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Lighting/Electrical

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Science Building-Phase 1

Buffalo State College-Buffalo, NY

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Technical Report 1

Executive Summary

The Science Building addition at Buffalo State College is a combination of technical and creative ideas on the inside and out. Its interior spaces require lighting performance that is practical and uniform for lectures and labs, but also responsive to the creative and collaborative nature of its occupants. The following is an analysis of the existing lighting design of four separate spaces: the Genetics Teaching Lab (Work Space), Director's Office (Special Purpose Space), Atrium (Circulation Space), and Roadway/Walkways Lighting (Outdoor Space). Spaces are evaluated based on technical requirements of IESNA and ASHRAE 90.1-2007, while simultaneously analyzing design considerations involving aesthetics and viewer experience.

All spaces met the minimum illuminance requirements, and in some cases exceeded the values. Several different cases were tried if the space utilized switched dimming. The Genetics Teaching Lab and Atrium analyses yielded LPD values that exceeded the maximum limit; however the existing design is compliant with ASHRAE 90.1 standards for LPD and automatic controls. Therefore, the error lies in the calculation employed in this report, which is based on the space-by-space method.

Overall, the lighting design performed well and the atrium stands out as the most aesthetically focused design concept. There is potential to make the appearance of luminaires and aesthetics bigger design considerations and develop the psychological reinforcements in several spaces.

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Introduction

The Science Building Phase 1 construction project is the first phase in a two-phase addition and renovation project for the School of Natural and Social Sciences at Buffalo State College. The 96,000 ft^2 LEED Gold addition is designed to reflect in its exterior, the high-tech education and research that occur within its laboratories and classrooms. Once completed in 2015 the addition and renovation will become the 224,000 ft^2 Mathematics and Science Complex.

Design elements of the addition are a conscious testament to the scientific and collaborative developments housed within its walls. Everything in the architectural elements, from materials and colors to proportions, has a purpose and hints towards different theories or scientific concepts.

The layout of the building is largely influenced by circulation, a practical and figurative indication of biological systems. The addition joins the existing building at a central atrium from which smaller corridors branch out to join the west corridor looking out onto the neighboring athletic play fields. The west corridor acts as a curtain wall skin to the building, with a seemingly random assortment of metal and glass panels that calls upon the principles of the Fibonacci sequence, genetics, and optics. The circulation spaces connect students and visitors to a multitude of research/teaching labs and offices where the lessons fuel ongoing developments in science.

Figure 1 – Western Façade (All photos courtesy of Cannon Design)

Genetics Teaching Lab - Work Space

Existing Conditions

Space:

The Genetics Teaching Lab (Room 306) is located on the northwest end of the building and borders the corridor overlooking the central atrium. It is surrounded on all sides by corridors or rooms, and therefore does not receive any natural light. The rectangular space serves as a teaching and experimental lab and is furnished with numerous pieces of casework to house tools and equipment. Tables are oriented perpendicular to the long wall in order to facilitate presentations that occur at the front of the room between the two entrances. A portion of the wall is painted with dry-erase surfacing paint to provide the writing surface. Finishes are plain and simple to create a space that is easy to work in and maintain. A summary of the materials follows.

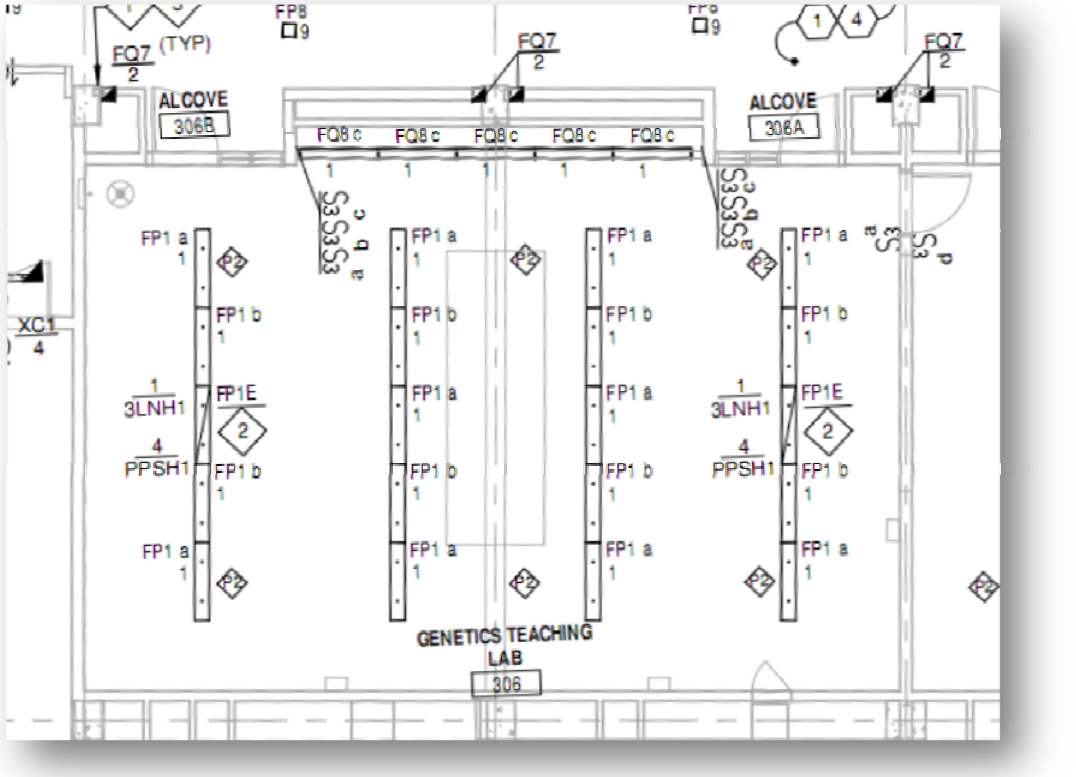


Figure 2-Genetics Teaching Lab Lighting Plan

Table 1

	Work Space		Genetics Teaching Lab		Room 306			
	Item	**Key Name**	**Manufacturer**	**Series/Pattern**	**Style #**	**Color**	**Comments**	**Reflectance**
Floor	Linoleum Tile	LTF-1	Forbo Flooring Systems	Marmoleum composite	MCT-621wt	Dove Gray	13”x13” tile	0.37
	Linoleum Tile	LTF-2	Forbo Flooring Systems	Marmoleum composite	MCT-607	White Marble	13”x13” tile	0.75
Wall	Paint	PNT-1	Sherwin Williams		SW 7006	Extra White		0.94
	Paint	PNT-2	Sherwin Williams		SW 6681	Butter up		0.88
	Dry Erase Surfacing	DE-1	MDC Flooring	Idea Paint		White		0.95
Ceiling	Acoustic Panel Ceiling	APC-1	Armstrong	Optima		White	2’x4’ Panels	0.90
	Acoustic Panel Ceiling	APC-3	Armstrong	Optima		Platinum	2’x4’ Panels	0.90

Lighting System:

The lighting system in the genetics lab is comprised of two different fluorescent luminaires. The linear, two-lamp luminaires (FP1) above the lab tables are controlled by a system type occupancy sensor and manual switch. The override toggle switch allows either all 20 luminaires to be turned on simultaneously, a group of eight, or a group of twelve. The other luminaire (FQ8), a wall-washer, provides the vertical luminance levels necessary for highlighting the dry-erase surface during a class. The luminaires are detailed below in Table 2.

Table 2

FP1	4 FT., 2 LAMP DIRECT/INDIRECT FLUORESCENT	INDIVIDUAL OR CONTINUOUS ROW, PENDANT HUNG 8.0 FT. AFF	F32T8	2 PER 4FT. LEN.	ELEC/T8	277V	OPEN TOP-60% UPLIGHT-STRAIGHT CROSS BAFFLE BOTTOM APERTURE-40% DOWNLIGHT	RECTILINEAR PROFILE-FLAT BOX SHAPE, NOM. 9-12"W X 3" MAX. H - CORD STYLE POWER FEED & AIRCRAFT CABLE INTERMEDIATE PENDENTS-WHITE PPC FINISH	CORELITE - "TRAVERSE" TB SERIES LEDALITE - "QUARTET" SERIES PINNACLE - "RIDGE2" SERIES OR EQUIVALENT
FQ8	4FT. 1 LAMP, FLUORESCENT WALL WASHER	RECESSED	F28T5	1	ELEC/T5	277V	CLEAR, SPECULAR ALUM. ASYMMETRIC THROW UPPER REFLECTOR-OPEN BOTTOM WITH BACKLIGHT DIFFUSER-DROPPED CL'G STYLE EYEBROW TRIM	FORMED, SHEET STEEL, HOUSING NOM. 4" X 4" X 48"L-FOR INSTALL IN GRID CLG.-WHITE PPC ON EXPOSED SURFACES-PAF	FOCAL POINT - FAVA-NS SERIES SE'LUX - M1W*/TB SERIES PINNACLE - EDGE EW SERIES

Design Criteria

Important (1)

- **Color Appearance + Color Contrast**

  Since the space demands experimentation involving various viewing methods and tools, color rendering should be of good quality. CCT values should be no smaller than 3000K and CRI should be ≥ 80.

- **Daylighting Integration and Control**

  Daylight provides the best quality of light in terms of color rendering and is desirable when controlled in a working space. Daylight penetration would be ideal for this space but is unattainable in the current location.
- **Direct Glare**

  Luminaires with matte louvers provide a more comfortable visual environment by reducing contrast between the lamp and housing and minimizing direct view of the source.
- **Light Distribution on Task Plane**

  Centrally positioned luminaires with a direct/indirect distribution provide more even luminance levels on the horizontal task plane. Uniformity is essential at the task surfaces in order to avoid distracting patterns or fatigue caused by inadequate luminance ratios.
- **Reflected Glare**

  Luminaires should not be positioned in direct line with the task surface. Specular finishes on the task plane should be avoided to minimize veiling reflections.
- **Shadows**

  Diffuse light should be used in the space to avoid creating shadows on the task plane.
- **Source/Task/Eye Geometry**

  Luminaires should be positioned outside of normal viewing angles at work spaces.

Somewhat Important

- **Points of Interest**

  Luminance levels on the dry-erase surface should be no less than 30 fc. Contrast for the overall space should satisfy a ratio of 5:1.
- **Flicker and Strobe**

  Flicker should be minimized by employing electronic ballasts.
- **Luminances of Room Surfaces**

  Surfaces in the room should be sufficiently illuminated so as not to create the sensation of dark spots. Direct and indirect/diffuse sources create more even light on the surfaces and increase visual comfort.
- **Modeling of Faces of Objects**

  Lighting should provide sufficient contrast for visual understanding of object textures and depths.
- **Surface Characteristics**

  Finishes with reflectances close to 0.80/0.50/0.20 should be selected to increase reflections between room surfaces.

Illuminance (1)

Horizontal and vertical levels should meet a minimum value of 50fc/500lux 30fc/300lux respectively.

Power Allowance (2)

Lighting power allowance for the space should not exceed 1.4 W/ft^2. Automatic controls should be integrated with manual control system.

Visual Comfort (3)

Visual clarity should be emphasized with higher luminance levels at work surfaces and moderate levels at the perimeter. Preparation and cleaning tasks performed at the room perimeter require sufficient light levels.

Evaluation

The existing design meets or exceeds all the minimum illuminance values for the space. Calculations for the evaluation are based on the light loss factors summarized in Table 3.

Table 3

Luminaire	LLD	LDD	RSDD	BF	LLF
FP1	0.95	0.92	0.90	0.9	0.71
FQ8	0.95	0.81	0.97	1	0.75

Figure 3-Comparison of Switched Analysis (L=60% on, R=100% on)

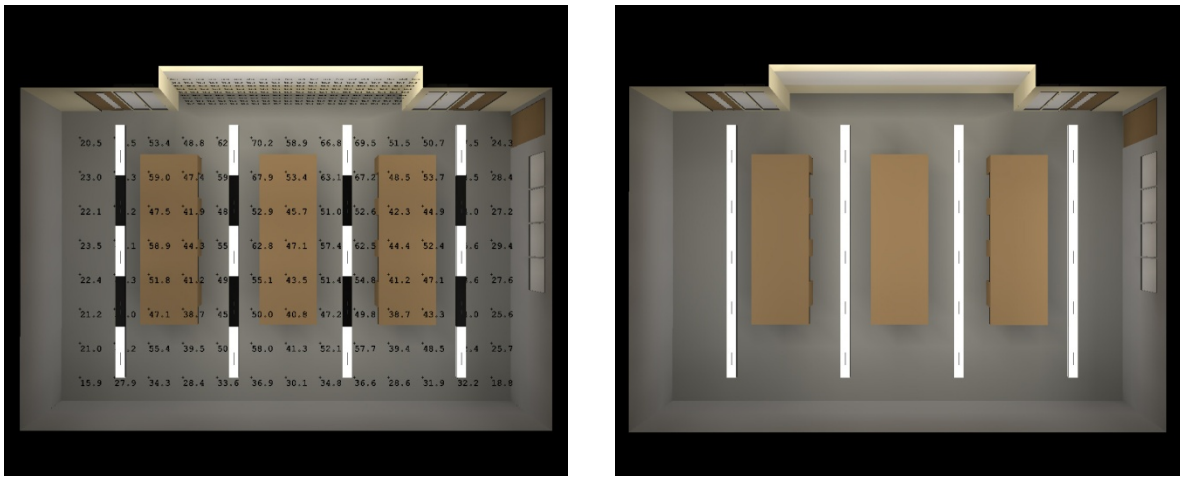
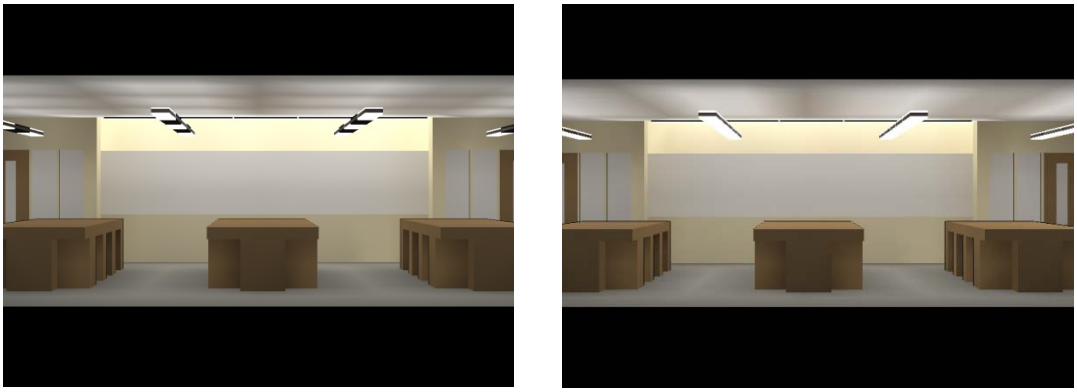


Figure 4-Comparison Elevation View (L=60%, R=100%)



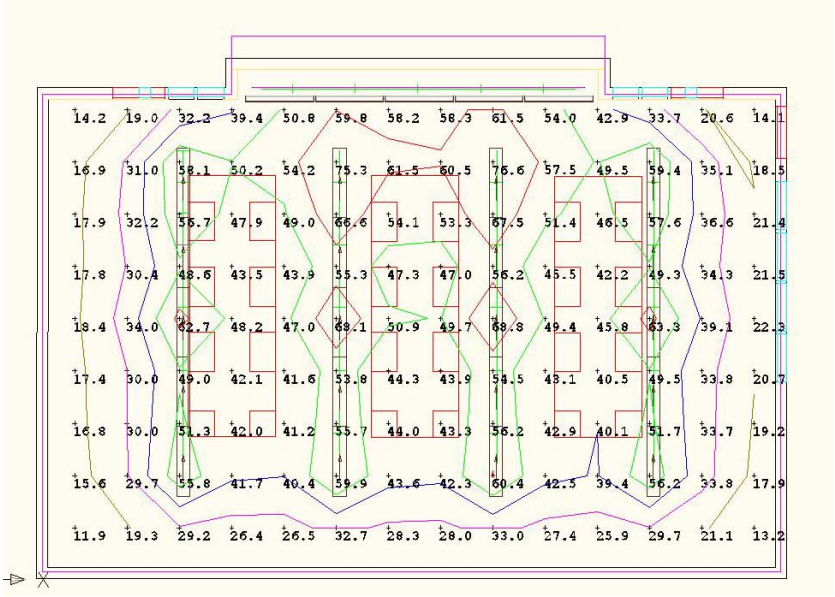


Figure 5 – Illuminance Isolines, 60% On

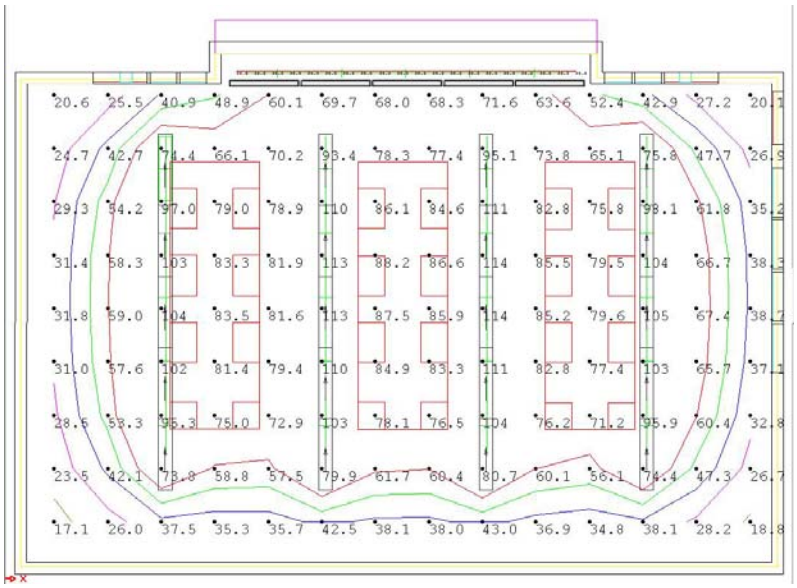


Figure 6 - Illuminance Isolines, 100% On

100% On

Table 4

Horizontal	Average Illuminance (fc)	Maximum Illuminance (fc)	Minimum (fc)
	66.22	114	17.1
Vertical	Average Illuminance (fc)	Maximum Illuminance (fc)	Minimum (fc)
	41.77	93.5	30.6

60% On

Table 5

Horizontal	Average Illuminance (fc)	Maximum Illuminance (fc)	Minimum (fc)
	41.55	76.6	11.9
Vertical	Average Illuminance (fc)	Maximum Illuminance (fc)	Minimum (fc)
	32.72	87.7	21.7

Table 6

Work Space	Genetics Teaching Lab		Room 306	
Lighting Power Allowance	1.40	W/ft^2	Net Difference	-0.18
Room Area	1185.24	ft^2		
Total Power	1875.00	W		
Calculated LPD	1.58	W/ft^2		

Approximately 17% of the power is attributed to the wall-washers that illuminate the white board. These are only used as needed, and when off, the Lighting Power Density (LPD) would be 1.32 W/ft^2 which is 6%

under the limit. Switching control also allows a toggling between eight and twelve of the FP1 luminaires which would provide a total power of 0.80 W/ft^2 or 1.06 W/ft^2 respectively.

Discussion

Overall, the existing system performs very well in supplying a uniformly lit space, as can be seen in the illuminance isoline diagrams in Figures 5 and 6. However, the configuration produces over the required amount of illuminance and causes the LPD to exceed the maximum allowance.

Visual clarity of the space is satisfied by the uniform illuminance levels, and the room surfaces are sufficiently lit for the tasks performed in the space. Vertical illuminance on the dry-erase board meets minimum levels at both 60% and 100%. However, considering the results of the calculations with 60% of the luminaires on , there could be a better configuration or dimming system to prevent LPD from exceeding its allowance at 100% output.

Director's Office- Special Purpose Space

Existing Conditions

Space:

The private office space in room 319A is occupied by the director of the Great Lakes Center and his administrative support. The Great Lakes Center (GLC) is an institute committed to research and education focused on the scientific understanding of the Great Lakes and holds a regional office at Buffalo State College. The layout of the 352 ft^2 rectangular office space is specific to the director's day-to-day tasks and includes a table where he can hold small meetings. It is also directly connected to the secretary's office and the GLC research labs. Though all walls are interior, there is a window that looks into the daylit west corridor. Glazing for the interior window must have a minimum transmittance of 0.75. Finishes for the room provide light-colored walls and a colored, patterned floor. Furniture is assumed to be made of a wood with a glossy finish. A summary of the materials follows in Table 7.

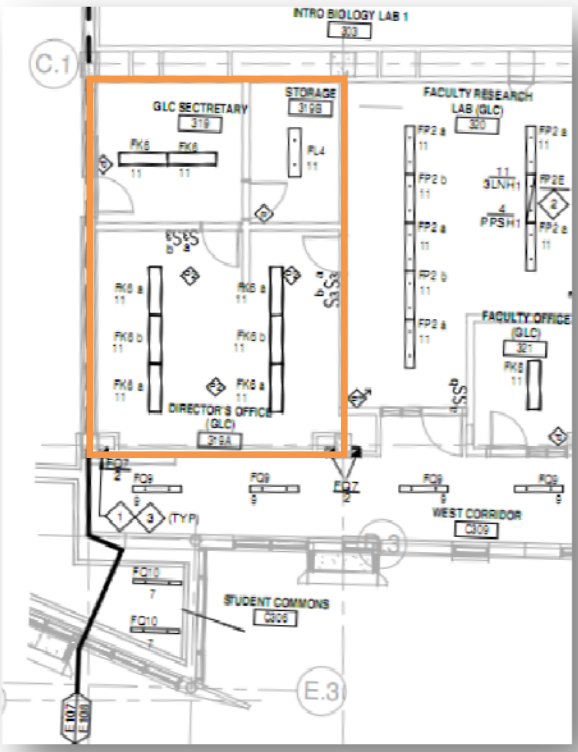


Figure 7-Director's Office (Room 319A)

Table 7

	Special Purpose Space		Director's Office		Room 319A			
Floor	**Item**	**Key Name**	**Manufacturer**	**Series/Pattern**	**Style #**	**Color**	**Comments**	**Reflectance**
	Carpet Tile	CPT-1	Interface FLOR	Entropy	7223	Wheat	2'x2' Tile	0.34
	Carpet Tile	CPT-2	Interface FLOR	Cubic	6393	Height	2'x2' Tile	0.36
Wall	Paint	PNT-3	Sherwin Williams		SW 7014	Eider White		0.87
	Dry Erase Surfacing	DE-1	MDC Flooring	Idea Paint		White		0.95
Ceiling	Acoustic Panel Ceiling	APC-2	Armstrong	Optima		White	2'x2' Panels	0.90

Lighting System:

The lighting system in the director's office is comprised of two different fluorescent luminaires. The linear, recessed luminaire, FK6, provides the light for the director's and secretary's office space. The director's office has a system type occupancy sensor and manual switch. A surface-mounted, wraparound luminaire is provided in an adjacent storage space. The storage space and the secretary's office are controlled solely by a wall box occupancy sensor. The override toggle switch in the director's office allows settings for 100%, 66%, or 33%. The luminaires are detailed below in Table 8.

Table 8

FK6	1X4	RECESSED	F32T8	2	ELEC/T8	277V	DOMED SHAPE, DIRECT/	DIE-FORMED, COLD ROLLED	MARK ARCH. LTG. - VERSA SERIES
	DIRECT/INDIRECT						INDIRECT UPPER REFL'R-	STEEL HOUSING-WHITE PPC-PAF	NEO-RAY LTG. - "SYMBIO" 194 S
	FLUORESCENT						WHITE-FLAT, CROSS		ZUMTOBEL - ML4 SERIES
	TROFFER						BLADED, CENTER LOUVER		
							W/OPAL WHITE ACRYLIC		
							OVERLAY		OR EQUIVALENT
FL4	4FT., 2 LAMP,	8.0 FT. AFF	F32T8	2	ELEC/T8	277V	FULL PERIMETER,	FULL PERIMETER, RECTANGULAR	COLUMBIA - MWN SERIES
	SURFACE	UNLESS					STRAIGHT SIDED,	STEEL HOUSING-WHITE PPC-PAF	DAYBRITE - DWN SERIES
	WRAPAROUND	OTHERWISE					WRAPAROUND STYLE,		LIGHTOLIER - CBS SERIES
	FLUORESCENT	NOTED					INJECTION MOLDED,	PROVIDE CHANNEL FRAMING	LITHONIA - AW SERIES
	SURFACE, OR						CLEAR, PRISMATIC	TYPE SUPPORT WHERE	METALUX - SA SERIES
	PENDANT HUNG						ACRYLIC LENS	PENDENT HUNG	

Design Criteria

Very Important (1)

- **Daylighting Integration and Control**

  Daylight is important for the quality of the lighting design in the space and has a great influence on occupant productivity and satisfaction. The office should be designed to allow as much controlled, daylight penetration as possible.

- **Direct Glare**

  Luminaires with matte louvers provide a more comfortable visual environment by reducing contrast between the lamp and housing and minimizing direct view of the source. Location of furniture and luminaires should be coordinated.

- **Luminances of Room Surfaces**

  Surfaces in the room should be sufficiently illuminated so as not to create the sensation of dark spots. The highly reflective matte paint finish should be used to increase surface luminances.

- **Reflected Glare**

  Luminaires should not be positioned in direct line with the task surface. Specular finishes on the task plane should be avoided to minimize veiling reflections. VDT screens need to be shielded from direct light causing veiling reflections, or should have a diffuse reflecting screen.

Important (1)

- **Appearance of Space + Luminaires**

  The space should provide a corporate image in terms of luminaire style and lighting mood. Fixtures must be laid out in the room so as not to create viewing issues for the occupant.

- **Color Appearance + Color Contrast**

  Color perception is not critical to the inherent tasks of the space, but a CRI above 70 must be achieved. CCT values should match with neighboring spaces (3000-3500K).

- **Flicker and Strobe**

  Flicker should be minimized by employing electronic ballasts.
- **Light Distribution on Task Plane**

  Uniformity is essential at the task surfaces in order to avoid distracting patterns or fatigue caused by inadequate luminance ratios. Contrast levels between paper tasks and VDT screens should be 3:1.
- **Modeling of Faces of Objects**

  Lighting should provide sufficient contrast for visual understanding of object textures and depths. The space is used to host many meetings and should not employ concentrated downlighting that would create harsh shadows.
- **Shadows**

  Diffuse light should be used in the space to avoid creating shadows on the task plane. Overhead lighting must be positioned so shadows are not created on writing surfaces.
- **Source/Task/Eye Geometry**

  Luminaires should be positioned outside of normal viewing angles at work spaces and not directly above the work surface.
- **Surface Characteristics**

  Finishes with reflectances close to 0.80/0.50/0.20 should be selected to increase reflections between room surfaces.

Illuminance (1)

Horizontal and vertical levels should meet a minimum value of 50fc/500lux and 5fc/50lux respectively.

Power Allowance (2)

Lighting power allowance for the space should not exceed 1.10 W/ft^2 (0.30 W/ft^2 for the storage space). Automatic controls should be integrated with the manual control system.

Psychological Reinforcement (3)

The space in question is to be analyzed for the psychological impressions of relaxation versus tension. Since the space functions as a "corporate" office and conference room, it should possess the lighting settings to create a relaxed environment. In order to achieve these lighting characteristics, a design incorporating more non-uniform, low-level light would need to be created. A tense mood would be created by the opposite conditions, or high levels of uniform light.

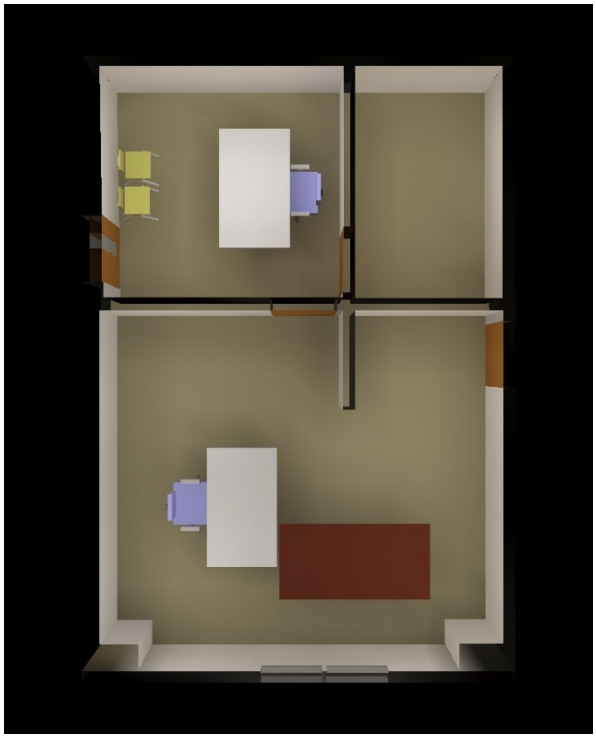
Evaluation

The existing design meets or exceeds all the minimum illuminance values for the space. Calculations for the evaluation are based on the light loss factors summarized in Table 9.

Table 9

Luminaire	LLD	LDD	RSDD	BF	LLF
FK6	0.95	0.87	0.96	0.9	0.71
FL4	0.95	0.85	0.94	0.9	0.69

Figure 8-Comparison of Switched Analysis (L=66% on, R=100% on)



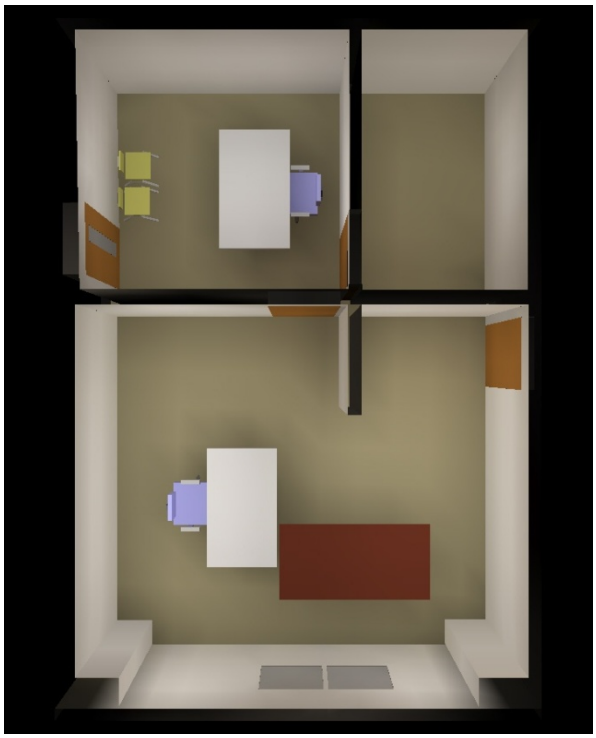
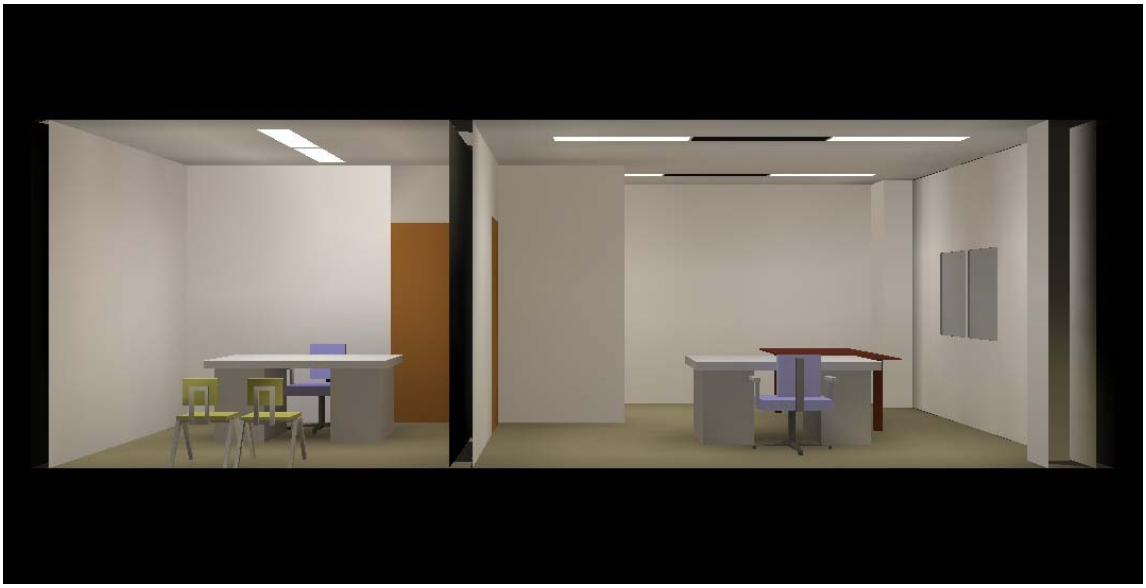
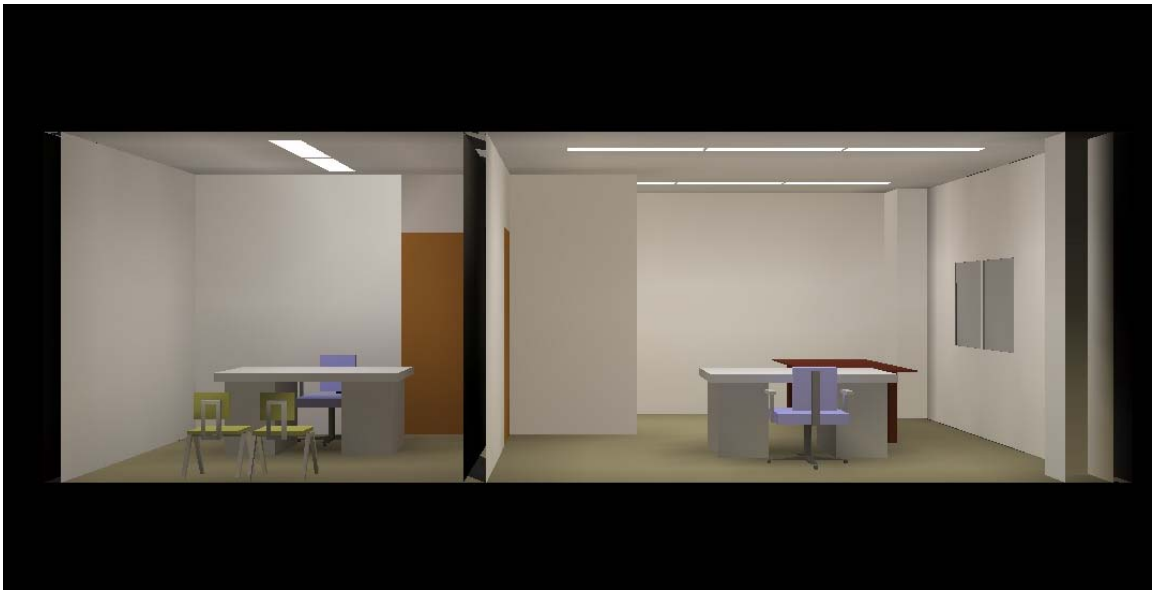


Figure 9-Comparison Elevation View (Top=66%, Bottom=100%)





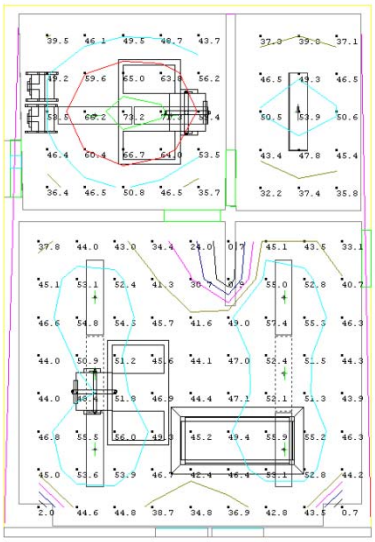


Figure 10 – Illuminance Isolines, 60% On

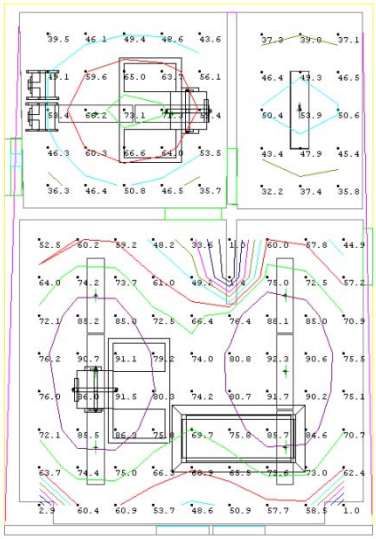


Figure 11 - Illuminance Isolines, 100% On

100% On

Table 10

Horizontal (Director)	Average Illuminance (fc)	Maximum Illuminance (fc)	Minimum (fc)
	67.45	92.3	1.0
Horizontal (Secretary)	41.77	93.5	30.6
Horizontal (Storage)	43.57	53.9	32.2

66% On

Table 11

Horizontal	Average Illuminance (fc)	Maximum Illuminance (fc)	Minimum (fc)
	44.11	57.4	0.7

Table 12

Special Purpose Space	Director's Office		Room 319	
Director's Office				
Lighting Power Allowance	1.10	W/ft^2	Net Difference	0.08
Room Area	352.00	ft^2		
Total Power	360.00	W		
Calculated LPD	1.02	W/ft^2		
GLC Secretary				
Lighting Power Allowance	1.10	W/ft^2	Net Difference	0.24
Room Area	140.00	ft^2		
Total Power	120.00	W		
Calculated LPD	0.86	W/ft^2		
Storage				
Lighting Power Allowance	0.30	W/ft^2	Net Difference	-0.29
Room Area	93.00	ft^2		
Total Power	55.00	W		
Calculated LPD	0.59	W/ft^2		
			Overall Net Difference	0.03

Discussion

Overall, the existing system satisfies the quantitative illuminance requirements while adhering to the LPD allowance. Luminaires are automatically controlled in accordance with ASHRAE 90.1 and permit manual switch dimming.

However, qualitative performance does not coincide with the design considerations for psychological reinforcement. The luminaires chosen are sufficient in terms of glare reduction, but they do not provide any sort of aesthetic interest. They create a fairly uniform distribution and due to their positioning risk causing potential veiling reflections on the director's desk or meeting table.

Consequently, the high illuminance levels could be reduced and simultaneously create a more relaxed atmosphere. Since this is a special purpose room, the space should incorporate a luminaire that stresses appearance and performance. A more developed

lighting system with low level indirect and/or peripheral light could be employed to address the conference role of the space.

Atrium - Circulation Space

Existing Conditions

Space:

The atrium space spans the length of the addition and covers 6,064 ft^2 at three levels. It serves primarily as a circulation space, though it is also intended for students to use as a casual meeting place. The atrium joins the existing Science 1 Building at its western façade, and therefore has an interior wall composed of brick with gypsum wallboard accents on its eastern side, see Figure 12. The western side of the atrium/lobby is essentially corridor space with a stair case extending from the second to third level. The roof of the atrium supplies daylighting into the space via a system of 13 sloped skylights and clerestories. The finishes of the majority of the atrium surfaces are presented in Table 13.

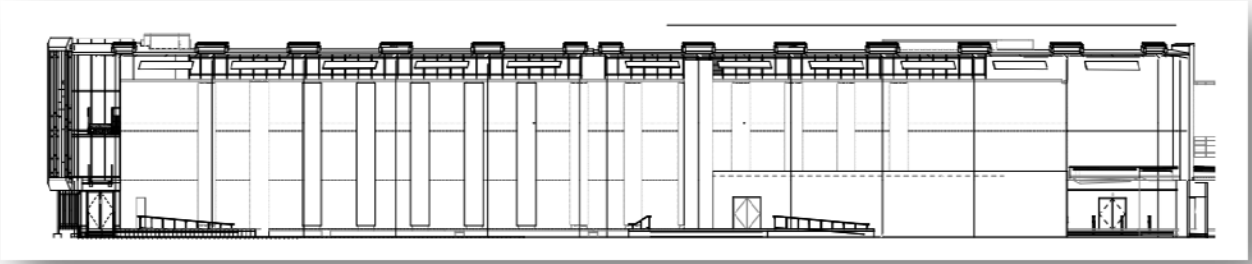


Figure 12-East Section of Atrium

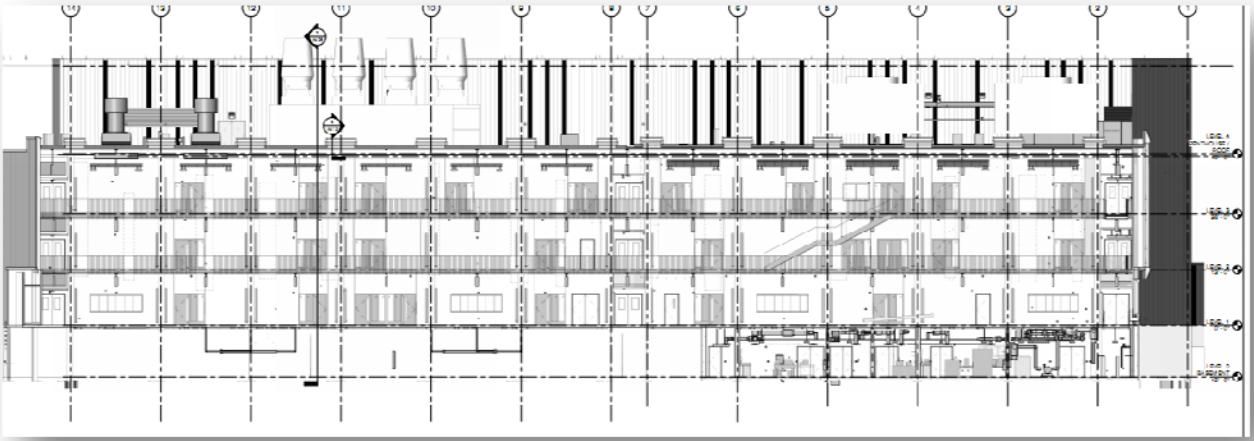


Figure 13-West Section of Atrium

Table 13

Floor	**Special Purpose Space**		**Director's Office**		**Room 319A**			
	Item	**Key Name**	**Manufacturer**	**Series/Pattern**	**Style #**	**Color**	**Comments**	**Reflectance**
	Porcelain Tile	PT-1	Caesar	More		Eclipse	24"x48" Tile (1/16" Joint)	0.15
	Porcelain Tile	PT-2	Caesar	More		Eclipse	12"x48" Tile (1/16" Joint)	0.15
Wall	Existing	BRK	Existing					0.25
Ceiling	Acoustic Panel Ceiling	APC-2	Armstrong	Optima		White	2'x2' Panels	0.90
	Glazing	G1						τ=0.7

Lighting System:

The first level of the atrium contains nine recessed LED step-lighting fixtures at a platform between the existing building and the new atrium space (PW7). Both these LED step luminaires and the vertical, recessed linear fluorescents along the edge of the atrium corridor (FQ7) are

connected to emergency lighting branch circuits. Therefore, they are not counted towards interior lighting power density. The PW7 and FQ7 luminaires are remote controlled through a single pole double throw switch in the basement electrical room. This network lighting control system has a monitor station with an interface that allows programming.

The majority of the lighting system, however, is composed of a decorative pendant (FP8) that is suspended in the bordering corridors, see Figure 14. These pendants are hung in each of the three levels of the atrium. At the third and final level, there are also indirect metal halide fixtures which are assumed to be aimed at the acoustic ceiling panel grids in between the sky lights. A detailed list of all the luminaires in the atrium is provided below in Table 14.

Figure 14

The atrium also potentially will have acrylic graphic panels covering LED strips that overlay the railings in the atrium corridor, as demonstrated in the cover image. These sources would be connected to a driver in the basement mechanical room. This specific aesthetic component of the atrium lighting design has yet to be approved.

Table 14

PJ1	INDOOR, HID	PENDANT	210/T9/CMH	1	**REMOTE**	277V	SPECULAR, COMPOUND	EXTRUDED & SHEET ALUMINUM	ELLIPTIPAR - STYLE M104 SERIES
	INDIRECT	HUNG	PGZ18 BASE		MAG/PS/MH		PARABOLIC, ASYMMETRIC,	FABRICATION-EXTRUDED ALUM.	WINONA - "WINDIRECT" P2/LS/*/LP1
	LIGHTING				ENCAPSUL'D		FORWARD THROW,	MITERED CORNER LENS FRAME-	PINNACLE LTG - "PEAK" PLS SERIES
	LUMINAIRE						EXTRUDED ALUMINUM	SOLID CUTOFF VISOR-SQUARE	
							REFLECTOR-MICRO PRISM.	TUBE, HANG STRAIGHT PENDENT-	OR EQUIVALENT
							TEMPERED GLASS LENS	INDIRECT MT'G-ALL WHITE PPC	
FP8	DECORATIVE	PENDANT	F50HL	2	ELEC/CFL/HL	277V	OPAL WHITE ACRYLIC	NOM. 8" SQ. X 1.5" D CANOPY-	BETA-CALCO - "QUADRATE" SER
	2 LAMP	HUNG			**INTEGRAL**		PANELS (4 SIDES + BOTT)-	FIELD ADJUSTABLE AIRCRAFT	WINONA-5450 SERIES MODIFIED
	PENDANT	9.0 FT. AFF			NOT REMOTE		SQUARE CYLINDER FORM	CABLE STY'LE PENDANTS-WHITE	MCFADDEN - MP0915 SERIES
		TO BOTTOM					NOM. 8" SQ. X 30" TALL	CORD STYLE POWER FEED-	
							REFER TO DETAIL 5/E-504	POLISHED METAL ACCENTS AS	OR EQUIVALENT
								REQ'D-ENCLOSED BOTTOM	
FQ7	8FT. 2 LAMP,	FULL RECESS	F28T5	2	(1)	ELEC/T5	FORMED STEEL INTERNAL	SINGLE 8FT. LONG SHEET STEEL	VISA - "VISAGE" CV 1600 SERIES
	VERTICAL	FLUSH-TO-WALL			PER	277V	REFLECTOR-OPAL WHITE	HOUSING-NOM. 8FT X 6"W X 4.5"D-	REGENT LTG - "GEO" MODIFIED EQUIV.
	FLUORESCENT	FRAME & TRIM			4FT.	(EMERGENCY)	SMOOTH ACRYLIC LENS	PAF-EXTRUDED ALUM. LENS	
	ACCENT LIGHT	ASSEMBLY			LEN.			FRAME W/FLUSH-TO-WALL	
								SEAMLESS TRIM-BRUSHED ALUM	OR EQUIVALENT
								FINISH	
PW7	LED STEP LIGHT	FLUSH TO WALL	≥ 1W	1	REMOTE	120V	CONCEALED, TOP MT'D	CONCEALED BACKBOX FOR	BEGA - 2230 SERIES
	STYLE	10" AFF	WHITE LED		LED DRIVER	(EMERGENCY)	TEMPERED GLASS LENS-	CONCRETE POUR-DIE CAST, NOM.	CON-TECH - P1ST SERIES
	LUMINAIRE				(located in		OPEN REGRESSED,	3-1/2" SQ. ALUMINUM FACEPLATE,	SOLAVANTI - 111291 SERIES
					basement		TRIANGULAR SHAPE,	WITH REFLECTOR CUTOUT-	MODALIGHT - MWO3 SERIES
					mech. room)		CORRUGATED REFLECT'R-	BRUSHED ALUMINUM FINISH-	OR EQUIVALENT
							BRUSHED ALUM. FINISH	REMOTE LED DRIVER	

Design Criteria

Very Important (1)

- **Daylighting Integration and Control**

  Daylight penetration is the key function of an atrium. Since this atrium functions primarily as a circulation space, clear glazing is acceptable in the skylight assembly. Issues of glare must be addressed with proper orientation, shading, and positioning of glazing.

Important (1)

- **Direct Glare**

  Luminaires at eyelevel or below must be addressed to ensure they will not create any discomfort to the viewer.

- **Light Distribution on Surfaces**

  Distributions must meet the design intent of the space. Since the atrium is not a dedicated work space, the accent and decorative lighting creates more isolated spots of light to guide the viewer in a certain direction.

- **Luminances of Room Surfaces**

  Horizontal and vertical luminances must be sufficient for circulation.

- **Shadows**

  Shadows from any downlight fixtures must be limited so as not to interfere with work surfaces.

Somewhat Important

- **Color Appearance + Color Contrast**

  Color matching is an important criterion in the atrium space. Light sources must be carefully matched so that CCT values do not create great differences in warm or cool light.

- **Modeling of Faces or Objects**

  The atrium serves as a decorative space within the building, and therefore, aiming angles and sources must be coordinated with the surfaces to obtain the desired effect.

- **Reflected Glare**

  Luminaires and interior glazing must be carefully located to prevent reflections of natural or interior light toward direct view of an occupant.

Illuminance (1)

Horizontal levels should meet a minimum value of 5fc/50 lux.

Power Allowance (2)

Lighting power allowance for the space should not exceed 0.6 W/ft^2 (for the first three levels).

Evaluation

The existing design would satisfy the quantitative requirements in the corridors and satisfy minimal requirements of lighting in the general space. However, the luminaires in the corridor require high input powers and may cause issues with LPD, see Table 16.

Table 15

Luminaire	LLD	LDD	RSDD	BF	LLF
PJ1	0.80	0.85	-	1	0.68
FP8	0.79	0.81	-	0.95	0.61
FQ7	0.95	0.85	-	0.9	0.73
PW7	-	-	-	-	0.75

Table 16

Circulation Space	Atrium		C101	
Level 1				
Lighting Power Allowance	0.60	W/ft^2	Net Difference	0.32
Room Area	6064.00	ft^2		
Total Power	1677.90	W		
Calculated LPD	0.28	W/ft^2		
Level 2				
Lighting Power Allowance	0.60	W/ft^2	Net Difference	0.32
Room Area	6064.00	ft^2		
Total Power	1678.00	W		
Calculated LPD	0.28	W/ft^2		
Level 3				
Lighting Power Allowance	0.60	W/ft^2	Net Difference	-1.13
Room Area	6064.00	ft^2		
Total Power	10478.00	W		
Calculated LPD	1.73	W/ft^2		
			Net Difference	-0.48

Discussion

The system should perform well, but it would not meet ASHRAE 90.1 standards according to the space-by-space method. There are two possible explanations for the high values. It could have been an operator error, or the high LPD values could have been traded off with circulation spaces that produced a LPD lower than the maximum allowance. In other words, the net value of circulation spaces would have to be considered to obtain permissible LPD.

Overall, it is a well-lit space, but there is potential for more creative/aesthetic lighting in the main area on the first level. The exploration of a variety of fixtures and mountings could unite the space visually.

Roadway/Entrance - Outdoor Space

Existing Conditions

Space:

The area considered for the outdoor space is a portion of the site that covers approximately 10,400 ft^2. It is located at the western face of the building, which runs parallel to a service road and athletic playing fields. This area was not directly considered in the scope of the project for a new lighting design, but is being affected by the addition. Additionally, there is 330 ft. of sidewalk that runs from the main western entrance south to the end of the complex. Figures 15, 16, and 17 illustrate the areas to be considered in the redesign.

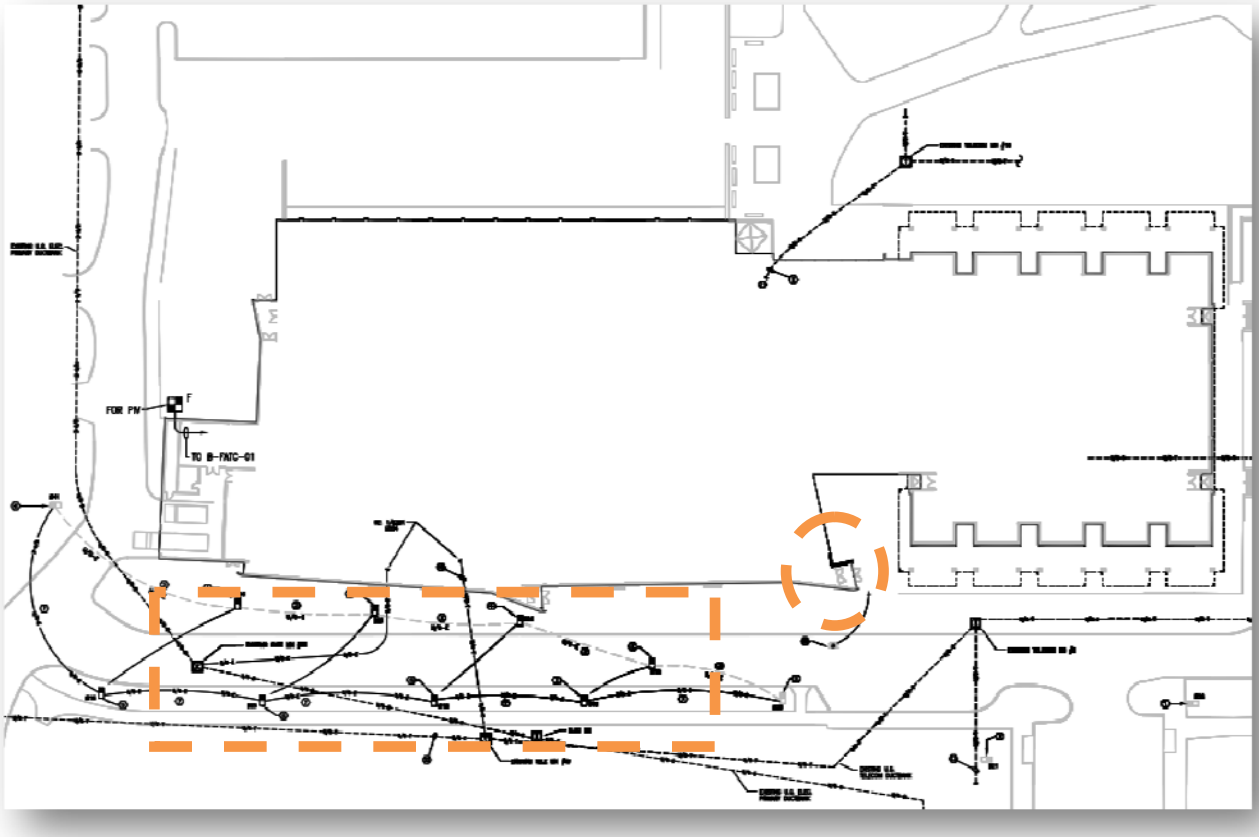


Figure 15 – Site

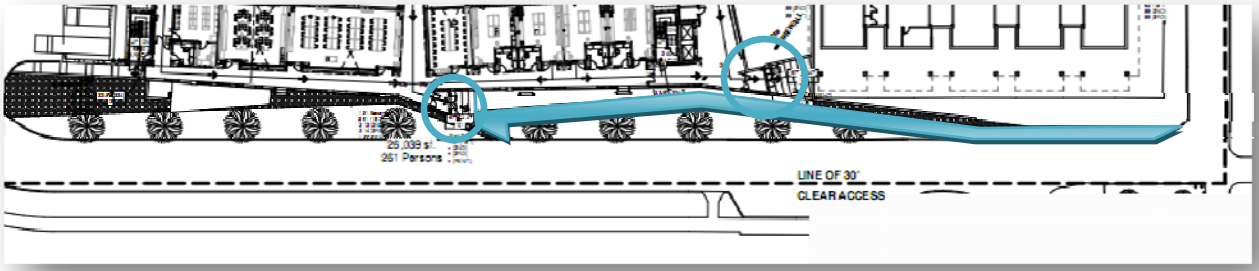


Figure 16-Site: Walkway and Entrances

Figure 17-Perspective of Main West Entrance

Lighting System:

The existing lighting system in this area on the site is classified as roadway lighting and the luminaires are pole-mounted at a height of approximately 25 ft. Exact model data is still being acquired, but for the estimates in this report, values are based on a Streetworks 175W metal halide, full cutoff source (4). The four existing luminaires for study in this area are being relocated across the access road.

Design Criteria

Very Important (1)

- **Appearance of Space and Luminaires**

  The area illuminated by the source should exhibit satisfactory contrast ratios and not interfere with the view of the landscape.

- **Direct Glare**

  Luminaires should be mounted at proper heights and setbacks so as not to create glare issues for drivers or pedestrians.
- **Light Distribution on Surfaces**

  Distribution should have sufficient width to illuminate surface directly in front of the driver and on the periphery.
- **Light Pollution/Trespass**

  Any and all exterior luminaires should be shielded to cut off indirect light and prevent trespass into the building.
- **Peripheral Detection**

  A wide distribution of downlight is needed to highlight the visual periphery and assist security.
- **Reflected Glare**

  Sources and aiming must be coordinated with surrounding surfaces to prevent visual impairment of viewers.
- **Shadows**

  Optics (in the form of lenses) and sources should be chosen to create the most diffuse light.
- **Source/Task/Eye Geometry**

  Pole-mounted luminaires should be positioned a sufficient distance from the curb/sidewalk in order to avoid glare at viewer height levels.

Important (1)

- **Modeling of Faces or Objects**

  Light levels, CCT, CRI and distribution all must be considered in providing a light source that provides a secure environment.

Somewhat Important

- **Color Appearance + Color Contrast**

  Sources with good/decent color rendering should be provided based on level of security needed for the area.
- **Points of Interest**

  Signs and road markings should be highlighted.
- **Surface Characteristics**

  Reflectance values of the paved surfaces and surrounding structures need to be considered.

Illuminance (1)

Horizontal is important and vertical is very important.

Power Allowance (2)

Lighting power allowance for the walkway is 1 W/ft. Lighting power allowance for the main and alternate entrance door is 30 and 20 W/ft respectively.

Evaluation

Outdoor Space	Western Walkway/Roadway	**Existing-West Façade**

Lighting Power Allowance	0.15	W/ft^2	Net Difference	0.07
Area	10400.00	ft^2		
Total Power	840.00	W		
Calculated LPD	0.08	W/ft^2		

Existing luminaires provide sufficient roadway lighting at acceptable lighting power density.

Outdoor Space	Western Walkway/Roadway	**Proposed**

Walkway

Lighting Power Allowance	1.00	W/ft	
Length of Walkway	330.00	ft	
Total allowable power	330.00	W	

Entrance

Lighting Power Allowance	30 or 20	W/ft	(main or other door)
Length of Walkway	12.80	ft	(one main, one other both 6.4')
Total allowable power	320.00	W	

Total Allowable Power for Proposed Site Lighting	650.00	W

Discussion

Roadway lighting is sufficient for the access road, but walkway lighting is absent from site plans. Entrances should be highlighted and pathways should be lit for security and direction. Light trespass is a major factor in the design considerations, due to the proximity of the building and its glazing. Luminaires with proper shielding and distributions need to be selected in order to keep exterior lighting from entering the building.

General Evaluation

The lighting design is successful in achieving the quantitative design criteria and quite often exceeds minimum illuminance requirements. The analysis performed in this study did not take into account all spaces of a specific type or the LPD for the entire building. Therefore, the variances obtained in LPD

values could be due to the method employed in this analysis. The existing design does satisfy the requirements of ASHRAE 90.1.

The major disadvantage to the layout of this building is the arrangement of the offices and classrooms. Due to the configuration of the circulation spaces, no office or classroom walls double as exterior walls. Therefore, any natural light that infiltrates the space is significantly reduced simply by the limits of penetration.

Qualitatively, the spaces achieve their necessary illuminance levels and distribution. The luminaires chosen, and their layouts, successfully continue the underlying rectilinear theme based on proportions and lines. Most of the interior spaces cannot justify aesthetics as the most important design consideration, due to their functions. However, all things considered, the interior spaces provide an appropriate atmosphere.

References

[1] IESNA Handbook-IESNA Lighting Design Guide: I. Interior Locations and Tasks
[2] ANSI/ASHRAE 90.1-2007 9.6
[3] http://ald3e.com/Chapter7/module7.3a/SubjectiveLighting.pdf
[4] http://www.streetworkslighting.com/common/brands.cfm?pg=Detail&brandName=Streetworks&category=Area&id=15183&extraHBX=BannerAd

All working files in “Tech 1 Content” Folder on enclosed CD or:

Y:\mso139\Thesis\Tech 1 Content