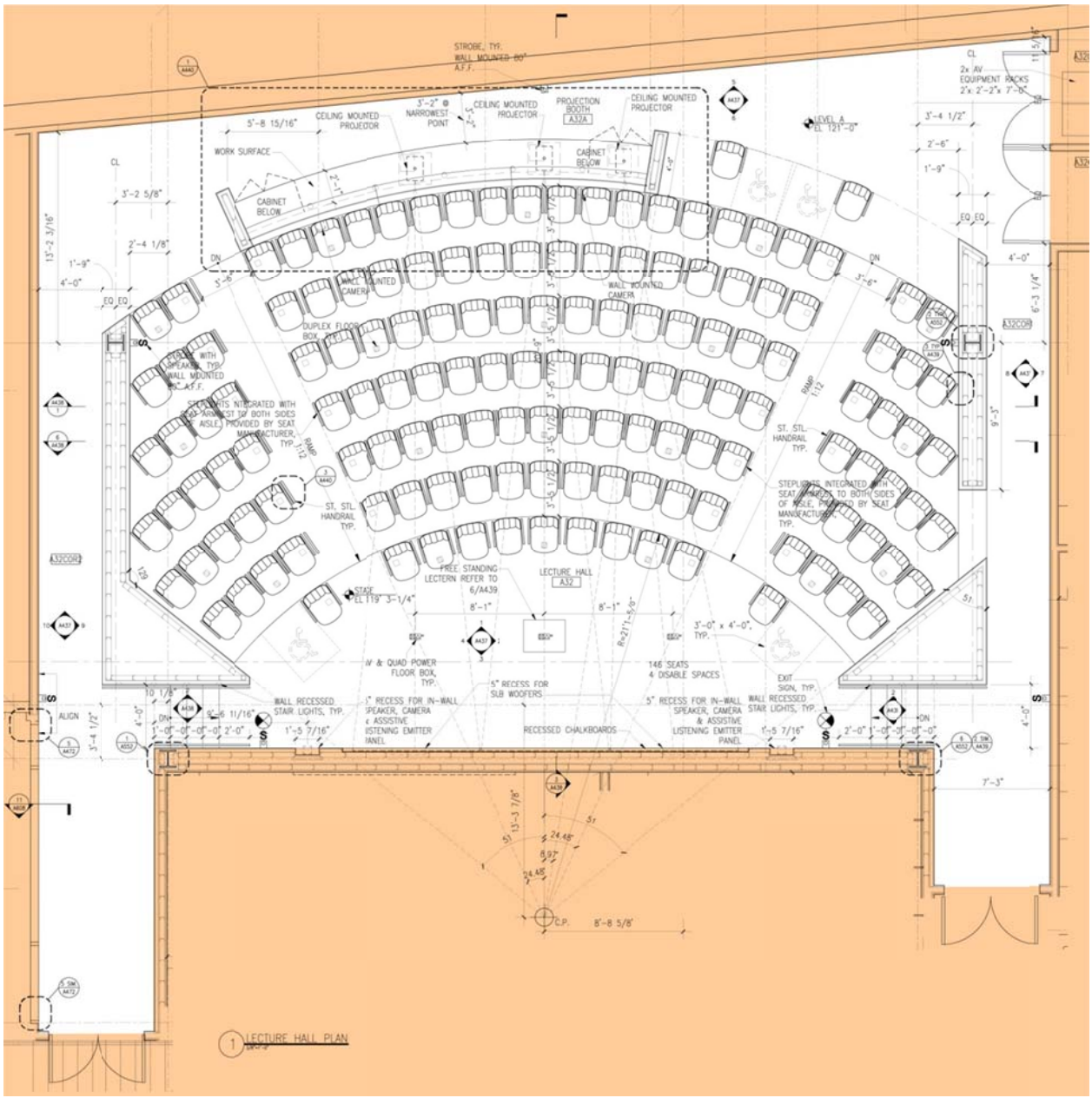
The general lighting of the Neuroscience & Psychology Complex includes two different systems. One was done by Fisher Marantz Stone and covers all the public areas and spaces that will be visible from the outside. The other lighting system was design by Arup and it includes most laboratory space, classrooms, and offices.

The most common light source is fluorescent with the exception of some halogen downlights in important spaces, metal halide source in the light monitors, and certain LED highlights. Most of the laboratory spaces have linear fluorescent fixtures while most of the public spaces are illuminated with downlights. The most common fixture in the circulation spaces is the Louis Poulsen Cirkul fixtures in several sizes and mountings.

The public spaces have mostly uniform lighting with some emphasize on the perimeter wooden walls. All luminaires used have lamps with a CRI in the 80s and a CCT of 3000K. This warm color temperature is good to bring out the wooden tones and the 80 CRI is enough for good color rendering. The private spaces have mostly downlight. The exterior is lacking a lighting design with the exception on the fixtures in the canopy and vestibules.

. Large Work Space | Lecture Hall A32 | Existing Conditions .

Description of Space | Half radially symmetric, the lecture hall has 145 seats with an inclination of 1:12. There is a projector booth on the rear of the room (north) with three ceiling mounted projectors. There are two entrances and the seating area is enclosed by corridors on three sides with the teaching space at the front (south). The main surface of the ceiling and walls is wood. The lecture hall is located in the northeast part of Level A in the Neuroscience portion of the complex.

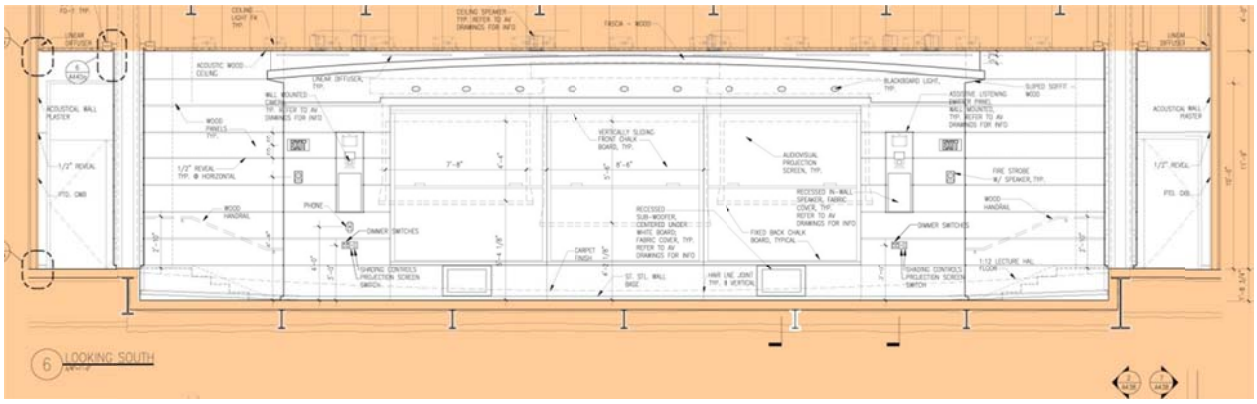


Lecture Hall, Plan, NTS

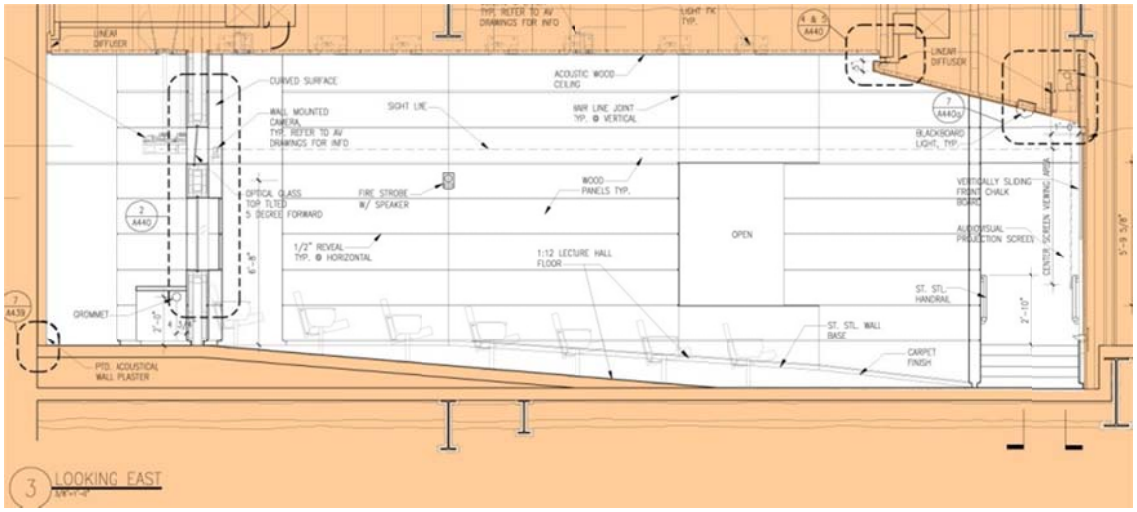
Furniture and Surface Materials | Auditorium chairs are the main furnishing of the lecture hall accompanied by a free standing lectern, chalkboards, and projection booth cabinets. Materials in the room include the following:

Material	Reflectance *	Specifications #	Location
Glazing	0.1	08910	A32COR west elevation
Painted acoustic wall plaster	0.8	09900	A32COR west elevation
Painted gypsum wall board	0.7	09250	A32COR
Wood panels	0.25	06400	Throughout
Acoustic wood ceiling	0.3	06400	Throughout
Carpet, Grama 44025 by Monterey Carpets, Color to be chosen by Architect	0.3	09681	Throughout
Chalk board	0.1		South elevation
Projection screen	0.8		South elevation
Curved glass	0.1	08800	Projection area
Auditorium seats, Irwin Seating Company Allegro Model No. 27.17.80.150, Color chosen by Architect	0.3	12710	Throughout

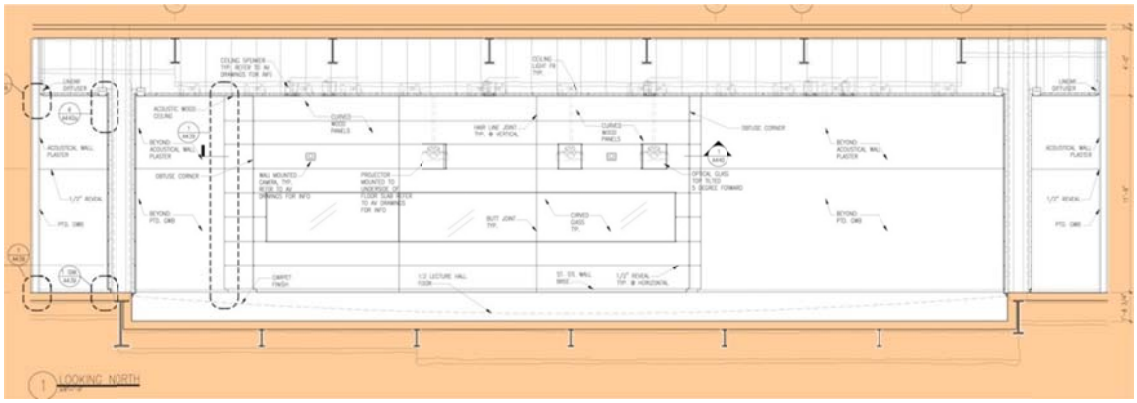
*Assumed, some from Figure 1-36 from IESNA Handbook Page 1-22, others from AGI32



Lecture Hall, Section looking South, NTS



Lecture Hall, Section looking East, NTS



Lecture Hall, Section looking North, NTS

Lighting Systems | The general lighting of the space consists of halogen downlights in the seating area and accent lights for the lecture area with perimeter emphasis provided by fluorescent wall-grazers. Steplights are used for safe circulation and wall slots illuminate the corridors. The existing fixture schedule for the luminaires in Lecture Hall A32 is below:

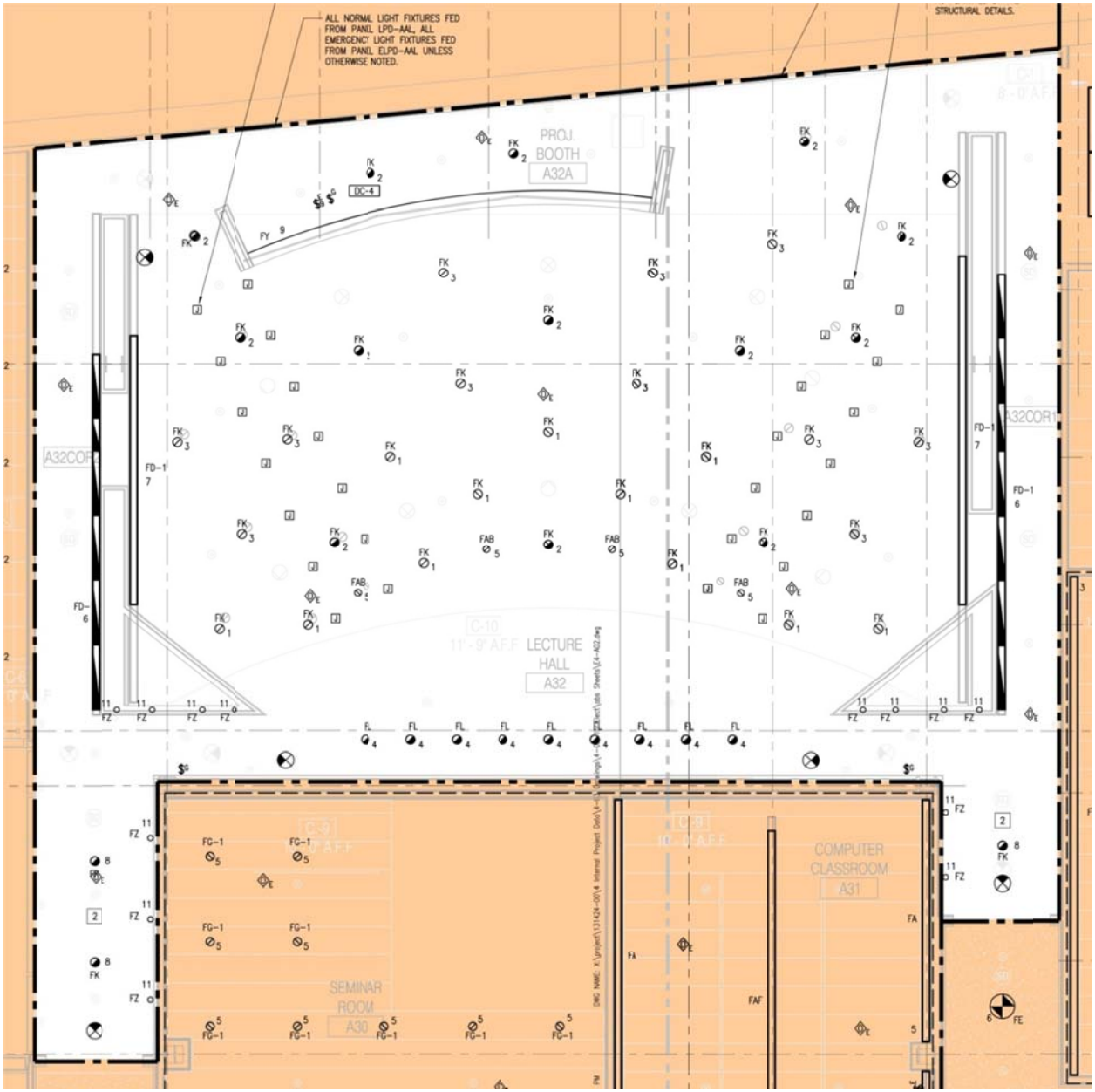
Type	Description	Lamp	Watt	Volt	Mfr	Catalog #
FD-1	Recessed staggered one-lamp linear fluorescent wall grazing troffer with 6" aperture, extruded aluminum housing, diffuse satin lens with Integral Osram Quicktronic PROStart PSX T* high efficiency electronic ballast	F17, F25, OR F32T8/830	7/lf	Per EE	Gammalux	GB66RC2-132T8ST-XXXVSPX-REC-ASLMD-WH
FK	Recessed low voltage tungsten halogen downlight	GE Q100T3/12	100	120/12	Erco	22453.023

	with 6" diameter aperture specular anodized aluminum reflector with overlap flange, frosted glass diffuser, and integral magnetic transformer.	V/CL				
FL	Recessed compact fluorescent wall washer with 6.5" diameter aperture, clear Alzak aluminum reflector with overlap flange, 85% spread lens, and integral Lutron EcoSystem 100-5% dimming ballast.	Philips PL-T 26W/830/4P/ALTO	26.4	Per EE	Edison Price	WLXT 126/6-Per EE-VOL-ECOSYS
FY	Surface mounted LED task light with injection molded plastic housing, polycarbonate lens, and integral onboard driver.	3000K Warm White LED (242 lms/ft, 83 CRI)	6/lf	120	Philips Color Kinetics	523-000004-22
FZ	Recessed low voltage tungsten halogen steplight with 3" diameter profile, die-cast aluminum housing, impact resistant satin matte crystal glass lens, and remote electronic transformer.	GE Q100T3/CL	10	12	Bega	2300-WHT
FAA	Fixed audience seating light	Warm white LED		Per EE		
FAB	Recessed tungsten halogen adjustable accent light with 6" diameter aperture, clear Alzak aluminum reflector with overlap flange, 358 degree horizontal lamp rotation and 45 degree tilt with beam smoother lens.	GE 75PAR30S/HAL/FL25	75	Per EE	Edison Price	DL 30/6AA-VOL with 20 OA HLDR CLR/3.75

Controls | There will be one locally programmable wall station with timeclock capabilities. Three keypad controls with four preset scenes, off and lower/raise will be located at the entrances and at the lectern.

Light Loss Factors for AGI32 calculation necessary for the evaluation of the Lecture Hall:

Luminaire Type	Lamp Lumen Depreciation	Ballast Factor	Lamp Dirt Depreciation	Total Light Loss Factor
FD-1	0.9186	0.88	0.95	0.7680
FK	0.9500	1.00	0.95	0.9025
FL	0.8600	1.00	0.95	0.8170
FZ	0.9500	1.00	0.95	0.9025
FAB	0.9500	1.00	0.95	0.9025



Lecture Hall, Lighting Plan, NTS

. Large Work Space | Lecture Hall A32 | Design Criteria .

Design Issues | The objective of the lighting design in an educational environment is to promote the learning processes. Education can be promoted by designing a lighting system that evokes the emotional and psychological responses of the learners making them feel pleasant and comfortable while accurately viewing the visual tasks necessary for learning. In a lecture hall, special attention must be paid to the horizontal illuminance, the vertical illuminance, and the uniformity of the light distribution on the work plane. Specifically in a lecture hall, there must be at least flexibility for two scenarios: one for note-taking/reading and the other for demonstrations. Since many of the surfaces are wood, the lighting should bring out the material with good CRI and warm CCT.

Visual Tasks | Reading and writing are the most important tasks and students are required to adjust rapidly from near to faraway visual tasks. Enough general lighting shall be provided and the recommendations are listed under the quantitative considerations below. Projection onto screen will also occur and the entire audience must be able to see it clearly. To successfully light the speaker/demonstration, directional downlights should be located 40-60 degree angle from the horizontal to the speaker. This minimizes glare and models well the facial expressions.

Qualitative System Performance Considerations | The following lists in order of importance the design issues that are of consideration for a Lecture Hall both for reading and demonstration. The ninth edition of The IESNA Lighting Handbook was referenced (Educational Facility Lighting, Lecture Hall both Reading and Demonstration).

Very Important | Light distribution on a task plane (uniformity) | It is important that the task area have an illuminance 1.5 to 3 times higher than the surroundings but not too much to cause visual fatigue. Uniform light distribution on the task plane increases visibility, comfort, and perception for demonstration settings in the Lecture Hall.

Very Important | Illuminance (horizontal) | Horizontal illuminance is crucial for note-taking and reading, both of which are horizontal tasks. High values of illuminance are necessary for these tasks to be performed diligently and effectively. Below are the values necessaries to achieve this.

Very Important | Illuminance (vertical) | When something is projected on the screen in the front of the lecture room, low illuminance is desirable. On the other hand, when the lecturer is utilizing the board, the audience, even from far away, must be able to see it. The values necessary for this will be listed below.

Important | Daylighting integration and control | Sunlight evokes psychological responses and the outdoors relaxes people. In this case, since the lecture hall is underground, daylight integration will not be possible.

Important | Direct glare | Glare causes discomfort and distraction. This is something not desirable in a space where the objective is to promote learning and concentration. To minimize glare, luminaires luminances should not more than 100 times of those of the surrounding surfaces.

Important | Flicker | Depending on the individual, flicker can be very distracting and bothersome. Again, this is not appropriate because it would not help promote learning. To eliminate flicker, high frequency electronic ballast must be used.

Important | Light distribution on surfaces | Patterns of light and shadows cause discomfort and affect visibility. Therefore, uniform light distribution is preferred and luminances levels should be within 3:1 ratio for different surfaces within the room.

Important | Luminances of room surfaces | Since the illuminance levels required are high, 50-100 fc, it is important to maintain surface luminances high for apparent brightness. It is desirable for the space to appear spacious and comfortable so the occupants are satisfied and can successfully perform the tasks.

Important | Points of interest | The main point of interest is the lectern space and the chalkboard and these will be highlighted with illumination when required. If the audience is required to take notes, the lecture hall will be more uniformly lit but there should still be emphasis on the front of the room. When the projector is in use, the light from the projector will be enough to attract attention while maintaining the rest of the space at low illuminance levels.

Important | Reflected glare | Reflected glare reduces task visibility. To reduce it, light sources can be placed on the sides of the task and the ratio of illuminance on the task from the mirror angle relative to the total illuminance on the task should be less than 0.3.

Important | Shadows | Shadows also reduce task visibility. To diminish them, linear or area sources can be used instead of point sources.

Important | Source/task/eye geometry | This relationship is critical for reading and writing. Coordination between the light source and the location of the task must be made.

Important | Surface characteristics | The characteristics of materials affect the perceived brightness of the space. Surfaces with higher reflectances are desired for uniformity and less wattage but sometimes darker colors and textures can add interest to a space. Since the lecture hall has several wood finishes, more light will be necessary for the tasks.

Somewhat Important | Appearance of space and luminaires | The lighting should give clues as to where areas of special attention are. Here, special attention should be paid to the front where the lectern is. Light should also enhance the architecture and this space has interestingly textured wooden walls that can be highlighted with illumination. The aesthetics are important for the entire building, designed by a world renowned architect; therefore, the lecture hall should maintain a lighting that carries the aesthetic themes of the building's design.

Somewhat Important | System control and flexibility | Since several different tasks will occur on the Lecture Hall, different light settings are required. There is a necessity for flexibility in the space, as the lighting for a speaker is not the same for projections onto a screen. Flexibility can be achieved with the use of controls and dimmers.

Quantitative System Performance Considerations | The following quantitative levels are recommended by The IESNA Handbook for successful design of a Lecture Hall.

Illuminance (horizontal) | 100fc (1000lux) for demonstration
30fc (300lux) for reading
5fc (50fc) for simple orientation for short visits

Illuminance (vertical) | 50fc (500lux) for demonstration

Reflectances | Walls: Nonspecular surfaces with 40-60% reflectance
Wall above luminaires: 80%
Ceiling: >80%, Nonspecular
Floor: 25%, Nonspecular

Luminance ratios | These ratios are critical for the lecture hall because the eye is constantly shifting from one task with one luminance to a different one. The background also takes an important role as it creates contrast against the task luminance. The luminance of a surface looked directly should not be greater than five times the luminance of the task for good visual performance. Any large area should not exceed three times the luminance of the task. Surfaces immediately adjacent to the task should have a lower luminance than the task but at least 1/3 of it; the closer the better. For good luminance ratios, the reflectances of the surfaces should be increased as well as the light on them.

Between surface looked directly and task:	max 5:1
Between large area and task:	max 3:1
Between adjacent surfaces and task:	lower but at least 1/3

Energy | ASHRAE 90.1 2004
Building Area Method Lighting Power Densities, School/University | 1.2 W/sqft
Space-by-Space Method Lighting Power Densities, Classroom/Lecture | 1.4 W/sqft

. Large Work Space | Lecture Hall A32 | Evaluation .

For the critique of the Lecture Hall, an AGI32 model was created. Horizontal illuminance values were measured at the seating area workplane for reading/writing, the steps for safe circulation, and at the rest of the floor for circulation. Vertical illuminance values were calculated at the movable chalkboard/projector display area and at the lectern.

The lighting of the space addresses all the tasks that will be performed in it and provides the flexibility and controls to achieve it. The horizontal illuminance levels for the seating area are spot on and the space has good uniformity. Additional lighting was located for the lectern with good angles for face modeling. Wall-washers on the back wall highlight the chalkboard area. The vertical illuminance levels for these areas were lower than what the criteria calls for and will have to be reevaluated. Circulation area lighting for the general floor is above the requirements but the steps are below and this could potentially be hazardous so this must also be fixed. Below are the qualitative data gathered from AGI32 for the Lecture Hall:

Calculation Area	Horizontal Illuminance (fc)	Vertical Illuminance (fc)	Maximum: Minimum Ratio	Luminance (cd/sqm)
Seating Area (Reading/Writing)	32.86		4.81	
Lectern (Demonstration)	21.74	15.72	5.00(H) 1.84(V)	
Chalkboard (Demonstration)	21.74	19.37	5.00(H) 4.35(V)	19.78
Steps (Simple orientation)	4.76		1.94	
Surrounding Floor (Simple orientation)	12.35		8.82	

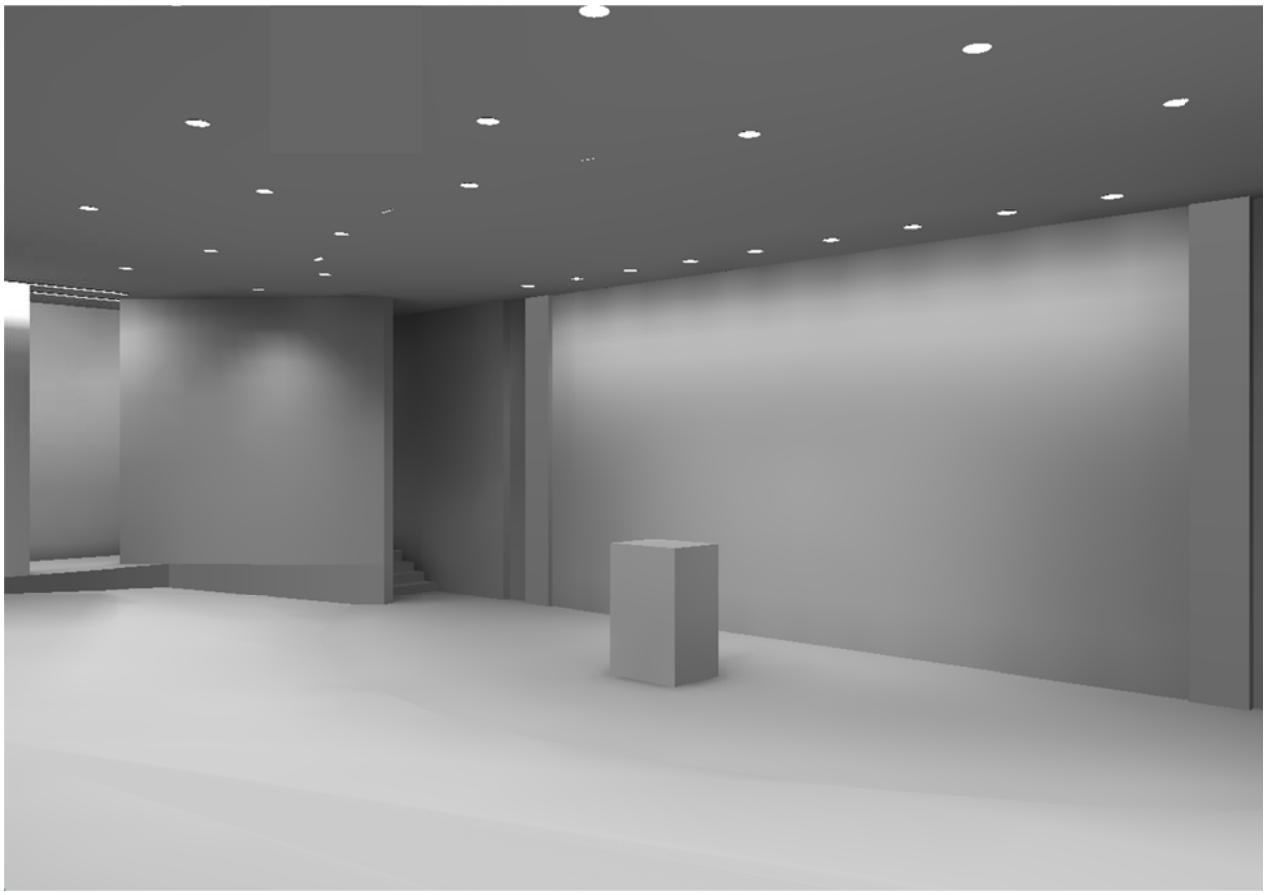
The space has many wood finished, and the reflectance was assumed to be 0.3 for these surfaces. If this is correct, most finish reflectances are below the recommendations for lecture halls according to the criteria making the room appear less bright. Further information about materials must be gathered before proceeding with changes. The existing lighting has a CCT of 3000K and a CRI in the 80s. The CCT is warm enough to bring out the red tones of the wood and the CRI is acceptable but could be better. The carpet floor reflectance is acceptable according the criteria.

In terms of qualitative considerations, the general downlight scheme provides good uniformity for the reading task and surfaces but it might create veiling reflections, direct glare, and some uncomfortable shadows. Therefore a more indirect lighting solution will be reviewed. There is no problem with flicker because electronic ballasts were used. Since the illuminance values appear to be lower at the lectern/chalkboard area, the points of interest are not clearly specified and the levels need to increase in these areas. There grazing on the perimeter walls highlights the architecture and gives the space some architectural interest. Because this is the largest lecture hall, and because the architecture of the entire building is extremely interesting, the lighting will be revised in a way that carries the themes of the complex even more.

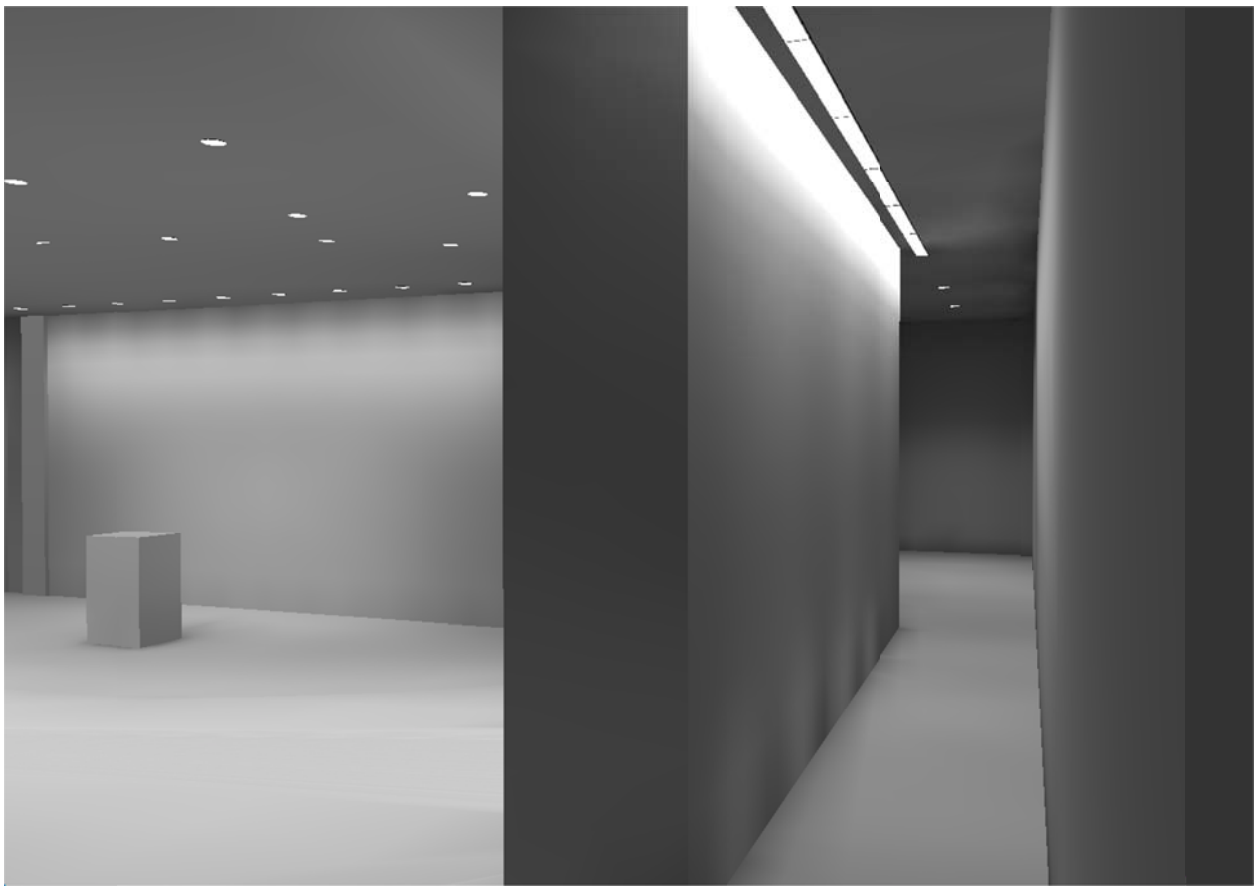
In terms of energy, the Lighting Power Densities are above the allowable according to ASHRAE 90.1 for both Space-by-Space and Building Area methods.

Lighting Power Density Calculation |
Area: 2861.7 sqft

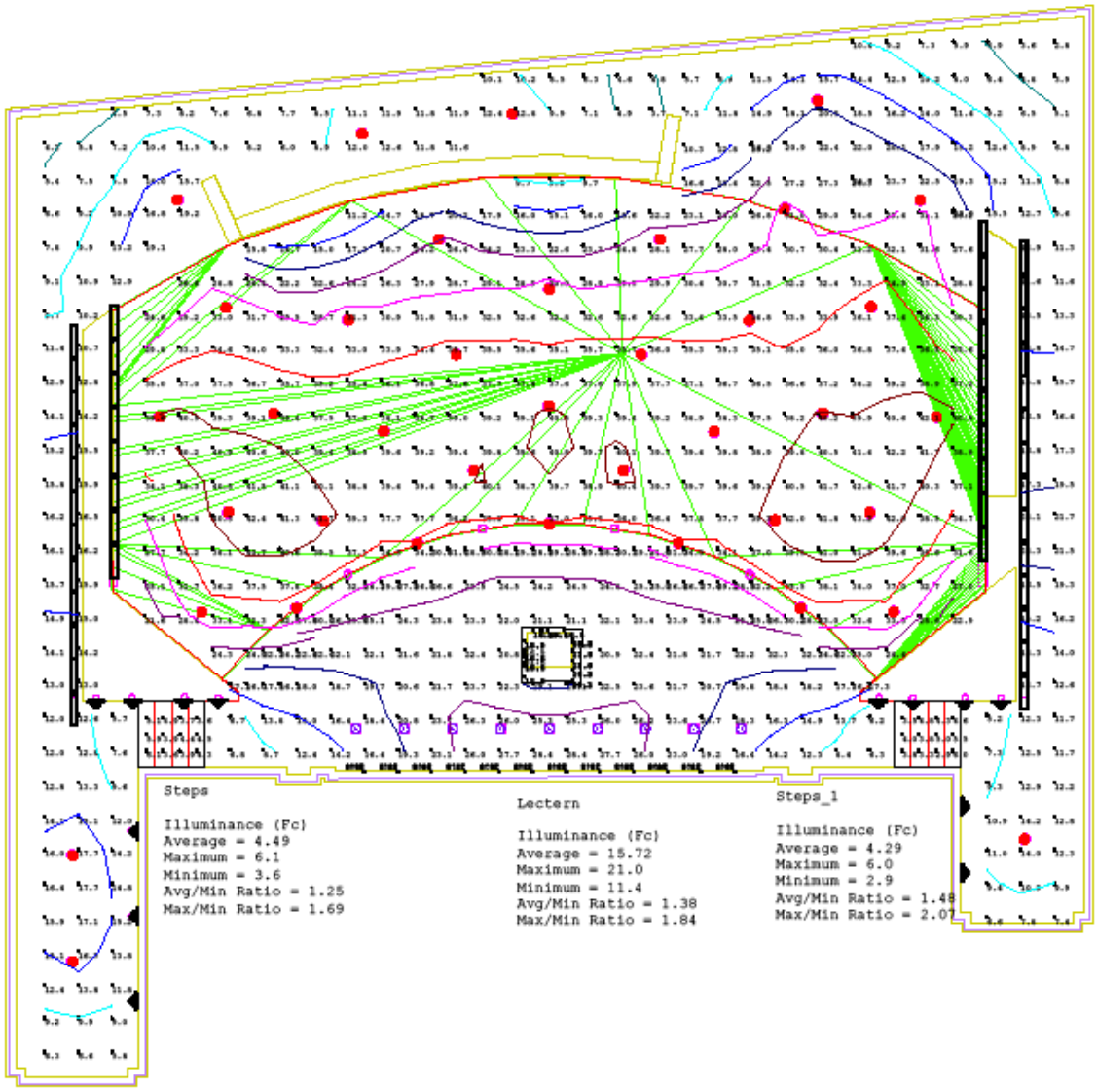
Luminaire Type	Quantity (length)	Watts/Luminaire	Total Watts
FD-1	88 lf	7/lf	616
FK	36	100	3600
FL	9	26.4	237.6
FY	28 lf	6/lf	168
FZ	14	10	140
FAB	4	75	300
		Total Watts:	5061.6 W
		LPD:	**1.77 W/sqft**



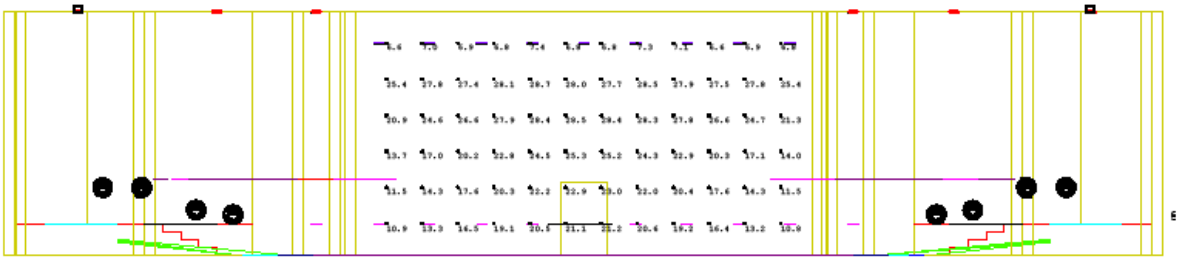
Lecture Hall, Rendering view looking towards lectern



Lecture Hall, Rendering view of corridor around seating area



Lecture Hall, Horizontal Illuminance Values

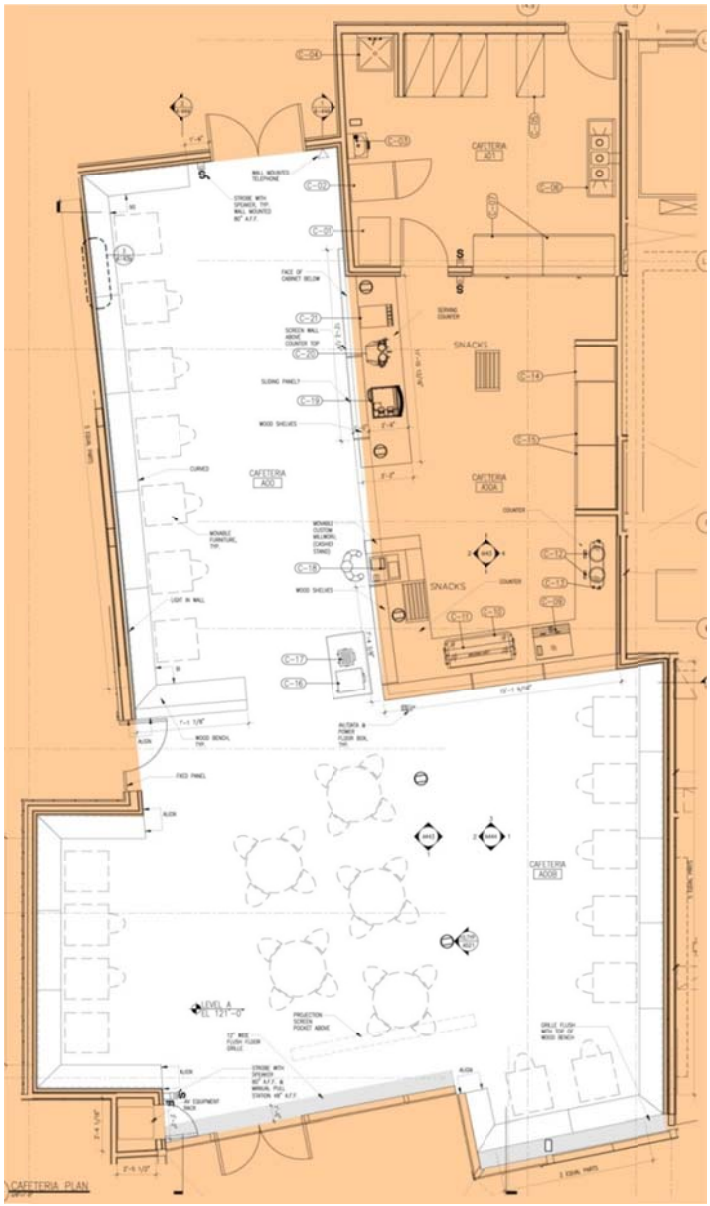


Lecture Hall, Vertical Illuminance Values at Chalkboard

. Special Purpose Space | Cafeteria A00 | Existing Conditions .

Psychological Reinforcement

Description of Space | The cafeteria is full of odd angles and corners. There is a separate area for serving with several counters and the cashier surrounded by wood shelving and the seating area of the space. There are 18 smaller tables around the perimeter wooden bench. There are also several center tables and that can be moved when the projection screen needs to be used. The southern wall is part of the exterior curtain wall. Since this café is within a university scene, studying and lounging will occur and the space can be accommodated to hold special seminars or other gatherings.

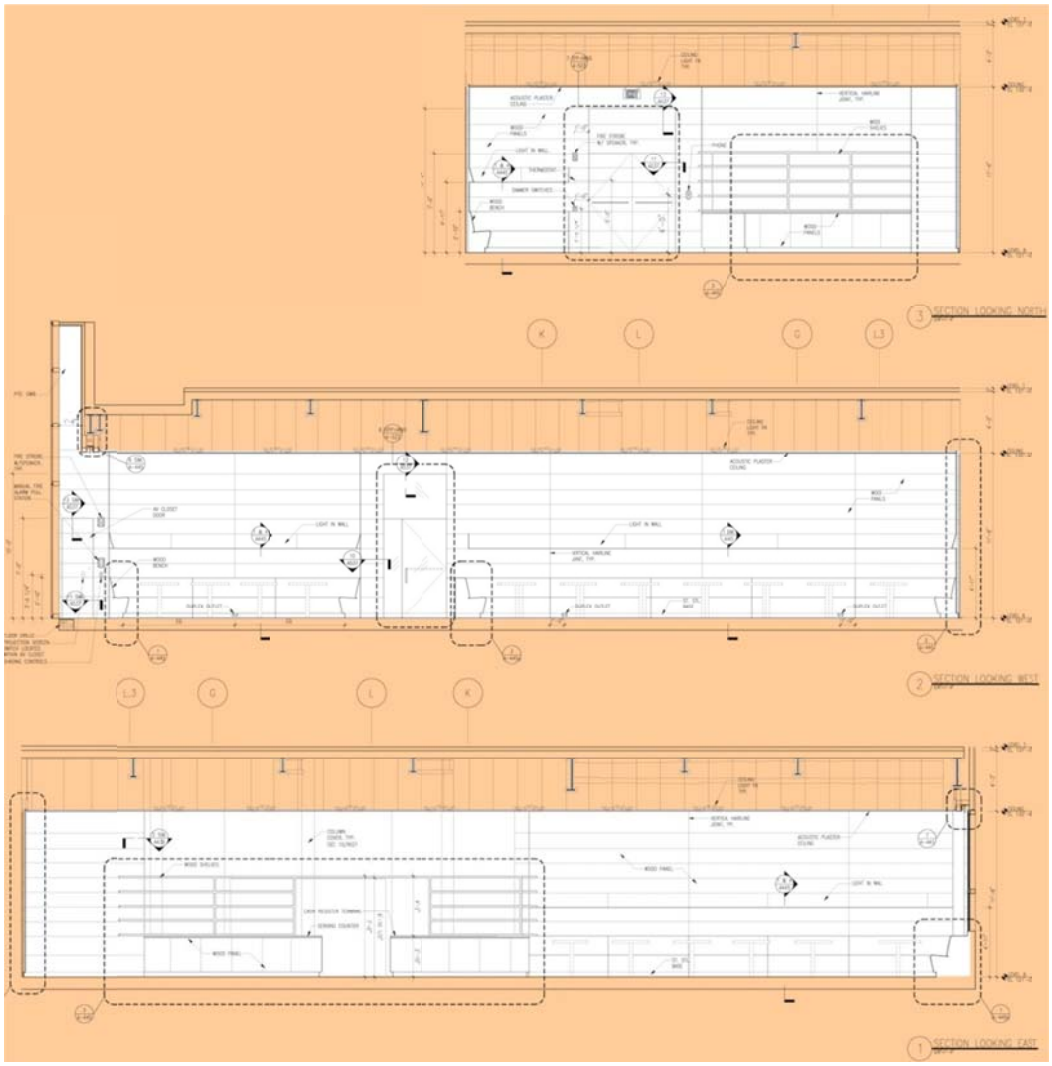


Cafeteria, Plan, NTS

Furniture and Surface Materials | The space is full of seating areas which include wooden benches, tables, and chairs. There are also wooden bookshelves around the food preparation area and there is a projector screen that drops from the ceiling when needed.

Material	Reflectance *	Specifications #	Location
Exterior curtain wall	0.10	08910	South wall
Acoustic plaster	0.78	09900	Throughout
Painted gypsum wall board	0.70	09250	Food preparation area
Wood	0.25	06400	Wall panels, benches, shelves
Painted glass fiber reinforced plaster	0.76		
Stone	0.30	09600	Floor
Projection screen	0.80		

*Assumed, some from Figure 1-36 from IESNA Handbook Page 1-22, some from 3ds Max



Cafeteria, Sections, NTS

Lighting Systems | The general lighting in the cafeteria is provided by purely fluorescent sources. White circular diffuse luminaires 18" wide manufactured by Louis Poulsen are evenly spaced throughout the cafeteria for uniform ambient illumination. The only other type of fixture is a linear channel used for perimeter emphasis within the architecture for several walls. The existing fixture schedule for the cafeteria luminaires is below:

Type	Description	Lamp	Watt	Volt	Mfr	Catalog #
FQ	Semi-recessed circline fluorescent downlight with powder coated spun aluminum housing, 18" diameter white two-layer opal glass diffuser, side illuminating reveal and Lutron EcoSystem 100-5% dimming electronic ballast.	(3) GE F26TBX/830/A/ECO	79.2	Per EE	Louis Poulsen	AJC-18.1"-MOD 3/26W/CF GX24-Q3
FAC	Surface mounted one-lamp profile linear fluorescent side-mount channel with integral Lutron Hi-Lume 3d 100-1% diming electronic ballast mounted within architectural niche.	F17, F25, OR F32T8/830	8/lf	Per EE	Bartco	MiT8-1S-XX/Lutron Hi-Lume 3d Ballast

Controls | There will be one locally programmable wall station with timeclock capabilities. Three keypad controls with four preset scenes, off and lower/raise will be located around the café.

Light Loss Factor calculation for AGI32 calculation necessary for the evaluation and critique of the Cafeteria:

Lamp	Lamp Lumen Depreciation	Ballast Factor	Lamp Dirt Depreciation	Total Light Loss Factor
FQ	0.8600	1.00	0.95	0.8170
FAC	0.9186	0.88	0.95	0.7680

Cafeteria, Lighting Plan, NTS

. Special Purpose Space | Cafeteria A00 | Design Criteria .

Psychological Reinforcement

Design Issues | The cafeteria will be designed as a leisure type of dining area and the Flynn Mode of Privacy will be enforced. Lounging will be encouraged. For those students who might want to read as well, some areas will have slightly higher illuminance values to accommodate for this task but it will not be the main focus of the space. Because of the projector screen, the room must have the flexibility to switch from a dining space to a demonstration one.

Psychological Reinforcement | Dr. John Flynn developed criteria for evaluating the lighting in spaces by determining users' subjective response. For a space to feel "relaxed" according to his studies, the lighting would include non-uniform distribution, wall lighting, and lower light levels. The idea here is to enforce the criteria of a leisure dining type spaces using Flynn's Mode of Relaxation.

Visual Tasks | The most important visual tasks will be eating. Secondary visual tasks will include lounging and studying. In cafeterias, color is important for food appearance. Projector viewing will not be a regular task but since the space is equipped for it, the lighting must be able to accommodate for it.

Qualitative System Performance Considerations | The following lists in order of importance the design issues that are of consideration for a cafeteria, specifically the dining area, not the food preparation area. The ninth edition of The IESNA Lighting Handbook was referenced (Both Dining area and Reading area). For the dining task, the leisure type was chosen for the criteria selection. For the Reading task, it was assumed that most of the writing would be from #2 pencil and 8-10 point type. If one of the design issues appears under both reading and dining, then the dining criteria will be followed because it is the primary objective of the space.

Very Important (Dining) | Color appearance and color contrast | Color contributes to the enjoyment of food and it affects visibility and aesthetics. Several factors contribute to color appearance like the spectral power distribution (SPD) of light sources, perception ability of viewers, and the surfaces' transmission and reflection properties. Lighting designers can control the SDP by choosing a source that has a high Color Rendering Index (CRI). Lamps with a CRI higher than 80 must be used to ensure a pleasant appearance of food.

Important (Dining) | Appearance of space and luminaires | In dining areas, it is important to have an aesthetic appeal. The style of luminaires when coordinated with the architecture can enhance the design of the space. Lighting can evoke emotions and create an image. In a leisure type dining area, the lighting can promote relaxation.

Important (Dining) | Direct glare | Direct glare includes “discomfort glare” and “overhead glare”. Both of these are undesirable in a place of relaxation. To minimize glare, luminaires luminances should not more than 100 times of those of the surrounding surfaces.

Important (Dining) | Points of interest | Even though the food is the most important part of a dining area, the focus should be kept away from the people to increase a sense of relaxation in accordance with the Flynn mode of relaxation.

Important (Dining) | System of control and flexibility | Control and flexibility are very important in dining environments were the illuminance levels are lower during the dining time and then need to increase for cleaning. Because this is a multi-function room, controls are necessary. There needs to be flexibility to change from a demonstration environment to a reading one as well as a leisure dining area.

Somewhat Important (Dining) | Daylight and integration controls | Daylight and the exterior view are important for psychological and physiological reasons. People feel more relaxed when they can see the outside. Since the cafeteria is located on the perimeter of the building, daylight will enter and help with ambient illumination. However, since sunlight (weather) is unpredictable and the space will be used at night, it cannot be the sole source of task illumination.

Somewhat Important (Dining) | Light distribution on surfaces, Light distribution on task plane (uniformity), and Shadows | Patterns of light and shadows cause discomfort and affect visibility for a specific task. However, non-uniformity of light enhances the relaxation feeling making the space feel more comfortable. Therefore, non-uniformity is desired for the lighting system in this space.

Somewhat Important (Dining) | Modeling of faces or objects | Just as color affects the perception of food, modeling of objects helps reveal the shape, depth, and texture of the food which can make it look more appealing.

Somewhat Important (Dining) | Sparkle/desirable reflected highlights | Small points of bright light can add interest to a space. For example, in dining areas, light creates sparkle on silverware adding a sense of elegance.

Somewhat Important (Dining) | Illuminance (vertical) | Vertical illuminance helps for face modeling and can be desirable for dining situations.

Very Important (Reading) | Illumination (horizontal) | It is crucial that there is enough horizontal illuminance levels to allow for reading/writing, normally horizontal tasks. The task plane is usually 30 inches above the ground; height of tables. Since this space is a leisure type dining area, the ambiance illuminance levels will be kept lower with certain highlights of higher illumination in some areas to accommodate for reading.

Very Important (Reading) | Reflected glare | Both bright and veiling reflections reduce task visibility and contrast which are very important for reading. To reduce them, light sources can be placed on the sides of the task and the ratio of illuminance on the task from the mirror angle relative to the total illuminance on the task should be less than 0.3.

Important (Reading) | Source/task/eye geometry | This relationship is critical for task visibility, in this case reading and writing. Coordination between the light source and the location of the task must be made.

Quantitative System Performance Considerations |

Illuminance (horizontal) | 5-10fc (50-100lux) for leisure types of dining spaces
30fc (300lux) for reading

Illuminance (vertical) | 3fc (30lux) for dining

Reflectances | Walls: There is no specific criterion listed for the reflectances of the space in the IESNA Handbook for the design of a leisure type dining space.

Luminance ratios | There are no specific characteristics for luminance ratios listed on the IESNA handbook for leisure type of dining spaces. Attention must be paid so that the luminance of decorative fixtures are not overwhelming compared to the ambient and task luminance.

Energy | ASHRAE 90.1 2004
Building Area Method Lighting Power Densities, School/University | 1.2 W/sqft
Space-by-Space Method Lighting Power Densities, Dining Area, Leisure Dining | 1.4 W/sqft

. Special Purpose Space | Cafeteria A00 | Evaluation .

The lighting for the cafeteria does not comply with the criteria for leisure type dining space as it surpasses the values required for it. It also does not match the criteria for a quick service type of dining space because the levels are too low. It does not comply with the levels for reading either. It appears that the space was thus designed for an in between use of the above types mentioned. For this project, however, the lighting design will be for a leisure type of dining area and this will completely change the existing lighting design.

Quantitatively, the spaces requires less horizontal and vertical illuminance overall. However, if some spaces will be dedicated to reading, then they should have higher levels. The lighting is very uniform, as shown in the coefficient of variation criterion, and this does not promote relaxation. According to Flynn, the lighting should be focused on the walls and non-uniform. There is existing perimeter lighting but it is not the main light source. The arrangement of the existing fixtures is very uniform and this will change in for the proposed lighting scheme for increased relaxation.

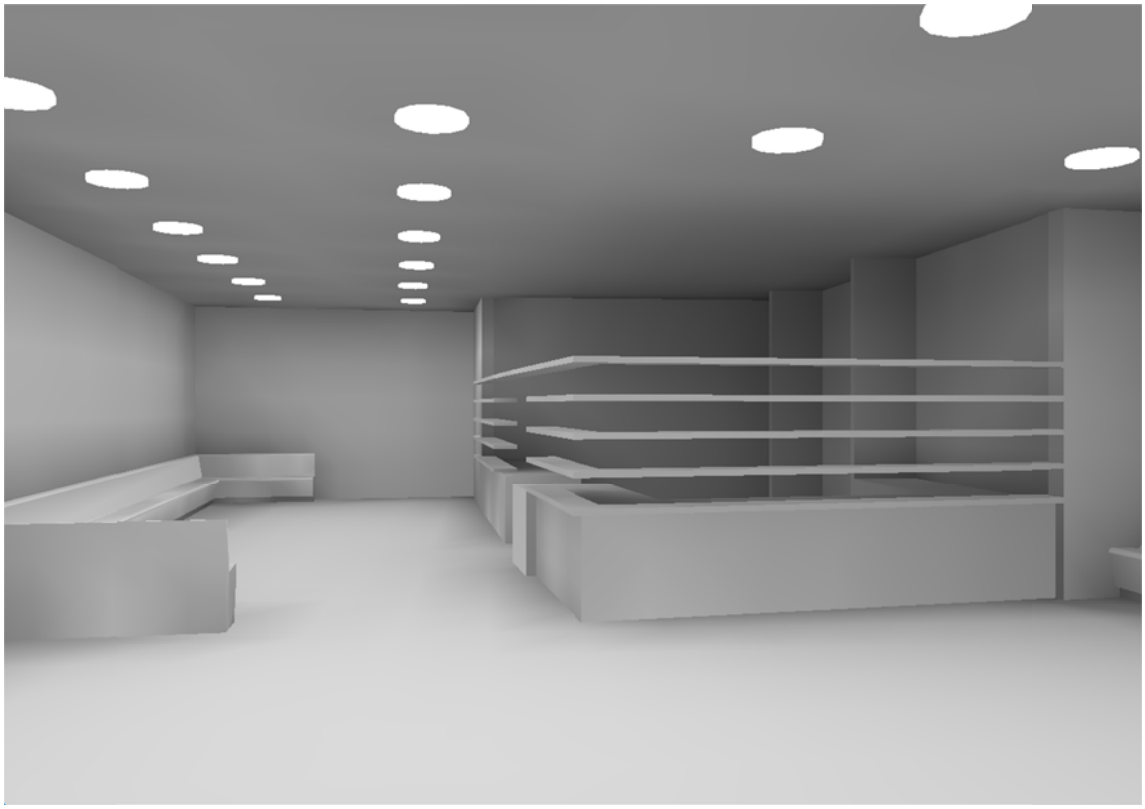
The existing lamps have an 80 CRI with 3000 K color temperature. Since color appearance and contrast are so important for food, lamps with an even better CRI will be used. The fixtures themselves will have an attractive and modern appearance like the existing Louis Poulsen fixtures. These however provide lighting from above and concentrate on the people. The new lighting design will have similarly styled fixtures but will be located non-uniformly and will highlight the walls. The Cirkul fixtures used have a diffusing lens which does not produce glare and models object well. However, the points of interest are undefined and there is no sparkle in the space. Controls already exist and take care of the flexibility required within the space. They do not however integrate the daylighting coming through the curtain wall which should be part of the design.

In terms of energy, the Lighting Power Densities are above the allowable according to ASHRAE 90.1 for both Space-by-Space and Building Area methods.

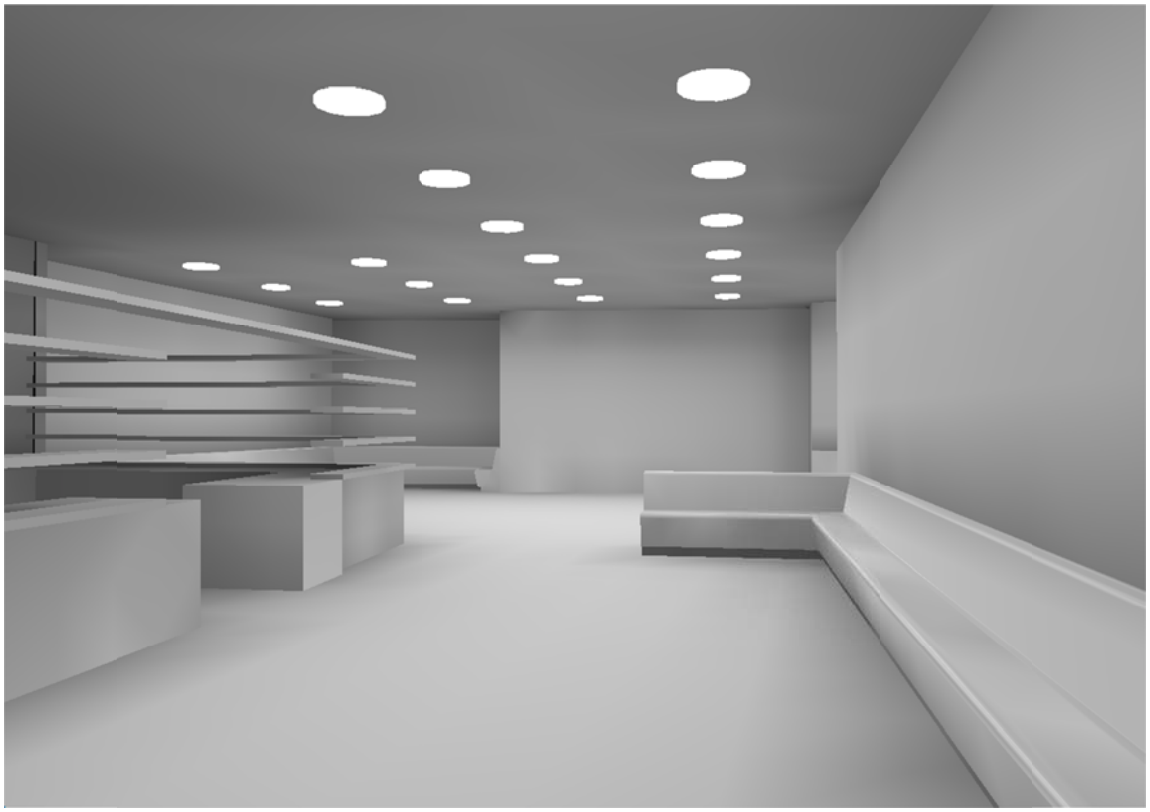
Calculation Area	Horizontal Illuminance (fc)	Vertical Illuminance (fc)	Maximum: Minimum Ratio	Coefficient of Variation
Dining Area	20.60	13.39	4.16(H) 2.13(V)	0.26(H) 0.08(V)

Lighting Power Density Calculation |
Area: 1657.9 sqft

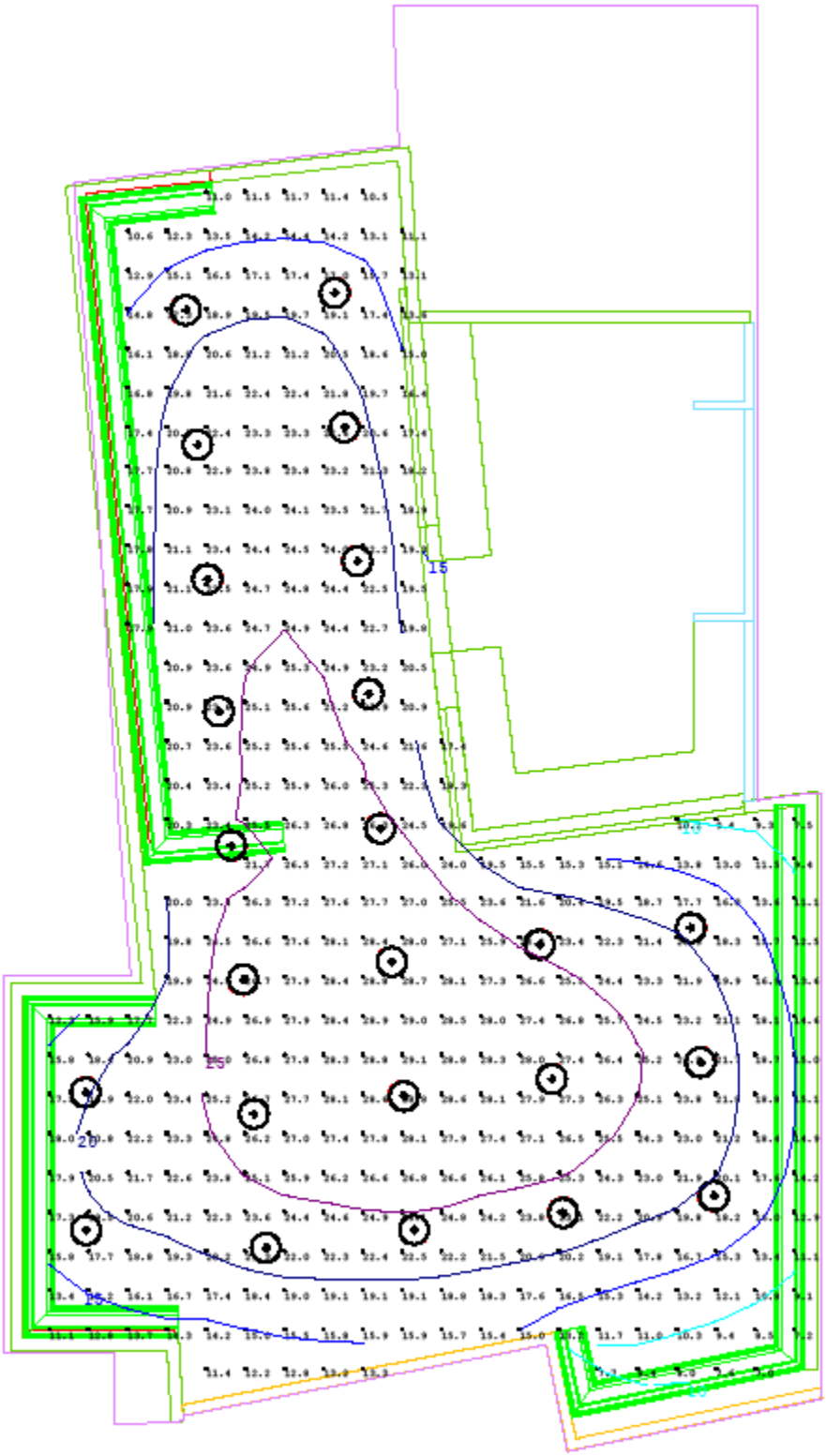
Luminaire Type	Quantity (length)	Watts/Luminaire	Total Watts
FQ	24	79.2	1900.8
FAC	97.3 ft	8/lf	778.4
		Total Watts:	2679.2
		LPD:	**1.62 W/sqft**



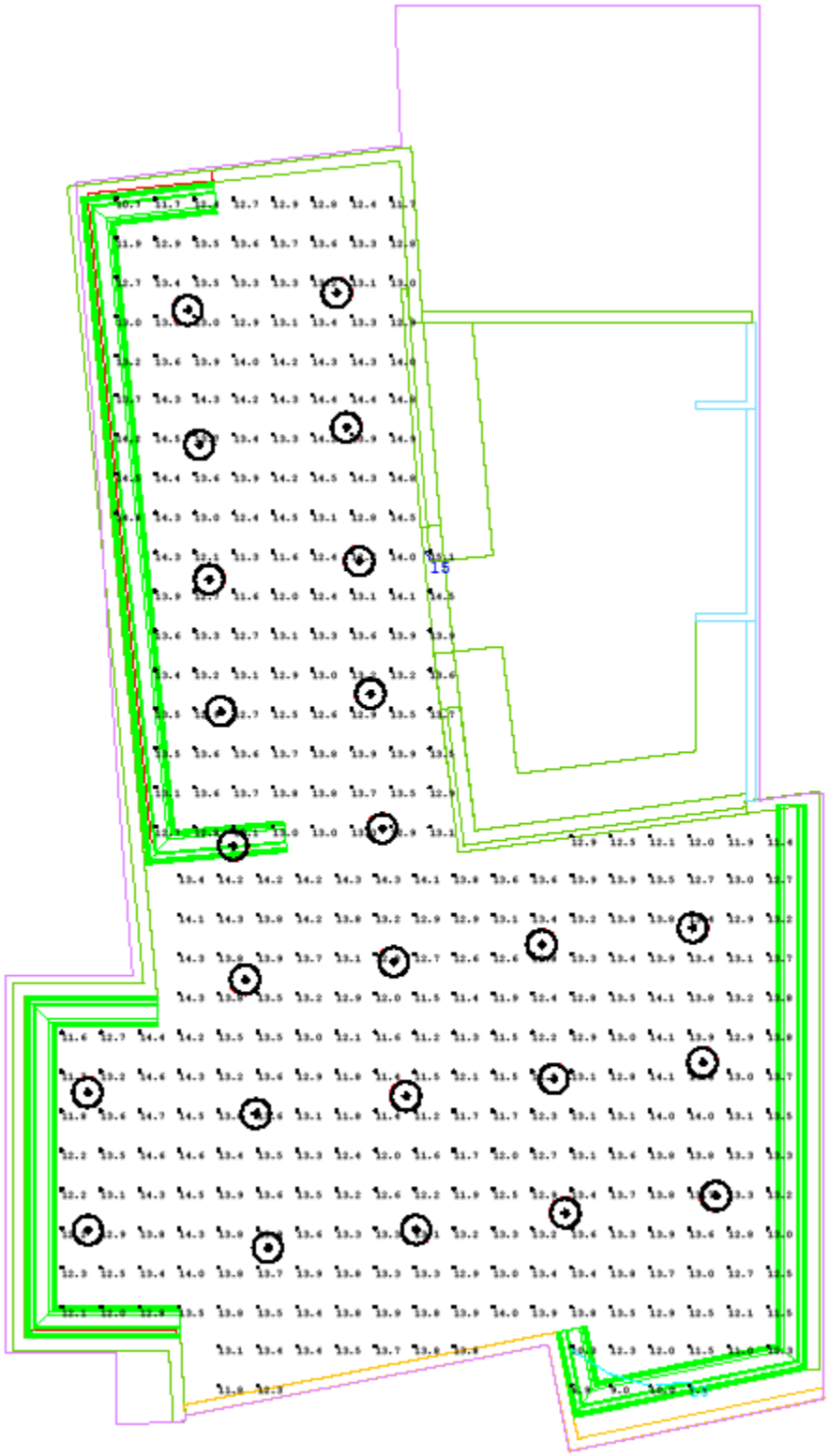
Cafeteria, Rendering looking north



Cafeteria, Rendering looking south



Cafeteria, Horizontal Illuminance Values



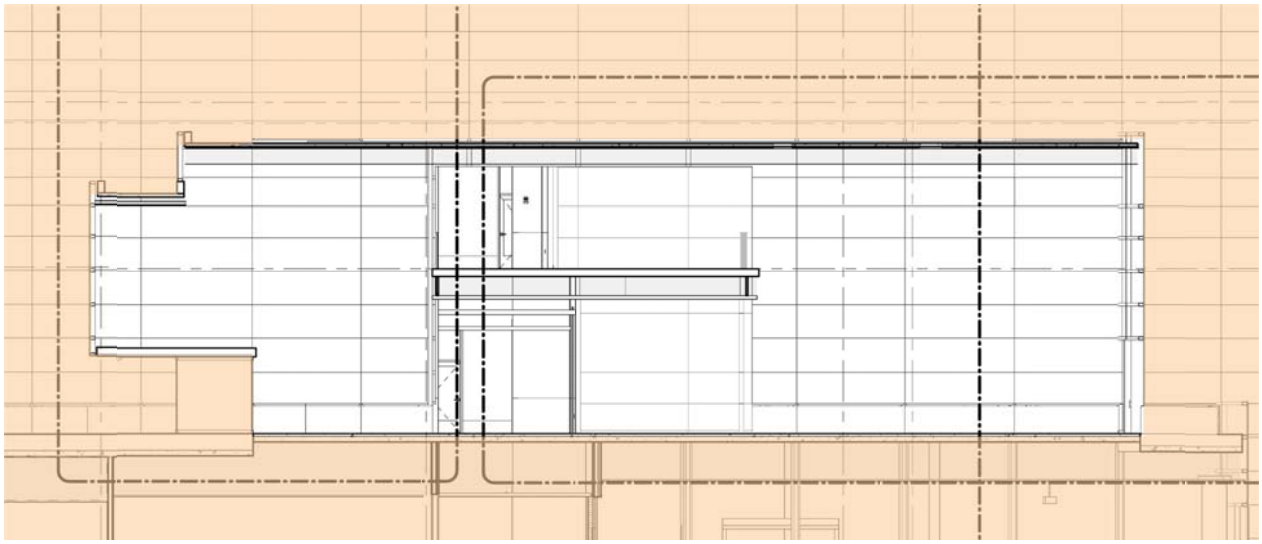
Cafeteria, Vertical Illuminance Values

. Circulation Space | Lobby | Existing Conditions .

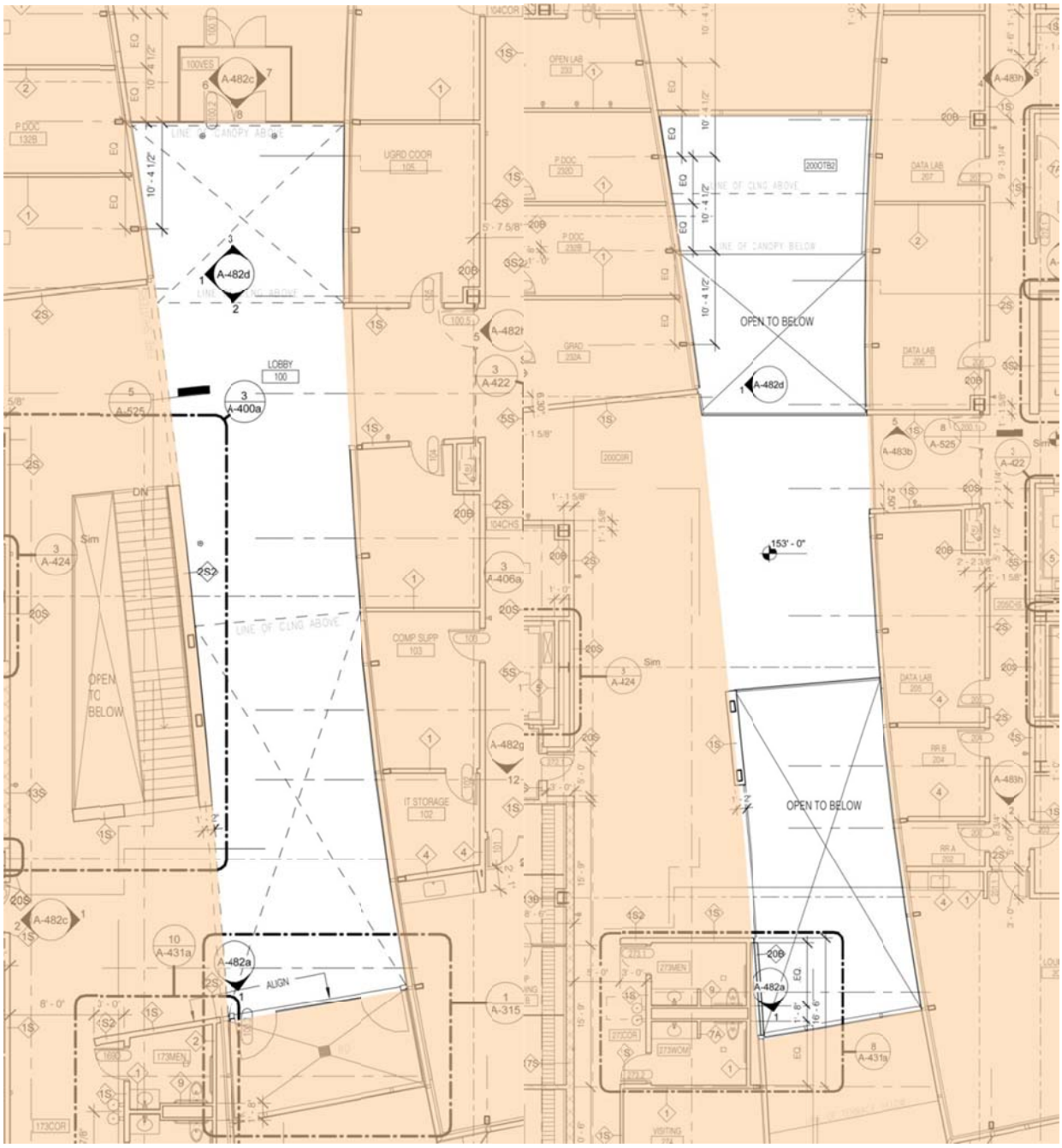
Three Schematic Design Concepts

Description of Space | This space brings both the Neuroscience and Psychology buildings together. It fills the gap and ties the architecture of both buildings connecting physically the science departments and bridging the exterior to the interior. Geometrically, it resembles the Streicker Bridge shown below which also provides a pedestrian connection between science facilities and is adjacent to the complex. It has curved walls on both sides and is capped by two vestibules on the north and south entrances. The lobby is two stories high and the first floor is more of a reception and circulation area while the second is a lounging space. The brain has millions of connections. Because this building deals with the science of the brain, this space of connection will be key in the entire lighting design and will carry the theme of the connection of the entire building.

Streicker Bridge



Lobby, Section



Lobby, First Floor Plan

Lobby, Second Floor Plan

Surface Materials | Stone is the predominant finish used. It covers several walls and the floor making contrast with the glass from the interior curtain wall of both buildings. Below is a complete list of the materials and their reflectances:

Material	Reflectance *	Specifications #	Location
Glazing	0.10	08900	Interior and exterior curtain wall
Aluminum framing	0.65	08900	Interior and exterior curtain wall
Painted gypsum wall board	0.70	09250	Walls
Vision glass	0.10	08800	Interior and exterior curtain wall
Opaque glass	0.25	08800	Interior and exterior curtain wall
Glacier Blue Devonian Sandstone, honed finish on all exposed surfaces	0.30	04401	Walls
Stone	0.30	09600	Floor

*Assumed, some from Figure 1-36 from IESNA Handbook Page 1-22 and some from 3ds Max.

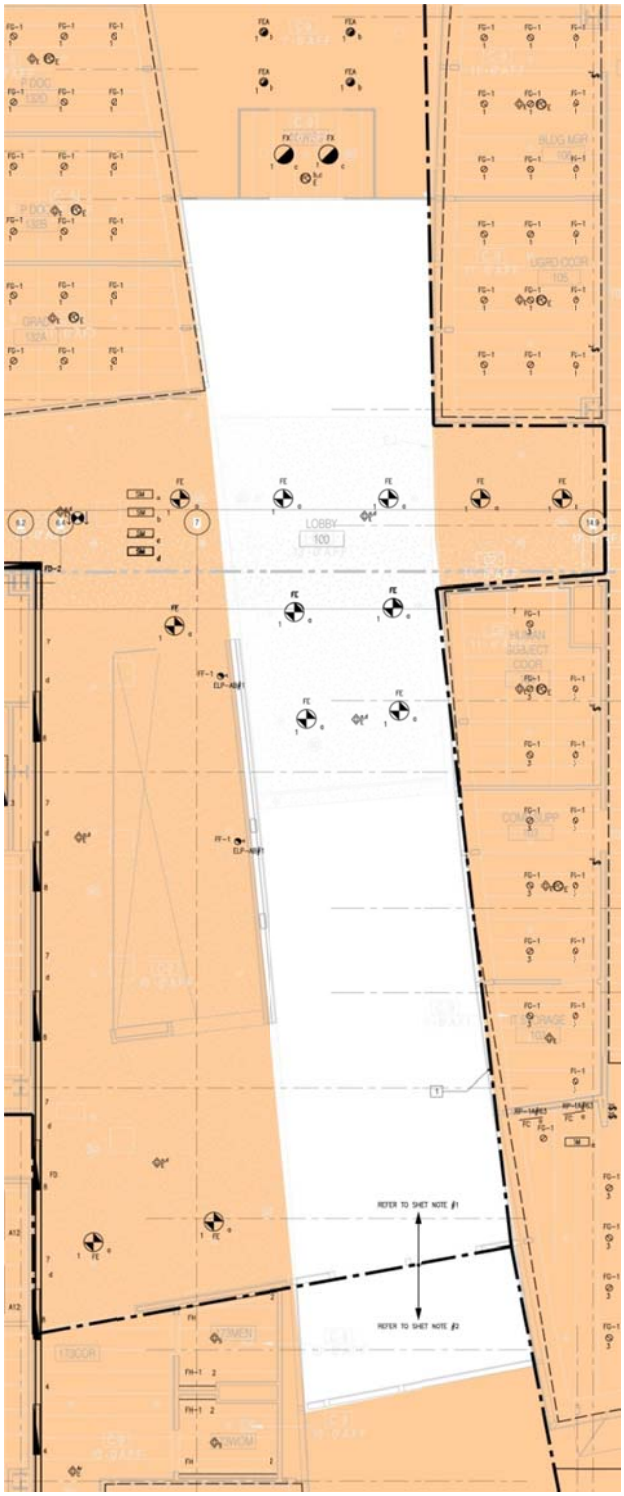
Revit Rendering of Lobby first floor looking south

Revit Rendering of Lobby first floor looking north

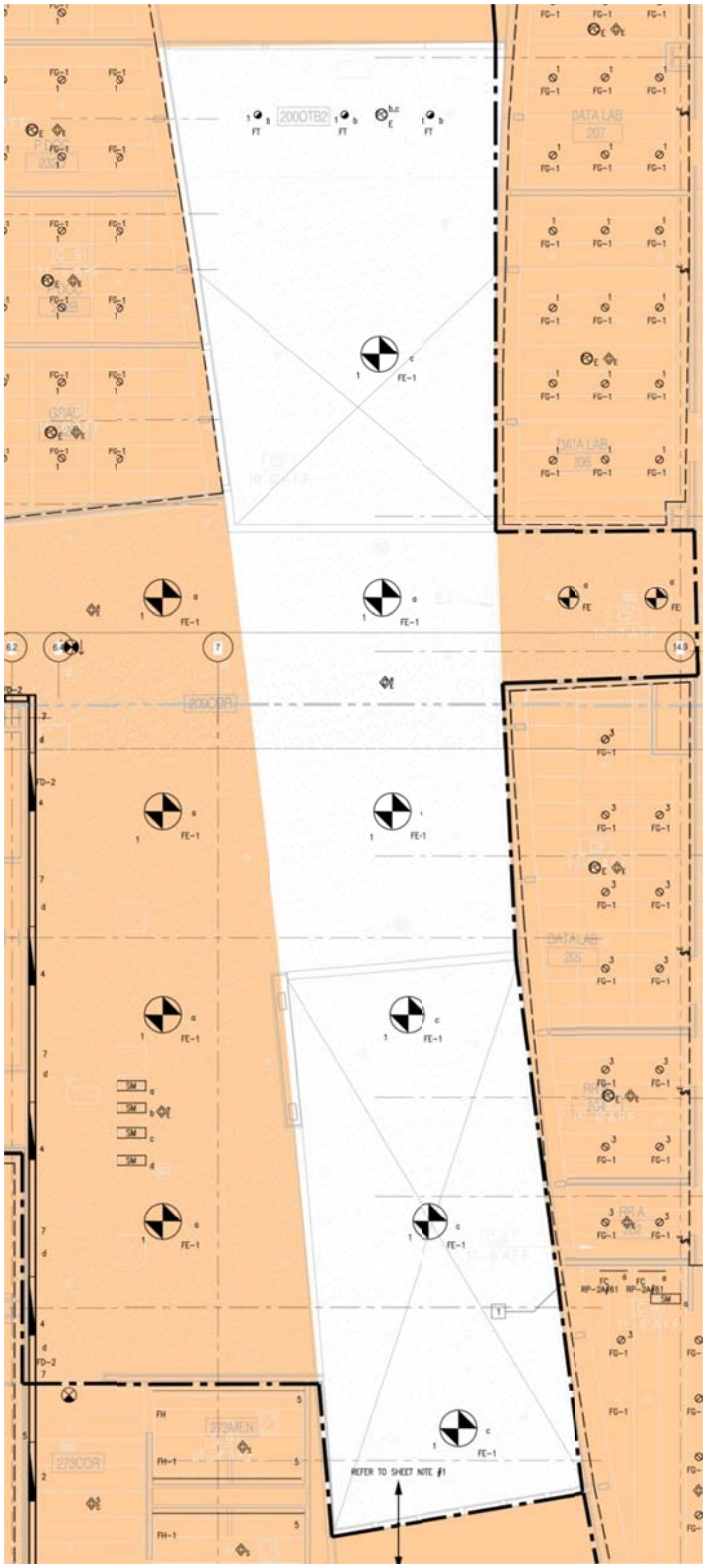
Lighting Systems | The general lighting

Type	Description	Lamp	Watt	Volt	Mfr	Catalog #
FE	Semi-recessed circline fluorescent downlight with powder coated spun aluminum housing, 18" diameter white two-layer opal glass diffuser, side illuminating reveal and (2) integral electronic ballast. Provide 2 circuits for by-level switching.	(1) Philips TL5C 22W/830, (1) Philips TL5C 40W/830	66	Per EE	Louis Poulsen	AJC-18.1"-1/22W/1/40 WT-5 2GX13-PEREE-SATIN-CHR PLA-OPAL-MOD
FE-1	Semi-recessed circline fluorescent downlight with powder coated spun aluminum housing, 30" diameter white two-layer opal glass diffuser, side illuminating reveal and (3) integral electronic ballast. Provide 2 circuits for by-level	(3) Philips TL5C 40W/830	126	Per EE	Louis Poulsen	AJC-MEG-3/40W/T-5GX13-PEREE-SATIN CHR PLA-OPAL-MOD
FT	Recessed compact fluorescent downlight with 7" aperture, clear Alzak aluminum reflector with overlap flange, and integral Lutron EcoSystem electronic ballast.	Philips PL-Y 26W/830/4P /ALTO	26.4	Per EE	Edison Price	TRPH 126/7-PEREE-VOL-ECOSYS

Controls | There will be two zones connected to the lighting management network switch and timeclock for bi-level switching of Type FE series fixtures. Every third lamp will be circuited for emergency lighting and will always be on.



Lobby, First Floor Lighting Plan



Lobby, Second Floor Lighting Plan

. Circulation Space | Lobby | Design Criteria .

Three Schematic Design Concepts

Design Issues | The lobby is the first impressions visitors get of the building so it must be aesthetically pleasing and the lighting should enhance the architecture. Since it is a transition space from the exterior to the interior, illuminance levels need to make the change comfortable. Walls are the most important part of the lobby and they should be highlighted. Here, some walls are made of stone which will look good grazed while the rest of the walls are glass. The ones that have translucent glass will be able to glow while the clear ones will allow light from adjacent rooms to trespass. Since there was no criteria for lobbies in educational facilities, the criteria for office lobby was used.

Three Schematic Designs | Since the lobby space is the most important space for the theme of connection in the complex, there will be three schematic lighting designs done to represent the idea. All designs will carry the theme of connection and circulation in different ways. The designs will explore guided and random circulation, neuroscience and the millions of brains connections as a theme, psychology and the effects lighting has on humans, and architecture.

Visual Tasks | The main task will be guided circulation. When a visitor walks into this space, he has several options of where he could go. The lighting will help guide visitors in and through the space. Another task is to show the theme of connection with the lighting. This is also a space that will be used for egress in case of emergencies. Therefore, the lighting must comply with safety requirements. As the main entrance to the building, security requirements must also be met.

Qualitative System Performance Considerations | The following lists in order of importance the design issues that are of consideration for a lobby. The ninth edition of The IESNA Lighting Handbook was referenced (Offices; Lobbies, lounges, and reception areas).

Very Important | Appearance of space and luminaires | Coordination between the space, the luminaires, and the architecture can produce visually appealing spaces leaving a positive impression on visitors. Since the architecture is modern and interesting, the fixtures should either appear invisible or complement the architectural design while guiding pedestrians through the building.

Important | Color appearance and color contrast | Usually the lobby has the most expensive finishes and surfaces. To render their color appearance properly, lamps must have a good CRI. This will enhance the first impression of the building.

Important | Direct glare | Direct glare is uncomfortable. The lighting should provide a safe transition from the outside to the inside by not blinding the pedestrians as they enter the building. Overhead glare is also annoying but since people will be circulating through the space, the effects of it will not be too bothersome. To minimize glare, luminaires luminances should not more than 100 times of those of the surrounding surfaces.

Important | Light distribution on surfaces | Patterns of light and shadows cause discomfort and affect visibility. Therefore, uniform light distribution is desirable and luminances levels should be within 3:1 ratio for different surfaces within the room.

Important | Luminances of room surfaces | Most wall surfaces on the lobby have low reflectances; therefore, more light will be needed for them to have higher luminances.

Important | Modeling of faces or objects | As a circulation space, the lobby will be full of people. Without good modeling of faces, they will look flat and unattractive. The lighting should make people feel and look better. Modeling of objects helps reveal the shape, depth, and texture. One of the main walls in the lobby is made of stone and the lighting should add depth by enhancing its texture. Modeling of faces is also important for security reasons.

Important | Surface characteristics | Surfaces have a profound effect on the interaction between the light and the space. Therefore, the lighting designers should coordinate with the architect to select building material and lighting systems that complement each other and achieve a good impression on the visitors.

Important | Illuminance (vertical) | In a lobby, even though the circulation plane is horizontal, people look at vertical surfaces to see where they are headed. Vertical illuminance highlights these surfaces. Also, the walls are the most important feature of the lobby and their plane of illuminance is vertical.

Somewhat Important | Daylighting integration and control | Because the lobby faces the exterior, sunlight will be a part of the lighting during the day. To make it more comfortable for people to transition between the spaces controls with dimming and photo sensors should be incorporated.

Somewhat Important | Flicker and strobe | Flicker can ruin someone's impression of the buildings and should not be present in what could be the most important space of the building. To eliminate flicker, high frequency electronic ballast must be used.

Somewhat Important | Reflected glare | Since many of the interior walls in the lobby are curtain wall, attention must be paid to unwanted reflections that might be occur. Grazing light from luminaires close to specular surfaces will minimize visible reflections.

Somewhat Important | Shadows | Shadows cast by occupants in the space should be avoided and this can be done with correct placement of luminaires. Shadows can cause confusion instead of guidance.

Somewhat Important | Illuminance (horizontal) | Even though the illuminance levels required for circulation are low, they must be met because after all the primary task of the space is walking.

Quantitative System Performance Considerations |

Illuminance (horizontal) | 10fc (100lux)

Illuminance (vertical) | 3fc (30lux)

Reflectances | The IESNA Handbook lists no specific criteria dealing with reflectances of surfaces in a lobby.

Luminance ratios | Since the lobby is next to the exterior, the luminance ratio from the interior to exterior varies with the time of day. During the daytime, the interior walls need to be brighter to be perceived from the outside, while at night the luminance levels should greatly decrease. There are no specific luminance ratios for a lobby listed in the IESNA handbook to use as criteria.

Energy | ASHRAE 90.1 2004
Building Area Method Lighting Power Densities, School/University | 1.2 W/sqft
Space-by-Space Method Lighting Power Densities, Lobby | 1.3 W/sqft

. Circulation Space | Lobby | Evaluation .

Three Schematic Design Concepts

The existing lighting design is very uniform only utilizing Louis Poulsen Cirkul fixtures in two sizes. These luminaires look modern and clean and glow much like the rain screen façade probably glows at night. However, the lighting design could be more interesting, enhance the architecture better, and demonstrate more clearly the theme of connectivity and guided circulation.

There is one stone wall that would look good with a grazing and there is none, so this would be one change. In terms of circulation, the lighting's uniformity does not guide the visitors anywhere and this will be revised. The fixtures have an 80 CRI and since color appearance is very important in a lobby space, this number could be better. The existing fixtures deal very well with glare, light distribution on surfaces, and shadows because of their diffuse lens and uniform arrangement. The existing controls do not account for daylight integration and they should especially since there is daylight coming in from both the north and south entrances.

There was no AGI32 model created for this space but since illuminance levels required are low because of the circulation nature of the space, the existing levels are probably compliant. The existing lighting design works for the tasks that will be performed in the space but do not make a bold statement in the space. Given the importance of the space, the lighting should leave an impression and be more than just task oriented. It should be art.

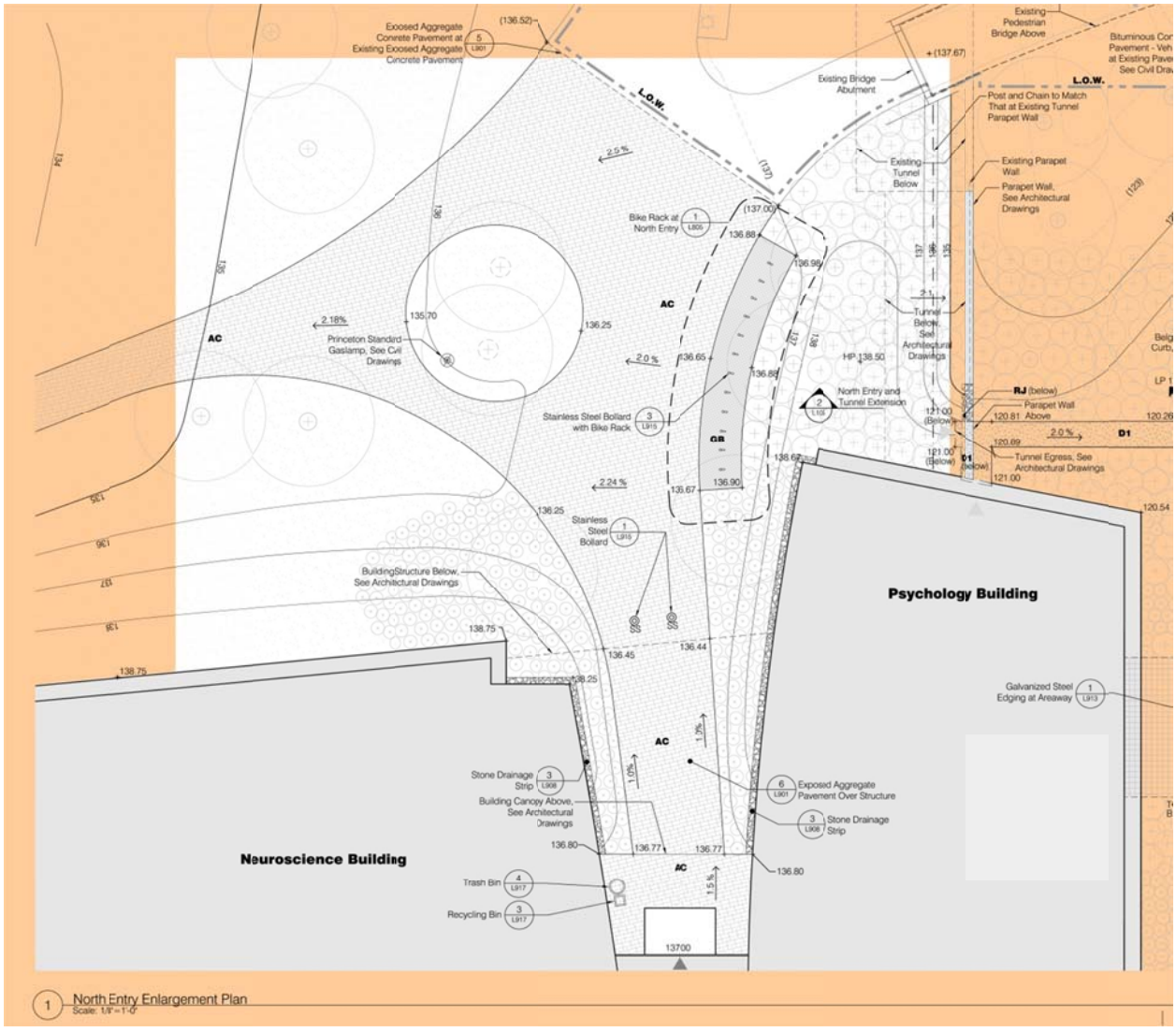
Lighting Power Density Calculation |

Area: 1685.7 sqft (first floor area, only)

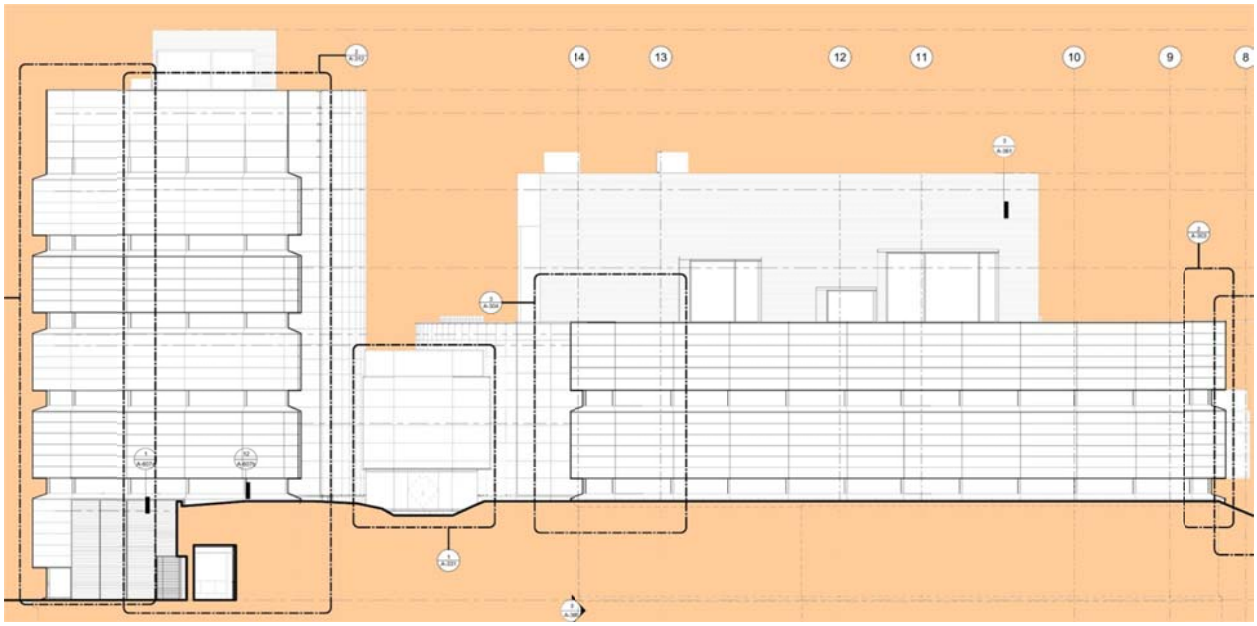
Luminaire Type	Quantity (length)	Watts/Luminaire	Total Watts
FE	6	66	396
FE-1	6	126	756
FT	3	26.4	79.2
		Total Watts:	1231.2
		LPD:	**0.73 W/sqft**

. Exterior Space | North Entrance | Existing Conditions .

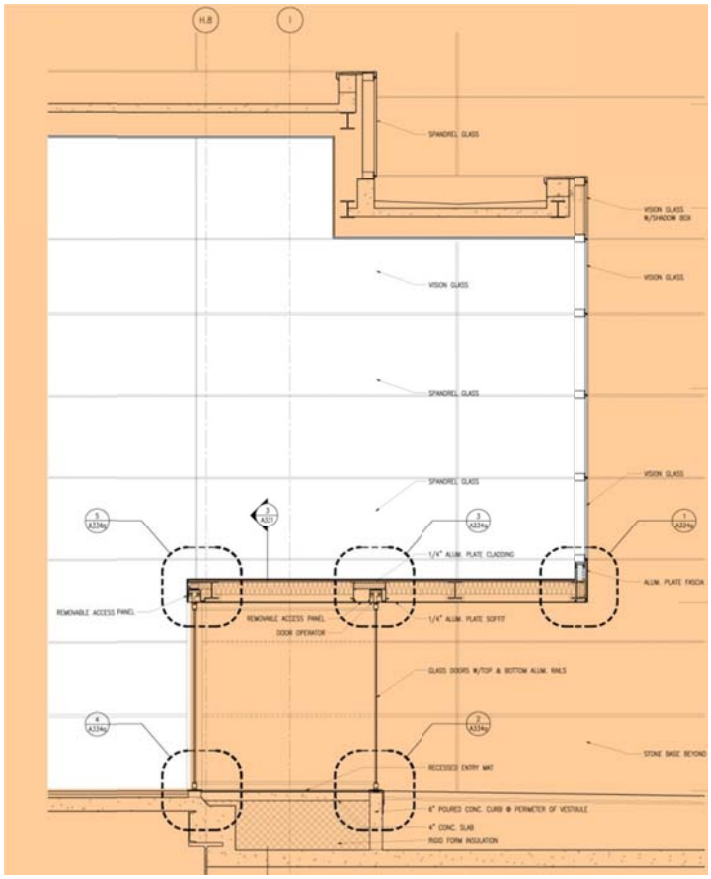
Description of Space | The north (main) entrance to the building is accessible by several pathways that connect in one node and lead you in. The walkways are surrounded by landscaping with many trees and smaller shrubs. The north vestibule leads into the lobby and is sandwiched by the Neuroscience and Psychology buildings. “The outer walls, composed of two "skins" of glass with a three-foot-wide airspace sandwiched between them, will have a luminous quality and will be energy-efficient” (Princeton University News). The façade curtain wall’s main feature is the rain screen modules.



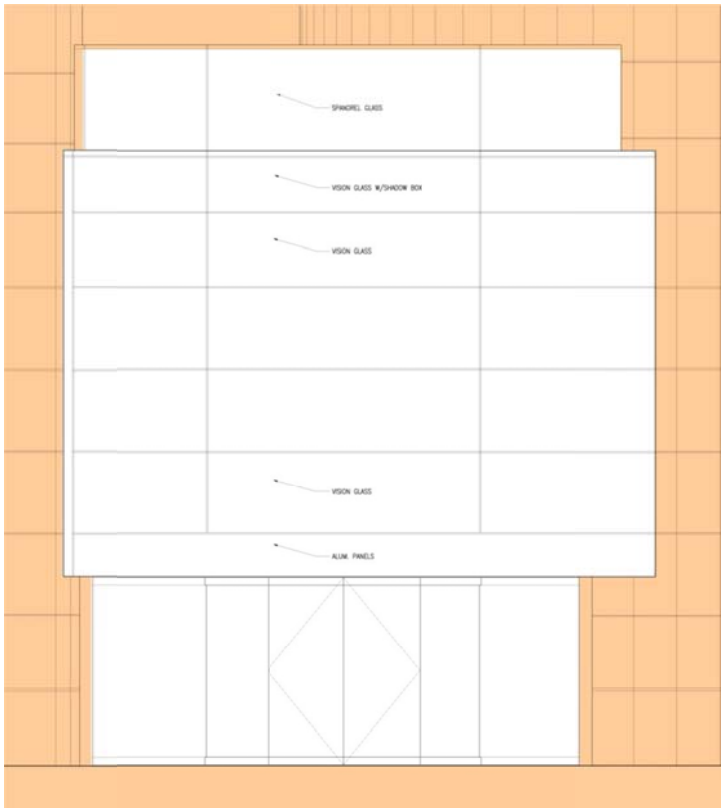
North Entrance, Landscape Plane, NTS



North Façade, Elevation



North Vestibule, Section

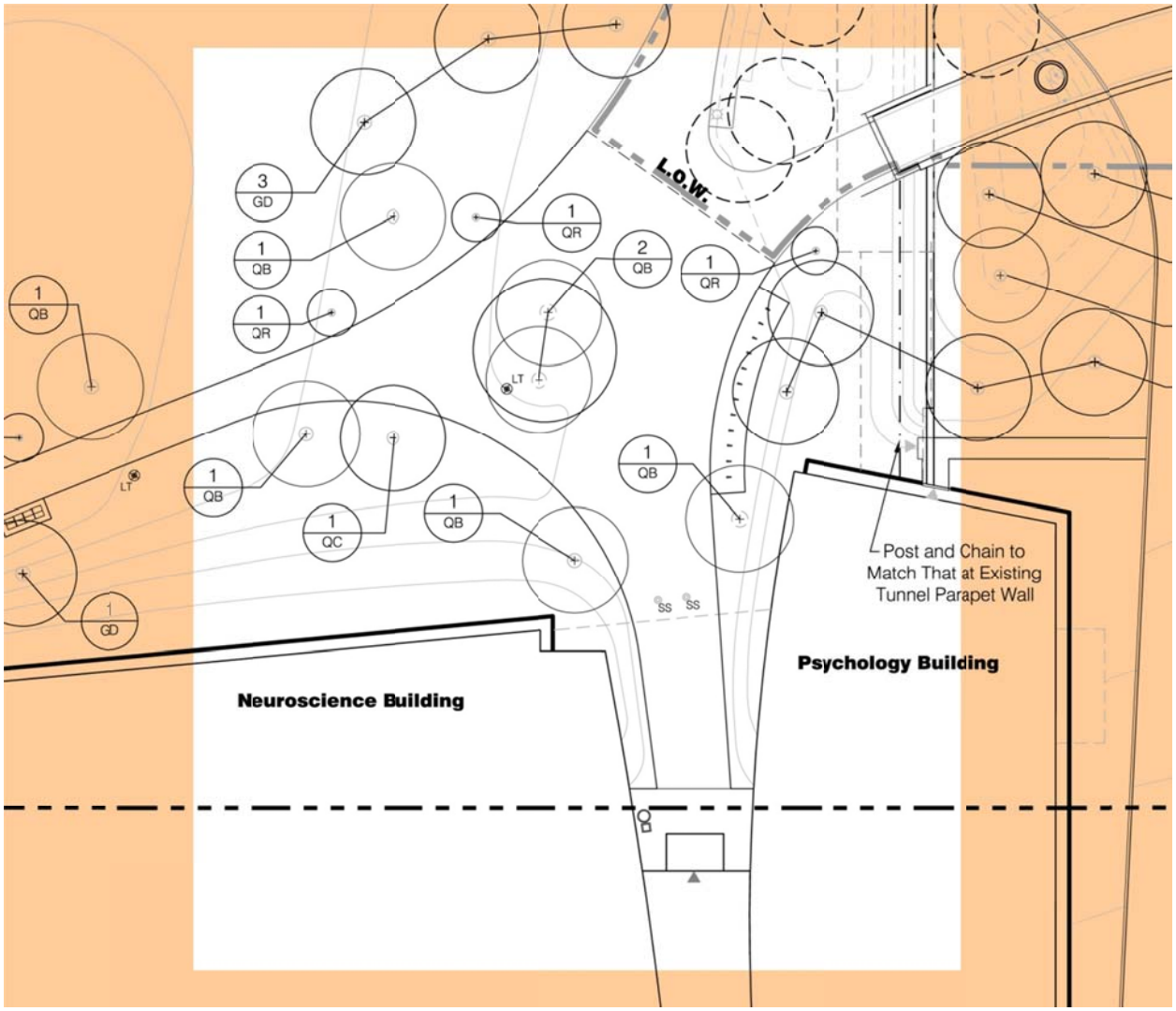


North Vestibule, Elevation

Surface Materials |

Material	Reflectance *	Specifications #	Location
Exposed aggregate concrete pavement	0.35		Walkways
Granular pavement	0.30		Landscape
River jacks	0.26		Neuroscience and Psychology Buildings
Granite block	0.26		Bike racks
Stainless steel	0.60		Bollards, bike rack
Aluminum louver	0.65	08900	Curtain wall, façade
Vision glass	0.10	08800	Curtain wall, façade
Cast glass	0.20	08800	Curtain wall, façade
Translucent glass	0.25	08800	Curtain wall, façade
Spandrel glass	0.70	08800	Curtain wall, façade

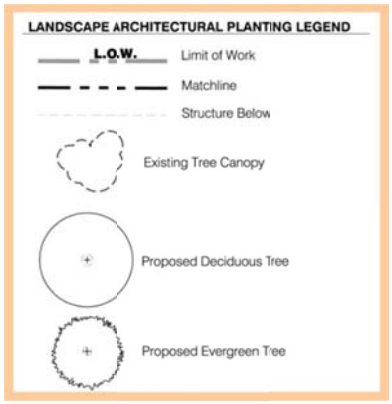
*Assumed, some from Figure 1-36 from IESNA Handbook Page 1-22 and some from 3ds Max.

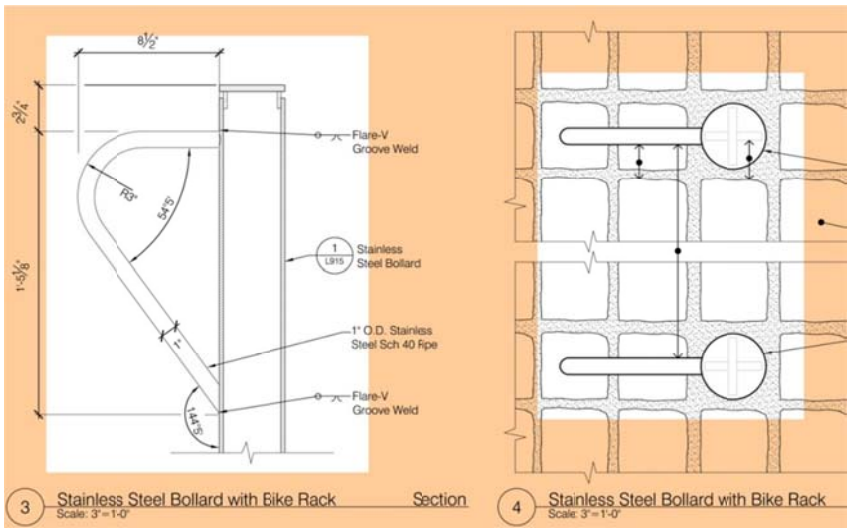


North Entrance, Tree Planting Plan

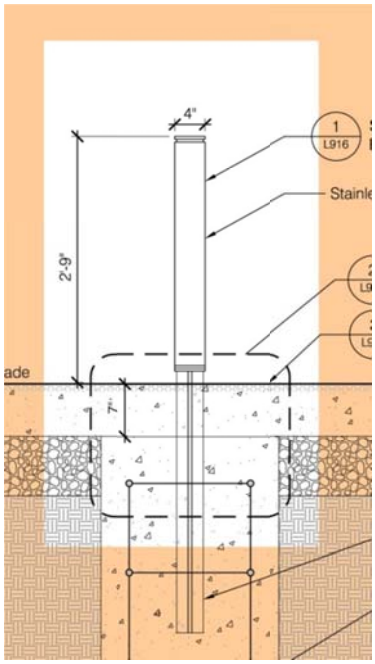
PLANTING SCHEDULE - Drawing L510 Only

Key	Qty	Botanical Name	Common Name	Size	Root	Notes
Tree						
CO	6	*Celtis occidentalis*	Common Hackberry	3"- 3.5" cal.	B&B	
GD	5	*Gymnocladus dioicus*	Kentucky Cofeetree	4" cal.	B&B	All Male - Field Select
IO	1	*Ilex opaca*	American Holy	14'-16' ht.	B&B	Unsheared
OV	1	Ostrya virginiana	American Hophornbeam	8'-10' ht.	B&B	
PO	1	*Picea orientalis*	Oriental Spruce	14'-16' ht.	B&B	Unsheared, To Be Field Located by Landscape Architect
PB	1	*Pinus bungeana*	Lacebark Pine	12'-14' ht.	B&B	Unsheared, To Be Field Located by Landscape Architect, Red Hill Nursery or Approved Equal
PS	2	*Pinus strobus*	White Pine	10'-12' ht.	B&B	Unsheared
QB	9	*Quercus bicolor*	Swamp White Oak	4" -5" cal.	B&B	
QC	3	*Quercus coccinea*	Scarlet Oak	4" -5" cal.	B&B	
QR	7	*Quercus robur 'Fastigiata'*	Columnar English Oak	5" cal.	B&B	Branchedto the Ground, To Be Field Located by Landscape Architect, Halka Nursery or Approved Equal

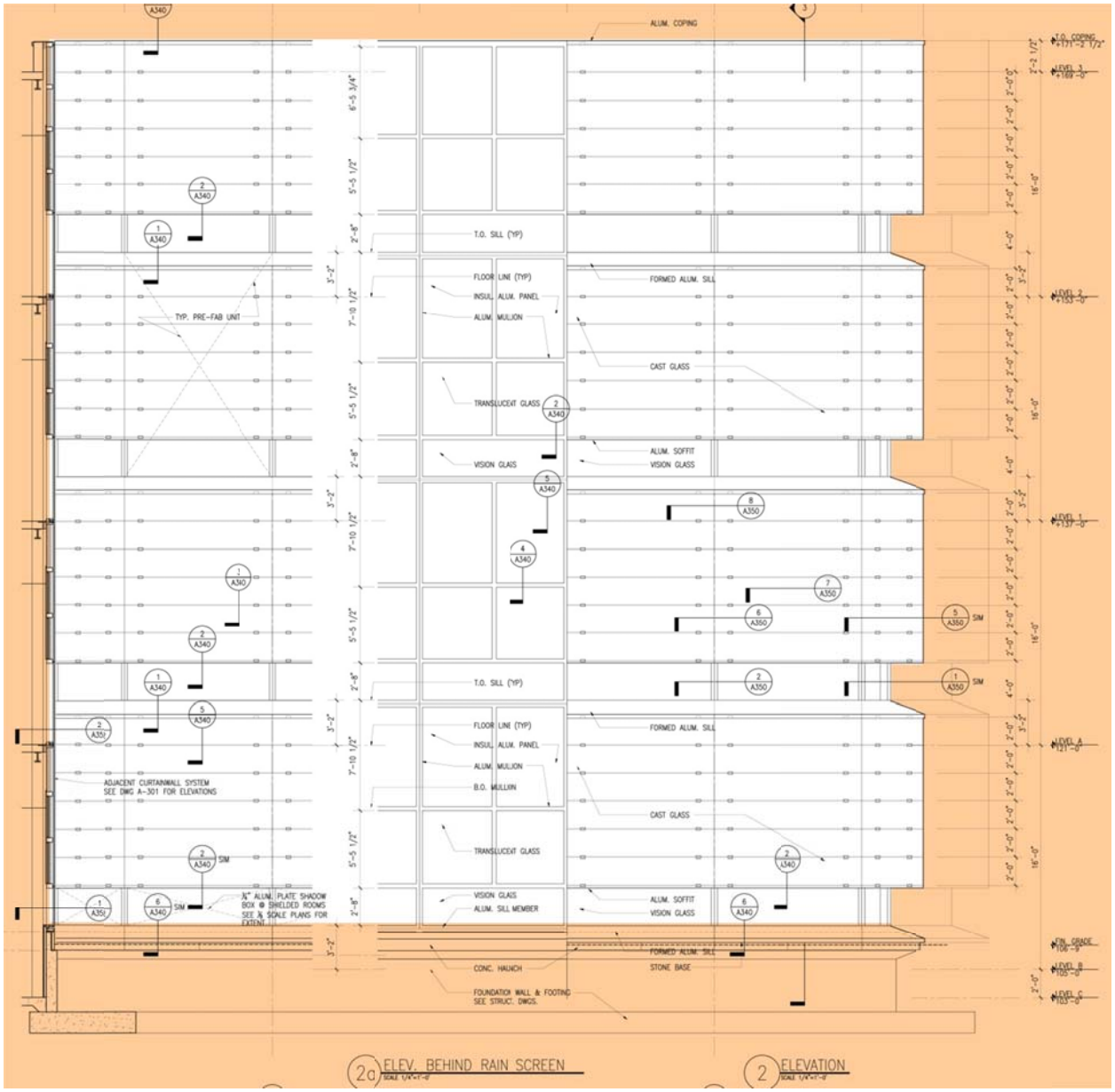




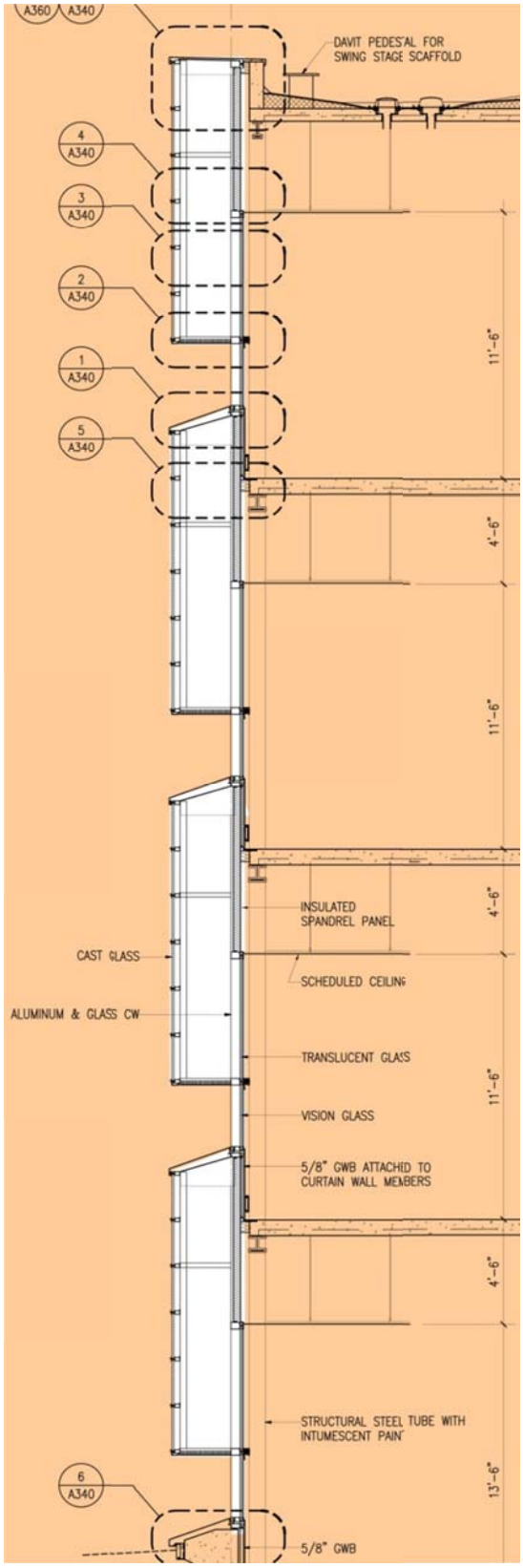
North Entrance, Details, NTS



North Entrance, Details



Curtain Wall System, Elevation, NTS



Curtain Wall System, Section, NTS

Lighting Systems | The only exterior lighting is the typical Princeton Pole.

Type	Description	Lamp	Watt	Volt	Mfr	Catalog #
LT	Princeton standard gas lamp, glow-top	QL induction lamp	85		Penn-glow	
FX	Semi-recessed circline fluorescent downlight with powder coated spun aluminum housing, 18" diameter white two-layer opal glass diffuser, side illuminating reveal with baked white enamel reflector, and integral electronic ballast. Location: entry vestibules	(1)Philips TL5C 22W/830, (1) Philips TL5C 40w/830	66	Per EE	Louis Poulsen	ALC-18.1"-1/22W/1/40 W T-5 2GX13-PEREE-SATIN-CHR-PLA-OPAL-X
FEA	Recessed, circular, remote phosphor LED downlight 4.5" aperture, reflector with overlap trim, integral electronic power supply, and new construction frame-in kit. Location: canopy	3000 K Remote Phosphor LED	20	Per EE	Lightolier	C420LEDDL30KKCCLDP (light engine), C420LEDRX (Frame-in kit)

Controls | There will be one zone for each vestibule and for each canopy connected to the lighting management network switch and photosensor(s) for on/off daylight control.

Original Princeton Pole

. Exterior Space | North Entrance | Design Criteria .

Design Issues | The façade has a very interesting curtain wall that acts as a rain screen. It includes several different types of glass (listed is the finish schedule above). The north vestibule exits at a pedestrian pathway that guides the way to the building. Night outdoors environments present several design challenges. The eye works differently at low light levels, people experience different emotions, and control of the light is expected. The façade must be illuminated in a way that attracts attention and enhances the architecture but at the same time complying with light pollution criteria and energy efficiency.

Visual Tasks | Guided circulation is the main visual task. The walkways need to be illuminated, and the entrance should have even higher levels to attract pedestrians. Safety and security needs to be assessed as well.

Qualitative System Performance Considerations | The following lists in order of importance the design issues that are of consideration for an exterior façade of a prominent building. The ninth edition of The IESNA Lighting Handbook was referenced (Building Exterior, Entrances and Prominent structures).

Very Important | Appearance of space and luminaires | Lighting should enhance the building's appearance at night and should attract attention to the entrance and make a favorable impression on the viewer. The lighting should render the structure otherwise lost without the sun, enhance the architecture, and guide pedestrians towards the main entrance. The architecture of the complex is very interesting and the curtain wall/rain screen is the main component and should be subtlety highlighted. The paths around the building intertwine and come together on nodes that resemble brain connections and the lighting should mimic this.

Very Important | Color appearance and color contrast | The natural colors of foliage and flowers is beautiful and the lighting should not omit it. Therefore, the CRI of lamps in the landscape should be good enough for pedestrians to see the full colors of their surrounding correctly.

Very Important | Direct and Reflected glare | Glare can be discomforting and impair visibility reducing safety and security.

Very Important | Light pollution/trespass | To control light pollution, the flux above the horizontal must be limited, non-target illumination minimized, and some of outdoor lighting turned off during hours of low use. To control light trespass, areas adjacent to the lighting design must be inspected, full-cut off reflectors and refractors and well shielded luminaires must be used, and floodlight angles must be kept low. All construction in Princeton University is expected to attain LEED Silver Accreditation. The point that deals with Light Pollution Reduction is not required to add up to the Silver rating therefore it is not required. However, light trespass and community affect the community so it must still be taken into account.

Very Important | Modeling of faces or objects | It is important to model faces of pedestrians walking around the entrance at night to increase security in the area.

Very Important | Peripheral detection | The lighting of the entrance should attract attention from people passing by on foot or car and should leave a positive impression. To better attract attention, the building entrance should be able to be detected from the peripheral view. With regards to security, being able to see peripheral movement for pedestrians is important.

Very Important | Points of interest | The main point of interest of a building exterior is usually the entrance. Therefore, the lighting design should guide the visitors to the entrance, either the north or south vestibules. The second point of interest will be the architecture and landscape, especially the rain screens and pedestrian walkways. Effective exterior lighting includes minimal ambient levels with highlights on points of interest such as destinations, architectural features, and hazards.

Very Important | Shadows | Patterns of light will highlight certain parts of the building leaving others in shadows. Without shadow, there is no light, and the use of both makes for an interesting exterior lighting design. See the description of Light distribution on surfaces above for more information.

Very Important | Source/task/eye geometry | When lighting the exterior, bollards should not be the only light source because they do not address higher vertical surfaces, like faces, and source/task/eye geometry would be hindered.

Very Important | Surface characteristics | Surface luminance is important for an exterior environment. It adds interest and depth to the scene while providing good visibility and security. Some of the surfaces in the exterior to be lit include landscape surfaces. Special attention must be paid to plant shape, size, foliage characteristic, branching pattern, trunk conditions, rood depth, growth rate, and seasonal changes.

Very Important | Illuminance (horizontal) | Horizontal illuminance is important for safety and security on pedestrian walkways and entrances around the building, especially the north and south vestibules. It is not of concern for the façade itself. The illuminance value required is listed below.

Very Important | Illuminance (Vertical) | Vertical illuminance is important for security and safety because it provides facial recognition and aids in peripheral vision. The sense of security provides a lighting that will allow enough response time to escape from a potential threat.

Important | Light distribution on surfaces | Patterns of light and shadow affect task visibility on interior spaces but they increase contrast on exterior spaces making them interesting. Therefore, uniformity is not a criterion in this case.

Important | Sparkle/desirable reflected highlights | Reflected highlight and sparkle can be discomforting in interior situations but can add character to an exterior environment by highlighting certain surfaces. Here, the building will have more a uniform and subdued glowing feel and contrast, with few reflections and sparkle.

Quantitative System Performance Considerations |

Illuminance (horizontal) | 5fc (50lux)

Illuminance (vertical) | 3fc (30lux)

Reflectances | The IESNA Handbook lists no specific criteria regarding the reflectances of the surfaces for an exterior entrance space.

Luminance ratios | High luminance differences in exterior night settings can cause annoyance, impair task visibility, create safety hazards, and disrupt the surrounding community. Therefore luminance levels should be lowered and the ratio should be set in accordance to the setting and the community. It should not exceed 20:1.

Energy | ASHRAE 90.1 2004

Building Exterior Lighting Power Densities | Walkways less than 10 feet wide: 1.0 W/lf
Walkways 10 feet wide or greater,
Special feature areas: 0.2 W/sqft
Main entries: 30 W/lf of door width
Canopies: 1.25 W/sqft
Building facades: 0.2 W/sqft or 5.0 W/lf

. Exterior Space | North Entrance | Evaluation .

The only landscape fixture is shown in the plans is the typical Princeton Pole. The vestibule and canopy have lighting which attracts attention from pedestrians. There is no specific lighting for the façade curtain wall either. The entrance of a building should be a subtly prominent feature. The levels do not need to be high but they need to be enough to create contrast and highlight important features and the existing lighting design does not do this. Therefore, new features will be added to enhance it.

Fixtures need to be added to the landscape, especially to the node where the pathways meet to guide circulation here. Also, the lighting needs to guide pedestrians to the entrance, and there is nothing doing this now. The existing exterior lighting design is lacking many of the features suggested for landscape and building exterior lighting.

The Princeton Pole fits well with the entire campus theme and maintains uniformity: therefore, it should not be eliminated. However, other fixtures, that assimilate the architecture of the complex, should be added to complement the Princeton Pole. They should have good CRI, not cause glare, and minimize light pollution while still modeling objects and faces correctly.

An AGI32 calculation was not done for this space but the illuminance levels for the canopy and vestibule probably comply with the guidelines required for building exterior. However, the walkways have no illumination and this issue needs to be addressed both for aesthetic reasons and security.

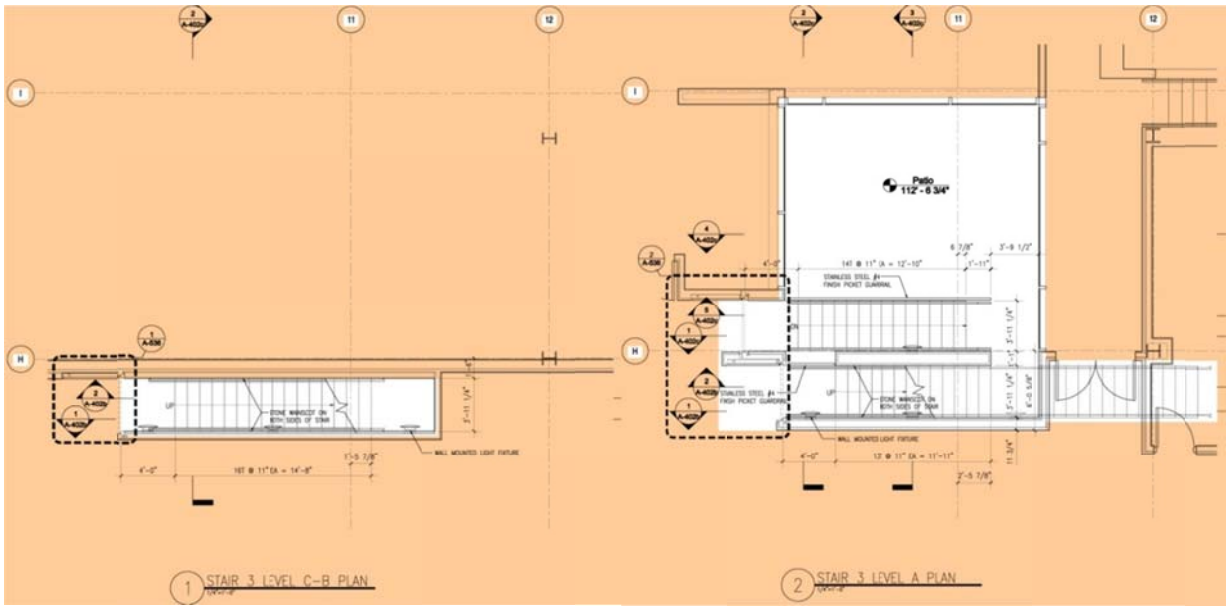
Lighting Power Density Calculation |

Main Entry: 30W/lf x 6ft (door) = 180 W allowable

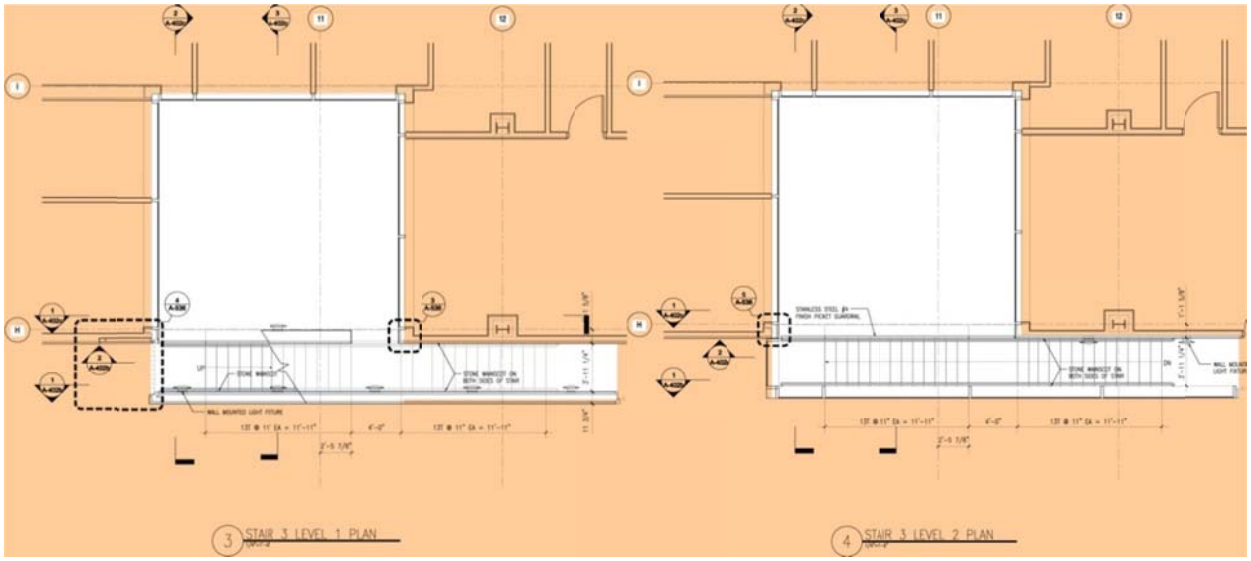
Luminaire Type	Quantity (length)	Watts/Luminaire	Total Watts
LT	1	85	85
FX	2	66	132
FEA	4	20	80
		Main Entry Total Walls:	212 W
		Difference:	**32 W** above allowable

. Extra Space | Large Patio | Existing Conditions .

Description of Space | Even though this space is called a patio, it is an interior space with stairs going through it. This light well goes from the top floor down three stories in the northeast section of the building. The stairs go into the light monitor for one story, then out for one and the wall that separates them disappears for the last floor. This space is very interesting because it breaks the boundaries of the outside/inside by bringing sunlight in and having the stairs braid in and out of the sunlight. It is an in-between space of connection.



Large Patio and Stairs 3, Plans, NTS

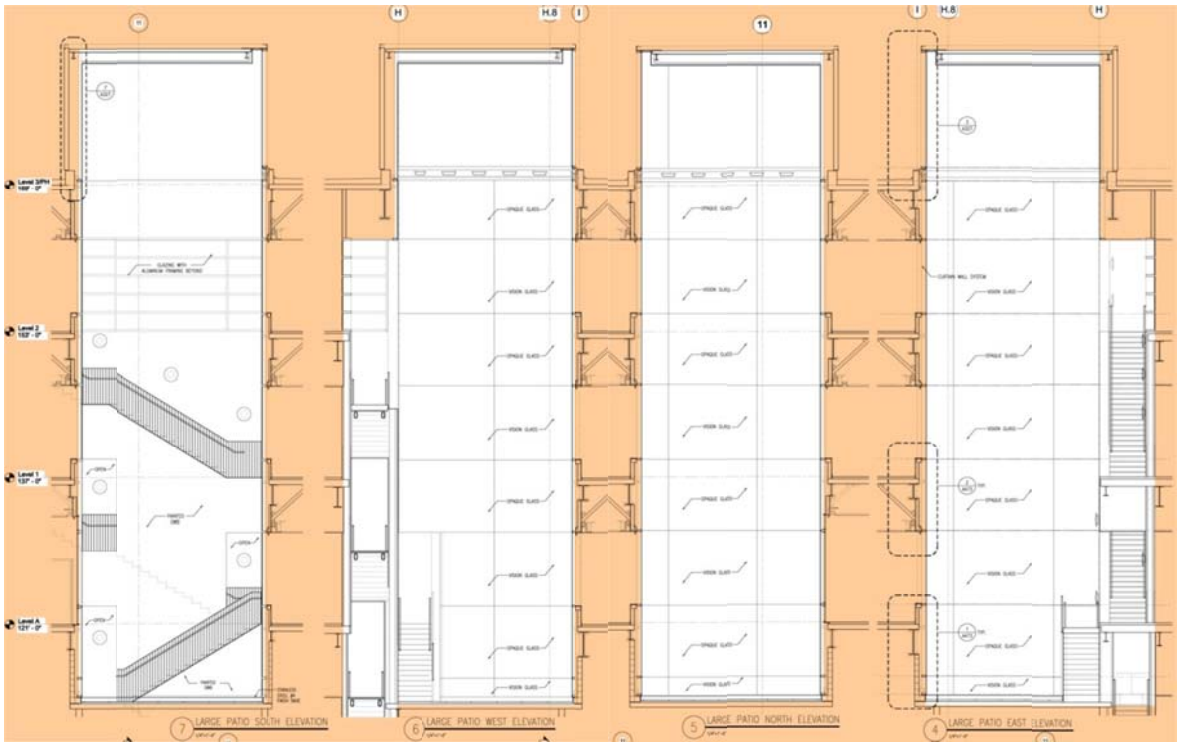


Large Patio and Stairs 3, Plans, NTS

Surface Materials |

Material	Reflectance *	Specifications #	Location
Glazing	0.10	08900	Light monitor
Aluminum framing	0.65	08900	Light monitor
Painted gypsum wall board	0.70	09250	Stairs wall
Vision glass	0.10	08800	Curtain wall
Opaque glass	0.25	08800	Curtain wall
Glacier Blue Devonian Sandstone, honed finish on all exposed surfaces	0.30	04401 09600	Stair wainscot
Stainless steel	0.60		Stair handrails

*Assumed, some from Figure 1-36 from IESNA Handbook Page 1-22 and some from 3ds Max.

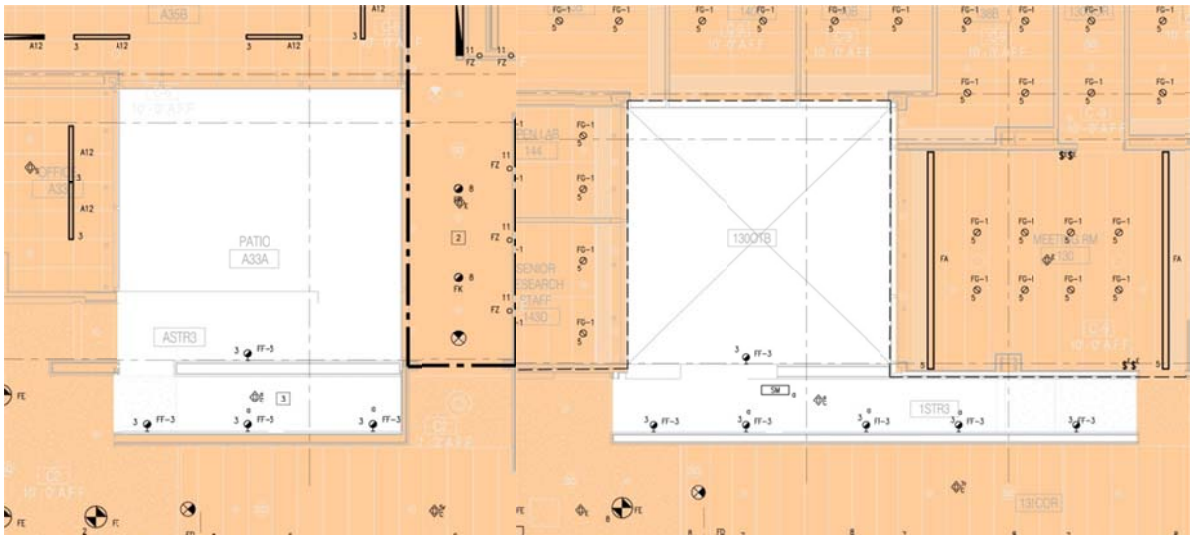


Large Patio and Stairs 3, Elevations, NTS

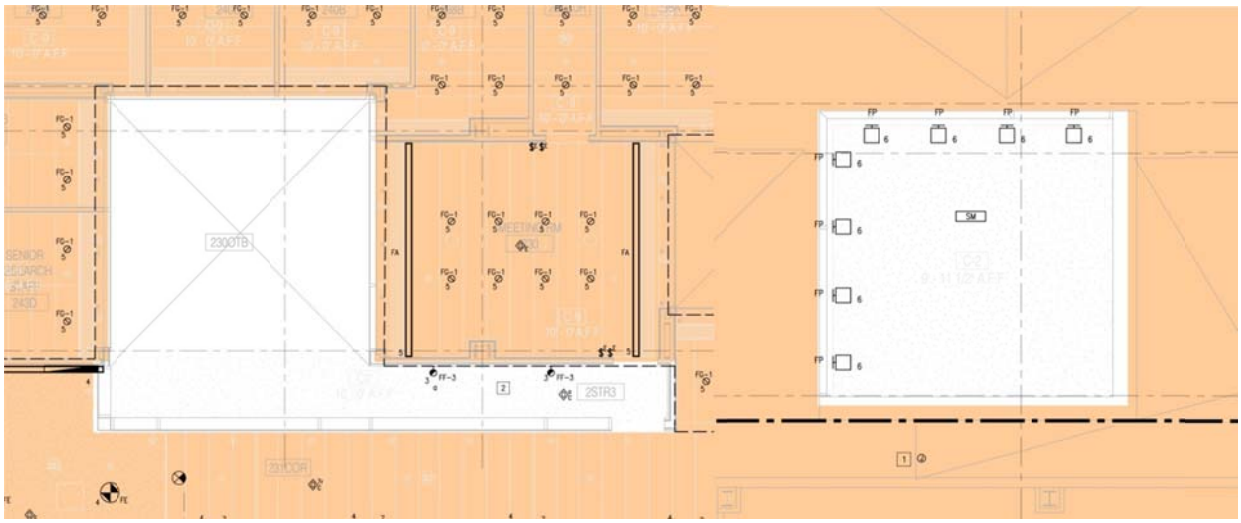
Lighting Systems | The general lighting

Type	Description	Lamp	Watt	Volt	Mfr	Catalog #
FF-3	Surface mounted compact fluorescent downlight with powder coated spun aluminum housing, 18" diamtere white opal glass diffuser, and integral	(2) GE F26TBX/830/A/ECO	56	Per EE	Louis Poulsen	AJE-17.7"-2/26W/CFGX24Q-3-PEREE-WHT-WALL

	electronic ballast within 1.5" architectural recess for ADA compliance.					
FP	Surface mounted ceramic metal halide floodlight with one piece die cast aluminum housing, 8"x10" housing with tempered acid etched glass lens, and integral electronic ballast mounted to wall recessed 3.5-4" octagonal wiring box.	Philips CDM35/TC/ 830	45	Per EE	Bega	7473MH—XXXV-RAL#-MOD ACID ETCHED GLASS LENS



Large Patio and Stairs 3, Lighting Electrical Plans



Large Patio and Stairs 3, Lighting Electrical Plans

. Extra Space | Large Patio | Design Criteria .

Design Issues | This specific stairway is especially important because in intertwines with the largest light monitor in the building. It carries the theme of connection by bringing the exterior in to all floors and creating a space of in-between. Since this is a public area, a lot of people will be moving through the space and the appearance is very important as well as the safety requirements. Since these areas are lit for long periods of time, attention must be paid to energy efficient fixtures. An auxiliary lighting system is required for power outages which will be powered by the generator (Refer to Technical Assignment 2 for Electrical Information.)

Visual Tasks | Stairs are very important for the entire building circulation and are used for egress in case of emergencies. The main visual task will be walking. Therefore, the work plane will be the floor.

Qualitative System Performance Considerations | The following lists in order of importance the design issues that are of consideration for a circulation space like a stairway. The ninth edition of The IESNA Lighting Handbook was referenced (Service Spaces, Stairways and Corridors. Ch11 Office Lighting, Public Areas).

Very Important | Shadows | Shadows cast by occupants in the space should be avoided and this can be done with correct placement of luminaires. Shadows can cause confusion and cause people to fall down the stairs.

Important | Daylighting integration control | In a place where lights are required to be on for extended periods of time, daylight integration can help with energy savings. Daylight sensors can be used to dim the artificial lights to maintain the required levels for safety while using less power. Daylight also adds aesthetic appeal and character to space and since this is a public area, this is desirable.

Important | Direct glare | Glare can be harmful in a stairway. If a person is blinded by a light source, they can hurt themselves. Careful consideration must be taken when placing the luminaires to reduce glare. To minimize glare, luminaires luminances should not more than 100 times of those of the surrounding surfaces.

Important | Light distribution on surfaces | Patterns of light and shadows affect visibility and can be harmful for the occupants of the stairway. Therefore, uniform light distribution is desirable and luminances levels should be within 3:1 ratio for different surfaces within the circulation space.

Important | Luminances of room surfaces | To be energy efficient, room surfaces should have higher reflectances. Surface luminance increases with higher reflectance, appearing brighter with the use of less power. This will make the space feel more comfortable and, if the architecture is successfully lit, will add aesthetic appeal.

Important | Modeling of faces or objects | Modeling of objects helps reveal the shape, depth, and texture. Adding depth to the stairs is important for safety because the occupant will have better visibility of the steps.

Important | Illuminance (horizontal) | The workplane (steps) are horizontal and the illuminance level on them is crucial for the safety requirements of the space.

Important | Maintenance | It is difficult to place ladders on stairs, so the luminaires should be easy to maintain.

Somewhat Important | Color appearance and color contrast | To exalt the nice finishes used in public spaces, a light source with a good color rendering index must be used in the stairs. This space is not just an emergency stairwell; it is an important part of the architecture as it connects to the light monitor.

Somewhat Important | Reflected glare | Reflected glare reduces task visibility and in this case that could potentially be harmful. To reduce it, light sources can be placed on the sides of the task and the ratio of illuminance on the task from the mirror angle relative to the total illuminance on the task should be less than 0.3.

Quantitative System Performance Considerations |

Illuminance (horizontal) | 5fc (50lux)

. Extra Space | Large Patio | Evaluation .

This space is one of the most interesting spaces in the building because of its interconnected nature of joining the outdoor/indoor, circulation space/light well, and the floors. The space runs three stories high of empty space where the daylight trickles in and creates interesting shadows and angles. The sunlight entering the spaces should be explored and a light sculpture should hang down. It would cause the daylight to sparkle as it bounces from it and at night, artificial sources could replicate the effect.

. Relevant Computer Files .

Lecture Hall, AGI32 Model | lecture hall.AGI

Cafeteria, AGI32 Model | cafeteria.AGI

. The End . El Fin . O Fim . C'est Finite . La Fine . Das Ende .